



Child and Youth Health and Well-Being Indicators Project:
Appendix F—*Report on the findings of the project*



Office of the
Provincial Health Officer



Canadian Institute
for Health Information
Institut canadien
d'information sur la santé



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Evidence Review

July 11, 2011

Prepared For
CIHI and the Office of the Provincial Health Officer

By



Table of Contents

TABLE OF CONTENTS	I
INTRODUCTION.....	1
BACKGROUND ON THE REPORT	1
OVERVIEW OF THE REPORT	2
CONCEPT/INDICATOR ASSESSMENT METHODOLOGY	4
KEY DATA SOURCES	8
HEALTH-ENHANCING PERSONAL BEHAVIOURS AND RELATED OUTCOMES.....	9
PHYSICAL ACTIVITY LEVELS	9
PROPER NUTRITION	26
HEALTHY WEIGHT.....	40
SLEEP LEVELS	50
HEALTH-COMPROMISING PERSONAL BEHAVIOURS AND RELATED OUTCOMES	58
TOBACCO USE	58
ALCOHOL USE	63
DRUG USE.....	68
SEXUAL BEHAVIOUR	80
SEXUALLY TRANSMITTED INFECTIONS	99
TEENAGE PREGNANCY	107
HEALTH SYSTEM ASPECTS AND RELATED OUTCOMES.....	125
IMMUNIZATION RATES	125
NEWBORN SCREENING	133
VISION AND HEARING SCREENING	137
ORAL HEALTH	142
HEALTH SERVICES ACCESSIBILITY	152
ANTENATAL CARE.....	168
BIRTH WEIGHT	176
PREGNANCY OUTREACH SERVICES AND TARGETS, INCLUDING FASD.....	187
DISEASE, VITAL STATISTICS, AND HEALTH STATUS	199
MAJOR CHRONIC DISEASES.....	200
CAUSE-SPECIFIC DISABILITY	209
MAJOR CHILDHOOD INFECTIOUS DISEASES.....	219
CAUSE-SPECIFIC MORTALITY	223
SELF-RATED HEALTH.....	226
INJURY AND SAFETY	238
MAJOR CHILDHOOD INJURIES	238
CAUSE-SPECIFIC EMERGENCY DEPARTMENT USE.....	243
ENVIRONMENTAL EXPOSURES	248
SUMMARY AND CONCLUSION.....	257
ANNEX F-1: DETAILS OF MAGNITUDE ESTIMATES	261

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Assessing Concepts and Potential Indicators of Child Health and Well-Being In British Columbia: *Physical Health Dimension*

Introduction

Background on the Report

The Office of the Provincial Health Officer (PHO) of British Columbia is considering the design of a suite of core or representative indicators that will inform future “report cards” on the health and well-being of children in British Columbia. The ultimate goal of the initiative will be to identify a limited number of indicators that are both significant to the health and well-being of children and youth and amenable to modification through policy, program, or service interventions.

A total of 264 indicators associated with child health and well-being were identified by an initial working group, partly based on sources identified during background research for this project. This list has been informed by the extensive Canadian work over the last decade on:

- Population-level health indicators (e.g., the *Health Indicators Project* sponsored by Statistics Canada and the Canadian Institute for Health Information)
- Certain indicator inventories with a specific connection to child health (e.g., the *Perinatal Health Indictors for Canada* managed by the Public Health Agency of Canada)
- The well-established research area related to the social determinants of health, especially as they pertain to child health and well-being

The first important analytic step in the project was to create a smaller working list of concepts through an initial relevance filter (the report summarizing this process is reproduced in Annex E-1 of the separate document entitled *Evidence Review Protocol for Assessing Concepts and Indicators*). A major part of the further analytic work conducted for this project consisted of a refinement of the initial relevance filter; this involved examining in more detail the following four aspects as they apply to each broad concept and/or an indicator related to the concept.

- ***Magnitude***

Proportion of B.C. child/youth population to which concept/indicator applies (considered in terms of an absolute number)

- ***Significance/Impact***

Association between the concept and health/well-being, with an emphasis on the particular dimension or sub-dimension of health and well-being that is under scrutiny at the time

- ***Modifiability***

Is the concept/indicator(s) amenable to change through public policy or other intervention?

- ***Data Availability/Validity***

Routine availability and quality of information for the pertinent indicator(s) for each concept

The part of this project represented by the present report involves understanding the association between 28 selected Physical Health concepts and the health and well-being of children. In other words, the series of literature reviews conducted were aimed at finding how **important** and **feasible** a particular concept (e.g., proper nutrition, self-rated health, or antenatal care) might be in terms of tracking pediatric health and well-being at a population level. Generally, evaluating **importance** related to the magnitude and significance/impact categories of assessment, and **feasibility** to the modifiability and data availability categories.

Overview of the Report

After the initial relevance filter was applied, 28 concepts related to the dimension of Physical Health of children and youth were highlighted for further investigation by the assigned review team. The stakeholders and working group initially clustered the concepts into four sub-dimensions; after the analysis described in this report, it seemed appropriate to refine this clustering, adding a dimension related to the health system and its services and making some adjustments to how the individual concepts were categorized. The final grid of physical health sub-dimensions is reflected in the table of contents for the report, as follows:

- Health-enhancing personal behaviours and related outcomes
- Health-compromising personal behaviours and related outcomes
- Health system aspects and related outcomes
- Disease, vital statistics, and health status
- Injury and safety

Since some of the concepts could be conceived in very broad terms, and thereby become stretched to encompass multiple sub-topics, it was important (given the already large size of the project and the need for precision) to scope the concept in specific terms. When necessary, an explicit subsection of scope was included in the introduction to a concept.

Generally, each of the selected concepts related to physical health were examined separately with regard to the evidence for a health and well-being effect, and then in terms of the other three assessment categories noted above. Sometimes it made sense to combine two topics in one chapter, such as vision and hearing screening, as well as considering fetal alcohol spectrum disorder as one critical target of pregnancy outreach services.

The information required by each evaluation category (magnitude, significance/impact, etc.) called for a specific strategy, as follows.

Often, identifying the latest information on the magnitude (or population prevalence) of a measurement of interest led naturally to understanding the range of data sources available, as well as to how routinely the related statistics were gathered and reported. It is clear that, in order to be useful as an indicator of baseline health and well-being and future progress,

population-level information specific to B.C. must be regularly updated through surveys or by mining administrative databases. This criterion eliminates, for example, a source such as the quadrennial *Health Behaviour in School-Aged Children* survey in Canada, which tracks national data but does not provide province-specific information. As the analysis was drawn towards a conclusion, the aim for the key recommendations was to identify the best “off the shelf” indicators that are available for use without delay; secondarily, other indicators may be identified as potentially high priority, but still needing substantial development in terms of data tracking in the context of British Columbia.

The largest volume of work for each concept and its associated indicator(s) involved the significance/impact category of assessment. While the issue of modifiability could have required an equally extensive investigation, the scoping for this already substantial project called for only a high-level evaluation of the degree to which each concept or indicator could be changed by policy or other interventions. Of course, evaluating the evidence for effectiveness of pertinent interventions, and thereby ranking the overall modifiability of a concept/indicator, would be a large exercise unto itself. For the present purposes, the evaluation of how much or how easily a concept could be improved for the sake of child health and well-being in B.C. was established by drawing on the expertise of the review team.

As laid out in the aforementioned *Systematic Review Protocol*, the information on the significance/impact of each concept was explored via one of two approaches, according to the availability of literature:

- Level A search: Review of systematic reviews (generally dating from 2005-present)
- Level B search: Review of primary studies (generally dating from 2000-present)

Occasionally, the available systematic reviews (or their included studies) were somewhat dated; or certain subtopics under the concept were found to be not well-covered in the identified reviews. In such cases, an additional search was conducted for updates in terms of more recent studies. Finally, when deemed to be useful, narrative reviews were consulted, especially in the absence of any systematic reviews.

Two inter-related provisos were added to the basic pattern outlined above, in order to further scope the work for this part of the project. First, the main effect of concepts/indicators related to physical health was assumed to be physical health itself. This is clear in the usual search terms noted in each chapter; although one of the regular Medical Subject Headings used as a coordinating term in the PubMed search (i.e., “health”) actually includes mental health, most of the search terms skewed towards the physical realm. When this assumption appeared to be inaccurate – for instance, when mental or cognitive health or some form of social well-being was a dominant outcome suggested in the literature – then a further literature search was conducted using appropriate coordinating terms. This additional process was followed for the concepts Physical Activity, Proper Nutrition, Sexual Behaviour, Teenage Pregnancy, and Self-Rated Health.

Second, there are a number of concepts where the connection to physical health is self-evident and thus does not need to be “proven” or evaluated per se. This qualification applies when the related indicator is a direct or implied measure of an actual physical health outcome; in such cases, the main investigative assignment was to assess the magnitude of the population affected by the outcome, with a secondary goal to simply describe the transparent health effects involved. The 11 concepts where this strategy was appropriate were the following: Sexually Transmitted Infections, Immunization Rates, Newborn Screening,

Vision and Hearing Screening, Major Chronic Disease, Cause-Specific Disability, Major Childhood Infectious Diseases, Cause-Specific Mortality, Major Injuries, and Cause-Specific Emergency Department Use.

Each concept chapter begins with a brief section on background and context, followed by (as appropriate) the literature search methodology and summary and discussion of results. Potential data sources for each indicator, the quality and regularity of the data stream, and the most up-to-date population magnitude related to the indicator are all noted. Finally, a conclusion is offered as to the utility of the concept or its component indicators in terms of a measure of child and youth health and well-being and a marker of progress following secular trends or any future public health interventions. Whether or not a concept and at least one associated indicator is recommended for the initial list of core or representative indicators is clearly stated in each case.

For ease of synthesis and comparison, the latter information is summed for each of the four evaluation categories noted above in a tabular form at the end of the report.

Concept/Indicator Assessment Methodology

Each category is assessed using the rubric of “high”, “medium” or “low” utility, as defined in the following grid:

Key to Summary Assessments by Evaluation Category				
	Magnitude <i>Estimated prevalence of affected B.C. children</i>	Significance / Impact <i>Physical and other health effects</i>	Modifiability <i>Expert assessment of prevention potential</i>	Data Availability/Validity <i>B.C.-specific information sources</i>
Low	< 19,000 (<2% of total pediatric cohort)	Minimal effects and/or little indication of direct causation	Underlying risk factor not well-identified or not amenable to further prevention	Data not routinely collected and reported
Medium	19,000 - 97,000 (2-10% of total pediatric cohort)	Substantial acute effects or moderate chronic effects; causation still not well-established	Medium Underlying risk factor theoretically amenable to further prevention, but potential interventions not yet proposed in the literature	Medium Data routinely collected but not easily accessible and/or of potentially questionable validity (e.g., mostly self-reported topics with stigma attached)
			Medium-High Underlying risk factor amenable to prevention, but identified interventions have not been well-tested and/or have shown mixed evidence of effectiveness	Medium-High Data routinely collected via sources based on self-reported information of high validity (e.g., the Census)
High	>97,000 (>10% of total pediatric cohort)	Substantial chronic effects and/or elevated mortality; strong evidence, with causation well-established	Underlying risk factor amenable to prevention, and identified interventions have been shown to be effective	Annual data routinely collected and reported via administrative sources or (objective) physical measurement methods

With respect to the significance/impact assessment category, there are a number of considerations when deciding on a high, medium, or low rating. Generally, a higher rating is dictated by: (i) larger effect sizes for outcomes of greater import (e.g., risk of chronic, disabling conditions, mortality); (ii) confidence about causation (because, for instance, potentially confounding factors have been well controlled); and (iii) strength of evidence at a pediatric population level. On the latter point, evidence of impact becomes progressively weaker when it focuses on a group other than the general pediatric population (such as an at-risk subgroup, or when the affected children reach adulthood and the risk of poor health persists); this caveat does not mean that intervention studies targeting at-risk groups or reports tracking health effects into adulthood are of no importance, just that they are less valuable as population-level evidence than effects that are measured within a general pediatric population.

A second implication is that actual health effects (i.e., incidence, morbidity) are deemed to be more vital in assessing an indicator than any indirect impact involving a risk factor; this means that an indicator's effect on obesity, for instance, is trumped by actual cardiovascular disease rates being elevated. The point is that if a *risk factor* is considered to be important enough to track carefully as an outcome, then it is most appropriate for it to be considered in its own right as a concept/indicator in the pediatric population rather than as simply a downstream effect of some other factor; in the current project, for instance, overweight/obesity in children is a risk factor that has in fact been placed on the list of candidate concepts to be investigated. Finally, there is a hierarchy within the range of true health impacts; thus, reduced morbidity (i.e., secondary prevention) is generally less compelling as evidence than reduced incidence (i.e., primary prevention). These sorts of nuances become important when evaluating the power of a candidate indicator as a measure of population health improvements among children (for example, see the discussion on general practitioner supply under the health services accessibility section later in the report).

Further, it is clear from the table above that extra granularity was required in the rating scheme for both modifiability and data availability/validity. As noted above, modifiability of a concept/indicator is being assessed mainly by reviewer expertise rather than by a full examination of the literature. The four levels in this category of assessment allow for distinguishing a high expectation for modifying a concept (given adequate resources) from the situation where there is low potential for further prevention progress *because most or all of the clear and effective approaches have already been applied to a substantial degree*. The latter distinction creates counterintuitive scenarios. For example, infectious diseases are certainly amenable to modification by immunization, but in some cases a “saturation level” has already been achieved for this intervention, so that *further* meaningful health gains for children in the province are not really practical; in this specific sense, a rating of Low for modifiability is appropriate. Likewise, for a great majority of children in British Columbia, the known effective interventions for oral health are already being applied. The two remaining intermediate assessment rankings cover situations where further prevention gains are notionally possible, but information about effective interventions is lacking in some way.

Next, the refined level of assessment for data is due to the inherent unreliability of self-reported information—which, importantly, is the class into which all survey data fall. However, self-reported information is not all created equal; in short, there is a difference between the issue of poor recall and outright dissembling. When the factor in question may be considered a high-stigma topic, such as sexual behaviour or alcohol abuse (e.g. binge drinking), then there is a certain rate of “reticence” across a population to report accurately; the inaccuracy may be compounded when parents or other “second-party” respondents are asked to report on behalf of their children (however, there may be some instances where parental information may be *more* accurate, as when identifying whether a child has a chronic disease or disability). Data streams based on self-report are generally assessed as having intermediate utility when informing an indicator. The more favourable intermediate category, Medium-High, is reserved for self-reported data related to topics of low or no stigma.

A good example of the distinctions between the categories is offered by the concept of Healthy Weight.

When pediatric obesity/overweight is assessed by first- or second-party survey respondents it may be reasonably assessed as a Medium data source (due to some stigma attached to admitting being overweight), as compared to body-mass index (BMI) calculations based on direct physical measurements, which would garner a High rating. The latter approach is rare

in public health settings in B.C. Objective measures were incorporated in the now defunct Health Assessment for School-Aged Children among grade 6 students, and are also used in the Canadian Health Measures survey—though results from that instrument are apparently not reported at a provincial level

As well as the three main rating levels, sometimes the available information did not allow any clear conclusion; for the purposes of notionally combining the four evaluation categories into an aggregate rating, the weight given to an “Unclear” assessment was equated to that found for “Low.”

While magnitude is also summarized in terms of the same basic rating scale used for the other three categories, it is the one assessment category where a *quantitative* approach was pursued. The following steps were followed (see Annex F-1 for a summary of the details across all the concepts):

1. The best incidence or prevalence information (preferably B.C.-specific, which mostly was achievable) was identified for the most pertinent indicator(s) under each concept
2. In the case of prevalence data, the absolute number of cases was simply calculated by applying that rate to the pertinent 2010 age cohort (see the table below).

BC Population by Gender and Age, July 2010			
Age	Male	Female	Total
<1	22,994	21,522	44,516
1	23,403	21,845	45,248
2	23,476	22,010	45,486
3	22,920	21,548	44,468
4	22,788	21,153	43,941
5	22,578	21,093	43,671
6	22,819	21,265	44,084
7	22,931	21,246	44,177
8	22,921	21,184	44,105
9	23,239	21,673	44,912
10	23,687	22,298	45,985
11	24,204	22,915	47,119
12	24,498	23,123	47,621
13	25,677	23,887	49,564
14	26,510	25,022	51,532
15	27,484	25,613	53,097
16	27,888	26,447	54,335
17	28,878	27,472	56,350
18	30,094	28,160	58,254
19	32,214	29,749	61,963
Total	501,203	469,225	970,428
Source: Statistics Canada			

3. Incidence data sometimes required an adjustment. For instance, when incidence was based on the annual birth cohort as the reference population (e.g., pregnancy outreach services and targets), then the absolute annual number of cases was generated by applying the incidence rate to the entire pediatric population of 970,428 (as of 2010)—the argument being that the health effects of the related risk factor would persist from year to year throughout the life of the child. The concept of Teenage Pregnancy is further complicated by the fact that it involves *two* parties from the pediatric age group, teenage mothers and newborns—with the potential health effects appearing to be marginally greater for the children born than for the mothers involved. Based on the assumption that the effects persist at least through the pediatric age span, the total prevalence of children born to teenage mothers over a generation was estimated by multiplying the annual absolute incidence (calculated by applying the age-specific incidence rate of live births to the teenage cohort) by a factor of 20 (i.e., the number of years in a generation).
4. As for the balance of the concepts with an incidence measure attached, when there was some reason to believe that at least the more acute health effects were reversible (e.g., *Chlamydia* infection, major childhood injuries), then incidence was assumed to be the same as the prevalence.

The resulting magnitude figures (and pertinent age range of the cohort generating the underlying prevalence rate) are provided in the summary table in Annex F-1 as well as at the end of each section for the various concepts related to the physical health dimension.

Five general observations about the assessment process would be useful at this juncture:

- The assessments provided always relate to a *particular* indicator pertinent to a concept. Often, an indicator was selected because magnitude data were in fact available, the totals involved were substantial, and/or it was a high-leverage focus for prevention that was amenable to routine data tracking; in other words, the indicator was poised to be rated reasonably high in terms of utility.
- It was not realistic to make age-standardization adjustments when the underlying prevalence rates were based on a specific age cohort, or to qualify the analysis when the absolute number of cases identified was for a cohort other than the entire 0-19 year age group; these limitations are likely not very critical, since the goal was to make broad quantitative assessments.
- In sum, the prevalence estimates are, by definition, not meant to be precise figures but rather a representation of “order of magnitude” information in order to allow comparisons at a high level only.
- The concepts are ordered in an Annex F-1 table based on the prevalence estimate, in order to highlight the effect of that assessment category; again, this has been done for ease of comparison across this one category, not because it is the most important category. By contrast, the summary table provided in the Summary and Conclusion section at the end of the entire report is ordered according to the aggregate rating across all four assessment categories.
- A final assessment category that could provide useful information would be the recent trend related to each indicator of interest, but assembling this information was beyond the scope of the project.

Key Data Sources

In order to avoid repetition, it is appropriate to introduce the main sources of data for potential core indicators examined in this report. Two such sources of B.C.-specific information occur most frequently in the chapters; a brief outline of each source is provided below.

Canadian Community Health Survey

The Canadian Community Health Survey (CCHS) is a cross-sectional survey that collects information related to health status, health care utilization, and health determinants for the Canadian population.¹ The target population for the sampling is all Canadians aged 12 years and over, with some exclusions.² The CCHS relies upon a large sample of respondents, allowing it to provide reliable estimates at the health region level. Building on a predecessor instrument, the National Population Health Survey, the CCHS was launched in 2000, with data collection initially occurring every two years; data are available for the 2001, 2003, and 2005 periods. In 2007, major changes were made to the survey design, and data collection became annual.

Adolescent Health Survey

The Adolescent Health Survey (AHS) was first conducted in British Columbia by the McCreary Centre Society in 1992; the inaugural work was followed by three more surveys in 1998, 2003, and 2008.³ It is designed to provide a comprehensive picture of the physical and emotional health of B.C. youth. The survey includes questions about perceptions of current physical and emotional health, risky behaviours, health-promoting practices, and broader issues such as family connectedness, school safety, and peer relationships. According to 2008 survey results, for example, less than 2% of teenage males and females had experienced pregnancy; among sexually active students, 7% had been involved in a pregnancy (8% males; 6% females).

The AHS is completed by B.C. public school students in grades 7-12; in the 2008 survey, 50 of 59 school districts participated, for a total of 29,440 students. Participation in the survey is voluntary, with parental consent procedures being determined by the individual school districts. The AHS is administered by trained public health nurses in classrooms. Funding is provided by the Ministry of Children and Family Development and the Ministry of Health, with additional support from other government departments

¹ Statistics Canada. Canadian Community Health Survey. Available at <http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SurvId=3226&SurvVer=1&InstalId=15282&InstaVer=5&SDDS=3226&lang=en&db=imdb&adm=8&dis=2>. Accessed April 2010.

² These include individuals living on Indian Reserves and on Crown Lands, institutional residents, full-time members of the Canadian Forces, and residents of certain remote regions

³ Available at <http://www.mcs.bc.ca/AHS>. Accessed September 2010.

Physical Activity Levels

Background and Context

Physical activity (PA) is measured and analyzed in a variety of ways. First, while PA is often considered in comprehensive terms (i.e., all bodily movement), some research distinguishes occupation-related activity from that of leisure or recreational time. The level of PA can range from low to high, as measured in a variety of ways (daily volume and weekly frequency—which, when combined, generates data on weekly volume—reported in terms of different intensity levels, usually described as vigorous, moderate, or light). Recently, interest has been expressed in how daily activity is fractionated into so-called “bouts” of relatively short duration, specifically to see whether there is a benefit in interrupting an otherwise “inactive” day with a higher number of activity sessions, independent of the effect of PA volume.⁴ Analyzing the effect of bout frequency represents a new approach, more akin to the topic of sedentary behaviours, and therefore outside of scope for this project (see below). Until the advent of such novel topics, the emphasis has been mostly on understanding the basic dose-response relationship between PA volume and one or more health effects. This long-standing research agenda was summed up by Pate over 15 years ago:⁵

The depth of our current knowledge of the dose-response gradient for physical activity and health is highly variable across the different health parameters. To the extent that the existing literature allows conclusions, it appears that (a) most health parameters are related to the amount of habitual physical activity in a graded fashion; (b) intensity of physical activity may be independently related, in a graded fashion, to some health parameters but unrelated to others; and (c) for some variables, the dose-response relationship is linear but, in other cases, is curvilinear. At present, these conclusions must be considered tentative, and most experts agree that further elucidation of dose-response relationships should be a major thrust of future research on physical activity and health [emphasis added].

The purpose of this review is to find research evidence of an association between PA in children and youth and their physical and non-physical health. An additional goal is to determine what the most useful indicator might be for tracking physical activity in children and youth. According to the World Health Organization (WHO), school-aged youth should engage in at least 60 minutes of moderate- to vigorous-intensity physical activity daily. The recently-revised Canadian Physical Activity Guidelines for children are similar (see following table):

⁴ Mark AE, Janssen I. Influence of bouts of physical activity on overweight in youth. *American Journal of Preventive Medicine*. 2009; 36(5): 416-21.

⁵ Pate RR. Physical activity and health: dose-response issues. *Research Quarterly for Exercise and Sport*. 1995; 66(4): 313-7.

Canadian Physical Activity Guidelines (January 2011)

	Activity Guideline	Which Includes:	
Children 5-11 years	60 min. of moderate to vigorous-intensity physical activity (PA) daily	Vigorous-intensity activities at least 3 days per week	Activities that strengthen muscle and bone at least 3 days per week
Youth 12-17 years	60 min. of moderate to vigorous-intensity PA daily	Vigorous-intensity activities at least 3 days per week	Activities that strengthen muscle and bone at least 3 days per week
Adults 18-64 years	150 min. of moderate to vigorous-intensity aerobic PA per week	Muscle and bone strengthening activities at least 2 days per week	
Older Adults 65+ years	150 minutes of moderate to vigorous-intensity aerobic PA per week	Muscle and bone strengthening activities at least 2 days per week	Performing PA to enhance balance and prevent falls

Source: Canadian Society for Exercise Physiology, 2011.

Despite the various well-publicized recommendations, a global decrease in PA levels among young people has been observed; according to the WHO, “it is estimated that less than one-third of young people are sufficiently active to benefit their present and future health and well-being.”⁶ Physical health benefits of PA that have been noted include development of healthy bones and muscles, development of a healthy cardiovascular system, and maintenance of a healthy body weight. Physical activity may also increase self-esteem, improve body image, improve mood and cognitive functioning, and aid in prevention of depression and anxiety. As England’s Chief Medical Officer stated in 2004: “Physical activity can be considered both for its preventive and its therapeutic effects on mental illness, and also for its impact on mental health in the general population. Also, the psychological benefits of physical activity are crucial determinants of people’s motivation to be physically active....”⁷ This review will determine the level of research evidence for both physical and psychological benefits of PA in young people.

If physical activity is confirmed as a concept marked by at least a reasonable association with pediatric physical and/or non-physical health, then it will become all the more important to know how to track the concept at a population level. In a review of methods of assessing physical activity in children and adolescents, de Vries et al. point out that “knowledge of physical activity patterns is needed to serve as a cornerstone in establishing appropriate federal health objectives....it is also desirable to determine what proportion of children and adolescents are meeting physical activity guidelines and to examine what proportion is in need of intervention programmes or whether to adjust physical education curricula for children.”⁸ This highlights the importance of using an appropriate and useful indicator to measure physical activity levels among young people in British Columbia.

⁶ World Health Organization Global Strategy on Diet, Physical Activity and Health. Available at http://www.who.int/dietphysicalactivity/factsheet_young_people/en/index.html. Accessed August 2010.

⁷ Winnipeg in Motion. Available at http://www.winnipeginmotion.ca/mental_health_in_motion. Accessed February 2011.

⁸ de Vries SI, Pronk MG, Hopman-Rock M et al. *Assessing Physical Activity in Children and Adolescents. A Review of Different Methods*. 2004. TNO. Available at http://www.tno.nl/downloads/TNO-KvL_Report_%20Assessment_Physical_Activity_Children1.pdf. Accessed August 2010.

Conceptual Scoping

The terminology related to activity is notoriously confusing. PA as a concept has been defined as “any bodily movement produced by skeletal muscles that results in energy expenditure.”⁹ Following this approach, some authorities maintain that PA is not identical to energy expenditure, but rather is a behaviour that has energy expenditure as a consequence.¹⁰ In practice, this distinction is not that important; as long as a catalogue of energy expenditure per behaviour is available, it is easy to translate an inventory of daily activity (measured by duration and intensity) into aggregate daily expenditure (typically measured in calories). The Canadian Community Health Survey (CCHS) follows this pattern, defining being physically active as expending at least 3.0 kcal/kg/day, being moderately active as expending 1.5-2.9 kcal/kg/day, and being inactive as expending less than 1.5 kcal/kg/day.

There is no such thing as *absolute* inactivity as a risk factor. As indicated in the case of the CCHS, to be classified as inactive typically means not meeting certain minimum standards for PA, or falling below a certain threshold on the gradient of PA (variously defined)—where such cut-offs are known to be associated with lower health benefits and/or increased risk of disease, compared to what is experienced when landing above the threshold.

Another term found in the literature overlaps with the usual use of inactive, namely, sedentary. For example, Medline has defined the recently adopted subject heading “sedentary lifestyle” as reflecting a persistent level of physical activity that is less than 30 minutes of moderate-intensity activity on most days of the week.

Adding to the complexity (and sometimes confusion), sedentary is also used as a qualifier of relatively low-activity behaviours that may, in one way or another, increase risk of poor health; the behaviours so identified range from the generic (e.g., prolonged sitting) to the more specific (e.g., watching television and exposure to other types of “screen time”). Unfortunately, the concept of PA is sometimes conflated with that of sedentary behaviours. In reality, exposure to different levels of sedentary behaviour is *distinct* in concept and practice from exposure to different levels of physical activity.¹¹ Thus, it represents a “category error” to conflate the two concepts. Different biological risk mechanisms and outcomes are involved with, for example, watching television compared with simply not moving around very much.¹² Moreover, it is theoretically possible for youth to engage in hours of sedentary behaviour and yet still qualify as physically active (due, for instance, to heavy sports involvement when not playing video games). This section of the report will focus on physical activity; the concept of sedentary behaviours is outside of scope—to make it eligible for investigation the original working panel would have had to deem it as a candidate concept in its own right.

⁹ Caspersen CJ, Powell KE, Christenson GM. Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports*. 1985; 100(2): 126-31.

¹⁰ Must A, Tybor DJ. Physical activity and sedentary behavior: a review of longitudinal studies of weight and adiposity in youth. *International Journal of Obesity*. 2005; 29 Suppl 2: S84-96.

¹¹ Dietz WH. The role of lifestyle in health: the epidemiology and consequences of inactivity. *Proceedings of the Nutrition Society*. 1996; 55(3): 829-40.

¹² Tremblay MS, Colley RC, Saunders TJ et al. Physiological and health implications of a sedentary lifestyle. *Applied Physiology, Nutrition, and Metabolism*. 2010; 35(6): 725-40.

Because of the semantic difficulties suggested above, being inactive (or sedentary) is not the most appropriate way to think about the group at-risk with respect to PA levels. Instead, for the purposes of this project the term “low physical activity” will be applied to the lowest grade of PA, thereby allowing the subgroup at greatest health risk to be identified and labelled without confusion.

Methodology and Provisional Results

Initial Search Process

For the **main electronic searches**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*
Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

Physical Health

"Motor Activity"[Majr] OR "Sedentary Lifestyle"[Majr] OR "Exercise"[Majr] OR "Exercise Therapy"[Majr]) OR "Physical Education and Training"[Majr]

AND

"Health/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Health Status Indicators"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Risk Factors"[Mesh] OR "Diseases Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Overweight"[Mesh] OR "Bone density"[Mesh]

Note that, in order to provide as targeted a search as possible, Medical Subject Headings (MeSH) were applied, qualified by subheadings and whether or not it was a Major term (Majr) for the article.

The search for review articles ultimately returned a sufficient volume (see below) of papers to qualify for a Level A search process. As well, a selective approach to the supplementary search was deemed to be all that was necessary. This involved a scan in Google for grey literature and for any obvious articles missed, using terms such as: **(physical activity OR physical fitness) AND children AND health**. Finally, as the most recent systematic review of the association of physical activity with health was dated 2010, and included primary studies as recent as 2008, an update of the most recent studies was not pursued.

Taken together, the search processes returned 191 reviews for consideration.

Preliminary Exclusion

The articles were scanned *by title* by two reviewers working individually, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between physical activity and physical health outcome(s), or if it was not about children, then it was excluded. When there was disagreement between the reviewers, the article in question was examined in more detail until a consensus was reached.

After completing this first exclusion process, the list of articles was reduced to 34.

Primary Exclusion

The full versions of the 32 reviews were divided between two researchers. Articles not pertinent to the research topic were excluded; specifically, if the article did not link physical activity with physical health outcome(s), or if it was not about children, it was excluded. Also excluded was any review that focused on a specific subgroup of children, such as those who were obese, African-American, etc., where there would be a limitation to the generalizability of results across the whole pediatric population in a jurisdiction such as British Columbia. If there was uncertainty as to whether an article should be excluded, the reviewers discussed the matter further to reach a consensus.

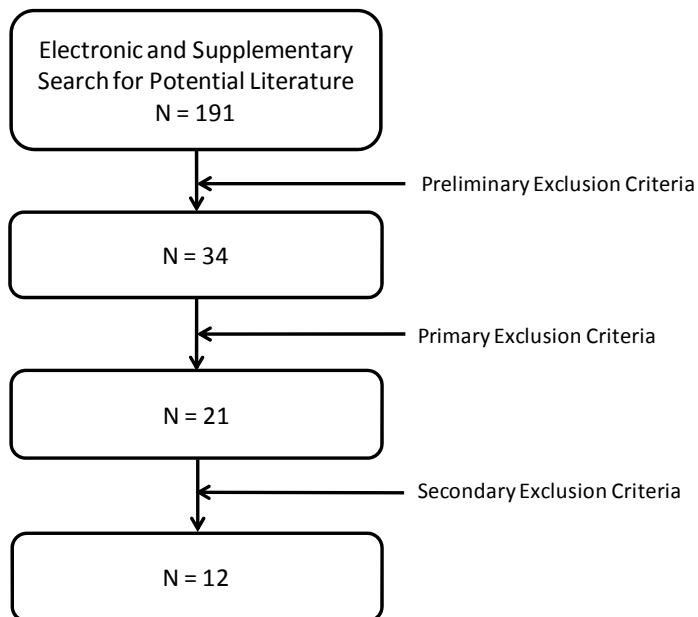
There were 21 reviews remaining in the list following the primary exclusion.

Secondary Exclusion

Studies and systematic reviews that were deemed to be of lesser quality or usefulness were excluded, yielding a final total of 12 reviews, as indicated in the following Volume Report.

Literature Review Volume Report: Reviews

Dimension: Physical Health **Concept:** Physical Activity **Impact:** Physical Health



Non-physical Health and Well-being

("Motor Activity"[Majr] OR "Sedentary Lifestyle"[Majr] OR "Exercise"[Majr] OR "Exercise Therapy"[Majr]) OR "Physical Education and Training"[Majr])

AND

("Psychological Phenomena and Processes"[Majr] OR "Behavior and Behavior Mechanisms"[Majr])

The search for review articles ultimately returned a sufficient volume (see below) of papers to qualify for a Level A search process. As well, a selective approach to the supplementary search was deemed to be all that was necessary. This involved a scan in Google for grey literature and for any obvious articles missed, using terms such as: **physical activity AND children AND mental health.**

Taken together, the search processes returned 176 reviews for consideration.

Preliminary Exclusion

The articles were scanned *by title* by two reviewers working individually, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between physical activity and mental health outcome(s), or if it was not about children, then it was excluded. When there was disagreement between the reviewers, the article in question was examined in more detail until a consensus was reached.

After completing this first exclusion process, the list of articles was reduced to 6.

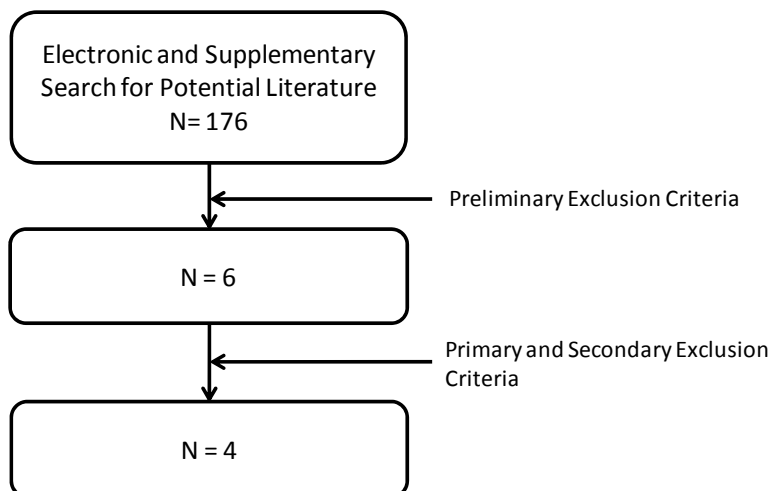
Primary and Secondary Exclusion

The full versions of the 6 reviews were divided between two researchers. Articles not pertinent to the research topic were excluded; specifically, if the article did not link physical activity with mental health outcome(s), or if it was not about children, it was excluded. Also excluded was any review that focused on a specific subgroup of children, such as those who were obese, African-American, etc., where there would be a limitation to the generalizability of results across the whole pediatric population in a jurisdiction such as British Columbia. If there was uncertainty as to whether an article should be excluded, the reviewers discussed the matter further to reach a consensus. Additionally, reviews deemed to be of lesser quality or usefulness were excluded.

There were 4 reviews remaining in the list following the exclusion steps, as outlined in the Volume Report below.

Literature Review Volume Report: Reviews

Dimension: Physical Health **Concept:** Physical Activity **Impact:** Non-physical Health



The reviews for both the physical health and non-physical health subcategories are listed in the table below.

Summary of Relevant Reviews

Dimension: *Physical Health*

Concept: *Physical Activity*

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	No. of Studies
Multiple Topics							
1	Systematic review of the health benefits of physical activity and fitness in school-aged children and youth	Janssen	2010	International Journal of Behavioural Nutrition and Physical Activity	2.63	1977-2008	86
2	Physical activity guidelines advisory committee report	U.S. Department of Health and Human Services	2008	N/A		1995-2007	210
3	Evidence based physical activity for school-age youth	Strong	2005	Journal of Pediatrics	3.84	1980-2005	(850)
Body Mass and Composition							
4	Associations between objectively measured habitual physical activity and adiposity in children and adolescents: Systematic review	Jimenez-Pavon	2010	International Journal of Pediatric Obesity	2.0 (2008)	2004-2008	48
5	Effect of school-based physical activity interventions on body mass index in children: a meta-analysis	Harris	2009	Canadian Medical Association Journal	7.4	1996-2007	15
6	Physical activity and abdominal obesity in youth	Kim	2009	Applied Physiology, Nutrition, and Metabolism	1.97 (2009)	1997-2008	38
7	Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence	Brown	2009	Obesity Reviews	7.82	1993-2007	38
8	Physical activity as a predictor of adolescent body fatness	Reichert	2009	Sports Medicine	3.33	1997-2007	24
Bone Mineral Density							
9	Weight-bearing exercise and bone mineral accrual in children and adolescents: A review of controlled trials	Hind	2007	Bone	3.94	1996-2005	22
Fitness/General Health							
10	After-school program impact on physical activity and fitness: A meta-analysis	Beets	2009	American Journal of Preventive Medicine	3.17	2003-2008	13
11	Inflammatory factors, physical activity, and physical fitness in young people	Thomas	2008	Scandinavian Journal of Medicine & Science in Sports	2.15	1996-2008	30
12	Adolescent physical activity and health	Hallal	2006	Sports Medicine	3.33	2000-2004	13
Non-physical Health Aspects							
13	Effects of exercise on body image	Campbell	2009	Journal of Health Psychology	1.68 (2009)	1972-2007	10
14	Exercise in prevention and treatment of anxiety and depression among children and young people	Larun	2006	Cochrane		1983-2005	16
15	Physical activity and student performance at school	Taras	2005	Journal of School Health	0.72	1987-2003	14
16	Can exercise improve self esteem in children and young people? A systematic review of randomised controlled trials	Ekeland	2005	British Journal of Sports Medicine	3.72	1979-1998	23

Detailed Results

For the 16 reviews ultimately identified by the literature search and exclusion process, a summary table of results was developed, as provided below.

Dimension: <i>Physical Health</i> Concept: <i>Physical Activity</i> Summary Table of Reviews			
Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Physical Health Aspects: Multiple Topics			
Janssen and LeBlanc (2010)	Systematic review of the health benefits of physical activity and fitness in school-aged children and youth	86	Physical activity was associated with numerous health benefits. The dose-response relations observed in observational studies indicate that the more physical activity, the greater the health benefit. Results from experimental studies indicate that even modest amounts of physical activity can have health benefits in high-risk youngsters (e.g., obese).
U.S. Department of Health and Human Services (2008)	Physical activity guidelines advisory committee report	210	Substantial data indicate that health and fitness benefits will occur in most children and youth who participate in 60 or more minutes of moderate-to-vigorous physical activity on a daily basis. Participation should include the following types of physical activity on 3 or more days per week: vigorous exercise, resistance exercise, and weight-loading activities.
Strong (2005)	Evidence based physical activity for school-age youth	Experts assessed a "long list" of 850 articles	<ol style="list-style-type: none"> 1. Evidence-based data are <i>strong</i> to conclude that physical activity has beneficial effects on adiposity (within overweight and obese youth), musculoskeletal health and fitness, and several components of general cardiovascular health. 2. Evidence-based data are <i>adequate</i> to conclude that physical activity has beneficial effects on adiposity levels in those with a normal body weight, on blood pressure in normotensive youth, on plasma lipid and lipoproteins levels, on non-traditional cardiovascular risk factors, and on several components of mental health.
Body Mass and Composition			
Jimenez-Pavon (2010)	Associations between objectively measured habitual physical activity and adiposity in children and adolescents: Systematic review	48	<p>Review supports the hypothesis that higher levels of habitual physical activity are protective against higher levels of child and adolescent adiposity. However, prospective longitudinal studies using more precise methods of measuring body composition are warranted.</p> <p>There is a need for more research on younger children, in a wider variety of settings and populations, and for more dose-response evidence.</p>
Harris (2009)	Effect of school-based physical activity interventions on body mass index in children: a meta-analysis	18	School-based physical activity interventions did not improve BMI, although they had other beneficial health effects.

Dimension: Physical Health Concept: Physical Activity

Summary Table of Reviews

Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Kim (2009)	Physical activity and abdominal obesity in youth	38	Limited evidence suggests that a high level of physical activity is associated with lower abdominal obesity, and that increased time spent in vigorous physical activities is independently associated with lower waist circumference and visceral fat. Engaging in regular aerobic types of exercise is associated with reductions in total fat and has a protective effect on age-associated increases in visceral fat in growing children and adolescents.
Brown (2009)	Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence	38	School-based interventions to increase physical activity and reduce sedentary behaviour may help children to maintain a healthy weight but the results are inconsistent and short-term. Physical activity interventions may be more successful in younger children and in girls.
Reichert (2009)	Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature	24	Most studies showed protective effects of physical activity against adiposity, mainly in individuals who were obese at baseline. However, few studies are available, with limitations relating to a lack of validity in the measurement of physical activity and body composition. The literature offers only limited support for a causal link between physical activity and adiposity in adolescence.
Bone Mineral Density			
Hind (2007)	Weight-bearing exercise and bone mineral accrual in children and adolescents: A review of controlled trials	22	Positive skeletal effects from weight-bearing exercise can be attained in girls and boys. Early puberty potentially represents an opportune maturity stage to augment bone mineral accrual through exercise, although definitive conclusions cannot yet be made. The characteristics of the optimal exercise program remain unclear.
Fitness/General Health			
Beets (2009)	After-school program impact on physical activity and fitness: A meta-analysis	13	Although there a limited number of studies, results of this review suggest that after-school programs that include a physical activity component can be effective in improving physical activity levels, physical fitness, body composition, and blood lipid profiles of children and young adolescents.
Thomas (2008)	Inflammatory factors, physical activity, and physical fitness in young people	30	The evidence for an inverse association between exercise and inflammatory factors in young people is inconsistent.
Hallal (2006)	Adolescent physical activity and health	13	There is consistent evidence that adolescent physical activity is positively associated with adult physical activity levels. Adolescent physical activity provides a long-term protective effect on bone health. Most evidence on the role of adolescent physical activity in breast cancer is positive.

Dimension: *Physical Health* Concept: *Physical Activity*

Summary Table of Reviews

Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Non-physical Health Aspects			
Campbell (2009)	Effects of exercise interventions on body image	10	Exercise interventions resulted in modest improvements in body image compared to a control group. When examined by age, larger effects were observed for older compared to younger populations.
Larun (2006)	Exercise in prevention and treatment of anxiety and depression among children and young people	16	The evidence base is scarce, so the ability to draw conclusions is limited. There appears to be a small effect in favour of exercise in reducing depression and anxiety scores in the general population of children and adolescents.
Taras (2005)	Physical activity and student performance at school	14	Conclusions are difficult to reach due to the small number of studies. Concentration appears to improve immediately after children are physically active, although this does not necessarily translate into improved academic performance; one study concluded that there is an improved rate of academic learning per unit of class time as a result of a physical activity program. Other studies found little or no effect of physical activity on academic performance in the long term.
Ekeland (2005)	Can exercise improve self esteem in children and young people? A systematic review of randomised controlled trials	23	Results are limited because of the small sample sizes in the included studies and methodological problems such as risk of bias. Despite this, results indicate that exercise may be effective in improving self esteem in children and young people.

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Strong WB, Malina RM, Blimkie CJ et al. Evidence based physical activity for school-age youth. *Journal of Pediatrics*. 2005; 146: 732-7.

Jimenez-Pavon D, Kelly J, Reilly JJ. Associations between objectively measured habitual physical activity and adiposity in children and adolescents: Systematic review. *International Journal of Pediatric Obesity*. 2010; 5: 3-18.

Harris KC, Kuramoto LK, Schulzer M et al. Effect of school-based physical activity interventions on body mass index in children: a meta-analysis. *Canadian Medical Association Journal*. 2009; 180: 719-26.

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- Hind K, Burrows M. Weight-bearing exercise and bone mineral accrual in children and adolescents: a review of controlled trials. *Bone*. 2007; 40: 14-27.
- Beets MW, Beighle A, Erwin HE et al. After-school program impact on physical activity and fitness: a meta-analysis. *American Journal of Preventive Medicine*. 2009; 36: 527-37.
- Thomas NE, Williams DR. Inflammatory factors, physical activity, and physical fitness in young people. *Scandinavian Journal of Medicine & Science in Sports*. 2008; 18: 543-56.
- Hallal PC, Victora CG, Azevedo MR et al. Adolescent physical activity and health: a systematic review. *Sports Medicine*. 2006; 36: 1019-30.
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- Larun L, Nordheim LV, Ekeland E et al. Exercise in prevention and treatment of anxiety and depression among children and young people. *Cochrane Database of Systematic Reviews*. 2006.
- Taras H. Physical activity and student performance at school. *The Journal of school health*. 2005; 75: 214-8.
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Summary of Results

Three extensive reviews were located that covered multiple types of physical outcome following PA; in each case, the reviewers were attempting to offer guidance to the process of developing PA guidelines. Strong et al. found that there was substantial data to support the claim that physical activity has beneficial effects on adiposity (within overweight and obese youth), musculoskeletal health and fitness, and several components of cardiovascular health, and adequate data to support the claim that physical activity has beneficial effects on adiposity levels in those with a normal body weight, on blood pressure in normotensive youth, on plasma lipid and lipoproteins levels, on non-traditional cardiovascular risk factors, and on several components of mental health.

A 2008 review by the U.S. Physical Activity Guidelines Advisory Committee (which provided recommendations for all ages, but parsed out data pertinent to the child/adolescent cohort), found substantial indications that health and fitness benefits will occur in most children and youth who participate in 60 or more minutes of moderate-to-vigorous physical activity on a daily basis. The Committee identified that participation should include the following types of physical activity on 3 or more days per week: vigorous exercise, resistance exercise, and weight-loading activities.

Finally, Janssen and LeBlanc supported the development of the most recent Canadian PA guidelines by conducting a literature review published in 2010; they found that PA was associated with numerous health benefits in the pediatric population, which generally reflected a dose-response relationship.

The more focused reviews examining PA with respect to a specific physical health impact were found to fall under several subcategories, similar to the pattern adopted by the multi-topic reviews; this included body mass and composition (including obesity, elevated adiposity, etc.) as both a condition and a risk factor, bone health, and physical fitness and general health (including metabolic conditions associated with cardiovascular risk). It is convenient to summarize the evidence under these three main headings.

In the subcategory of bone health, reviews indicated that there is in fact a beneficial effect of PA on skeletal health, as reflected in bone mineral content, bone mineral density, and bone mineral apparent density. Results further suggest that pre-pubertal children, or those in early puberty, are most likely to accrue these benefits, whereas the effect is not as clearly established for adolescents in later stages of puberty. One review, however, did find that there is a consistent long-term protective effect of adolescent PA on bone health.

Regarding the critical area of overweight and related phenomena, there is limited evidence from review papers that habitual PA is protective against higher levels of adiposity in children and adolescents. One review found that a moderately intense regular exercise program for overweight children and adolescents resulted in a reduction in total body and visceral adiposity; however, such programs did not influence the percentage of body fat in normal weight children and adolescents, which is of greater importance from a population health perspective.

In the fitness/general health subcategory, reviews indicate that PA can be effective in improving physical fitness in children. With regard to cardiovascular risk factors, one review found strong evidence for a beneficial effect of PA on high-density lipoprotein cholesterol and triglyceride levels, as well as on reducing blood pressure in youth with mild hypertension. Another review focusing on the influence of adolescent PA on adult health found that most of the literature does not report a positive long-term impact of PA on risk

factors for cardiovascular morbidity. In this same review, however, it was reported that most studies found that adult female breast cancer risk is reduced with increased PA in adolescence.

In the non-physical health subcategory, the evidence base is modest; this is due not only to a small number of studies, but also to heterogeneity of studies and methodological issues. Despite this, small effect sizes were noted for the impact of exercise on body image enhancement, on reducing depression and anxiety, on improving self esteem, and on increasing concentration in the classroom among children and youth.

Data Sources on Physical Activity

A new minimal data set related to tracking information on PA in the province is under development by the Ministry of Health. In the meantime, there are several surveys that currently collect data on physical activity in children in British Columbia, as described below.

Canadian Community Health Survey

The physical activity section of the CCHS¹³ asks questions regarding leisure time physical activity, including the type of activity, frequency, and duration. This allows for the proportion of the population meeting and not meeting recommended physical activity levels to be established. The most recent data for physical inactivity in B.C. adolescents is provided in the following table:

Physical Inactivity in British Columbia		
Aged 12 - 19, by Gender		
2009		
	Number of Individuals	Percent of Population
Males	36,679	17.7%
Females	61,879	30.6%
Total	98,558	24.1%
Source: Statistics Canada. <i>Cansim table 105-0501</i> . 2009.		

As explained earlier in this section, for clarity the term “low physical activity” will be used in place of “physical inactivity” for the purposes of this project.

Adolescent Health Survey

The Adolescent Health Survey (AHS)¹⁴ includes questions about perceptions of current physical and emotional health, risky behaviours, health promoting practices, and broader issues such as family connectedness, school safety, and peer relationships. The AHS asks youth to self-report their participation in at least 20 minutes of daily physical activity in the past week, as well as weekly involvement in sports/physical activities with and without a coach.¹⁵

¹³ See the background description in the Introduction.

¹⁴ See the background description in the Introduction

¹⁵ McCreary Centre Society. A Picture of Health: Highlights from the 2008 BC Adolescent Health Survey. Available at <http://www.mcs.bc.ca/pdf/AHS%20IV%20March%2030%20Final.pdf>. Accessed April 2010.

Health Assessment of School-Aged Children

Health Assessment of School-Aged Children (HASAC) was a project (managed by the Provincial Health Services Authority, or PHSA, and funded by the Ministry of Healthy Living and Sport, PHSA and Child Health BC) that aimed to gather data on the nutrition, physical activity, smoking behaviour, and self-perception of grade 6 students in B.C.¹⁶ The first year of the project was 2008, when 17 schools participated; by comparison, 19 schools took part in the 2009 assessment.

The health assessment project was comprised of two parts:

- Student questionnaire, developed in collaboration with the Centre for Behavioural Research and Program Evaluation at the University of Waterloo. Students complete this questionnaire under the supervision of school staff.
- Direct height and weight measurements. Trained project staff people record each student's height and weight in private, away from the view of other students.

The HASAC project has reportedly been terminated.¹⁷

Discussion

There is strong research evidence that physical activity in children and youth has a positive effect on physical fitness. In other areas of health such as bone strength, cardiovascular disease risk profile, and maintenance of a healthy weight, some reviews indicate that physical activity in children and youth can have a positive effect, though the evidence is more modest. The evidence in the realm of non-physical health is even more limited, so that it is difficult to draw any firm conclusions. Nevertheless, small positive effects were generally observed in the four different topics identified in the reviews. Other literature suggests that there is stronger evidence for physical activity affecting the cognitive dimension among adults, especially with regard to a protective effect against late-life cognitive decline and dementia; further study is needed among children with adequate follow-up to determine whether beneficial cognitive effects last longer than the short term.^{18,19} Of related importance is the evidence that good PA effects (and possibly good PA habits) in youth do persist into adulthood, with potential benefits in terms of preventing the onset of a variety of chronic diseases.^{20,21,22}

With regard to tracking physical activity levels, self-report of physical activity is most practical for use at the population level since objective measures based on equipment such as accelerometers are labour-intensive and expensive to administrate. Ideally, any inquiry tools would generate information regarding frequency, intensity, duration, and type of physical

¹⁶ Health Assessment of School-Aged Children. Backgrounder 2009. Available at <http://www.phsa.ca/NR/rdonlyres/9529AC51-BE69-45D2-B623-04EB82DF5E71/0/HASACFactSheet0809.pdf>. Accessed April 2010.

¹⁷ Personal communication from Lisa McKellar, B.C. Ministry of Health. January 24, 2011.

¹⁸ Studenski S, Carlson MC, Fillit H et al. From bedside to bench: does mental and physical activity promote cognitive vitality in late life? *Science of Aging Knowledge Environment* 2006; 2006(10): pe21.

¹⁹ Angevaeren M, Aufdemkampe G, Verhaar HJ et al. Physical activity and enhanced fitness to improve cognitive function in older people without known cognitive impairment. *Cochrane database of systematic reviews*. 2008; (2): CD005381.

²⁰ Boreham C, Riddoch C. The physical activity, fitness and health of children. *Journal of Sports Sciences*. 2001; 19(12): 915-29.

²¹ Hallal PC, Victora CG, Azevedo MR et al. Adolescent physical activity and health: a systematic review. *Sports Medicine*. 2006; 36(12): 1019-30.

²² Telama R. Tracking of physical activity from childhood to adulthood: a review. *Obesity Facts*. 2009; 2(3): 187-95.

activity of children and adolescents in a reliable, valid, and practical manner.²³ Unfortunately, most of the assessment tools that do exist have either unknown validity or clear limitations in terms of accuracy. The primary disadvantage with children's self-report of physical activity is poor memory recall; in general, children have difficulty recalling their physical activity behaviour over longer time periods, and this is especially a challenge for children younger than 10 years of age.²⁴ The reliability of certain survey results may therefore be questionable.

There are several surveys that currently collect self-reported physical activity data among B.C. children, though each of these has specific limitations. The CCHS and AHS target adolescents, which is only one subset of the children and youth population. The AHS, which aims to survey all members of the cohort, has a high participation rate among B.C. youth. On the other hand, the CCHS also includes all ages over 12 years, but it is a cross-sectional survey building on a sample (rather than attempting to get information from all youth in the province); notably, it also explicitly excludes individuals living on Indian Reserves. When it was in operation, HASAC was even more limited in scope, with only 19 schools reporting in the most recent application; as well, only grade 6 students were part of the survey.

Conclusion

The concept of PA continues to be extensively studied in Canadian and other contexts, accounting for the large volume of recent systematic reviews of the area; novel hypotheses and measures directly or tangentially related to PA are constantly being added to the research agenda, but remain investigative and do not yet contribute to the basic assessment provided herein. While gaps exist in the science, there appears to be strong evidence supporting the tracking of physical activity as a useful pointer to pediatric physical fitness and other developmental and health impacts at the general pediatric population level. In other physical health areas, as well as in the non-physical realm, the evidence associating physical activity with beneficial effects among children and youth is more modest; unfortunately, these sort of weaker results appear to pertain to the important topic of childhood obesity, where increasing PA levels does not seem to be the panacea for which some public health leaders might have hoped.

Overall, however, PA represents a concept that bears serious consideration as a core indicator of child health and well-being. This conclusion is partly driven by the persistence of youth PA habits into adulthood, as well as signs of health benefits in later years. As well, even if the direct benefits in childhood are found to be dominated by various aspects of physical fitness, this alone would be an important component of enjoying a life marked by well-being. Focusing in particular on the vigorous activity end of the spectrum, Ekeland et al. concluded that, "as exercise has no known negative effects, and many positive effects, on somatic health, it is an important instrument in improving children's health."²⁵

The Adolescent Health Survey, with its high participation rate across the province, is a potential physical activity assessment tool for B.C. youth. In order to collect the most pertinent data, however, the physical activity portion of the survey could be modified. Information on the frequency, intensity, type, and duration of physical activity (similar to CCHS questions) would be valuable in terms of calculating overall PA levels to inform a

²³ de Vries SI, Pronk MG, Hopman-Rock M et al. *Assessing Physical Activity in Children and Adolescents. A Review of Different Methods*. 2004. TNO. Available at http://www.tno.nl/downloads/TNO-KvL_Report_%20Assessment_Physical_Activity_Children1.pdf. Accessed August 2010.

²⁴ Kohl HW, Fulton JE, Caspersen CJ. Assessment of Physical Activity among Children and Adolescents: A Review and Synthesis. *Preventive Medicine*. 2000; 31: S54-S76.

²⁵ Ekeland E, Heian F, Hagen KB. Can exercise improve self esteem in children and young people? A systematic review of randomised controlled trials. *British Journal of Sports Medicine*. 2005; 39(11): 792-8; discussion -8.

selected indicator among children in British Columbia. Expansion of the surveyed population to include grades 5 and/or 6 could be strategic; rationales for such a change include providing more comprehensive coverage of the pediatric population, and the fact that some authorities believe important lifestyle patterns have been set before children reach grade 7.

Summary Assessment					
Low Physical Activity Level					
Age group (Years)	Est. Prevalence among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
12-19	104,000	High	Medium	Medium-High	Medium-High

As summarized in the table above, assessments have been applied to the Physical Activity concept, specifically in terms of the indicator with the most compelling support in the literature, namely: *proportion of the population that exhibits low physical activity levels*. Because of the clear dose-response effect seen for PA and several health-related outcomes, the lowest grade of PA is automatically the cut-off of greatest interest. This indicator was also chosen over a positive version (i.e., moderate-or-higher activity levels) because it is convenient to match other concepts/indicators and cast the size of the affected population in terms of the group where public policy intervention is required.

The pediatric population **Magnitude** of the potential indicator is assessed as **High**. According to 2009 CCHS data, 17.7% of males and 30.6% of females aged 12-19 in B.C. exhibit low physical activity (or are “inactive” in CCHS terms). This corresponds to an estimated combined prevalence of 104,000 individuals. This is greater than 10% of the total pediatric cohort (97,000), resulting in a Magnitude classification of High. It should be noted this total is actually conservative; if the science and data tracking supported it, a full inventory of children with a PA deficit might include those found in the preschool and elementary school cohorts.

The **Significance** of Low Physical Activity shown by the evidence of impact on an individual’s health and well-being is assessed as **Medium**. The body of evidence for a direct health effect that could be characterized as *strong* certainly exists but is quite limited.

The **Modifiability** of the potential indicator is assessed as **Medium-High**. Extensive and encouraging research has been pursued on effective interventions to increase PA levels among school-age children and adolescents.

Data Availability/Reliability for the potential indicator is assessed as **Medium-High**. Data are routinely collected through more than one survey source, and any stigma associated with reporting low physical activity is likely not influential enough to invalidate results.

Based on the indicated assessment, an indicator related to low physical activity is **Recommended** for consideration as a core indicator of child health and well-being. There is a high magnitude of affected children in the province, as well as the promise of trackable improvements in PA levels that will generate health enhancement at the population level in the short- and long-term.

Proper Nutrition

Background and Context

The purpose of this review is to find research evidence of an association between proper nutrition in childhood and the physical health of children. It is well established that nutrition plays a significant role in determining an individual's health throughout their lifespan. Nutritional status in early life has been suggested to affect overall growth, body composition, neuro-cognitive development, and a range of other health outcomes. Breastfeeding, for instance, is a significant aspect of child nutrition that is well-studied in the literature in terms of health outcomes for both the mother and the infant. The World Health Organization recommends the following: "...infants should be exclusively breastfed for the first six months of life to achieve optimal growth, development and health. Thereafter, to meet their evolving nutritional requirements, infants should receive nutritionally adequate and safe complementary foods while breastfeeding continues for up to two years of age or beyond."²⁶ Breastfeeding has been shown to confer protection against infectious diseases and to have beneficial effects on growth and cognitive development; more recent studies have begun to make linkages between breastfeeding and future health outcomes, including the possible avoidance of chronic disease.^{27,28} Given its prominence in the literature, breastfeeding will emerge as a focus in this section, along with a number of other aspects of proper nutrition.

The traditional place to begin thinking about nutrition after the infant period is the Food Guide published in Canada from time to time. The current version is provided in the following table.

Canada's Food Guide: Recommended Number of Servings per Day									
Age (Years)	Children			Teens		Adults			
	2-3	4-8	9-13	14-18		19-50		51+	
	Girls and Boys			Females	Males	Females	Males	Females	Males
Vegetables and Fruit	4	5	6	7	8	7-8	8-10	7	7
Grain Products	3	4	6	6	7	6-7	8	6	7
Milk and Alternatives	2	2	3-4	3-4	3-4	2	2	3	3
Meat and Alternatives	1	1	1-2	2	3	2	3	2	3

Source: Health Canada, 2009.

Conceptual Scoping

Nutrition, diet, etc. can consist of a very wide umbrella as a concept. For the purposes of this project, the focus was on nutrition per se, or the provision of nourishment to sustain and enhance life. This is still broad, allowing consideration of all micro-nutrients, macro food categories, and even standard meals, such as breakfast. Some areas were deemed outside of scope due to substantial confounding by factors other than nutrition; this included the separate concept of eating together as a family.

²⁶ World Health Organization. Infant and young child nutrition: Global strategy on infant and young child feeding. Available at http://apps.who.int/gb/archive/pdf_files/WHA55/ea5515.pdf. Accessed February 2011..

²⁷ Wu TC, Chen PH. Health consequences of nutrition in childhood and early infancy. *Pediatric Neonatology*. 2009; 50(4): 135-42.

²⁸ Demmelmair H, von Rosen J, Koletzko B. Long-term consequences of early nutrition. *Early Human Development*. 2006; 82(8): 567-74.

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

Physical Health

("Nutritional Sciences"[Majr] OR "Diet"[Majr] OR "Nutritional Assessment"[Majr] OR "Nutrition Therapy"[Majr] OR "Nutritional Requirements"[Majr] OR "Nutritional Status"[Majr] OR "Breast Feeding"[Majr]) AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Overweight"[Mesh] OR "Bone Density"[Mesh] OR "Physical Fitness"[Majr] OR "Growth and Development"[Majr] OR "Insulin resistance"[Majr] OR "Diabetes Mellitus"[Majr] OR "Allergy and Immunology"[Majr])

Taken together, the search processes returned 411 reviews for consideration.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between proper nutrition and physical health outcome(s), then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 149.

Primary Exclusion

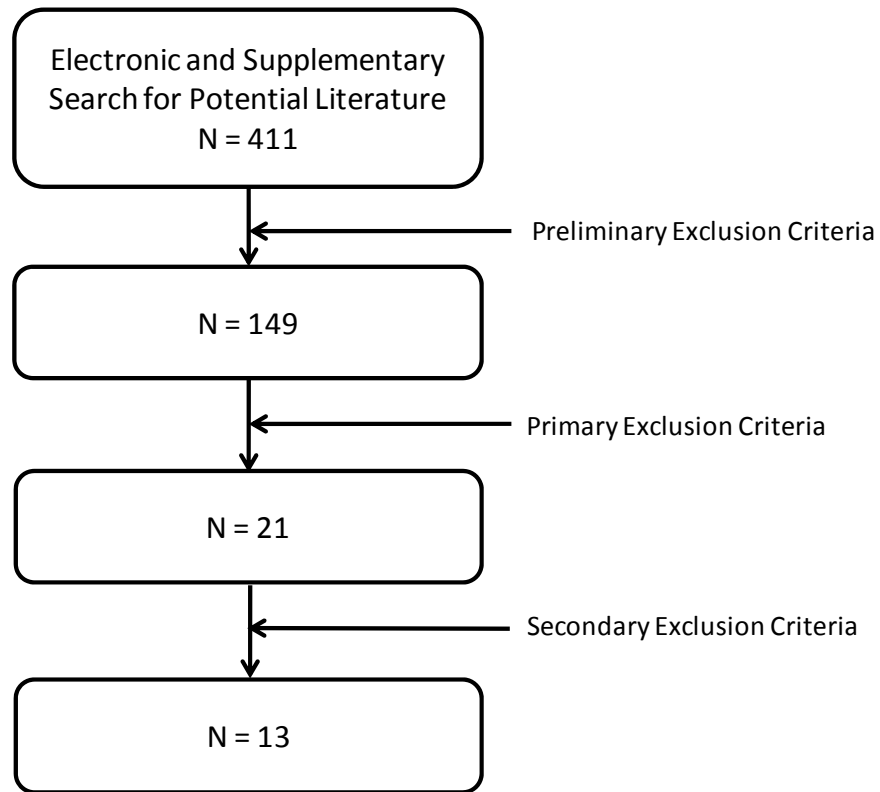
The abstracts and/or full versions of the 149 articles were then reviewed. Articles not pertinent to the research topic were excluded; specifically, if the article did not link proper nutrition with physical health outcome(s), or if it was not about children, it was excluded. There were 21 reviews remaining in the list following the primary exclusion.

Secondary Exclusion

Systematic reviews that were deemed to be of lesser quality or usefulness were excluded, yielding a final total of 13 reviews, as indicated in the following Volume Report.

Literature Review Volume Report: Reviews

Dimension: Physical Health ***Concept:*** Proper Nutrition ***Impact:*** Physical Health



Non-physical Health and Well-being

("Nutritional Sciences"[Majr] OR "Diet"[Majr] OR "Nutritional Assessment"[Majr] OR "Nutrition Therapy"[Majr] OR "Nutritional Requirements"[Majr] OR "Nutritional Status"[Majr] OR "Breast Feeding"[Majr])

AND

("Psychological Phenomena and Processes"[Majr] OR "Behavior and Behavior Mechanisms"[Majr])

A supplementary search was also conducted, using the "related citations" link in PubMed, and using search terms such as "nutrition and psychological effects in children." Take together, the search processes returned 215 reviews for consideration.

Preliminary and Primary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between proper nutrition and non-physical health outcome(s), then it was excluded.

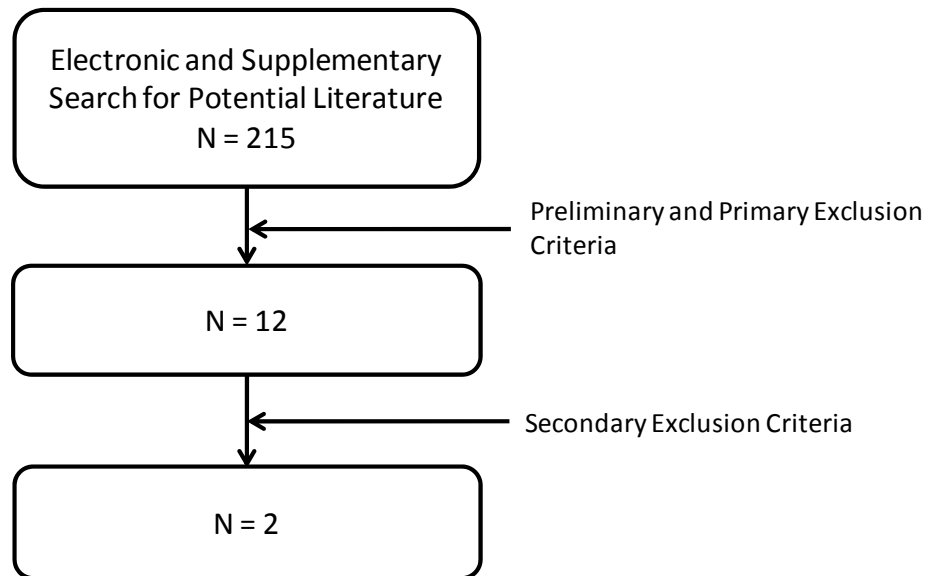
After completing this first exclusion process, the list of articles was reduced to 12.

Secondary Exclusion

Systematic reviews that were deemed to be of lesser quality or usefulness were excluded, yielding a final total of 2 reviews, as indicated in the following Volume Report.

Literature Review Volume Report: Reviews

Dimension: Physical Health ***Concept:*** Proper Nutrition ***Impact:*** Non-physical Health



The reviews for both physical and non-physical health impacts are outlined in the table below.

Summary of Relevant Reviews

Dimension: *Physical Health*

Concept: *Proper Nutrition*

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	No. of Studies Reviewed
Breastfeeding							
1	Systematic review: the role of breastfeeding in the development of pediatric inflammatory bowel disease	Barday	2009	Journal of Pediatrics	3.84	1983-2004	7
2	Does initial breastfeeding lead to lower blood cholesterol in adult life? A quantitative review of the evidence	Owen	2008	American Journal of Clinical Nutrition	5.85	1975-2008	17
3	Breastfeeding and maternal and infant health outcomes in developed countries	Ip	2007	Evidence Report - Technological Assessment	n/a	1981-2005	43
4	Does breastfeeding influence risk of type 2 diabetes in later life? A quantitative analysis of published evidence	Owen	2006	American Journal of Clinical Nutrition	5.85	1980-2005	23
5	Review of case-control studies related to breastfeeding and reduced risk of childhood leukemia	Guise	2005	Pediatrics	4.27	1997-2003	10
6	Duration of breastfeeding and risk of overweight: a meta-analysis	Harder	2005	American Journal of Epidemiology	5.07	1979-2003	17
7	Breast-feeding and childhood cancer: A systematic review with metaanalysis	Martin	2005	International Journal of Cancer	4.70	1988-2004	26
8	Breastfeeding in infancy and blood pressure in later life: Systematic review and meta-analysis	Martin	2005	American Journal of Epidemiology	5.07	1981-2004	15
9	The effect of breastfeeding on mean body mass index throughout life: a quantitative review of published and unpublished observational evidence	Owen	2005	American Journal of Clinical Nutrition	5.85	1989-2005	36
Breakfast							
10	Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe	Szajewska	2010	Critical Reviews in Food Science and Nutrition	3.88	1998-2008	16
11	A systematic review of the effect of breakfast on the cognitive performance of children and adolescents	Hoyland	2009	Nutrition Research Reviews	2.05	1977-2008	45
12	Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents	Rampersaud	2005	Journal of the American Dietetic Association	2.38	1981-2003	18
Specific Diets/Nutrients							
13	Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk	Rosenheck	2008	Obesity Reviews	5.09 (2009)	2001-2007	16
14	Importance of salt in determining blood pressure in children: Meta-analysis of controlled trials	He	2006	Hypertension	6.33	1980-2004	13
15	Intake of sugar-sweetened beverages and weight gain: a systematic review	Malik	2006	American Journal of Clinical Nutrition	5.85	1998-2006	20

Detailed Results

For the 15 reviews identified by the literature search and exclusion process, a summary table of results was developed, as provided below.

Dimension: <i>Physical Health</i> Concept: <i>Proper Nutrition</i>			
Summary Table of Reviews			
Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Breastfeeding			
Barclay (2009)	Systematic Review: The role of breastfeeding in the development of pediatric inflammatory bowel disease	7	The current evidence demonstrates a possible protective effect for breast milk in the development of early onset inflammatory bowel disease; however, the quality of existing data is generally poor.
Owen (2008)	Does initial breastfeeding lead to lower blood cholesterol in adult life? A quantitative review of the evidence	17	Initial breastfeeding (particularly when exclusive) may be associated with lower blood cholesterol concentrations in later life.
Ip (2007)	Breastfeeding and maternal and infant health outcomes in developed countries	43	A history of breastfeeding was associated with a reduction in the risk of acute otitis media, non-specific gastroenteritis, severe lower respiratory tract infections, atopic dermatitis, asthma (young children), obesity, type 1 and 2 diabetes, childhood leukemia, sudden infant death syndrome, and necrotizing enterocolitis. The relationship between breastfeeding and cardiovascular diseases was unclear.
Owen (2006)	Does breastfeeding influence risk of type 2 diabetes in later life? A quantitative analysis of published evidence	23	Breastfeeding in infancy is associated with a reduced risk of type 2 diabetes, with marginally lower insulin concentrations in later life, and with lower blood glucose and serum insulin concentrations in infancy.
Guisse (2005)	Review of case-control studies related to breastfeeding and reduced risk of childhood leukemia	10	Of only 4 studies that provided fair-quality evidence, two associated breastfeeding with a lower risk of acute lymphocytic leukemia, while the other two did not find an association
Harder (2005)	Duration of breastfeeding and risk of overweight: a meta-analysis	17	The duration of breastfeeding is inversely and linearly associated with the risk of overweight in later life. The risk of overweight was reduced by 4 percent for each month of breastfeeding.
Martin (2005)	Breast-feeding and childhood cancer: A systematic review with meta-analysis	26	Ever having been breastfed is inversely associated with acute lymphoblastic leukemia, Hodgkin's disease, and neuroblastoma in childhood; however, the association may be explained in part by uncontrolled confounding, selection bias, and publication bias. Consequently, the public health importance is moot.
Martin (2005)	Breastfeeding in infancy and blood pressure in later life: Systematic review and meta-analysis	15	A small reduction in blood pressure in later life was associated with breastfeeding, though publication bias and residual confounding cannot be excluded.
Owen (2005)	The effect of breastfeeding on mean body mass index throughout life: a quantitative review of published and unpublished observational evidence	36	Mean BMI is lower among breastfed subjects. Overall, breastfeeding is associated with at most a small effect on BMI in adolescence and adult life, and the effect is likely to be strongly influenced by publication bias and uncontrolled confounding factors. Encouraging breastfeeding for the purpose of reducing mean BMI cannot be advocated based on the results of this review.

Dimension: *Physical Health* Concept: *Proper Nutrition*

Summary Table of Reviews

Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Breakfast			
Szajewska (2010)	Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe	16	Results suggest that breakfast consumption is associated with a reduced risk of becoming overweight or obese and a reduction in the BMI in children and adolescents. However, causality is not clear.
Hoyland (2009)	A systematic review of the effect of breakfast on the cognitive performance of children and adolescents	45	The evidence indicates that breakfast consumption is more beneficial to cognitive performance than skipping breakfast; this effect may be linked to increased attendance/reduced absenteeism, and it is most apparent in children whose nutritional status is otherwise compromised.
Rampersaud (2005)	Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents	18	Breakfast consumption may positively benefit cognitive function and psychosocial aspects of well-being, particularly memory, academic performance, school attendance rates, and mood. Results may be confounded by socioeconomic status or other social or educational variables.
Specific Diets/Nutrients			
Rosenheck (2008)	Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk	16	It is unclear as to whether an association exists between fast food consumption and actual weight gain; there is strong evidence, however, for the independent role of fast food consumption contributing to increased caloric intake, likely making individuals more susceptible to weight gain.
He (2006)	Importance of salt in determining blood pressure in children: Meta-analysis of controlled trials	13	Reduced salt intake in children causes immediate and significant reductions in blood pressure; if this pattern can be continued, it may lessen the rise in blood pressure often seen with ageing.
Malik (2006)	Intake of sugar-sweetened beverages and weight gain: a systematic review	20	Findings from several large cross-sectional investigations, well-powered prospective cohort studies with long follow-up and repeated measures of diet and weight, a school-based intervention targeting soda consumption, and an RCT assessing the effect of reducing sweetened beverage consumption have provided strong evidence for the independent role of the intake of sugar-sweetened beverages, particularly soda, in the promotion of weight gain and obesity in children and adolescents.

Bibliography for Table of Reviews

Barclay AR, Russell RK, Wilson ML et al. Systematic review: the role of breastfeeding in the development of pediatric inflammatory bowel disease. *Journal of Pediatrics*. 2009; 155: 421-6.

Owen CG, Whincup PH, Kaye SJ et al. Does initial breastfeeding lead to lower blood cholesterol in adult life? A quantitative review of the evidence. *American Journal of Clinical Nutrition*. 2008; 88: 305-14.

Ip S, Chung M, Raman G et al. Breastfeeding and maternal and infant health outcomes in developed countries. *Evidence Report - Technological Assessment*. 2007; 1-186.

Owen CG, Martin RM, Whincup PH et al. Does breastfeeding influence risk of type 2 diabetes in later life? A quantitative analysis of published evidence. *American Journal of Clinical Nutrition*. 2006; 84: 1043-54.

Guise JM, Austin D, Morris CD. Review of case-control studies related to breastfeeding and reduced risk of childhood leukemia. *Pediatrics*. 2005; 116: e724-31.

- Harder T, Bergmann R, Kallischnigg G et al. Duration of breastfeeding and risk of overweight: a meta-analysis. *American Journal of Epidemiology*. 2005; 162: 397-403.
- Martin RM, Gunnell D, Owen CG et al. Breast-feeding and childhood cancer: A systematic review with metaanalysis. *International Journal of Cancer*. 2005; 117: 1020-31.
- Martin RM, Gunnell D, Smith GD. Breastfeeding in infancy and blood pressure in later life: systematic review and meta-analysis. *American Journal of Epidemiology*. 2005; 161: 15-26.
- Owen CG, Martin RM, Whincup PH et al. The effect of breastfeeding on mean body mass index throughout life: a quantitative review of published and unpublished observational evidence. *American Journal of Clinical Nutrition*. 2005; 82: 1298-307.
- Szajewska H, Ruszczynski M. Systematic review demonstrating that breakfast consumption influences body weight outcomes in children and adolescents in Europe. *Critical Reviews in Food Science and Nutrition*. 2010; 50: 113-9.
- Hoyland A, Dye L, Lawton CL. A systematic review of the effect of breakfast on the cognitive performance of children and adolescents. *Nutrition Research Reviews*. 2009; 22: 220-43.
- Rampersaud GC, Pereira MA, Girard BL et al. Breakfast habits, nutritional status, body weight, and academic performance in children and adolescents. *Journal of the American Dietetic Association*. 2005; 105: 743-60; quiz 61-2.
- Rosenheck R. Fast food consumption and increased caloric intake: a systematic review of a trajectory towards weight gain and obesity risk. *Obesity Reviews*. 2008; 9: 535-47.
- He FJ, MacGregor GA. Importance of salt in determining blood pressure in children: meta-analysis of controlled trials. *Hypertension*. 2006; 48: 861-9.
- Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. *American Journal of Clinical Nutrition*. 2006; 84: 274-88.

Summary of Results

The majority of the reviews identified for this section studied the effects of breastfeeding on various physical health outcomes in later life. Associations have been made between breastfeeding and reduced risk of diseases such as acute lymphocytic leukemia, Hodgkin's disease, early onset inflammatory bowel disease, and gastroenteritis; however, the quality of the existing data is generally poor, there are too few studies on which to base conclusions, and causality often cannot be inferred. Ip et al. reported on an association between a history of breastfeeding and a reduction in the risk of allergic diseases such as asthma and atopic dermatitis, though the studies on asthma were again equivocal. Some health outcomes with *stronger* evidence are reduction in risk of overweight and type 2 diabetes, lower blood cholesterol, and a small reduction in blood pressure in later life. While there are a greater number of studies on these topics, the effect size was still small, and confounding factors could not be completely ruled out.

Another nutrition-related behaviour reviewed was breakfast consumption. Results from the Szajewska et al. review suggest that breakfast consumption is associated with a reduced risk of becoming overweight in the pediatric years. However, because the studies reviewed were observational, causation cannot be proven. The remaining two reviews in this area focused on the effect of breakfast habits on cognition in children. Hoyland et al. determined that the quality of the studies in their review were generally poor; additionally, most of the studies reviewed were sponsored in whole or in part by the food industry. They note that, while the evidence points toward beneficial effects of breakfast consumption on cognitive performance, these effects may be linked mostly with increased attendance at school. As for specific effects, the majority of studies and evidence point to improved memory function; there is a lack of supporting evidence for effects on other cognitive variables. Rampersaud et al. indicate that confounding factors such as SES can complicate interpretation of results for studies attempting to associate breakfast consumption with various aspects of cognitive functioning.

In the specific diets/nutrients subcategory, Rosenheck conducted a systematic review of studies that assessed fast food consumption and caloric intake/weight gain. While a clear association could be demonstrated between fast food consumption and increased caloric intake among children, no such association could be found for weight gain or BMI. He et al. conducted a meta-analysis of controlled trials studying the effect of reduced salt intake on blood pressure in children. They concluded that reduced salt intake in children results in immediate and significant reductions in blood pressure that could persist into adulthood. The final review in this category is on the topic of sugar-sweetened beverages and the link with weight gain/obesity. There has been a lot of interest in this area in recent years, as evidenced by the volume of literature published on the topic and the coverage in the media regarding policies such as taxation on soda pop and other sugar-sweetened drinks. Only one peer-reviewed systematic review was identified, however, that specifically examined evidence for an association between consumption of sugar-sweetened beverages in children (most studies tend to be conducted in the adult population) and physical health outcomes (such as weight gain/being overweight). Malik et al. concluded that there is a positive association between greater intakes of sugar-sweetened beverages and weight gain and obesity in both children and adults; the authors also note that "although more research is needed, sufficient evidence exists for public health strategies to discourage consumption of sugary drinks as part of a healthy lifestyle".²⁹

²⁹ Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. *American Journal of Clinical Nutrition*. 2006; 84(2): 274-88.

Data Sources on Proper Nutrition

The most relevant indicator for this topic area, based on the results of the literature review conducted, appears to be breastfeeding rates. As with other health behaviour topics, the BC Stats agency points directly to Statistics Canada as a source of information in this regard, and specifically to the Canadian Community Health Survey (CCHS); in fact, data are available for both breastfeeding initiation and exclusive breastfeeding for at least 6 months. The following table presents the data for Canada and British Columbia, 2003-2009:

Breastfeeding Rates in Canada and British Columbia				
% of mothers who had a baby in the last 5 years				
Year	Canada		British Columbia	
	Breastfeeding initiation	Exclusive breastfeeding, at least 6 months	Breastfeeding initiation	Exclusive breastfeeding, at least 6 months
2003	84.8	17.2	93.5	28.3
2005	87	20.3	93.1	31.1
2007	87.1	21	94.9	39.7
2008	88.3	25.1	94.6	35.4
2009	87.5	24.4	97.3	33.6

Source: Statistics Canada CANSIM Table 105-0501

Breastfeeding initiation rates have been increasing in the past decade, with a rate as high as 97.3% in British Columbia in 2009. Exclusive breastfeeding rates (at least 6 months) are much lower, though these have also increased since 2003.

The only other nutrition-related statistic routinely collected by the CCHS is fruit and vegetable consumption. The exception to this rule was CCHS Cycle 2.2 administered in 2004; it collected and reported on the first comprehensive nutrition data since the Nutrition Canada survey was conducted nearly 35 years earlier. Unfortunately, such a one-time snapshot is not useful in the development of indicators; the same may be said for the information gathered through the B.C. Nutrition Survey conducted in 1999.

As always with the annual CCHS instrument, there is the inherent challenge of the respondent age group beginning at 12 years, limiting the utility of results in a pediatric context. According to 2009 data from this source, 48% of 12-19-year-olds in B.C. consumed fruits and vegetables 5 or more times per day.³⁰ The more comprehensive CCHS Cycle 2.2 in fact reported that the consumption of fruits and vegetables among 4 to 8 years old Canadians was substantially lower, but it is not possible to confirm this information in the years since 2004.³¹

Additional nutritional information for B.C. youth is collected via the Adolescent Health Survey. The 2008 results from this source indicate that 8% of students consumed no fruit or vegetables on the day before the survey, 20% had only one serving, and at least half did not consume the recommended five daily portions of fruit and vegetables.³² This is very consistent with the results found in the CCHS. The AHS also surveys students regarding their beverage consumption on the day before the survey; 32% of students reported drinking pop/soda, and 10% reported drinking it twice or more.

³⁰ CANSIM Table 105-0501. Statistics Canada. Available at http://cansim2.statcan.gc.ca/cgi-win/cnsmcgi.pgm?Lang=E&RootDir=CII/&Array_Pick=1&ArrayId=105-0501&C2DB=PRD&ResultTemplate=CII%2FCII. Accessed November 2010.

³¹ Garriguet D. *Overview of Canadians' Eating Habits*. 2004. Available at <http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=82-620-MIE2006002&lang=eng>. Accessed February 2011.

³² A Picture of Health. Highlights from the 2008 BC Adolescent Health Survey. Available at http://mcs.bc.ca/ahs_frontpage. Accessed November 2010.

Another source of nutritional-related information on younger children was B.C.'s Health Assessment of School-Aged Children (HASAC); this survey (now defunct) represented a project to help BC schools gather information on the nutrition, physical activity, smoking behaviour, and self-perception of grade six students. It was last conducted during the 2008-09 school year in 19 schools around the province. When asked about fruit and vegetable consumption on the day before the survey, 33% of girls and 34% of boys reported consuming vegetables and fruit at least six times.³³ Students were also asked how many servings of sweetened beverages they consumed on the day before the survey; 71% reported drinking at least one serving, and 20% reported drinking 4 or more servings on the previous day.

Discussion

It appears that, although there are many studies of the effect of child nutrition on a variety of health outcomes, most of them are observational and thus causation cannot be inferred with much confidence. However, evidence presented in most of the reviews is at least suggestive of potential benefits to child physical health. As pointed out by Rosenheck, behavioural patterns such as fast food consumption in children could put youth at risk of obesity; while no association could be made between fast food consumption and BMI among children, energy needs are reduced in early adulthood, and therefore a pattern of consumption of such energy-dense foods may result in weight gain.

Some of the breastfeeding health outcomes with stronger evidence include reduced risk of overweight/obesity, lower blood cholesterol, reduction in blood pressure, and reduced risk of type 2 diabetes. It is not as clear that there is any benefit with respect to other areas of health that have been investigated. For example, there is conflicting evidence for associations between breastfeeding and a lower risk of leukemia; similarly, the topic of breastfeeding and reduced risk of allergic diseases is controversial, having generated inconclusive and conflicting results in the literature.^{34,35,36} Overall, there is little conclusive evidence that breastfeeding, reduced salt intake, or regular breakfast consumption would have more than a small population health effect. Nonetheless, other considerations might encourage the development of a core indicator related to breastfeeding; it is important to note that the specific indicator of interest would relate to *exclusive breastfeeding persisting for 6 months*, since *basic initiation* rates in British Columbia have already reached saturation levels.

While the broad nutrition-related literature search did not retrieve any or many reviews related to fruit and vegetable consumption or sugar-sweetened beverage intake by youth, they still represent topics of substantial interest to public health officers in recent years. With regard to fruit and vegetables, many studies in the pediatric realm focus on interventions to increase consumption; literature is sparse, however, on the health effects in children. One study by Holt et al. showed that, among adolescents, fruits and vegetable intake had beneficial effects on markers of inflammation and oxidative stress (which are predictors of coronary heart disease risk).³⁷

³³ Health Assessment of School-Aged Children 2008-09. Feedback Report for All Schools. Available at <http://www.phsa.ca/HealthProfessionals/Population-Public-Health/Surveillance-Health-Indicator-Reports/default.htm>. Accessed November 2010.

³⁴ Wu TC, Chen PH. Health consequences of nutrition in childhood and early infancy. *Pediatric Neonatology*. 2009; 50(4): 135-42.

³⁵ Friedman NJ, Zeiger RS. The role of breast-feeding in the development of allergies and asthma. *Journal of Allergy and Clinical Immunology*. 2005; 115(6): 1238-48.

³⁶ Ip S, Chung M, Raman G et al. Breastfeeding and maternal and infant health outcomes in developed countries. *Evidence Report - Technological Assessment*. 2007; (153): 1-186.

³⁷ Holt EM, Steffen LM, Moran A et al. Fruit and vegetable consumption and its relation to markers of inflammation and oxidative stress in adolescents. *Journal of the American Dietetic Association*. 2009; 109(3): 414-21.

Although there is a greater volume of literature on the topic of sugar-sweetened beverages and obesity, only one pertinent systematic review was identified that specifically discussed the association in children. Malik et al. concluded that there is strong evidence for an association between greater consumption of sugar-sweetened beverages in children and weight gain and obesity.³⁸ Other recent non-systematic reviews drew similar conclusions.^{39,40,41,42} Overall, the papers suggest that such beverages contribute to obesity by “limiting satiety, increasing insulin resistance, and providing an abundance of excess energy storage.” While other reviews/studies that have found there is no association with overweight,^{43,44} their objectivity may be questioned; the funding sources for the research have included the sugar or beverage industry. In this regard, Vartanian et al. found that there were lower overall effect sizes in industry-funded studies.⁴⁵

One of the most important aspects of fostering proper nutrition in childhood is the potential for developing lifelong habits that could generate health impacts in later years.⁴⁶ This phenomenon provides an indirect linkage to some diet-health associations that have been more thoroughly studied in adults. High fruit and vegetable consumption and reduced consumption of red meat, refined carbohydrates, and dairy products in the adult years is linked to decreased rates of cancer (e.g., esophageal, gastric, prostate and colorectal),^{47,48,49,50} as well as a reductions in cardiovascular risk factors and actual incidence of coronary heart disease.^{51,52,53}

³⁸ Malik VS, Schulze MB, Hu FB. Intake of sugar-sweetened beverages and weight gain: a systematic review. *American Journal of Clinical Nutrition*. 2006; 84(2): 274-88.

³⁹ Harrington S. The role of sugar-sweetened beverage consumption in adolescent obesity: a review of the literature. *Journal of School Nursing*. 2008; 24(1): 3-12.

⁴⁰ Malik VS, Popkin BM, Bray GA et al. Sugar-sweetened beverages, obesity, type 2 diabetes mellitus, and cardiovascular disease risk. *Circulation*. 2010; 121(11): 1356-64.

⁴¹ Libuda L, Kersting M. Soft drinks and body weight development in childhood: is there a relationship? *Current Opinion in Clinical Nutrition and Metabolic Care*. 2009; 12(6): 596-600.

⁴² James J, Kerr D. Prevention of childhood obesity by reducing soft drinks. *International Journal of Obesity*. 2005; 29 Suppl 2: S54-7.

⁴³ Gibson S. Sugar-sweetened soft drinks and obesity: a systematic review of the evidence from observational studies and interventions. *Nutrition Research Reviews*. 2008; 21(2): 134-47.

⁴⁴ Forshee RA, Anderson PA, Storey ML. Sugar-sweetened beverages and body mass index in children and adolescents: a meta-analysis. *American Journal of Clinical Nutrition*. 2008; 87(6): 1662-71.

⁴⁵ Vartanian LR, Schwartz MB, Brownell KD. Effects of soft drink consumption on nutrition and health: a systematic review and meta-analysis. *American Journal of Public Health*. 2007; 97(4): 667-75.

⁴⁶ Mikkila V, Rasanen L, Raitakari OT et al. Longitudinal changes in diet from childhood into adulthood with respect to risk of cardiovascular diseases: The Cardiovascular Risk in Young Finns Study. *European Journal of Clinical Nutrition*. 2004; 58(7): 1038-45.

⁴⁷ Verberne L, Bach-Faig A, Buckland G et al. Association between the Mediterranean diet and cancer risk: a review of observational studies. *Nutrition and Cancer*. 2010; 62(7): 860-70.

⁴⁸ Miller PE, Lesko SM, Muscat JE et al. Dietary patterns and colorectal adenoma and cancer risk: a review of the epidemiological evidence. *Nutrition and Cancer*. 2010; 62(4): 413-24.

⁴⁹ Newmark HL, Heaney RP. Dairy products and prostate cancer risk. *Nutrition and Cancer*. 2010; 62(3): 297-9.

⁵⁰ Steevens J, Schouten LJ, Goldbohm RA et al. Vegetables and fruits consumption and risk of esophageal and gastric cancer subtypes in the Netherlands cohort study. *International Journal of Cancer*. 2011; E-pub ahead of print.

⁵¹ Oude Griep LM, Geleijnse JM, Kromhout D et al. Raw and processed fruit and vegetable consumption and 10-year coronary heart disease incidence in a population-based cohort study in the Netherlands. *PLoS One*. 2010; 5(10): e13609.

⁵² Mirmiran P, Noori N, Zavareh MB et al. Fruit and vegetable consumption and risk factors for cardiovascular disease. *Metabolism*. 2009; 58(4): 460-8.

⁵³ Bendinelli B, Masala G, Saieva C et al. Fruit, vegetables, and olive oil and risk of coronary heart disease in Italian women: the EPICOR Study. *American Journal of Clinical Nutrition*. 2011; 93(2): 275-83.

As noted earlier, there are several other topics of interest tangentially related to eating habits and child health outcomes that were determined to be outside the scope of the present report; these include family meal frequency and TV watching while eating.^{54,55}

Conclusion

There is weak to fair evidence that breastfeeding is beneficial to a child's physical health. There were no recent systematic reviews identified in the literature search regarding beneficial effects of breastfeeding on immunity, though this association has often been suggested. Based on the evidence presented in this review, increasing breastfeeding rates for the purpose of improving physical health is likely to have a population health impact in childhood and even into adulthood. Thus, monitoring breastfeeding rates is of at least moderate utility in terms of pediatric (and later adult) health; the utility may be increased if maternal health and other aspects of child well-being are also considered. In fact, other than fruit and vegetable intake, it is one of the rare nutritional data points routinely tracked in B.C.

Other nutritional behaviours with weak to fair evidence for beneficial health outcomes include breakfast consumption and reduced salt intake. According to limited research, salt intake may be important to child health, but routine data pertinent to an indicator for B.C. children are lacking. There is strong evidence of an association between consumption of sugar-sweetened beverages and weight gain/obesity in children. It has been noted, however, that discouraging consumption of sugar-sweetened beverages should be just one component of a multi-factorial obesity reduction strategy. Routine data to populate an indicator in this area are not available through the annual CCHS route, but could be derived from the AHS conducted every 5 years.

Evidence on other pediatric nutritional areas needs to be further developed; this is true even for a much-publicized dietary concern such as adequate fruit and vegetable intake, although there may be a pertinent argument to encourage children to establish dietary habits such as these even if the greatest effect may be the development of eating pattern into adulthood that could reducing chronic disease onset.⁵⁶ A major step forward would be to commit to a more comprehensive data collection program, similar to CCHS Cycle 2.2 and following the lead of the National Health and Nutrition Examination Survey (NHANES), a survey of the health and nutritional status of both adults and children in the United States. The survey combines interviews (which include demographic, socioeconomic, dietary, and health-related questions), and physical examinations (which include medical, dental, physiological measurements, and certain laboratory tests). This program began in the early 1960s, and in 1999 it committed to an annual examination of a nationally representative sample of about 5,000 persons. Results from the survey are used to determine risk factor and disease prevalence, allowing for investigation of the relationship between nutritional status and disease prevention.⁵⁷

⁵⁴ Rollins BY, Belue RZ, Francis LA. The beneficial effect of family meals on obesity differs by race, sex, and household education: the national survey of children's health, 2003-2004. *Journal of the American Dietetic Association*. 2010; 110(9): 1335-9.

⁵⁵ Temple JL, Giacomelli AM, Kent KM et al. Television watching increases motivated responding for food and energy intake in children. *American Journal of Clinical Nutrition*. 2007; 85(2): 355-61.

⁵⁶ Fuemmeler BF, Pendzich MK, Tercyak KP. Weight, dietary behavior, and physical activity in childhood and adolescence: implications for adult cancer risk. *Obesity Facts*. 2009; 2(3): 179-86.

⁵⁷ See http://www.cdc.gov/nchs/nhanes/about_nhanes.htm

Summary Assessment					
Not Exclusively Breastfed for At Least 6 Months					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	644,000	High	Medium	Medium	High

As summarized above, assessments have been applied to the Proper Nutrition concept, specifically in terms of the indicator with the most compelling support in the literature and the most routinely available data, namely: *proportion of newborns not exclusively breastfed for at least 6 months*.

The pediatric population **Magnitude** of the potential indicator is assessed as **High**. Based on 2009 CCHS data, 66.4% of infants are not exclusively breastfed for at least 6 months. When this percentage was applied to the total pediatric cohort (so as to represent the number of individuals who are susceptible to adverse health and well-being outcomes across a generation), it was estimated that approximately 644,000 BC children were not exclusively breastfed for 6 months. This is greater than 10% of the total pediatric cohort (97,000), resulting in a Magnitude classification of High.

The **Significance** of the potential indicator as indicated by the evidence of impact on an individual's health and well-being is assessed as **Medium**. There is limited evidence that breastfeeding has beneficial effects on child health; the evidence that does exist indicates the effects are at best moderate, and causation is difficult to establish. On the other hand, some of the effects with stronger support include vital areas such as reducing overweight and other cardiovascular/metabolic risk factors.

The **Modifiability** of the potential indicator is assessed as **Medium**. The reasons are the potential for bringing a variety of well-studied interventions to bear on a population that is relatively accessible; the key issue is the level of policy resources invested.

Data Availability/Reliability for the potential indicator is assessed as **High**. Data on breastfeeding rates are available from Statistics Canada on an annual basis.

Based on the indicated assessment, the indicator related to not being exclusively breastfed for at least 6 months is **Recommended** for consideration as a core indicator of child health and well-being. In addition to being one of the rare nutritional data points tracked on a routine basis, the reasons for the recommendation include the high magnitude of children implicated, a reasonable level of evidence of health effects (especially taking potential adult impacts into account), and good feasibility for applying interventions to improve the duration of breastfeeding.

Healthy Weight

Background and Context

Maintaining a healthy body weight is important to the overall health of an individual. The purpose of this review is to confirm research evidence of an association between healthy weight in children and their overall health and well-being. The literature focus related to risk is predominantly on excess weight, usually characterized as being overweight or obese. A person is obese if his or her fat storage is clearly approaching a level that compromises health. In other words, for children or adults, being “fat” is defined in terms of health impacts rather than cosmetic aspects related to size and shape. Despite representing a relatively minor part of the literature, underweight and specialized topics such as rapid weight gain and weight cycling are also a concern.

The most well-accepted measure of healthy and unhealthy weight in adults is the body mass index (BMI), which takes into account an individual’s weight and height. Adult classifications based on the index include underweight (BMI<18.5), normal weight (18.5-24.99), overweight (≥ 25.0), and obese (≥ 30.0).⁵⁸ However, applying adult BMI cut-offs to children is problematic both methodologically, and conceptually.⁵⁹ As noted by the U.S.-based Physical Activity Guidelines Committee, “indicators of body composition change with chronological age and associated changes in normal growth and maturation. On average, BMI declines during infancy and early childhood, reaches a nadir at about 5 to 7 years, and then increases through the remainder of childhood and adolescence.”⁶⁰ In this light, specific BMI cut-offs have been developed for children and adolescents that correspond to the adult BMI categories (underweight, normal weight, overweight, and obese) but take into account age- and gender-specific variations. Such measures have been shown to identify the fattest children adequately, with a low to moderate false negative rate and a low false positive rate.⁶¹ Currently there are three widely-used methods for establishing pediatric cut-offs: the Centers for Disease Control and Prevention (CDC),⁶² the International Obesity Task Force (IOTF),⁶³ and the World Health Organization (WHO).⁶⁴ Both the CDC and IOTF methods provide semi-annual BMI cut-offs for children aged 2 to 20 years, whereas the WHO ranges from birth to 19 years. For each of these approaches, cut-offs are determined by choosing a specific BMI percentile from a growth reference chart (incidentally, Canada has recently adopted this chart to replace the U.S. model for clinical purposes). As the populations that fall within certain percentiles vary between growth charts, so does the proportion of the population that is in each weight category.

The WHO, for example, established cut-off points for overweight as between one and two standard deviations above the mean weight for an age group, and obese as more than two

⁵⁸ See http://apps.who.int/bmi/index.jsp?introPage=intro_3.html. Accessed February 2011.

⁵⁹ Himes JH. Challenges of accurately measuring and using BMI and other indicators of obesity in children. *Pediatrics*. 2009; 124 (Suppl 1): S3-22.

⁶⁰ Physical Activity Guidelines Committee. *Physical Activity Guidelines Committee Report*. 2008. Available at <http://www.health.gov/paguidelines/committeereport.aspx>. Accessed February 2011.

⁶¹ Reilly JJ. Assessment of obesity in children and adolescents: synthesis of recent systematic reviews and clinical guidelines. *Journal of Human Nutrition and Dietetics*. 2010; 23(3): 205-11.

⁶² Centers for Disease Control. *2000 CDC Growth Charts for the United States: Methods and Development*. 2002. Available at http://www.cdc.gov/nchs/data/series/sr_11/sr11_246.pdf. Accessed February 2011.

⁶³ Cole TJ, Bellizzi MC, Flegal KM et al. Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ*. 2000; 320(7244): 1240-3.

⁶⁴ de Onis M, Onyango AW, Borghi E et al. Development of a WHO growth reference for school-aged children and adolescents. *Bulletin of the World Health Organization*. 2007; 85(9): 660-7.

standard deviations above the mean. One standard deviation and two standard deviations correspond to the 84th and 97.7th percentiles, respectively. A 2010 study by Shields et al. compared all three methods applied to 2004 Canadian data for those aged 2 to 17 years and found that the WHO method estimated a higher combined prevalence of overweight and obesity (35%) compared to the IOTF or CDC methods (26% and 28%, respectively).⁶⁵ Despite the broad pediatric age range covered in that study, Statistics Canada only makes data publicly available for the 12-17 year age cohort.

Overweight in childhood has been associated with an increased risk of overweight or obesity in adulthood, which in turn has many well-established health effects related to cancer, cardiovascular diseases, type 2 diabetes mellitus, musculoskeletal disorders, and respiratory disorders. There are also reported health effects of overweight or obesity specific to the pediatric period, including polycystic ovary disease, orthopedic complications, and hypertension.^{66, 67}

Due to its increasing prevalence worldwide, childhood overweight and obesity has been deemed a global epidemic by the WHO. The table below shows the prevalence of overweight and obese among Canadian and B.C. youth aged 12 to 17 years (based on self-reported BMI in the Canadian Community Health Survey) in 2007-2009. While information exists for younger individuals (via reports provided by parents), it does not appear to be regularly made available to the public. It is important to note that Statistics Canada used the IOTF method to determine these prevalence estimates. This reflects the fact that the IOTF method has a more international reference population compared with the CDC (which is strictly U.S.-based), and the reality that the WHO method was only recently developed.

Overweight or Obese Youth Aged 12-17 Years						
Canada and British Columbia, 2007-2009						
Region	Year					
	2007		2008		2009	
	Number	%	Number	%	Number	%
Canada	419617	18.7	423996	19.3	449945	19.7
British Columbia	38705	14.7	52392	19.5	48640	17.5

Source: Statistics Canada CANSIM Table 105-0501

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

⁶⁵ Shields M, Tremblay MS. Canadian childhood obesity estimates based on WHO, IOTF and CDC cut-points. *International Journal of Pediatric Obesity*. 2010; 5(3): 265-73.

⁶⁶ Schuster DP. Changes in physiology with increasing fat mass. *Seminars in Pediatric Surgery*. 2009; 18(3): 126-35.

⁶⁷ Wills M. Orthopedic complications of childhood obesity. *Pediatric Physical Therapy*. 2004; 16(4): 230-5.

Electronic Search Keywords

“Body Weights and Measures”[Majr] AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR “Adiposity”[Majr] OR “Abdominal Fat”[Majr])

The search processes returned 594 reviews for consideration.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between child weight and physical health, then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 207.

Primary Exclusion

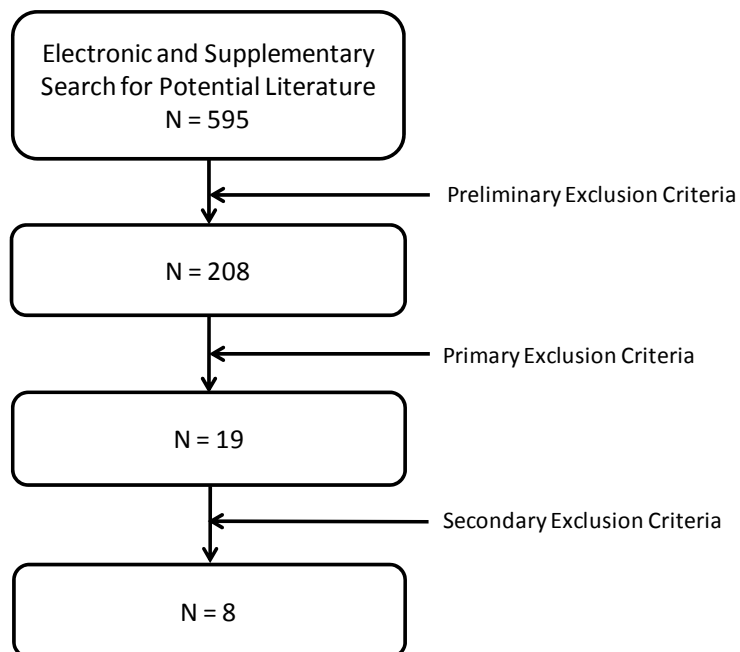
The abstracts and/or full versions of the 207 articles were then reviewed. Articles not pertinent to the research topic were excluded. There were 18 reviews remaining in the list following the primary exclusion.

Secondary Exclusion

Systematic reviews that were deemed to be of lesser quality or usefulness were excluded, yielding a final total of 7 reviews, as indicated in the following Volume Report. The list of review papers is then detailed in the table that follows.

Literature Review Volume Report: Reviews

Dimension: Physical Health **Concept:** Healthy Weight



Summary of Relevant Reviews

Dimension: *Physical Health*

Concept: *Healthy Weight*

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	No. of Studies
Cancers							
1	Weight, dietary behavior, and physical activity in childhood and adolescence: implications for adult cancer risk	Fuemmeler	2009	Obesity Facts	2.11 (2009)	1976-2008	45
2	Systematic review of prostate cancer's association with body size in childhood and young adulthood	Robinson	2008	Cancer Causes and Control	3.20	1985-2007	6
Asthma, Apneas, and Breathing Problems							
3	Is there a clear link between overweight/obesity and sleep disordered breathing in children?	Kohler	2008	Sleep Medical Reviews	3.97	1989-2008	27
4	A meta-analysis of the effect of high weight on asthma	Flaherman	2006	Archives of Disease in Childhood	1.79	1990-2004	12
5	The epidemiology of obesity and asthma	Ford	2005	Journal of Allergy and Clinical Immunology	7.67	1999-2004	8
General/Other							
6	Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review.	Reilly	2010	International Journal of Obesity	4.34	2002-2006	14
7	Tracking of childhood overweight into adulthood: a systematic review of the literature	Singh	2008	Obesity Reviews	5.09 (2009)	1985-2006	25
8	Has blood pressure increased in children in response to the obesity	Chiolero	2007	Pediatrics	4.27	1986-2004	14

Detailed Results

For the 7 reviews identified by the literature search and exclusion process, a summary table of results was developed; this table is provided below.

Dimension: <i>Physical Health</i> Concept: <i>Healthy Weight</i> Summary Table of Reviews			
Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Reilly (2010)	Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review.	14	A relatively large and fairly consistent body of evidence now demonstrates that overweight and obesity in childhood and adolescence have adverse consequences on premature mortality and physical morbidity in adulthood.
Fuemmeler (2009)	Weight, dietary behaviour, and physical activity in childhood and adolescence: Implications for adult cancer risk	45	Greater BMI at age 18, or higher perceived body fat relative to others during childhood, is associated with an approximately 20-50% decreased risk of breast cancer. Four of seven studies indicated a positive association between late adolescent BMI and risk of ovarian cancer, while three studies reported a null or lack of association. Four of nine studies indicated a positive association between adolescent weight and endometrial cancer risk. Three studies indicated a positive association between larger body mass in youth and later adult colon cancer risk. In two studies of renal cancer, one found a weakly positive association with cancer risk among men related to retrospective report of BMI at age 18; another found no association between perceived body size at age 12 and renal cancer risk.
Singh (2008)	Tracking of childhood overweight into adulthood: a systematic review of the literature	25	All studies included in this review reported increased risk for overweight or obese youth to become overweight or obese in adulthood. Among the 13 high-quality studies, the risk of overweight children to become overweight adults was at least twice as high compared with healthy weight children.
Robinson (2008)	Systematic review of prostate cancer's association with body size in childhood and young adulthood	6	Two of 3 studies examining pre-adolescence reported a lower rate of advanced prostate cancer among the heaviest pre-adolescent boys. Studies examining peri-puberty did not indicate any associations between prostate cancer and self-reported size or weight.
Kohler (2008)	Is there a clear link between overweight/obesity and sleep disordered breathing in children?	27	Childhood obesity is associated with an increased prevalence in sleep disordered breathing (SDB), though not in a straightforward manner; the risk of SDB is likely dependent on moderators, including age, ethnicity, and craniofacial morphology.
Chiolero (2007)	Has blood pressure increased in children in response to the obesity epidemic?	14	The available data do not support the hypothesis that the worldwide epidemic of overweight in children has resulted in a commensurate increase in blood pressure levels in children.
Flaherman (2006)	A meta-analysis of the effect of	12	High body weight among school aged children increases the risk of future asthma by approximately

Dimension: Physical Health Concept: Healthy Weight
Summary Table of Reviews

Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
	high weight on asthma		50%. The effect of high birth weight is also significant, with an RR of 1.2 compared to babies without high birth weight.
Ford (2005)	The epidemiology of obesity and asthma	8	In children, 3 of 4 prospective studies showed a significant association between excess weight and asthma incidence. Cross-sectional studies are less consistent in linking measures of excess weight to asthma.

Bibliography for Table of Reviews

Reilly JJ, Kelly J. Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *International Journal of Obesity*. 2010; E-pub ahead of print.

Fuemmeler BF, Pendzich MK, Tercyak KP. Weight, dietary behavior, and physical activity in childhood and adolescence: implications for adult cancer risk. *Obesity Facts*. 2009; 2: 179-86.

Singh AS, Mulder C, Twisk JW et al. Tracking of childhood overweight into adulthood: a systematic review of the literature. *Obesity Reviews*. 2008; 9: 474-88.

Robinson WR, Poole C, Godley PA. Systematic review of prostate cancer's association with body size in childhood and young adulthood. *Cancer Causes Control*. 2008; 19: 793-803.

Kohler MJ, van den Heuvel CJ. Is there a clear link between overweight/obesity and sleep disordered breathing in children? *Sleep Medicine Reviews*. 2008; 12: 347-61.

Chiolero A, Bovet P, Paradis G et al. Has blood pressure increased in children in response to the obesity epidemic? *Pediatrics*. 2007; 119: 544-53, Flaherman V, Rutherford GW. A meta-analysis of the effect of high weight on asthma. *Archives of Disease in Childhood*. 2006; 91: 334-9.

Ford ES. The epidemiology of obesity and asthma. *Journal of Allergy and Clinical Immunology*. 2005; 115: 897-909.

Summary of Results

Among the located literature, Singh et al. present some of the strongest evidence for adverse health outcomes of childhood overweight; all studies that they reviewed reported increased risk for overweight or obese youth to become overweight or obese in adulthood, a pattern that has continued with the most recent studies.⁶⁸ While an elevated risk factor in adulthood is not a *direct* link to a physical health outcome, the consequential relationships between obesity, illness, and mortality in adults have been well-established.⁶⁹ The review by Reilly and Kelly added to this picture by showing that not only is morbidity elevated in adults following pediatric overweight/obesity, but premature mortality as well.

The specific effect of childhood overweight on adult cancer risk was reflected in two reviews; the strongest evidence in this case is contrary to usual expectations, indicating a *decreased* risk of breast cancer with greater BMI at age 18 years. High BMI may also have a protective effect for prostate cancer, though evidence is more limited. For various other cancers, evidence is modest for a positive association between youth body weight and cancer risk. Although the cancer effects may be equivocal, the other long-term dangers of being overweight in childhood remain sufficiently compelling.

Less is known about the physical health effects of obesity specific to the pediatric time period, but this represents an area of growing interest. Reviews by Flaherman et al. and Ford and colleagues reported a significant association between excess weight in children and asthma incidence. Further, Kohler et al. concluded that childhood obesity is associated with an increased prevalence in sleep disordered breathing, though this relationship is likely moderated by a number of factors. Finally, Chiolerio et al. could not find direct evidence that the increase in pediatric overweight has resulted in increased blood pressure in children during the past few decades, though they also point out that appropriate studies are lacking and methods for measurement of blood pressure need to be standardized.

Data Sources on Healthy Weight

There are three main sources of data for overweight and obesity in British Columbia youth: the Canadian Community Health Survey (CCHS), the British Columbia Adolescent Health Survey (AHS), and the British Columbia Health Assessment of School-Aged Children (HASAC). Each of these sources is detailed further below.

Canadian Community Health Survey (CCHS)

The CCHS⁷⁰ data available for body mass index of youth is based on self-reported height and weight, with 2009 data being the most recent that are available; the reader may refer to the tables in the Background and Context subsection for the B.C. and Canada figures. Of note is the one-time nutrition module (CCHS Cycle 2.2), conducted in 2004, that included measured height and weight across a subset of the survey sample, thereby allowing for more objective BMI calculations; of course, this information cannot be used to inform an indicator as the process was not reproduced in subsequent years, though it might add another perspective on baseline prevalence.

⁶⁸ Herman KM, Craig CL, Gauvin L et al. Tracking of obesity and physical activity from childhood to adulthood: the Physical Activity Longitudinal Study. *International Journal of Pediatric Obesity*. 2009; 4(4): 281-8.

⁶⁹ Daniels SR. Complications of obesity in children and adolescents. *International Journal of Obesity*. 2009; 33 (Suppl 1): S60-5.

⁷⁰ See the background description in the Introduction.

Adolescent Health Survey (AHS)

The AHS⁷¹ also asks youth to self-report their height and weight.⁷² The 2008 survey results indicate that 13% of youth were overweight and 4% were obese, which appears to be slightly less than the total generated by the CCHS (see the table provided in the background section).

Health Assessment of School-Aged Children (HASAC)

HASAC is a project that aims to gather data on the nutrition, physical activity, smoking behaviour, and self-perception of grade 6 students in B.C.⁷³ The first year of the project was 2008, in which 17 schools participated; 19 schools took part in the 2009 assessment. The data instrument is comprised of a student questionnaire, and measured height and weight. Results from the 2008-09 survey indicate that 34% of males and 27% of females were overweight or obese, figures that trend higher than the total found by the CCHS.⁷⁴

Discussion

Strong evidence is available concerning the association of childhood overweight/obesity with asthma and adult overweight/obesity. More limited evidence has been reported for an association with sleep disordered breathing and adult cancer risks. There are in fact a wide range of co-morbid conditions and complications associated with childhood obesity, though a *causative* link has not been established in most cases. The most significant of these co-morbidities is arguably type 2 diabetes mellitus. Based on the observation that “the increase of type 2 diabetes in children parallels rising rates of childhood obesity,”⁷⁵ few are surprised to hear that “excess adiposity is considered a major risk factor for development of type 2 diabetes in youth.”⁷⁶ However, working out the pathophysiology remains a very complex task. In this regard, it is true that insulin resistance is an important factor in the development of type 2 diabetes, and that obesity is one of the risk factors associated with onset of insulin resistance; other factors include family history and ethnicity.^{77,78}

There is good data availability regarding youth weight status in British Columbia, with three surveys reporting data from either 2008 or 2009. It should be noted that both the CCHS and the AHS use self-reported height and weight, with similar results being reported (approximately 17-19% of adolescents are overweight or obese). HASAC, a project that surveyed grade 6 students only (ages 11-12) in the province, was one of the rare instances of objective data related to BMI, that is, based on the collection of *measured* height and weight; this source has suggested a much higher proportion (around 30%) of overweight/obese individuals in a relatively narrow age cohort that is not covered by the

⁷¹ See the background description in the Introduction.

⁷² McCreary Centre Society. A Picture of Health: Highlights from the 2008 BC Adolescent Health Survey. Available at <http://www.mcs.bc.ca/pdf/AHS%20IV%20March%2030%20Final.pdf>. Accessed October 2010.

⁷³ Health Assessment of School-Aged Children. Background 2009. Available at <http://www.phsa.ca/NR/rdonlyres/9529AC51-BE69-45D2-B623-04EB82DF5E71/0/HASACFactSheet0809.pdf>. Accessed October 2010.

⁷⁴ Health Assessment of School-Aged Children 2008-09. Feedback Report for all Schools. Available at <http://www.phsa.ca/NR/rdonlyres/768CBFF0-3A9A-42AA-A393-F0E5A62DDA76/0/HASACAllSchoolsReport0809.pdf>. Accessed October 2010.

⁷⁵ Amed S, Dean HJ, Panagiotopoulos C et al. Type 2 diabetes, medication-induced diabetes, and monogenic diabetes in Canadian children: a prospective national surveillance study. *Diabetes Care*. 2010; 33(4): 786-91.

⁷⁶ Mayer-Davis EJ. Type 2 diabetes in youth: epidemiology and current research toward prevention and treatment. *Journal of the American Dietetic Association*. 2008; 108(4 Suppl 1): S45-51.

⁷⁷ Gungor N, Hannon T, Libman I et al. Type 2 diabetes mellitus in youth: the complete picture to date. *Pediatric Clinics of North America*. 2005; 52(6): 1579-609.

⁷⁸ Daniels SR. Complications of obesity in children and adolescents. *International Journal of Obesity*. 2009; 33 (Suppl 1): S60-5.

other two surveys. While BMI may differ between specific pediatric age groups, it is possible that much of the observed difference in results is due to the inherent unreliability of self-reporting related to height and (especially) to weight.

While underweight is not a focus in the literature or this section, there are aspects of this subtopic that are a concern. Particular attention has been focused on eating disorders, illnesses associated with severe body image distortion and resulting obsession with weight.⁷⁹ Anorexia nervosa and bulimia nervosa are currently considered the predominant eating disorders.⁸⁰ Anorexia nervosa is marked by a severely calorie-restricted diet, resulting in a body weight 85% or less of expected levels.⁸¹ Bulimia nervosa is characterized by recurrent periods of binge-eating followed by compensatory behaviours such as purging.⁸²

These conditions represent an increasing public health problem.⁸³ However, the prevalence of eating disorders is difficult to determine, since many people (and especially youth) are either unaware of their condition or unwilling to report it. Canadian studies have put the one-year prevalence of anorexia at 0.7% for women and 0.2% for men, and of bulimia at 1.5% for women and 0.1% for men.^{84,85} In Ontario, the lifetime prevalence of bulimia among women aged 15 to 65 years was estimated at 1.1% in a 1990 survey.⁸⁶ In the U.S., it is estimated that 1 to 4% of young women are affected by eating disorders.⁸⁷ The consequences of the various eating disorders can be very serious, with as many as 1 in 10 to 1 in 20 cases leading to death from starvation, cardiac arrest, alcoholism, or suicide.⁸⁸ Some authorities suggest that eating disorders have the highest mortality rate of any mental illness.⁸⁹

Conclusion

There is good evidence for an association between childhood overweight/obesity and poor physical health outcomes. Additionally, there are several surveys with recent data available on the weight status of B.C. youth. The combination of these two factors offers a solid rationale for using overweight/obesity as an indicator of child physical health. In terms of comprehensiveness and regularity, the annual information generated by the CCHS appears to be the superior data source, notwithstanding the ongoing concerns about self-reported information related to body weight (and therefore to body mass index).

⁷⁹ National Eating Disorders Screening Program. Available at: <http://www.mentalhealthscreening.org/eat/eat-faq.htm> (accessed November 2004).

⁸⁰ Polivy J, Herman CP. Causes of eating disorders *Annual Review of Psychology* 2002; 53: 187-213.

⁸¹ Gucciardi E, Celasun N, Ahmad F et al. Eating Disorders. *Women's Health Surveillance Report*. Health Canada, 2001.

⁸² National Eating Disorders Screening Program. Available at <http://www.mentalhealthscreening.org/eat/eat-faq.htm> (accessed November 2004).

⁸³ Gucciardi E, Celasun N, Ahmad F, Stewart DE. Eating Disorders. *Women's Health Surveillance Report*. Health Canada, 2001.

⁸⁴ Offord DR, Boyle MH, Campbell D et al. One-year prevalence of psychiatric disorder in Ontarians 15 to 64 years of age *Canadian Journal of Psychiatry* 1996; 41: 559-563

⁸⁵ Bland RC, Newman SC, Orn H. Period prevalence of psychiatric disorders in Edmonton *Acta Psychiatrica Scandinavica* 1988; 77(Suppl 338): 33-42.

⁸⁶ Gucciardi E, Celasun N, Ahmad F et al. Eating Disorders. *Women's Health Surveillance Report*. Health Canada, 2001.

⁸⁷ Eating Disorders. *Office on Women's Health: US Department of Health and Human Services*, 2000.

⁸⁸ Keel PK, Dorner DJ, Eddy KT et al. Predictors of mortality in eating disorders *Archives of General Psychiatry* 2003; 60(2): 179-83.

⁸⁹ Krueger H, Williams D, Kaminsky B et al. *The Health Impacts of Smoking & Obesity and What To Do About It*. University of Toronto Press Incorporated; 2007.

Summary Assessment					
Unhealthy Weight (i.e., Overweight or Obese)					
Age group (Years)	Est. Prevalence among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
12-17	55,800	Medium	Medium	Medium	Medium

As summarized above, assessments have been applied to the Healthy Weight concept, specifically in terms of the indicator with the most compelling support in the literature, namely: *the proportion of the population that is overweight or obese*.

The pediatric population **Magnitude** of the potential indicator is assessed as **Medium**. Based on 2009 CCHS data from Statistics Canada, 22.6% of males and 12.8% of females aged 12-17 years in B.C. were overweight or obese. When applied to the entire pediatric cohort of the same age range, it resulted in an estimated absolute prevalence of 36,400 males and 19,400 females, for a total of 55,800 individuals. This number falls between 2 and 10% (19,000 and 97,000) of the total pediatric cohort in B.C., resulting in a Magnitude classification of Medium.

The **Significance** of the potential indicator as indicated by the evidence of impact on an individual's health and well-being is assessed as **Medium**. There is generally strong evidence of an association between child overweight/obesity and poor health outcomes, though results for some areas are more mixed; causal mechanisms still need to be confirmed and elucidated.

The **Modifiability** of the potential indicator is assessed as **Medium**. Overweight/obesity appears to be amenable to primary prevention, though the effectiveness of weight loss interventions among overweight individuals in all age groups is notoriously weak. Some real-world prevention projects focused on children are showing promise, after many years of less encouraging results.

Data Availability/Reliability for the potential indicator is assessed as **Medium**. Data are available annually from the CCHS; the information is self-reported, however, which can be unreliable when the questions are related to weight, wherein some stigma is attached.

Based on the indicated assessment ratings consistently falling in the moderate range, the indicator tracking prevalence of unhealthy weight is **Not Recommended** for consideration as a core indicator of child health and well-being. However, it should be retained as good candidate for "secondary interest" given the strong attention being paid to this topic in Canada and globally. In terms of health impact, the evidence of pediatric overweight tracking into later overweight or obesity and leading to more direct health effects in adulthood is of particular importance.

Sleep Levels

Background and Context

The purpose of this review is to find research evidence of an association between sleep levels and the physical health of children. Lack of sleep in children has been connected with a wide variety of adverse health-related outcomes, including obesity and diabetes, reduced immunity, impeded physical development, and poor motor skills.

It is commonly noted that children—along with adults—are getting less sleep today than needed for optimal functioning. For instance, data from the 2004 *Sleep in America* poll indicated that 27% of school-aged children do not get enough sleep.⁹⁰ Increased use of media is often cited as a contributing factor; television viewing, the Internet, video games, and cell phones may all lead to later bedtimes for children and adolescents. Additionally, adolescents often have part-time jobs, evening activities, and school commitments early in the morning, further compounding the problem of reduced sleep time.

The fact is that, compared to health-enhancing behaviours such as physical activity and nutrition, sleep receives modest research attention—a situation that B.C. researcher Wendy Hall is attempting to correct in the Rocky Sleep Study, at least with respect to infants.⁹¹ Exactly what constitutes enough sleep in children remains a complex question, highly variable according to the age and other factors of the individual child.⁹² One Canadian study, based on a random sample of 5-10-year-old Quebec children, suggested that chronic health effects may set in when sleep duration dropped below 10 hours.⁹³

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-20 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

In order to provide as targeted a search as possible, Medical Subject Headings (MeSH) were applied, qualified by subheadings and whether or not it was a Major term (Majr) for the article. The precise terms used were as follows:

“Sleep Deprivation”[Mesh]

⁹⁰ Summary of Findings: 2004 Sleep in America Poll. Available at <http://www.sleepfoundation.org/sites/default/files/FINAL%20SOF%202004.pdf>. Accessed November 2010.

⁹¹ See study website at <http://www.rockysleepstudy.com/contact.html>. Accessed November 2010.

⁹² Canadian Sleep Society. *Sleep in Children*. 2005. Brochure available at http://www.css.to/sleep/sleep_children.pdf. Accessed November 2010.

⁹³ Chaput JP, Brunet M, Tremblay A. Relationship between short sleeping hours and childhood overweight/obesity: results from the 'Quebec en Forme' Project. *International Journal of Obesity*. 2006; 30(7): 1080-5.

AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Overweight"[Mesh] OR "Insulin Resistance"[Majr] OR "Diabetes Mellitus"[Majr] OR "Growth and Development"[Majr] OR "Immunity"[Majr])

The search for review articles ultimately returned a sufficient volume (see below) of papers to qualify for a Level A search process. As well, a selective approach to the supplementary search was deemed to be all that was necessary. This involved a scan in Google for grey literature and for any obvious articles missed, using terms such as: (**sleep duration** OR **sleep loss**) AND **children** AND **health**. Finally, as the most recent systematic review of the association of sleep levels with health was dated 2008, an update related to more recent studies was not pursued.

Taken together, the search processes returned 19 reviews for consideration.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between sleep levels and physical health outcome(s) in children, then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 7.

Primary Exclusion

The abstracts and/or full versions of the 7 articles were then reviewed. Articles not pertinent to the research topic were excluded; specifically, if the article did not link sleep levels with physical health outcome(s), or if it was not about children, it was excluded.

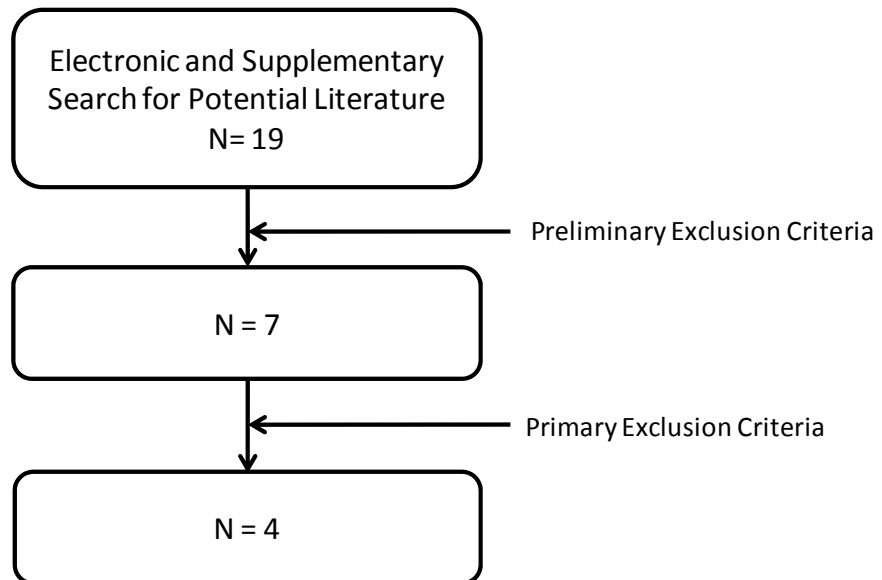
There were 4 reviews remaining in the list following primary exclusion.

Secondary Exclusion

The secondary exclusion step was not applied due to the small number of articles identified in the search process.

Literature Review Volume Report: Reviews

Dimension: Physical Health **Concept:** Sleep Levels



Summary of Relevant Reviews

Dimension: *Physical Health*

Concept: *Sleep Levels*

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	Number of Studies Reviewed
1	Meta-analysis of short sleep duration and obesity in children and adults	Cappuccio	2008	Sleep	4.95	1992-2007	12
2	Is sleep duration associated with childhood obesity? A systematic review and meta-analysis	Chen	2008	Obesity	3.37	1992-2007	17
3	Shortened sleep duration is associated with pediatric overweight	Hart	2008	Behavioral Sleep Medicine	---	1992-2007	10
4	Short sleep duration and weight gain: A systematic review	Patel	2008	Obesity	3.37	1192-2006	13

Detailed Results

For the 4 reviews identified by the literature search and exclusion process, a summary table of results was developed; this table is provided below.

Dimension: <i>Physical Health</i> Concept: <i>Sleep Levels</i> Summary Table of Reviews			
Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Cappuccio (2008)	Meta-analysis of short sleep duration and obesity in children and adults	12	Cross-sectional studies from around the world show a consistent increased risk of obesity amongst short sleepers in children and adults. Although this link to obesity is potentially important, a causal association has not yet been proven.
Chen (2008)	Is sleep duration associated with childhood obesity? A systematic review and meta-analysis	17	Children with shorter sleep duration had a 58% higher risk for overweight or obesity; children with shortest sleep duration had an even higher risk (92%) when compared with children having longer sleep duration. A significant linear dose-response relationship can be found only in young children (<10-year-old) or for combined overweight and obesity, but not for all sleep-deprived children considered as a group.
Hart (2008)	Shortened sleep duration is associated with pediatric overweight	10	Epidemiological studies with children have found evidence for an association between shortened sleep duration and increased overweight. In particular, cross-sectional studies with adolescents show results consistent with these findings.
Patel (2008)	Short sleep duration and weight gain: a systematic review	13	Across the spectrum of pediatric studies, results were fairly uniform: short sleep duration was positively associated with increased weight.

Bibliography for Table of Reviews

Cappuccio FP, Taggart FM, Kandala NB et al. Meta-analysis of short sleep duration and obesity in children and adults. *Sleep*. 2008; 31: 619-26.

Chen X, Beydoun MA Wang Y. Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. *Obesity*. 2008; 16: 265-74.

Hart CN, Jelalian E. Shortened sleep duration is associated with pediatric overweight. *Behavioral Sleep Medicine*. 2008; 6: 251-67.

Patel SR, Hu FB. Short sleep duration and weight gain: a systematic review. *Obesity*. 2008; 16: 643-53.

Summary of Results

All reviews identified in the search process focus on the association between sleep duration and weight gain/overweight/obesity. These recent reviews all concluded that shorter sleep duration is positively associated with increased weight in children; however, a causal link is yet to be proven. Results from selected studies highlighted in the reviews are as follows:

- A Japanese birth cohort of 8,274 children was assessed between the ages of 6 and 7. Compared to children with sleep duration of 10 hours or more, the odds ratio (OR) for obesity was 1.49, 1.89, and 2.89 for sleep durations of 9-10, 8-9, and fewer than 8 hours, respectively⁹⁴
- A study of 422 Canadian children ages 5-10 found that, compared to a sleep duration of 12 hours or more, the OR for obesity was 1.42 and 3.45 for sleep durations of 10.5-11.5 hours and 10 or fewer hours, respectively⁹⁵
- A prospective cohort study in the UK of 7,758 children aged 3 years at baseline found that short sleep duration (<10.5 h) at age three was associated with obesity at age seven (OR = 1.45)⁹⁶

Results for adolescents were inconsistent; some studies reported association with overweight in the expected direction, while others showed no association among adolescent girls.⁹⁷

Data Sources for Sleep Levels

There were no routine British Columbian or Canadian data sources identified that provide information on sleep duration among children. While Statistics Canada has previously produced reports on sleep patterns, the cohorts surveyed were aged 15 years and over, providing at best a partial picture of the pediatric population. The prevalence information provided in the Canadian study cited above appears to be the best currently available; Chaput et al. found that 11.4% of girls and 12.3% of boys aged 5-10 years slept less than 10 hours a night—a level where chronic health effects could already be detected.⁹⁸

Discussion

Overall, there is modest evidence for an association between shortened sleep duration and increased weight in children. In addition to the reviews from 2008 included in this report, new studies continue to be published on this topic (as recent as September 2010).^{99,100,101}

⁹⁴ Sekine M, Yamagami T, Handa K et al. A dose-response relationship between short sleeping hours and childhood obesity: results of the Toyama Birth Cohort Study. *Child: Care, Health and Development*. 2002; 28(2): 163-70.

⁹⁵ Chaput JP, Brunet M, Tremblay A. Relationship between short sleeping hours and childhood overweight/obesity: results from the 'Quebec en Forme' Project. *International Journal of Obesity*. 2006; 30(7): 1080-5.

⁹⁶ Reilly JJ, Armstrong J, Dorosty AR et al. Early life risk factors for obesity in childhood: cohort study. *British Medical Journal*. 2005; 330(7504): 1357.

⁹⁷ Chen X, Beydoun MA, Wang Y. Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. *Obesity*. 2008; 16(2): 265-74.

⁹⁸ Chaput JP, Brunet M, Tremblay A. Relationship between short sleeping hours and childhood overweight/obesity: results from the 'Quebec en Forme' Project. *International Journal of Obesity*. 2006; 30(7): 1080-5.

⁹⁹ Bell JF, Zimmerman FJ. Shortened nighttime sleep duration in early life and subsequent childhood obesity. *Archives of Pediatrics & Adolescent Medicine*. 2010; 164(9): 840-5.

Although many other physical health effects of sleep deprivation are discussed in various sources, no recent studies or reviews could be identified that presented scientific evidence of an association between sleep duration and physical health (other than obesity) in children. A large proportion of the studies of the effects of shortened sleep on health outcomes have been conducted among adult populations.

There are a number of limitations in the literature that prevent any definitive conclusion that shortened sleep duration *causes* accelerated weight gain. Objective measurements of sleep duration are rarely used, with most studies relying on questionnaires and self-report and thus raising questions about data reliability. In addition, there are many potentially confounding factors involved with the topic of sleep duration and weight. While some studies have attempted to control for factors such as parental weight status, parental education, family income, and television viewing, there are other variables of concern, including parenting behaviours and skills, nutritional habits, energy expenditure, and cultural norms. Chen et al. suggest that increasing sleep duration may be an important strategy in fighting the growing childhood obesity epidemic, and that further studies are required to test the effectiveness of such a strategy.¹⁰² As summarized by Must and Parisi, “further delineation of the complex interrelation of sleep, time use, mood, and familial factors in racially and economically diverse samples are needed before sleep interventions can be designed or preventive guidance offered.”¹⁰³

Conclusion

The evidence is moderate-to-strong for an association between shortened sleep duration and obesity; there is no proof yet of causation, though potential mechanisms are being explored.¹⁰⁴ As yet, there are no routine British Columbian (or Canadian) data available on sleep duration among children. Thus, instituting sleep levels as an indicator of child physical health would currently be of low utility. However, it may be an area to consider developing, as long as issues of data availability/reliability could be resolved, along with the biological plausibility of sleep deprivation as a cause of pediatric overweight.

¹⁰⁰ Watanabe M, Kikuchi H, Tanaka K et al. Association of short sleep duration with weight gain and obesity at 1-year follow-up: a large-scale prospective study. *Sleep*. 2010; 33(2): 161-7.

¹⁰¹ Danielsen YS, Pallesen S, Stormark KM et al. The relationship between school day sleep duration and body mass index in Norwegian children (aged 10-12). *International Journal of Pediatric Obesity*. 2010; 5(3): 214-20.

¹⁰² Chen X, Beydoun MA, Wang Y. Is sleep duration associated with childhood obesity? A systematic review and meta-analysis. *Obesity*. 2008; 16(2): 265-74.

¹⁰³ Must A, Parisi SM. Sedentary behavior and sleep: paradoxical effects in association with childhood obesity. *International Journal of Obesity*. 2009; 33(Suppl 1): S82-6.

¹⁰⁴ Must A, Parisi SM. Sedentary behavior and sleep: paradoxical effects in association with childhood obesity. *International Journal of Obesity*. 2009; 33 (Suppl 1): S82-6.

Summary Assessment					
Getting Less than 10 hours of Sleep					
Age group (Years)	Est. Prevalence among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	115,100	High	Medium	High	Low

As summarized above, assessments have been applied to the Sleep Levels concept, specifically in terms of the indicator with the most compelling support in the literature, namely: *the proportion of the subpopulation getting less than 10 hours of sleep*.

The pediatric population **Magnitude** of the potential indicator is assessed as **High**. A 2006 publication by Chaput et al. found that 12.3% of males, and 11.4% of females aged 5-10 got less than 10 hours of sleep per night. In order to estimate the significance of this indicator across the whole pediatric cohort, these gender-specific prevalence rates were applied to those aged 0-19, leading to a figure of 115,400 individuals get less than 10 hours of sleep per night. This is greater than 10% (97,000) of the total pediatric cohort, resulting in a Magnitude classification of High.

The **Significance** of the potential indicator as indicated by the evidence of impact on an individual's health and well-being is assessed as **Medium**. There is reasonably good evidence for a link between shortened sleep duration and obesity, although causality has not been proven.

The **Modifiability** of the potential indicator is assessed as **High**. The intuitive rationale is that, despite the fact that relatively little research has been pursued on underlying risk factors or related interventions to improve sleep duration, the application of disciplined routines at home could reverse a substantial portion of the sleep deficit.

Data Availability/Reliability for the potential indicator is assessed as **Low**. Data on sleep levels are not routinely collected or reported in B.C. or Canada.

Based on the indicated assessment, the indicator related to not sleeping at least 10 hours in the 5- to-10-year-old age group is **Not Recommended** for consideration as a core indicator of child health and well-being. The reasons are the Low ratings for data availability/reliability, and the fact that the research on the optimal standard for sleep hours and the outcomes of substandard sleep—including psychosocial impacts—is still at a young stage of development. It is important to recall that the main agenda of the project was to identify high-leverage indicators that could be taken “off the shelf” and applied in the near term in B.C. On the other hand, a combination of improved evidence base and establishment of a data tracking approach could propel this concept/indicator into at least the investigational category, that is, as a candidate for potential development.

Health-Compromising Personal Behaviours and Related Outcomes

Tobacco Use

Background and Context

The purpose of this review is to find research evidence of an association between tobacco use among youth and physical health outcomes. As stated by Lenney and Enderby, “tobacco dependence is considered a paediatric disease because most people begin smoking as young teenagers at which time they are likely to become dependent on nicotine.”¹⁰⁵ Early smoking initiation in the British Columbia context is illustrated by data from the 2005 Canadian Community Health Survey (CCHS); among current and former smokers in B.C., 85% had begun smoking at 19 years of age or younger.¹⁰⁶ Tobacco smoking has long been associated with adverse health effects; in 1950 the first major evidence of such effects was published, linking the prevalence of lung cancer with smoking rates.¹⁰⁷ Tobacco smoking is now identified as a major cause of a vast number of diseases and other adverse effects, including heart disease, stroke, lung cancer and various other cancers, diabetes, and hypertension.¹⁰⁸ Indeed, a major conclusion of the 2004 U.S. Surgeon General’s report *The Health Consequences of Smoking* was that “smoking harms nearly every organ of the body, causing many diseases and reducing the health of smokers in general.”¹⁰⁹ Among other sources, prevalence data for tobacco smoking among British Columbia youth is available from the Youth Smoking Survey; according to the 2008/09 survey results, 35% of youth in grades 6 to 12 reported having ever tried smoking, and about 9% of youth reported being a current smoker.¹¹⁰

Conceptual Scoping

The main focus of this concept is on first-hand effects of tobacco use, that is, where the youth are smokers. The subtopic of environmental tobacco smoke (ETS) could have been categorized in this section or possibly under another concept (e.g., environmental exposures, or even antenatal care); however, it was convenient to handle it under the section Pregnancy Outreach Services and Targets, where the focus is on *the impacts that adult behaviours have on child health*. Of course, that later section of the report was also the appropriate umbrella under which to house the consequences for infants of smoking during pregnancy.

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

¹⁰⁵ Lenney W, Enderby B. "Blowing in the wind": a review of teenage smoking. *Archives of Disease in Childhood*. 2008; 93(1): 72-5.

¹⁰⁶ Statistics Canada. CANSIM Table 105-0501. Available at <http://cansim2.statcan.gc.ca/cgi-win/CNSMCGI.PGM>. Accessed October 2010.

¹⁰⁷ Musk AW, de Klerk NH. History of tobacco and health. *Respirology*. 2003; 8(3): 286-90.

¹⁰⁸ Wipfli H, Samet JM. Global economic and health benefits of tobacco control: part 1. *Clinical Pharmacology & Therapeutics*. 2009; 86(3): 263-71.

¹⁰⁹ The Health Consequences of Smoking: A Report of the Surgeon General. 2004. Available at http://www.cdc.gov/tobacco/data_statistics/sgr/2004/index.htm. Accessed October 2010.

¹¹⁰ Smoking Profile for British Columbia Youth. Youth Smoking Survey 2008/09. Available at http://www.yss.uwaterloo.ca/results/yss08_provincial_report_BC.pdf. Accessed October 2010.

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

("Smoking"[Majr] OR "Tobacco Use Cessation"[Majr] OR "Tobacco Use Disorder"[Majr])

AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr])

The search processes returned 73 reviews for consideration. Upon review of the list, however, it was determined that, surprisingly, none of them qualified as systematic reviews examining physical health effects of tobacco use among youth. Relevant narrative review articles were thus selected as an alternate basis for discussion.

Data Sources on Tobacco Use

Two major sources of information for tobacco use among youth in British Columbia are the Canadian Community Health Survey (CCHS) and the Youth Smoking Survey (YSS), as mentioned in the Background Context section. These sources are detailed below, including the elements related specifically to youth smoking. There are other provincial surveys that bear on this topic, including the Adolescent Health Survey and CHESS (see below). However, these instruments do not provide *annual* information comparable to the CCHS; as well, CHESS covers a narrower age range than does the CCHS.

Statistics Canada – Canadian Community Health Survey (CCHS)

According to the 2009 CCHS survey¹¹¹, 8.6% of the individuals in the 12- to 19-year-old age group were current smokers in that year.¹¹² While this rate is low relative to CTUMS and CHESS information (see below), it is difficult to make comparisons due to variation in the target age range.

Youth Smoking Survey (YSS)

Funded by Health Canada, the YSS is Canada's only nationwide survey focusing on student smoking. It is administered to students in grades 6 to 12 on a biennial basis.¹¹³ YSS was first administered in 1994 and, at that time, it represented the largest and most comprehensive

¹¹¹ See the background description in the Introduction.

¹¹² Statistics Canada. CANSIM Table 105-0501. Available at <http://cansim2.statcan.gc.ca/cgi-win/CNSMCGI.PGM>. Accessed October 2010.

¹¹³ Youth Smoking Survey. Available at <http://www.yss.uwaterloo.ca/index.cfm?section=1001&page=248>. Accessed October 2010.

survey on youth smoking behaviour since 1979. The YSS was repeated in 2002, 2004/2005, 2006/2007, and most recently in 2008/2009. Data collected by the YSS include the following:

- Benchmarks for national smoking prevalence rates
- Detailed information about student smoking behaviours and perceptions
- Information about student alcohol and drug use
- Correlations between student physical activity and eating behaviours and their connection to smoking
- Levels of youth exposure to environmental tobacco smoke
- Students' feeling of connectedness to their school and fellow classmates

As noted in the Background section, 2008/2009 YSS results indicate that 35% of youth in grades 6 to 12 have ever tried smoking, and about 9% of youth reported being a current smoker.¹¹⁴ This is similar to the percentage found by the CCHS instrument for a slightly larger age range.

Canadian Tobacco Use Monitoring Survey (CTUMS)

Health Canada's CTUMS provides timely, reliable, and continual data on national and provincial tobacco use rates.¹¹⁵ The survey's primary objective is to track changes in smoking status and amount smoked, especially for the 15- to 24-year-old age group where the risk is highest for taking up smoking, a behaviour that can then persist across the life course. According to 2009 annual results, 12.5% of British Columbia youth aged 15-19 years were current smokers. There has been a steep downward trend in this proportion since 1999, when fully 20% of 15-19-year-olds were reported to be current smokers.

Community, Health, Education and Social Services (CHESS) Omnibus Survey

The CHESS Omnibus Survey was conducted by BC Stats in 2008. It covered topics such as tobacco and alcohol use, pregnancy, employment and workplace issues, disability, and general demographics in British Columbia. Among 15- to 19-year-olds, 10.7% were reported to be current smokers in 2008, a lower rate than generated by CTUMS for the same age group.¹¹⁶

Summary of Results and Discussion

The adverse health effects of tobacco smoking in adults are well-established; these include a range of cancers, cardiovascular diseases, and respiratory conditions. The U.S. Surgeon General's 2004 report concluded that smoking diminishes the overall health of smokers in extensive ways.¹¹⁷ These effects are significant to the concept of youth tobacco use because of the high likelihood that those who initiate smoking in adolescence will become dependent and continue smoking through adulthood.^{118,119,120} Additionally, evidence suggests that

¹¹⁴ Smoking Profile for British Columbia Youth. Youth Smoking Survey 2008/09. Available at http://www.yss.uwaterloo.ca/results/yss08_provincial_report_BC.pdf. Accessed October 2010.

¹¹⁵ Canadian Tobacco Use Monitoring Survey. Available at http://www.hc-sc.gc.ca/hc-ps/tobac-tabac/research-recherche/stat/ctums-esutc_2009-eng.php. Accessed November 2010.

¹¹⁶ Tobacco Attitudes and Behaviours Survey Report. 2009. BC Stats. Available at <http://www.bcstats.gov.bc.ca/data/lss/social.asp>. Accessed November 2010.

¹¹⁷ The Health Consequences of Smoking: A Report of the Surgeon General. 2004. Available at http://www.cdc.gov/tobacco/data_statistics/sgr/2004/index.htm. Accessed October 2010.

¹¹⁸ Mathers M, Toumbourou JW, Catalano RF et al. Consequences of youth tobacco use: a review of prospective behavioural studies. *Addiction*. 2006; 101(7): 948-58.

adolescent tobacco smoking increases the likelihood of alcohol use or development of alcohol-related problems, and it is also strongly associated with illegal drug use.^{121,122} B.C. data from the 2008-2009 Youth Smoking Survey illustrates these associations: youth who had ever tried smoking a cigarette were more likely to have had a drink of alcohol in the last 12 months than those who have never smoked (82% vs. 36%), and 97% of current smokers reported having a drink of alcohol (more than just a sip).¹²³ Furthermore, 89% of current smokers had ever used or tried marijuana.

There are also a number of more short-term adverse health effects associated with youth tobacco use; children and adolescents who smoke are less physically fit, experience more respiratory illnesses, and their lung function declines faster than their non-smoking peers.¹²⁴ Mental health problems, difficulties at school, crime, and early parenthood have also been correlated with tobacco use at a young age, though these impacts lie outside of the strict realm of physical health.¹²⁵

Conclusion

There is strong evidence that tobacco smoking in youth is associated with adverse physical health effects. Adding to its potential utility as a concept/indicator, up-to-date data on youth tobacco use in B.C. is available from both the Youth Smoking Survey and the Canadian Community Health Survey. There are other sources with tobacco use data specific to the province, but these only report information for ages 15 years and older and/or they are not conducted on a regular basis.

¹¹⁹ Lenney W, Enderby B. "Blowing in the wind": a review of teenage smoking. *Archives of Disease in Childhood*. 2008; 93(1): 72-5.

¹²⁰ Mathers M, Toumbourou JW, Catalano RF et al. Consequences of youth tobacco use: a review of prospective behavioural studies. *Addiction*. 2006; 101(7): 948-58.

¹²¹ Myers MG, Kelly JF. Cigarette smoking among adolescents with alcohol and other drug use problems. *Alcohol Research & Health*. 2006; 29(3): 221-7.

¹²² Mathers M, Toumbourou JW, Catalano RF et al. Consequences of youth tobacco use: a review of prospective behavioural studies. *Addiction*. 2006; 101(7): 948-58.

¹²³ Smoking Profile for British Columbia Youth. Youth Smoking Survey 2008/09. Available at http://www.yss.uwaterloo.ca/results/yss08_provincial_report_BC.pdf. Accessed October 2010.

¹²⁴ The Health Consequences of Smoking: A Report of the Surgeon General. 2004. Available at http://www.cdc.gov/tobacco/data_statistics/sgr/2004/index.htm. Accessed October 2010.

¹²⁵ Mathers M, Toumbourou JW, Catalano RF et al. Consequences of youth tobacco use: a review of prospective behavioural studies. *Addiction*. 2006; 101(7): 948-58.

Summary Assessment

Current Smoking

Age group (Years)	Est. Prevalence among B.C. Children (2010)	Data			
		Magnitude	Significance/Impact	Modifiability	Availability/Validity
12-19	37,200	Medium	High	High	Medium-High

As summarized above, assessments have been applied to the Tobacco Use concept, specifically in terms of the indicator with the most compelling support in the literature, namely: *the proportion of the pediatric population that consists of current smokers.*

The pediatric population **Magnitude** of the potential indicator is assessed as **Medium**. Based on 2009 CCHS data, it is estimated that 8.6% of children aged 12-19 are current smokers. When this percentage is applied to the 2010 pediatric cohort of the same age, the estimated absolute prevalence of current smokers is 37,200 individuals. This total lies is between 2 and 10% (19,000 and 97,000) of the total pediatric cohort, resulting in a Magnitude classification of Medium.

The **Significance** of the potential indicator as indicated by the well-known evidence of impact on an individual's health and well-being is assessed as **High**. There are significant adverse health and well-being effects associated with tobacco use, and the evidence for causation is well-established; moreover, youth who initiate smoking are likely to continue the practice into adulthood, with concomitant health effects and ultimately the risk of premature death.

The **Modifiability** of the potential indicator is assessed as **High**. Interventions for reducing/preventing tobacco use have been widely studied, with strong evidence of effectiveness, including among youth when the appropriate levels of investment are made.

Data Availability/Reliability for the potential indicator is assessed as **Medium-High**. Data on youth tobacco use is available from CCHS and other sources; this clearly is a reliable, routinely tracked indicator, based on self-report.

Based on the indicated assessment, the indicator related to current smoking is **Recommended** for consideration as a core indicator of child health and well-being. The reasons are the uniformly medium-to-high ratings across the four assessment categories.

Alcohol Use

Background and Context

The purpose of this review is to find research evidence of an association between alcohol use by youth and their physical health. Guerri and Pascual point out that “alcohol is one of the first drugs of choice among young people and adolescents, and heavy binge-drinking is becoming increasingly frequent in high school students in different countries.”¹²⁶ Binge drinking is generally defined as episodic excessive consumption of alcohol; in the BC Adolescent Health Survey (AHS), it is defined as having five or more drinks of alcohol within a couple of hours. This type of drinking contributes to a substantial portion of alcohol-related deaths; it has been associated with alcohol poisoning, unintentional injuries (including motor vehicle crashes), suicide, hypertension, sexually transmitted infections, meningitis, alcohol-related disorders and alcohol dependence.^{127,128}

According to the AHS, alcohol use among B.C. youth has recently been in decline; the percentage of teens from three different age groups who had ever drank alcohol decreased between 2003 and 2008, as shown in the following table:¹²⁹

BC Students Who Ever Drank Alcohol		
Age	Year	
	2003	2008
13-year-olds	34%	29%
15-year-olds	64%	58%
17-year-olds	79%	78%

Source: BC Adolescent Health Survey, 2008.

Contrary to these encouraging signs, Canadian Community Health Survey data indicates that heavy or binge drinking (defined as 5 or more drinks on one occasion, at least once a month in the past year) has increased from 10.8% in 2003 to 15.1% in 2009 among B.C. youth aged 12-19.¹³⁰

One of the lines of evidence that supports teenage drinking as an area of concern, and a concept that could be considered as the impetus for a core indicator, is the fact that age of drinking initiation is highly associated with risk of drinking problems such as alcohol dependence later in life, as indicated in the following chart.¹³¹

¹²⁶ Guerri C, Pascual M. Mechanisms involved in the neurotoxic, cognitive, and neurobehavioral effects of alcohol consumption during adolescence. *Alcohol*. 2010; 44(1): 15-26.

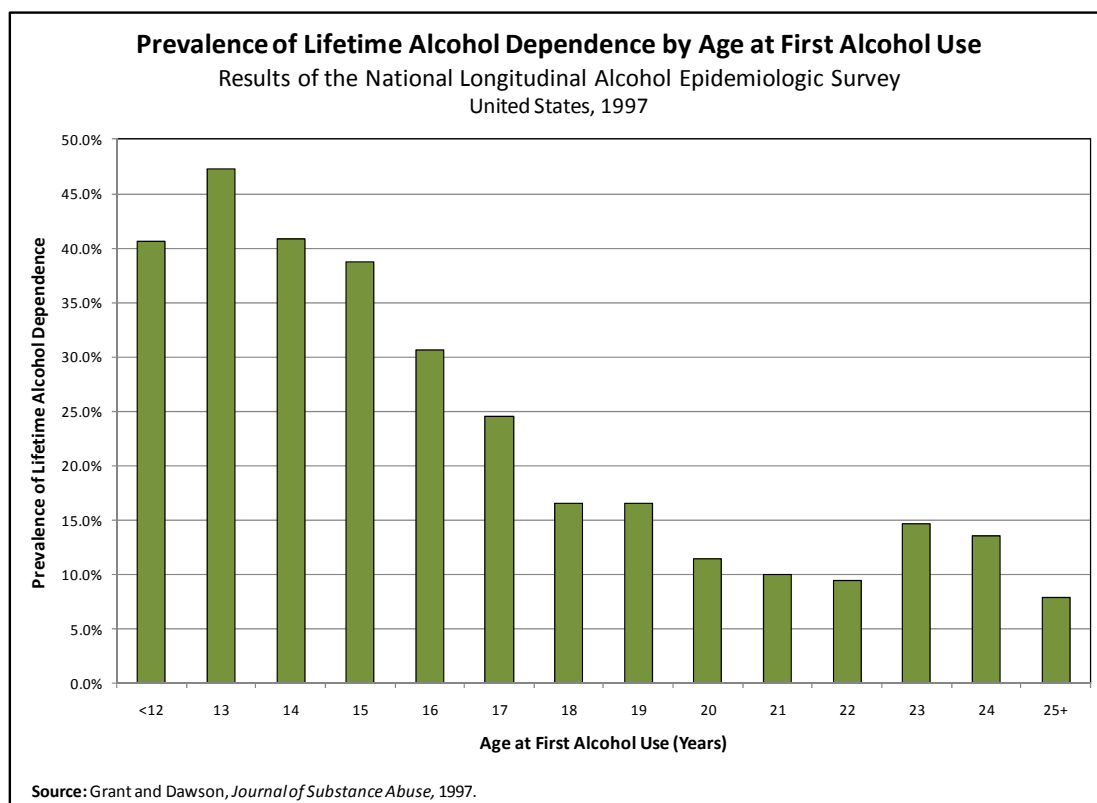
¹²⁷ Stolle M, Sack PM, Thomasius R. Binge drinking in childhood and adolescence: epidemiology, consequences, and interventions. *Deutsches Arzteblatt International*. 2009; 106(19): 323-8.

¹²⁸ Courtney KE, Polich J. Binge drinking in young adults: Data, definitions, and determinants. *Psychological Bulletin*. 2009; 135(1): 142-56.

¹²⁹ McCreary Centre Society. A Picture of Health: Highlights from the 2008 BC Adolescent Health Survey. Available at <http://www.mcs.bc.ca/pdf/AHS%20IV%20March%2030%20Final.pdf>. Accessed October 2010.

¹³⁰ Statistics Canada. CANSIM Table 105-0501. Available at <http://cansim2.statcan.gc.ca/cgi-win/CNSMCGI.PGM>. Accessed October 2010.

¹³¹ Grant BF, Dawson DA. Age at onset of alcohol use and its association with DSM-IV alcohol abuse and dependence: results from the National Longitudinal Alcohol Epidemiologic Survey. *Journal of Substance Abuse*. 1997; 9: 103-10.



As well, alcohol dependence in young adults has been associated with the specific behaviour of binge drinking in the adolescent years.¹³²

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

("Alcohol Drinking"[Majr] OR "Alcoholism"[Majr] OR "Alcoholic Intoxication"[Majr])

¹³²Bonomo YA, Bowes G, Coffey C et al. Teenage drinking and the onset of alcohol dependence: a cohort study over seven years. *Addiction*. 2004; 99(12): 1520-8.

AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr])

The search processes returned 79 reviews for consideration. Upon review of the list, however, it was determined that none of them qualified as systematic reviews examining physical health effects of alcohol use among youth. Relevant narrative review articles were then selected for discussion purposes. It is perhaps not surprising that clinical trials are not part of the available investigations (and reviews), due to the ethical barriers with supplying a study group with alcohol.

Finally, a supplementary search was conducted in Google, using search terms such as "alcohol" AND "adolescents" and "alcohol" AND "health effects."

Data Sources on Alcohol Use

There are two main sources of data on alcohol use by B.C. youth: the Adolescent Health Survey (AHS) and the Canadian Community Health Survey (administered by Statistics Canada), already introduced in the Background and Context section.¹³³ Alcohol-related information available from the AHS includes the proportion of students who ever drank alcohol, at what age they first drank, the types of alcohol used "last Saturday," and binge drinking rates. CCHS data on alcohol use by 12-19-year-olds is available for most years from 2003-2009.

In addition to these two main sources of routine information, alcohol use is surveyed in the Canadian Alcohol and Drug Use Monitoring Survey (CADUMS).¹³⁴ However, this is a national dataset, with 15-24-year-olds as the only youth age group for which data is available. While some provincial data is presented, it is not broken down by age group.

Summary of Results and Discussion

As noted in the Methodology section, there were no systematic reviews or clinical trials identified for this chapter. The discussion of results was therefore limited to narrative-type reviews of adverse health effects of alcohol use among youth, as well as any grey literature on the topic.

In the U.S. Surgeon General's *Call to Action to Prevent and Reduce Underage Drinking*, some of the prominent adverse physical consequences of underage alcohol use are listed, as follows:¹³⁵

¹³³ See the background description of the two sources in the Introduction to the report.

¹³⁴ Canadian Alcohol Use and Drug Monitoring Survey. Health Canada. Available at http://www.hc-sc.gc.ca/hc-ps/drugs-drogues/stat/_2009/summary-sommaire-eng.php. Accessed November 2010.

¹³⁵ U.S. Department of Health and Human Services. U.S. Surgeon General's *Call to Action to Prevent and Reduce Underage Drinking*. U.S. Department of Health and Human Services, Office of the Surgeon General, 2007.

- Alcohol use is a leading contributor to injuries and to death caused by intentional or unintentional injury. Annually, about 5,000 people under age 21 die from alcohol-related injuries (including motor vehicle crashes, homicides, and suicides). In Canada in 2002-2003, 27% of people admitted to a specialized trauma hospital due to alcohol-related injuries were between the ages of 10 and 24.¹³⁶
- It plays a significant role in risky sexual behaviour, increasing the rate of contracting sexually transmitted infections
- Alcohol use increases the risk of physical and sexual assault
- It can directly cause a range of physical consequences, from hangovers to death from alcohol poisoning
- Alcohol use is a risk factor for heavy drinking later in life. Continued heavy use of alcohol leads to increased risk across the lifespan for various cancers, liver cirrhosis, pancreatitis, and hemorrhagic stroke.

Additionally, studies of adolescent brain maturation over the last decade indicate that alcohol exposure during this critical developmental stage could result in behavioural and cognitive deficits.^{137,138,139}

Conclusion

Based on population data on alcohol-related injury among youth, as well as strong evidence that alcohol consumption (and especially binge drinking) is a risk factor for various health-related outcomes in the short- and long-term, there is strong rationale for monitoring alcohol use among youth. Additionally, there are recent and relevant population-level data available for alcohol use among British Columbia youth. These figures confirm that, although basic consumption rates may have declined or at least reached a plateau, the number of drinking youth remains high; furthermore, binge drinking appears to still be on the rise, making this area a matter of ongoing urgency in terms of public health.

¹³⁶ Canadian Institute for Health Information. Available at

http://secure.cihi.ca/cihiweb/dispPage.jsp?cw_page=media_22jun2005_e#youth. Accessed October 2010.

¹³⁷ Maldonado-Devincci AM, Badanich KA, Kirstein CL. Alcohol during adolescence selectively alters immediate and long-term behavior and neurochemistry. *Alcohol*. 2010; 44(1): 57-66.

¹³⁸ Guerri C, Pascual M. Mechanisms involved in the neurotoxic, cognitive, and neurobehavioral effects of alcohol consumption during adolescence. *Alcohol*. 2010; 44(1): 15-26.

¹³⁹ Clark DB, Thatcher DL, Tapert SF. Alcohol, psychological dysregulation, and adolescent brain development. *Alcoholism: Clinical and Experimental Research*. 2008; 32(3): 375-85.

Summary Assessment					
Binge Drinking					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
12-19	65,300	Medium	High	Medium-High	Medium

As summarized above, assessments have been applied to the Alcohol Use concept, specifically in terms of the indicator with the most compelling support in the literature, namely: *the proportion of the population that engages in binge drinking*.

The pediatric population **Magnitude** of the potential indicator is assessed as **Medium**. Based on 2009 CCHS data, 15.1% of individuals aged 12-19 years engaged in binge drinking. When this percentage is applied to the 2010 pediatric cohort of the same age, the estimated absolute prevalence of binge drinkers is 65,300 individuals. This is between 2 and 10% (19,000 and 97,000) of the total pediatric cohort, resulting in a Magnitude classification of Medium.

The **Significance** of the potential indicator as indicated by the evidence of impact on an individual's health and well-being is assessed as **High**. Binge drinking is associated with a number of adverse health outcomes, including death due to unintentional trauma.

The **Modifiability** of the potential indicator is assessed as **Medium-High**. Binge drinking is theoretically amenable to prevention, and some interventions have been proposed/tested (e.g., brief motivational interventions, as described by Stolle et al.); however, further study of this area appears to be warranted.

Data Availability/Validity for the potential indicator is assessed as **Medium**. Information on binge drinking in youth is available on a routine basis from the BC Adolescent Health Survey, though it is self-reported and has a degree of attached stigma, so the reliability of the data may be somewhat in question.

Based on the indicated assessment, the indicator related to is **Recommended** for consideration as a core indicator of child health and well-being. The reasons are the uniformly medium-to-high ratings across the four assessment categories.

Drug Use

Background and Context

The purpose of this review is to find research evidence of an association between drug use by youth and adolescents, and the resulting physical and non-physical health outcomes. The focus will be on the direct health and well-being effects of drug use as a behaviour “freely” adopted, rather than indirect effects arising from the illegal status of certain drugs (e.g., violence due to involvement with the black market in such substances). For the purposes of conceptual scoping, “drug use” here refers to the use of non-prescription, illegal drug use rather than the abuse of medication, steroids, growth hormones, etc. that otherwise have routine, legitimate applications.^{140,141,142} Cannabis to some extent transcends this distinction, due to prescriptions for “medical marijuana.”¹⁴³

Among youth, illegal substances beyond cannabis include: so-called “party” or “club” drugs such as ecstasy; cocaine; crystal methamphetamine; inhalants (i.e., glue, solvent, paint, fuel); LSD; and many others. Some of the substances are occasionally grouped as hallucinogens, but this refers to a specific psychological effect rather than to the basic biological/chemical classification of the substance involved; other terms such as “street drugs” and “recreational use,” like the category “party” or “club” used above, attempt to specify a social context for usage, but are generally challenging to apply accurately.

A wide range of physical impacts and potential mental health effects have been associated with many of these types of drugs, ranging from acute effects of short duration to chronic health conditions to serious toxicity and death (e.g., from overdose). In Canada, cannabis is by far the most widely used illegal drug, with consumption generally being more prevalent among youth than adults in many jurisdictions.¹⁴⁴ According to the 2008 Adolescent Health Survey (AHS), 30% of B.C. high school students have “ever used” marijuana, a proportion that has in fact decreased from 40% in 1998.¹⁴⁵ The use and known short-term effects of this and other common drugs among youth in British Columbia are summarized in the following table.¹⁴⁶

¹⁴⁰ Bahrke MS, Yesalis CE, Kopstein AN et al. Risk factors associated with anabolic-androgenic steroid use among adolescents. *Sports Medicine*. 2000; 29(6): 397-405.

¹⁴¹ Fleary SA, Heffer RW, McKyer EL. Dispositional, ecological and biological influences on adolescent tranquilizer, Ritalin, and narcotics misuse. *Journal of Adolescence*. 2010: E-pub ahead of print.

¹⁴² Apodaca TR, Moser NC. The use and abuse of prescription medication to facilitate or enhance sexual behavior among adolescents. *Journal of Clinical Pharmacology & Therapeutics*. 2011; 89(1): 22-4.

¹⁴³ Cohen PJ. Medical marijuana: the conflict between scientific evidence and political ideology. Part two of two. *Journal of Pain & Palliative Care Pharmacotherapy*. 2009; 23(2): 120-40.

¹⁴⁴ Foley JD. Adolescent use and misuse of marijuana. *Adolescent Medical Clinic*. 2006; 17(2): 319-34.

¹⁴⁵ McCreary Centre Society. A Picture of Health: Highlights from the 2008 BC Adolescent Health Survey. Available at <http://www.mcs.bc.ca/pdf/AHS%20IV%20March%2030%20Final.pdf>. Accessed October 2010.

¹⁴⁶ Leslie K. Youth substance use and abuse: challenges and strategies for identification and intervention. *Canadian Medical Association Journal*. 2008; 178(2): 145-8.

Selected Illegal Drugs: Their Effects and Usage Among B.C. Students Grades 7-12

Drug	Also Known As	Method(s) of Ingestion	Clinical Effects	Duration of Effects	'Ever Used' Prevalence B.C. Grades 7-12 (2008)*
Cannabis	Marijuana, grass, weed, pot, herb, dope, hashish	Smoked, oral	Distortion of senses, conjunctivitis, appetite stimulation	1-3 h	30%
Ecstasy	E, X, XTC, MDMA, Adam	Oral, snorted	Stimulant effects, euphoria, bruxism	1-6 h (dose dependent)	7%
Cocaine	Coke, blow, snow, crack	Snorted, injected (intravenous), smoked	Stimulant effects	5-60 min (snorted) 5-10 min (smoked)	4%
Crystal Methamphetamine	Speed, crystal meth, crystal, ice, jib, meth	Oral, snorted, smoked, injected (intramuscular)	Stimulant effects, flushing, excitation	6-8h (orally or injected) 10-12 h (smoked)	2%

*Table modified from: Leslie, *Canadian Medical Association Journal*, 2008; data derived from B.C. Adolescent Youth Health Survey.

In addition, the 2008 AHS also found increases since 2003 in the use of hallucinogens (which include ecstasy), steroids, and prescription pills without a doctor's consent, as well as a small but significant increase in the proportion of students who had ever tried heroin and other injection drugs. The latter behaviour expands the potential for a specific type of acute and/or chronic effect, namely, the infectious diseases that can be contracted through sharing contaminated injection equipment.

Methodology and Provisional Results

Initial Search Process

For the various **electronic searches**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used. The one exception was in the case of the marijuana-specific searches. Given that marijuana use in adolescence is known to be a predictor of marijuana use later in life,¹⁴⁷ the decision was made to cover the *adult* health and well-being outcomes more fully in the present analysis.

Physical Health

Electronic Search Keywords

“Substance-Related Disorders”[Majr] AND

¹⁴⁷ Swift W, Coffey C, Carlin JB et al. Adolescent cannabis users at 24 years: trajectories to regular weekly use and dependence in young adulthood. *Addiction*. 2008; 103(8): 1361-70.

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr])

The search processes returned 284 reviews for consideration. Upon review of the list, however, it was determined that none of them qualified as systematic reviews examining physical health effects of drugs.

Non-physical Health and Well-being

Electronic Search Keywords

"Substance-Related Disorders"[Majr] **AND**

("Psychological Phenomena and Processes"[Majr] OR "Behavior and Behavior Mechanisms"[Majr])

This second search process returned 214 reviews for consideration. Upon review of the list, however, it was determined that none of them qualified as systematic reviews examining the non-physical health effects of drugs.

Given the unfruitful results across the broad search terms, a targeted search of specific drugs was performed.

Targeted (Drug-specific) Search

Electronic Search Keywords

1. a. "Marijuana smoking/adverse effects" [Majr] – 21 reviews in total

1. b. "Marijuana smoking"[Majr] **AND**

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Psychological Phenomena and Processes"[Majr] OR "Behavior and Behavior Mechanisms"[Majr]) – 45 reviews in total

1. c. "Cannabis/adverse effects"[Majr] – 5 reviews in total

2. MDMA/adverse effects [Majr] – 7 reviews in total

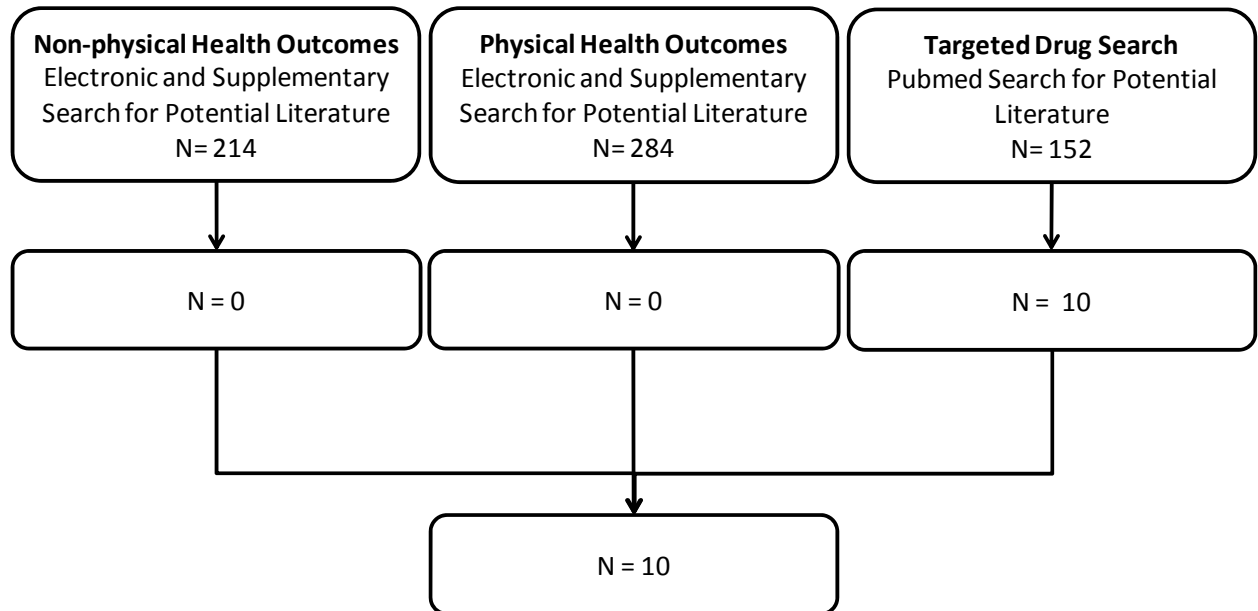
3. Cocaine/adverse effects [Majr] – 7 reviews in total

4. Methamphetamine/adverse effects [Majr] – 67 reviews in total

Upon close assessment of the results, it was determined that 8 reviews for marijuana, 1 review for methamphetamine, and 1 review for MDMA met the inclusion criteria, as summarized in the Volume Report and summary table below.

Literature Review Volume Report: Reviews

Dimension: Physical Health **Concept:** Drug Use



Summary of Relevant Reviews

Dimension: *Physical Health*

Concept: Drug Use

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	No. of Studies
<i>Methamphetamine</i>							
1	Health outcomes associated with methamphetamine use among young people: a systematic review.	Marshall	2010	Addiction	3.70	1970-2009	47
<i>Marijuana/Cannabis</i>							
2	Assessing evidence for a causal link between cannabis and psychosis: A review of cohort studies.	McLaren	2010	International Journal of Drug Policy	2.54	1987-2005	10
3	Cannabis use and educational achievement: Findings from three Australasian cohort studies	Horwood	2010	Drug and Alcohol Dependence	3.60	1989-2008	3
4	Effect of cannabis usage on the oral environment: a review.	Versteeg	2008	International Journal of Dental Hygiene	N/A	1978-2004	7
5	Cannabis use and risk of psychotic or affective mental health outcomes: a	Moore	2007	The Lancet	30.80	1987-2006	35
6	Effects of marijuana smoking on pulmonary function and respiratory	Tetrault	2007	Archives of Internal Medicine	8.02	1971-2005	34
7	The association between marijuana smoking and lung cancer.	Mehra	2006	Archives of Internal Medicine	8.02	1972-2005	19
8	Epidemiologic review of marijuana use and cancer risk.	Hashibe	2005	Alcohol	1.74	1978-2001	14
9	Cannabis as a risk factor for psychosis: systematic review	Semple	2005	Journal of Psychopharmacology	3.65	1987-2002	7
<i>MDMA/ecstasy</i>							
10	A review of the acute subjective effects of MDMA/ecstasy	Baylen	2006	Addiction	3.70	1986-2003	24

Detailed Results

For the 10 reviews identified by the literature search and exclusion process, a summary table of results was developed, as below.

Dimension: <i>Physical Health</i> Concept: <i>Drug Use</i> Summary Table of Reviews			
Lead Author	Review Title	No. of Studies Reviewed	Conclusions/Comments
<i>Methamphetamine</i>			
Marshall (2010)	Health outcomes associated with methamphetamine (MA) use among young people: a systematic review.	47	Available evidence indicates a consistent relationship between MA use and mental health outcomes and an increased risk of mortality due to suicide and overdose. There was insufficient evidence of an association between MA use and other previously cited harms, including increased infections diseases and poor dental outcomes.
<i>Marijuana/Cannabis</i>			
McLaren (2010)	Assessing evidence for a causal link between cannabis and psychosis: A review of cohort studies.	10	Whilst the criteria for causal association between cannabis and psychosis are supported by the studies reviewed, the contentious issue of whether cannabis use can cause serious psychotic disorders that would not otherwise have occurred cannot be resolved.
Horwood (2010)	Cannabis use and educational achievement: Findings from three Australasian cohort studies.	3	Findings suggest a robust association between age of onset of cannabis use and subsequent educational achievement.
Versteeg (2008)	Effect of cannabis usage on the oral environment: a review.	7	Based on limited data, it seems justified to conclude that oral health care providers should be aware of associated side effects of marijuana smoking, such as xerostomia, leukoedema, and an increased prevalence and density of <i>Candida albicans</i> .
Moore (2007)	Cannabis use and risk of psychotic or affective mental health outcomes: a systematic review	35	The evidence confirms the view that cannabis increases the risk of psychotic outcomes independently of confounding and transient intoxication effects, although evidence for affective outcomes is less strong.
Tetrault (2007)	Effects of marijuana smoking on pulmonary function and respiratory complications.	34	Short-term exposure to marijuana is associated with bronchodilation, long-term smoking is associated with increase respiratory symptoms suggestive of obstructive lung disease.
Mehra (2006)	The association between marijuana smoking and lung cancer.	19	Marijuana smoking was associated with increased tar exposure, alveolar macrophage tumoricidal dysfunction, increase oxidative stress, and bronchial mucosal histopathologic abnormalities compared with non-smoking controls. Observational studies of subjects with marijuana exposure failed to demonstrated significant associations between marijuana smoking and lung cancer after adjusting for tobacco use.
Hashibe (2005)	Epidemiologic review of marijuana use and cancer risk.	14	Insufficient studies are to adequately evaluate marijuana impact on cancer risk. Many methodological limitations are noted.

Dimension: *Physical Health* Concept: *Drug Use*
Summary Table of Reviews

Lead Author	Review Title	No. of Studies Reviewed	Conclusions/Comments
Sample (2005)	Cannabis as a risk factor for psychosis: systematic review	7	The available evidence supports the hypothesis that cannabis is an independent risk factor, both for psychosis and the development of psychotic symptoms.
MDMA/ecstasy			
Baylen (2006)	A review of the acute subjective effects of MDMA/ecstasy	24	Common noted effects included both the emotional (anxiety, depression, fear, euphoria) and somatic (nausea/vomiting, bruxism—or teeth grinding, muscle aches, headache, sweating, numbness, body temperature changes, fatigue, dizziness, dry mouth). Only limited instances of sexual, cognitive, sensory-perceptual, sleep-related, and appetite-related effects were reported.

Bibliography for Table of Reviews

- Marshall BD, Werb D. Health outcomes associated with methamphetamine use among young people: a systematic review. *Addiction*. 2010; 105: 991-1002,
- McLaren JA, Silins E, Hutchinson D et al. Assessing evidence for a causal link between cannabis and psychosis: a review of cohort studies. *International Journal of Drug Policy*. 2010; 21: 10-9,
- Horwood LJ, Fergusson DM, Hayatbakhsh MR et al. Cannabis use and educational achievement: findings from three Australasian cohort studies. *Drug and Alcohol Dependence*. 2010; 110(3): 247-53.
- Versteeg PA, Slot DE, van der Velden U et al. Effect of cannabis usage on the oral environment: a review. *International Journal of Dental Hygiene*. 2008; 6: 315-20,
- Moore TH, Zammit S, Lingford-Hughes A et al. Cannabis use and risk of psychotic or affective mental health outcomes: a systematic review. *Lancet*. 2007; 370(9584): 319-28.
- Tetrault JM, Crothers K, Moore BA et al. Effects of marijuana smoking on pulmonary function and respiratory complications: a systematic review. *Archives of Internal Medicine*. 2007; 167: 221-8,
- Mehra R, Moore BA, Crothers K et al. The association between marijuana smoking and lung cancer: a systematic review. *Archives of Internal Medicine*. 2006; 166: 1359-67,
- Hashibe M, Straif K, Tashkin DP et al. Epidemiologic review of marijuana use and cancer risk. *Alcohol*. 2005; 35: 265-75,
- Sample DM, McIntosh AM, Lawrie SM. Cannabis as a risk factor for psychosis: systematic review. *Journal of Psychopharmacology*. 2005; 19(2): 187-94.
- Baylen CA, Rosenberg H. A review of the acute subjective effects of MDMA/ecstasy. *Addiction*. 2006; 101: 933-47.

Summary of Results

Marshall and Werb investigated methamphetamine and health and well-being outcomes. Based on the combined results of 47 eligible studies that they identified, the authors found evidence that methamphetamine (MA) was associated with depression, psychosis, behavioral problems, and concurrent drug and alcohol use disorders. Additionally, suicide attempts and overdose likely explain the increased morbidity and mortality among young methamphetamine users. Several oft-reported MA harms were not observed, including increased risk of HIV and other STI infection, and elevated onset of dental diseases such as tooth decay.

Eight studies investigating marijuana and adverse outcomes were included in the review for this concept. Updating previous reviews (e.g., Moore et al., 2007; Semple et al., 2005), McLaren and colleagues investigated marijuana use and psychosis in 2010; they found that “the criteria for causal association between cannabis and psychosis are supported by the studies reviewed.” However, the reviewers also concluded that “it seems likely that cannabis produces psychotic disorders in individuals who possess *an underlying vulnerability to psychosis*” [emphasis added].

Versteeg et al. noted that dry mouth (xerostomia) was increased in marijuana users, and that there is evidence that it can increase the prevalence of caries and periodontal disease. Other measures of oral health, such as leukodema, plaque, the presence of decayed, filled, or missing surfaces, and *Candida albicans* growth, were also found to be more prevalent among marijuana users; on the other hand, oral cancers did not show an association with marijuana use. Hashibe et al. found similar results for tumours, noting that “sufficient studies are not available to adequately evaluate marijuana impact on cancer risk.” Mehra and colleagues looked specifically at marijuana smoking and lung cancer. While the behaviour increased tar exposure, alveolar macrophage tumoricidal dysfunctions, oxidation stress, and bronchial mucosal hisopathologic abnormalities compared to tobacco smoking and non-smoking controls, “observation studies failed to demonstrate significant associations between marijuana smoking and lung cancer after adjusting for tobacco use.” The so-called “benign” impacts are a different matter. Tetrault et al. focused on pulmonary function and respiratory complications and found many short-term effects reported in the included studies; this covered the effects noted by Mehra et al., but also elevated risk for a chronic condition such as obstructive lung disease.

Finally, in terms of school, Horwood et al. found that there was a “robust association between age of onset of cannabis use and subsequent educational achievement.” Other reviewers have attributed this impact to effects of marijuana use on memory, attention, and processing speed, or to increased drop-out rates among users, though the latter may simply be an artifact of the sort of sub-population that takes up marijuana smoking in the first place.^{148,149,150}

Baylen and Rosenberg evaluated the subjective effects of MDMA/ecstasy. Most of the impacts were classifiable as either emotional (e.g., anxiety, depression, fear, etc.) or somatic (nausea/vomiting, teeth grinding, muscle aches, etc.).

¹⁴⁸ McArdle P. Use and misuse of drugs and alcohol in adolescence. *BMJ*. 2008; 337: a306.

¹⁴⁹ Jacobus J, Bava S, Cohen-Zion M et al. Functional consequences of marijuana use in adolescents.

Psychopharmacology, Biochemistry & Behaviour. 2009; 92(4): 559-65.

¹⁵⁰ Townsend L, Flisher AJ, King G. A systematic review of the relationship between high school dropout and substance use. *Clinical Child and Family Psychology*. 2007; 10(4): 295-317.

Finally, more is required on what is now recognized as the critical/vulnerable period known as adolescence—“during which the long term direction of biopsychosocial development can be altered.”¹⁵¹ Somewhat beyond the scope of this review (due to the dependence on animal rather than human studies) is the particular attention that has been paid to neuromaturation in adolescence and the potential effects of using drugs, including alcohol, on such processes. As a precaution, there is good reason to warn youth contemplating using drugs (or quitting) that development of the brain and other aspects of the central nervous system could be permanently influenced by the abuse of substances that are, after all, designed to have a psychoactive effect.^{152,153}

Data Sources on Drug Use

British Columbia Adolescent Health Survey (AHS)

The most recent AHS¹⁵⁴ survey results indicate that the number of students who have ever tried marijuana decreased from 37% in 2003 to 30% in 2008. The percentage of students who had ever used other drugs, such as mushrooms, cocaine, and amphetamines, also decreased from 2003 to 2008. For the first time, the 2008 survey asked grade 7 to 12 students about using ecstasy and crystal meth in particular; in response, 7% reported they had used ecstasy and 2% crystal meth.

Additionally, drug use is part of the Canadian Alcohol and Drug Use Monitoring Survey (CADUMS).¹⁵⁵ However, this generates a national dataset, with 15-24-year-olds as the only youth age group for which information is available. While some provincial data are presented, they are not further stratified by age group.

Finally, the Canadian Tobacco Use Monitoring Survey and the Canadian Community Health Survey ask similar questions about using marijuana, including examining usage in the last 12 months, which could serve as an approximation for “current usage.” However, given the evidence for long-term neurological effects from consumption that starts early (even if it comes to an end), an indicator based on comprehensive surveying of “ever-usage” among youth (as conducted by the AHS) may be the most appropriate direction to follow.

Discussion

The four drugs most commonly discussed in the literature, and of greatest relevance based on B.C. Adolescent Youth Health Survey data, are marijuana (cannabis), ecstasy (MDMA), cocaine, and methamphetamine (especially the formulation known as crystal meth). Pertinent systematic review results were available for all of these substances apart from cocaine.

With regard to cannabis use, some evidence of adverse short-term and chronic effects was identified. The most consistent results in terms of health and well-being outcomes associated with long-term smoking of marijuana include chronic bronchitis, impaired respiratory

¹⁵¹ McArdle P. Use and misuse of drugs and alcohol in adolescence. *BMJ*. 2008; 337: a306.

¹⁵² Rubino T, Parolaro D. Long lasting consequences of cannabis exposure in adolescence. *Molecular and Cellular Endocrinology*. 2008; 286(1-2 Suppl 1): S108-13.

¹⁵³ Squeglia LM, Jacobus J, Tapert SF. The influence of substance use on adolescent brain development. *Clinical EEG & Neuroscience*. 2009; 40(1): 31-8.

¹⁵⁴ See the background description in the Introduction.

¹⁵⁵ Canadian Alcohol Use and Drug Monitoring Survey. Health Canada. Available at http://www.hc-sc.gc.ca/hc-ps/drugs-drogués/stat/_2009/summary-sommaire-eng.php. Accessed November 2010.

function, and poor oral health. The oral health and cardiopulmonary effects have been noted in other, narrative reviews; increased heart rate and vasodilation have been mentioned in those sources, effects that can lead to coronary vessel ischemia in susceptible individuals.^{156,157,158} Chronic health effects have not been as clearly demonstrated, particularly in the realm of cancer. Two reviews in the analysis examined marijuana smoking and cancer risk in particular, finding no evidence of an association; other recent studies focused on head and neck cancers have come to the same conclusion.^{159,160} This area of investigation is compromised by poor study quality; as pointed out by Hall, the researchers depending on “observational studies ... have limited ability to adequately control for major sources of confounding or to rule out reverse causation.”¹⁶¹ Despite the lack of demonstrated association with cancer, it is argued by some authorities that smoking marijuana is as damaging as, or even more harmful than, tobacco smoking; this is because it generally involves unfiltered smoking and deeper inhalation, which may result in 3 to 5 times the level of tar deposition than found in the lungs of tobacco cigarette smokers.¹⁶² For both political and scientific reasons, these sorts of assertions are highly contested.¹⁶³

Party drug use, which is reportedly common in a subset of young adults, also occurs among teens. It involves the intermittent use of stimulants or amphetamine-type substances to heighten enjoyment of social gatherings. Ecstasy, an amphetamine derivative, creates short-term subjective and physical effects that are undesirable (such as depression, fear, fatigue, or dizziness). No reviews evaluating the chronic physical health effects of ecstasy were located in this analysis; however, based on clinical case reports, the adverse outcomes can include hypertension, tachycardia, cardiac ischemia, acute hepatotoxicity, hypoglycaemia, and acute kidney injury.¹⁶⁴ Additionally, there have been reports of acute severe anxiety/panic disorder, multi-organ failure (including the liver), and sudden death.¹⁶⁵ The full extent of these health outcomes is difficult to estimate, however, due to lack of accurate data at a population level; there are indications that several of these effects may be extremely rare. Nonetheless, it is

¹⁵⁶ Cho CM, Hirsch R, Johnstone S. General and oral health implications of cannabis use. *Australian Dental Journal*. 2005; 50(2): 70-4.

¹⁵⁷ Hall W. The adverse health effects of cannabis use: what are they, and what are their implications for policy? *International Journal of Drug Policy*. 2009; 20(6): 458-66.

¹⁵⁸ Cho CM, Hirsch R, Johnstone S. General and oral health implications of cannabis use. *Australian Dental Journal*. 2005; 50(2): 70-4.

¹⁵⁹ Chen AL, Chen TJ, Braverman ER et al. Hypothesizing that marijuana smokers are at a significantly lower risk of carcinogenicity relative to tobacco-non-marijuana smokers: evidenced based on statistical reevaluation of current literature. *Journal of Psychoactive Drugs*. 2008; 40(3): 263-72.

¹⁶⁰ Berthiller J, Lee YC, Boffetta P et al. Marijuana smoking and the risk of head and neck cancer: pooled analysis in the INHANCE consortium. *Cancer Epidemiology, Biomarkers & Prevention*. 2009; 18(5): 1544-51.

¹⁶¹ Hall W. The adverse health effects of cannabis use: what are they, and what are their implications for policy? *International Journal of Drug Policy*. 2009; 20(6): 458-66.

¹⁶² Diplock J, Plecas D. *Clearing the Smoke on Cannabis*. 2009. Available at <http://www.ccsa.ca/Eng/KnowledgeCentre/OurPublications/Research/Pages/default.aspx>. Accessed October 2010.

¹⁶³ Chen AL, Chen TJ, Braverman ER et al. Hypothesizing that marijuana smokers are at a significantly lower risk of carcinogenicity relative to tobacco-non-marijuana smokers: evidenced based on statistical reevaluation of current literature. *Journal of Psychoactive Drugs*. 2008; 40(3): 263-72.

¹⁶⁴ Campbell GA, Rosner MH. The agony of ecstasy: MDMA (3,4-methylenedioxymethamphetamine) and the kidney. *Clinical Journal of the American Society of Nephrology*. 2008; 3(6): 1852-60.

¹⁶⁵ Hall AP, Henry JA. Acute toxic effects of 'Ecstasy' (MDMA) and related compounds: overview of pathophysiology and clinical management. *British Journal of Anaesthesia*. 2006; 96(6): 678-85.

sobering to consider that, while many of the more common health effects associated with drug use are modest, “in excess quantities all street drugs can lead to critical illness.”¹⁶⁶

Finally, an issue common to the use of marijuana, ecstasy, and methamphetamine, and likely most other illegal drugs is that their use is correlated with using other substances, notably alcohol and tobacco, which are themselves known to adversely affect health.^{167,168} Other high-risk behaviours also accompany drug and alcohol use, such as unplanned, unwanted, and unprotected sexual activity, driving while intoxicated, failing to wear a seat belt, and various types of intentional self-injury.¹⁶⁹ Such activities, while perhaps driven by other factors than drug use per se, certainly can have disastrous consequences. For instance, an increased risk of trauma, particularly from road traffic accidents, has been associated with ecstasy use.¹⁷⁰

Conclusion

Although there is some clinical evidence for the adverse health effects of drugs among youth, the population-level data derived from epidemiologic studies is more modest. However, one drug, marijuana, does stand out in terms of having more attempts to collect prevalence data in British Columbia and a larger number of studies related to health and well-being effects in the pediatric population.¹⁷¹ As will be shown below, the evidence and other assessments do not create a lot of momentum for even this area as a core indicator, a situation that could change with new research into neurodevelopment in adolescents, mechanisms related to psychosis and marijuana use, and other potentially serious concerns.^{172,173,174,175}

¹⁶⁶ Mokhelesi B, Garimella PS, Joffe A et al. Street drug abuse leading to critical illness. *Intensive Care Medicine*. 2004; 30(8): 1526-36.

¹⁶⁷ Hall W. The adverse health effects of cannabis use: what are they, and what are their implications for policy? *International Journal of Drug Policy*. 2009; 20(6): 458-66.

¹⁶⁸ Kalant H. The pharmacology and toxicology of "ecstasy" (MDMA) and related drugs. *Canadian Medical Association Journal*. 2001; 165(7): 917-28.

¹⁶⁹ Leslie K. Youth substance use and abuse: challenges and strategies for identification and intervention. *Canadian Medical Association Journal*. 2008; 178(2): 145-8.

¹⁷⁰ Hall AP, Henry JA. Acute toxic effects of 'Ecstasy' (MDMA) and related compounds: overview of pathophysiology and clinical management. *British Journal of Anaesthesia*. 2006; 96(6): 678-85.

¹⁷¹ Hall W, Degenhardt L. Adverse health effects of non-medical cannabis use. *Lancet*. 2009; 374(9698): 1383-91.

¹⁷² Schweinsburg AD, Brown SA, Tapert SF. The influence of marijuana use on neurocognitive functioning in adolescents. *Current Drug Abuse Reviews*. 2008; 1(1): 99-111.

¹⁷³ Trezza V, Cuomo V, Vanderschuren LJ. Cannabis and the developing brain: insights from behavior. *European Journal of Pharmacology*. 2008; 585(2-3): 441-52.

¹⁷⁴ Malone DT, Hill MN, Rubino T. Adolescent cannabis use and psychosis: epidemiology and neurodevelopmental models. *British Journal of Pharmacology*. 2010; 160(3): 511-22.

¹⁷⁵ Sewell RA, Ranganathan M, D'Souza DC. Cannabinoids and psychosis. *International Review of Psychiatry*. 2009; 21(2): 152-62.

Summary Assessment

Ever-Use of Marijuana

Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
12-17	93,800	Medium	Medium	Medium	Low

As summarized above, assessments have been applied to the Drug Use concept, specifically to the indicator with the most pertinent research and the most results potentially pointing to chronic effects on health and well-being, namely, *the proportion of the pediatric population ever-using marijuana*. Statistics for *current* usage would traditionally be the expectation for this kind of indicator, but these data do not seem to be as readily reported as the “ever-used” information reported by the AHS in British Columbia.

The pediatric population **Magnitude** of the potential indicator is assessed as **Medium**. Based on 2008 Adolescent Health Survey data, 30% of individuals aged 12-17 years have ‘ever used’ marijuana. When this percentage is applied to the 2010 pediatric cohort of the same age, the estimated absolute prevalence of those who have ever used marijuana is 93,800 individuals. This is between 2 and 10% (19,000 and 97,000) of the total pediatric cohort, resulting in a Magnitude classification of Medium.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual’s health and well-being is assessed as **Medium**. Serious long-term health effects are potentially associated with (especially early) marijuana use, though likely not in the expected area of cancer risk; furthermore, reviewers typically note that causality is difficult to establish.

The **Modifiability** of the potential indicator is assessed as **Medium**. While cessation of and/or preventing initiation of marijuana use is theoretically possible, interventions in the real world appear to have at best modest traction; this is partly due to the prevailing social climate of acceptance for this behaviour.

Data Availability/Validity for the potential indicator is assessed as **Low**. Data on the use of the most common types of drugs are available on a routine basis from the BC Adolescent Health Survey; however, this represents self-reported information on a topic of an illegal nature, so its reliability may be questionable; as well, the survey is only conducted every 5 years, and does not focus on *current* usage of marijuana or other substances.

The potential indicator related to ever-use of marijuana is **Not Recommended** for consideration as a core indicator of child health and well-being. The reasons are that all assessment ratings were moderate or lower, including the Low assigned to the critical category of Data Availability/Validity. Given the continually emerging information about the impacts of early and/or long-term marijuana use, it is appropriate to place this indicator on the list for potential development.

Sexual Behaviour

Background and Context

The purpose of this review is to determine if there is research evidence of a link between youth sexual behaviour and physical health. Sexual behaviour is influenced by a number of different factors. A 2006 systematic review cited seven key attitudes or perspectives that influence sexual activity in young people:¹⁷⁶

1. Young people subjectively assess the risks from sexual partners on the basis of whether they are “clean” or “unclean”
2. Sexual partners have an important influence on behaviour in general
3. Condoms can be stigmatizing and associated with lack of trust
4. Gender stereotypes are crucial in determining social expectations and behaviour
5. There are penalties and rewards for sex from wider society
6. Reputations and social displays of sexual activity or inactivity are important
7. Social expectations hamper communication about sex

These themes hint at the complexity and multi-factorial nature of this subject area, encompassing many social and psychological phenomena. Despite the broad range of concerns, related research has tended to focus on a few key themes, including age of first sexual intercourse, number of intercourse partners in the last year, and contraceptive use (most notably condom use). With respect to physical health per se, the most investigated outcome measure is incidence of sexually transmitted infection (STI). STIs can result in serious physical health effects. As described in the next section of the report, such infections are common among adolescents. For example, 15-19-year-old females in B.C. have higher incidence of gonorrhea and syphilis infections than any other age cohort.¹⁷⁷

With respect to non-physical health, research has largely focused on sexual debut as the predictor, with outputs such as intention for and participation in further education, later delinquency, psychological outcomes (including depression, suicidal thoughts and attempts, etc.), and psychosocial outcomes (such as hyperactivity, antisocial behavior, etc.).

Methodology and Provisional Results

Physical Health Outcomes

Review Search Process

For the electronic search for reviews in this area, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

¹⁷⁶Marston C, King E. Factors that shape young people's sexual behaviour: a systematic review. *Lancet*. 2006; 368(9547): 1581-6.

¹⁷⁷B.C. Centre for Disease Control. *Annual Surveillance Report: HIV and Sexually Transmitted Infections*. 2010. Available at <http://www.bccdc.ca/default.htm>. Accessed October 2010.

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

In order to locate suitable reviews, both MeSH terms (see below under Study Search Process) and the following basic terms were employed: (“teenage” OR “adolescent” OR “youth”) AND (“sexuality OR "sexual behaviour" OR "sexual activity" OR "sexual health") AND (“health” OR “disease” OR “risk” OR “infection”).

Examining the 371 located papers, it was determined that there were no systematic or other reviews pertinent to this concept, so the decision was made to execute a “Level B” search process focusing on individual studies.

Study Search Process

The electronic search conducted for individual studies in this area again was based on PubMed, with the following limits:

Date: 2000-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Clinical Trial, Randomized Controlled Trial, Controlled Clinical trial.

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

The MeSH terms employed in the search were as follows:

("Sexual behaviour"[Majr] **AND**

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Sexually Transmitted Diseases"[Majr] OR "Disease Transmission, Infectious"[Majr] OR "Neoplasms"[Majr]))

There were 315 studies relating to physical health identified in this search process.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between sexual behaviour and physical health outcome(s), then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 21.

Primary Exclusion

The full articles were then reviewed, with articles not pertinent to the research topic being excluded; specifically, if the article did not link sexual behaviour with physical health outcome(s), it was excluded. Also excluded was any study that focused on a specific subgroup, such as sex workers, or studies that did not explicitly break down age groups to

include a pediatric population and link this to outcomes such as STI rates. If there was uncertainty as to whether an article should be excluded, the reviewers discussed the matter further to reach a consensus.

As noted in the integrated Volume Report below, there were 3 articles remaining following the primary exclusion step; a secondary exclusion step was not deemed to be necessary.

Non-physical Health and Well-being Outcomes

Review Search Process

For the electronic search for reviews in this area, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

"Sexual behavior"[Majr] **AND**

("Psychological Phenomena and Processes"[Majr] OR "Behavior and Behavior Mechanisms"[Majr])

Examining the 188 located papers, it was determined that there were no systematic or other reviews pertinent to this concept, so the decision was made to execute a "Level B" search process focusing on individual studies.

Study Search Process

The electronic search conducted for individual studies in this area was again based on PubMed, with the following limits:

Date: 2000-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

The same MeSH terms employed in the earlier search were used, that is:

"Sexual behavior"[Majr] **AND**

("Psychological Phenomena and Processes"[Majr] OR "Behavior and Behavior Mechanisms"[Majr])

There were 352 studies identified in this search process. None were deemed of relevance in a non-physical health context. For this reason, a more targeted search approach using Google Scholar and PubMed was employed. Terms used included: sexual debut, sexual initiation,

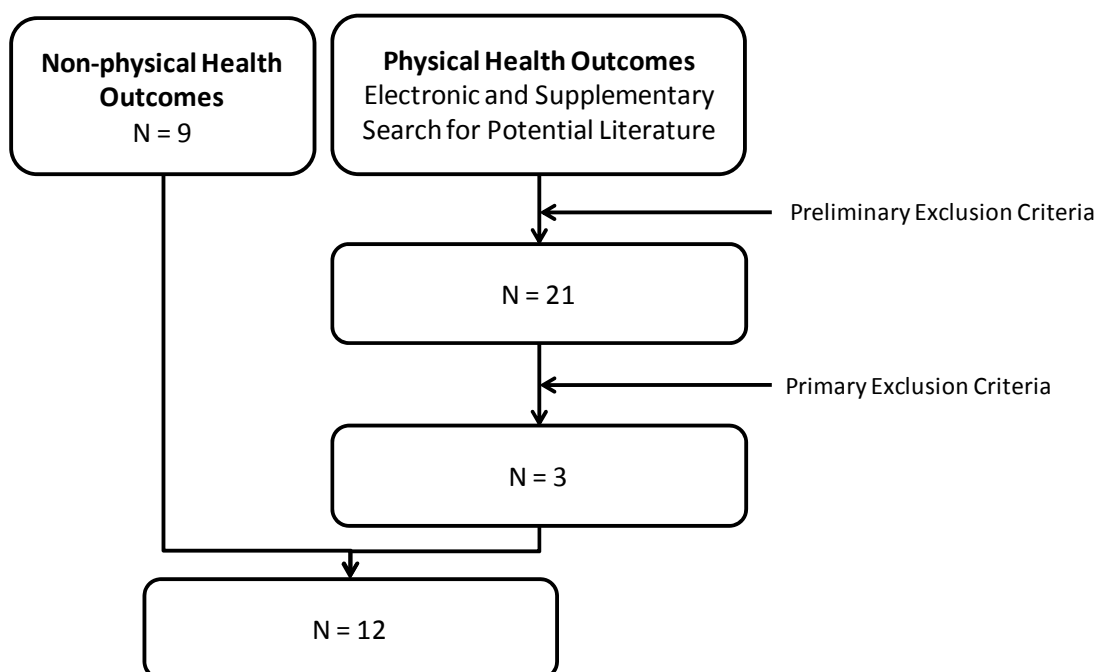
condom use, first sexual intercourse, number of sexual partners AND mental health, psychological outcomes, and social/psychosocial outcomes. In PubMed, the related articles function was also employed. Only studies focusing on children/adolescents that were published since 2005 were included.

Overall, 9 studies met the inclusion criteria for the non-physical health dimension. These studies did not require a formal preliminary or primary exclusion.

In total, 12 articles were included in our review: 3 related to physical health outcomes, and 9 to the non-physical health sphere, as indicated in the integrated Volume Report and Summary table below.

Literature Review Volume Report: Individual Studies

Dimension: Physical Health **Concept:** Sexual Behaviour



Results After Applying Primary Exclusion: Studies

Dimension: *Physical Health*

Concept: *Sexual Behaviour*

Title of Study	Author(s)	Year	Journal	Journal Impact Factor (2009)	Type of Study	Sample Size	Sample Population	Location	Conflict of Interest
Sexually Transmitted Infections									
1 Time from first intercourse to first sexually transmitted infection diagnosis among adolescent women	Tu et al.	2009	Archives of Paediatrics & Adolescent Medicine	3.56 (2005)	Longitudinal cohort study	386	Young women (14-17)	United States	None
2 HIV/STD risk reduction interventions for African American and Latino adolescent girls at an adolescent medicine clinic: a randomized controlled trial	Jemmott et al.	2005	Archives of Paediatrics & Adolescent Medicine	3.56 (2005)	Randomized Controlled Trial	682	Adolescent Latino and African American girls (12-19)	United States	None
3 Efficacy of an HIV prevention intervention for African American adolescent girls: a randomized controlled trial	DiClemente et al.	2004	Journal of the American Medical Association	23.33 (2005)	Randomized Controlled Trial	522	African American girls (14-18)	United States	None
Delinquency									
4 Rethinking timing of first sex and delinquency	Harden et al.	2008	Journal of Youth and Adolescence	1.38	Cross-sectional Study (longitudinal data)	534	Twins from a national study	United States	Not Stated
5 Adolescent sexual debut and later delinquency	Armour and Haynie	2007	Journal of Youth and Adolescence	1.38	Cross-sectional Study (longitudinal data)	7,297	Grade 7-12 American middle and high-school students	United States	Not Stated
Tertiary Education									
6 Does early sexual debut reduce teenagers' participation in tertiary education? Evidence from the SHARE longitudinal study	Parkes et al.	2010	Journal of Adolescence	2.79 (5-year)	Cross-sectional Study (longitudinal data)	5,061 (expectations); 2,130 (participation)	Grade 7-12 American middle and high-school students	United Kingdom	Not Stated
7 Timing of sexual debut and initiation of postsecondary education by early adulthood	Spriggs and Halpern	2008	Perspectives on Sexual and Reproductive Health	2.22	Cross-sectional Study (longitudinal data)	3,965	Grade 7-12 American middle and high-school students	United States	Not Stated
Psychological/Psychosocial									
8 The relationship between sexual debut and psychosocial outcomes: a longitudinal study of Dutch adolescents	Udell et al.	2010	Archives of Sexual Behaviour	3.24	Longitudinal Study	470	Grade 8 students	Netherlands	Not Stated
9 Early adolescent sexual initiation and physical/psychological symptoms: A comparative analysis of five nations	Madkour et al.	2010	Journal of Youth and Adolescence	1.38	Cross-sectional Study (longitudinal data)	6,111	15-year olds	International (5 nations)	Not Stated
10 Relationship between mental disorders/suicidality and three sexual behaviours: Results from the National Comorbidity Survey Replication	Mota et al.	2010	Archives of Sexual Behaviour	3.24	Cross-sectional Study	5,692	18-years and older (national sample)	United States	Not Stated
11 The association of socioemotional problems with early sexual initiation	McLeod and Knight	2010	Perspectives of Sexual and Reproductive Health	2.22	Cross-sectional (longitudinal, prospective study)	1,836	10-11 year olds, with follow-up	United States	Not Stated
12 Sexual debut timing and depressive symptoms in emerging adulthood	Spriggs and Halpern	2008	Journal of Youth and Adolescence	1.38	Cross-sectional Study (longitudinal data)	5,061	Grade 7-12 American middle and high-school students	United States	None

Detailed Results

For the 12 studies identified by the literature search and exclusion process, a summary table of results was developed; this table is provided below.

Dimension: *Physical Health Concept: Sexual Behaviour*

Summary Table of Studies

Citation	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
<i>Sexually Transmitted Infections</i>							
Tu et al. (2009)	To determine the time between first sexual intercourse and first sexually transmitted infection (STI) with <i>C. trachomatis</i> , <i>N. gonorrhoeae</i> , or <i>T. vaginalis</i> , and the time between repeated infections	Follow young women (14-17 years of age) over time, studying factors related to STIs	United States N=386 young urban women aged 14-17 at enrolment (maximum follow-up of 8.2 years)	Longitudinal cohort study Follow-ups were conducted at 3-month intervals	- Time from first sexual intercourse to first STI test - Time from first sexual intercourse to first STI diagnosis - Time from initial STI to first reinfection	- The median interval between first sexual encounter and first STI test was 4.9, 3.5, 2.1, 1.8, and 1.2 years in those who first had sex at 10, 11, 12, 13, and 14 years, respectively - Median time between first sexual intercourse and <i>C. trachomatis</i> , <i>N. gonorrhoeae</i> , or <i>T. vaginalis</i> infections was 3, 5, and 6 years, respectively - Median age of first <i>C. trachomatis</i> , <i>N. gonorrhoeae</i> , or <i>T. vaginalis</i> infection was 17, 19, and 19 years, respectively - Median length of infection-free interval following first sexual intercourse was 2 years - Median time to first <i>C. trachomatis</i> , <i>N. gonorrhoeae</i> , or <i>T. vaginalis</i> reinfection was 1.6, 2.4, and 1.7 years, respectively	-Sexual intercourse at a younger age delays first STI test in young women -Young women commonly become sexually active during adolescence -There is a high level of primary STI infection amongst sexually active young women -STI reinfection is common, and the time between infections is relatively short
Jemmott et al. (2005)	To determine the efficacy of skills-based & information-based STD risk-reduction interventions on self-reported sexual behaviour and STI rates	Follow young Latino and African American adolescent girls after a skills-based sexual health intervention, information-based sexual	United States N= 682 sexually experienced young girls (aged 12-19 years)	Randomized controlled trial Follow-ups at 3-, 6-, and 12-months	- Self reported information related to: unprotected sex, sexual intercourse while intoxicated, number of sexual partners - Biologically confirmed STIs - General knowledge	- The skills-based intervention participants reported less unprotected sexual intercourse at 12-month follow-up compared to the information-based intervention participants (p=0.03) and to the health-promotion control intervention participants (p=0.002) -At 12-month follow up, the skills-intervention participants reported	-Skill-based interventions can reduce sexual risk behaviours and STI rates among African American and Latino adolescent girls at 12-months follow-up

Dimension: *Physical Health Concept: Sexual Behaviour*

Summary Table of Studies

Citation	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
		health intervention, or health-promotion control intervention			and beliefs about condoms and sexual behaviour	fewer sexual partners than the health control-intervention participants ($p=0.04$) and were less likely to test positive for STIs than the health control-intervention participants ($p=0.05$)	
DiClemente et al. (2004)	To evaluate efficacy of an intervention to reduce sexual risk behaviours, STIs, and pregnancy rates	Intervention (4 x 4h sessions) targeting African American girls that emphasized gender pride, HIV knowledge, communication, condom use skills, and healthy relationships while evaluating self-reported sexual behaviours and STI rates	United States N=522 sexually experienced African American girls (aged 14-18)	Randomized controlled trial Follow-up was completed at 6- and 12-months	- Included report of consistent condom use, incident STI infection, and self-reported pregnancy	-Intervention participants were more likely to report using condoms consistently in the 30 days preceding the 6-month assessment ($p=0.06$) and the 12-month assessment ($p=0.02$), and over the entire 12-month period ($p=0.003$). -Intervention participants were more likely to report using a condom at last vaginal sexual intercourse, less likely to report a pregnancy, and less likely to report having a new vaginal sex partner in the 30 days prior to assessment -At 12-month follow-up, results suggest a significant treatment advantage in reducing <i>Chlamydia</i> infections ($p=0.04$) but not trichomonas ($p=0.16$) or gonorrhoea ($p=0.21$)	-Interventions can enhance STI/HIV preventive behaviours, skills, and mediators, and may reduce pregnancy and <i>Chlamydia</i> infection
Delinquency							
Harden et al. (2008)	To evaluate the predictors of debut, and the relationship between debut of sexual intercourse and delinquency	To test the study by Amour and Haynie (see below) by evaluating only twins in order to reduce confounding factors.	534 same-sex twins	Cross-sectional study Use longitudinal data from the Add Health multi-survey (3 waves – 7 years apart in total)	- Age at first sex - Delinquent behaviours (graffiti, damage property, stealing, etc.)	- Nearly 31% of the variation in age at first sex between same-sex twins was accounted for by additive genetic factors, 10% by shared environmental factors, and 59% by non-shared environmental factors. - Age at first sex was important for the prediction of later delinquency after controlling for genetic and shared environmental differences, however	Twins differ in their age at first intercourse, indicating that non-shared environmental factors are the strongest influence on sexual timing. Twins who experience first sex earlier than their co-twins did not

Dimension: Physical Health Concept: Sexual Behaviour

Summary Table of Studies

Citation	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
						earlier sex actually predicted <i>lower</i> levels of delinquency in early adulthood.	demonstrate higher levels of delinquency, suggesting that early debut timing does not per se elevate delinquent behaviour.
Armour and Haynie (2007)	To answer the question: Does sexual debut increase the risk of later delinquent behaviour? Also evaluated timing of sexual debut relative to peers.	Evaluate whether or not sexual debut has lasting effects on behaviour in adulthood through the Add Health multi-survey (3 survey points over multiple years)	United States N=7,297 students grades 7-12	Cross-sectional study Use longitudinal data from the Add Health multi-survey. (3 waves – 7 years apart in total)	- Age at sexual debut - Depression (CES-D scale) - School GPA - Parental support - Illegal substance use (created scale 0-7) - Later delinquency	- Early sexual debut is associated with a 20% increase in predicted delinquency compared to youth debuting at a later time. - Early sexual debut increases risks of engaging in delinquency one year later. - Experiencing sexual debut later than one's peers offers a protective effect and reduces the risks of engaging in subsequent delinquency. - The effect of timing of sexual debut persists beyond one year, and into adulthood.	-Delaying sexual debut is associated with a decreased risk of delinquent behaviour for a number of years after.
Tertiary Education							
Parks et al. (2010)	To evaluate the longitudinal association between sexual debut and tertiary education and psychosocial changes.	Self-completed anonymous questionnaire administered at school or through the post, telephone, or Internet.	East Scotland and other UK N=5,061 (expectation of tertiary education) N=2,130 (participation)	Use data from the SHARE trial to evaluate two successive cohorts in three waves at two year intervals (ages 14,16, and 18)	- No expectation of tertiary education, no participation in tertiary education vs. sexual debut.	- Sexual debut was associated with lower expectation for tertiary education: 45% of wave 1 and 39% of wave 2 debut groups did not expect to participate in tertiary education, compared to only 24% of virgins. - Actual participation was similar: 64% of wave 1 and 50% of wave 2 debut groups did not attend tertiary education, compared with 29% of wave 2 virgins.	-Sexual debut by age 16 was associated with reduced expectation for and participation in tertiary education, regardless of the level of academic achievement at age 16. This effect was found in both boys and girls. Pregnancy does not appear to be the key mediating reason for leaving school.

Dimension: *Physical Health Concept: Sexual Behaviour*

Summary Table of Studies

Citation	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
Spriggs and Halpern (2008)	To determine if adolescent sexual debut is associated with educational progress in an age-dependent manner, and whether any trend is consistent across gender and race/ethnicity.	Use the Add Health data from Waves 1 and 3 (1994-1995 and 2001, respectively). Add Health data are collected via in-home computer-administered interviews, and audio computer-assisted self-interviewing.	United States N=3,965	Add Health survey data from wave 1 and 3 were used (two sample points)	- Highest grade level completed, degrees received, and in-school status vs. age at sexual debut.	- Sexual debut timing was strongly associated with early adult postsecondary initiation; 49% of those who experienced early debut had initiated postsecondary education by wave 3, compared with 63% of those who had typical debut, and 78% of those who had late debut. - Protective factors (female gender, white race, cognitive ability, living with both biological parents, mean grades, neighbourhood education, and desire to go to college) and risk factors (cigarette and marijuana use, and childhood maltreatment) for early debut were also identified.	Sexual debut timing is associated with a range of risk and protective factors, as well as early adult educational progress. In sum, delaying debut resulted in a greater chance of attending post secondary education. At least part of this effect is believed to be attributable to confounding characteristics.
Psychological/Psychosocial							
Udell et al. (2010)	To evaluate ways in which early sexual initiation is related to subsequent attachment, self-perception, and internalizing and externalizing problems.	Longitudinal study evaluating psychosocial and psychological outcomes that are correlated with initiation of sexual intercourse.	Netherlands N=650 adolescents	Longitudinal study including two waves.	- Initiation of sexual intercourse - Perceived relationship quality between parents and peers - Self perception - Subset of Youth Self-Report: externalizing and internalizing syndromes	- Low levels of maternal attachment and high levels of rule-breaking and aggression were associated with an increase likelihood of early sexual initiation among male adolescents; self-concept and internalizing problems did not predict early initiation for this sample. - Attachment, self-concept, externalizing problems, and internalizing problems did not predict early sexual initiation for females.	Findings from this study suggest that early sexual initiation may not relate to negative predictors. As this research is not pertinent to evaluating debut as a predictor, it is only represents suggestive background information.
Madkour et al. (2010)	Compare data from 5 nations regarding sexual initiation and correlate that timing with physical or	Cross-sectional study using population-based data to evaluate the relationship between sexual initiation and	United States, Finland, Scotland, France, and Poland	Cross-sectional study using longitudinal data from population-based samples (Health	- Sexual initiation - Physical symptoms (headaches, trouble with sleeping) - Psychological symptoms (general happiness, feeling	- Sexual initiation by age 15 varies from 17.6% (Finland) to 32.7% (Scotland) in boys, and 11.3% (Poland) to 37.2 (Scotland) for girls. - Evidence suggests that there is not a statistically significant relationship between early sexual initiation and	The evidence suggests that sexual initiation may not necessarily be related to adolescent maladjustment in all national contexts and that, where sexual

Dimension: Physical Health Concept: Sexual Behaviour

Summary Table of Studies

Citation	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
	psychological symptoms.	relevant outcomes.		Behaviors in School-Aged Children Study and National Longitudinal Study of Adolescent Health) N=6,111	low/sad, feeling lonely, feeling moody or irritable) - Demographic, individual, and family characteristics	symptoms for boys in the US, a result that is thought to hold for other countries - Evidence suggests that there is a statistically significant and positive relationship between ever having sexual intercourse at a young age and symptoms for girls in the US and Poland.	initiation is seen to be related to maladjustment, girls are more affected than boys.
Mota et al. (2010)	Examine the relationship between sexual behaviours and mental disorders and suicidality.	Evaluating interview data in a retrospective manner.	United States N=5,692 individuals aged 18+ years	Cross-sectional evaluation of longitudinal data Data collected using interviews	- Age of first sexual intercourse, sexual behaviours - DSM-IV mental disorders diagnosis - Suicidal behaviour - Demographic characteristics	- Individuals reporting age of first intercourse between the ages of 12-14 were more likely to have substance use, disruptive behaviour, and other mental disorders, as well as suicidal ideation and attempts than those who experienced first intercourse between 15 and 17 years. - Individuals with two or more partners in the past year were more likely to have disorders from all diagnostic categories than those who had not had any partners. - Individuals who rarely/never used a condom were more likely than those always using a condom to have a mood, substance use, or any mental disorder, in the past year, and an increased likelihood of suicide attempts.	There are several strong relationships between earlier sexual intercourse and negative outcomes according to a nationally representative sample of adults aged 18+ years.
McLeod and Knight (2010)	Evaluate the association between socio-emotional problems and early sexual initiation.	Longitudinal data was analyzed for three waves (1992, 1994, and 1996)	United States N=1,839	Cross-sectional analysis of longitudinal data	- Socio-emotional problems based on the Behaviour Problems Index. - Early sexual initiation (i.e., before age 15 years)	- Youth initiating sex before age 15 had significantly more socio-emotional problems at age 10-11, had spent a greater proportion of their lives in poverty, and were more likely to have an unmarried mother. - Internalizing and externalizing problems were both associated with	Externalizing problems (hyperactivity and antisocial behaviour, specifically) were significantly associated with early sexual initiation. The results did not differ by gender or

Dimension: *Physical Health Concept: Sexual Behaviour*

Summary Table of Studies

Citation	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
						early sexual initiation, but only the latter showed significance.	race/ethnicity. As with the study by Udeh et al., this examination of early debut as an outcome rather than a predictor of health is not directly pertinent to the main question at hand.
Spriggs and Halpern (2008)	Examine the relationship between timing of sexual debut and depressive symptomology in adolescence and emerging adulthood.	Longitudinal data was analyzed in three waves (1994/5, 1995/6, 2001)	United States N=5,061	Cross-sectional analysis of longitudinal data from the National Longitudinal Study of Adolescent Health	- CES-D depression scale - Sexual debut timing	- Baseline depressive symptomology was significantly more prevalent for early and typical sexual initiators compared to late initiators in females, but not in males - For females, depressive symptoms decreased with age, so that by age 16 sexual debut timing was no longer significantly associated with depression; for males, sexual debut was not significantly associated with depressive symptoms at any age - As well, pre-debut depression in females was in fact associated with depression in adulthood; however, there was no such correlation observed in males.	Evidence suggests that sexual debut in females, although possibly related to short-term increases in depressive symptomology, is not necessarily a driver of longer-term depressive outcomes. There was no correlation concerning depression observed in males experiencing early sexual debut.

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DiClemente RJ, Wingood GM, Harrington KF et al. Efficacy of an HIV prevention intervention for African American adolescent girls: a randomized controlled trial. *Journal of the American Medical Association*. 2004; 292(2): 171-9.

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Summary of Results

There were twelve studies that met the criteria for inclusion; three focused on physical health, evaluating adolescent girls in particular and utilizing STI incidence as an outcome measure. Two studies examined timing of sexual debut and delinquency later in life, two studies focused on sexual debut and intention/actual participation in tertiary education, and five studies evaluated sexual debut in terms of psychological/psychosocial outcomes or (less usefully) predictors.

Tu et al. tracked the time from first sexual intercourse to first STI diagnosis, and the time to reinfection during a period of ongoing sexual activity. The study found that: young women who begin having sex at a younger age take longer to begin STI testing; this is a public health concern because STIs and reinfections are common among the sexually active individuals in this cohort. Two other studies investigated the effect of sexual health interventions on minority populations by means of a randomized controlled trial; they found that health education programs were capable of modifying sexual behaviour, most notably by increasing condom use and decreasing the number of sexual partners. Jemmott et al. found that participants in skills-based sexual health interventions were significantly less likely to test positive for an STI than control participants. The STIs included in outcome testing were *N. gonorrhoeae*, *C. trachomatis*, and *T. vaginalis*. DiClemente et al. investigated the same three STIs, observing that intervention participants were significantly less likely to test positive for *C. trachomatis* at 12-months follow-up compared with control participants; there were no significant differences in rates of infection with either *N. gonorrhoeae* or *T. vaginalis*.

Armour and Haynie found that early adolescent sexual debut is associated with delinquency in the year following. Debuting later appeared to have a protective effect, which can be sustained for a number of years. Harden et al. re-evaluated this evidence, performing an analysis on a sub-sample of twins—a strategy aimed at reducing confounding factors; the authors found that the twins who experienced first sex earlier than their co-twins did not demonstrate higher levels of delinquency.

Both studies evaluating the impact of sexual initiation on tertiary/post-secondary education found a negative effect for young people debuting before age 16. While Spriggs and Halpern found this association was particularly strong for females, Parkes et al. observed no gender differential.

Two of the five studies focusing on psychological/physical symptoms and sexual initiation were based on the National Longitudinal Study of Adolescent Health from the U.S. In 2008, Spriggs and Halpern found that timing of sexual debut was not associated with depressive symptoms for either male or female respondents in emerging adulthood, but that it did affect females in particular in the adolescent years. In a 2010 study, Spriggs et al. compared U.S. data to that of four other jurisdictions, evaluating physical and psychological symptoms in reference to sexual debut; the researchers found that sexual initiation was not related to symptoms among boys in any of the five nations, but was significantly related to symptoms among girls in Poland and the U.S.

Udell et al. found that early sexual debut was not associated with negative psychosocial predictors (self-concept, problem behaviours—both internalizing and externalizing, and perceived attachment in important relationships) in Dutch adolescents. McLeod and Knight found that both internalizing problems and externalizing problems were associated with early sexual initiation, but only externalizing problems represented a statistically significant result.

When stratifying specific problems, only hyperactivity and antisocial behaviour (both externalizing types) were associated with a higher probability of early sexual debut. These associations were not found to differ by gender or race. As noted in the table above, both of these studies examine sexual debut as an outcome rather than a predictor, so they are not of direct application to the topic at hand.

Mota et al. looked specifically at mental and psychological challenges, including suicidality (both intentions and attempts); they found that younger age at first intercourse was associated with increased rates of lifetime disruptive behaviour, substance use, mental disorder, and suicidal ideation and attempts. Additionally, the researchers observed that individuals who had two or more sexual partners in the past year experienced increased rates of conditions from all mental disorder groups; furthermore, individuals who were never married and rarely/never used condoms were more likely to experience mood, substance use, or any mental disorder, as well as suicide attempts, compared with those who always used condoms. As the preceding information (other than that dealing with early adolescent sexual debut) relates to sexual behaviours (such as condom use) in the adult years, it is only of tangential interest in terms of evidence for this report. Importantly, the issue of condom use and related impacts in younger individuals that are sexually active is a substantial concern, one that bears more investigation; it is likely that proper condom usage is low in younger teens (and preteens), due to stigma, access barriers, and lack of knowledge and experience—a factor that would in turn generate increased risks for pregnancy and STIs at a young age.

Data Sources for Sexual Behaviour

There are two sources through which sexual behaviour in British Columbia can be monitored: Statistics Canada, specifically the Canadian Community Health Survey (CCHS), and the B.C. Adolescent Health Survey. These two sources are described in detail in the Introduction; details that are pertinent to the present concept are outlined below.

Canadian Community Health Survey

Canadians, including youth aged 15-19 years, are now surveyed every year by the CCHS, with questions focusing on sexual behaviour topics, as follows:

- Ever diagnosed with a sexually transmitted disease
- Ever had sexual intercourse
- Had sexual intercourse – last 12 months
- Usually used birth control – past 12 months
- Usual birth control method – condom/ pill/diaphragm/spermicide/other/ injection
- Birth control method used last time – condom/ pill/diaphragm/spermicide/other/ injection
- Importance of contraception: to avoid getting pregnant; to avoid getting partner pregnant

Data on these topics are available as absolute numbers and proportions across the population, with the most recent information released in August of 2006. A number of reports have been generated, specifically covering early sexual intercourse, condom use, and STI rates.^{178,179,180,181} Since 1996/97, there has been a significant decrease in the proportion of 15-

¹⁷⁸ Garriguet D. Early sexual intercourse. *Health Reports*. 2005; 16(3): 9-16.

¹⁷⁹ Rotermann M. Sex, condoms and STDs among young people. *Health Reports*. 2005; 16(3): 39-45.

19-year-old Canadians who have had sexual intercourse at least once. Conversely, the number of individuals reporting multiple partners (over the preceding 12 months) has increased, though not significantly; fortunately, the number of sexually active youth reporting condom use at last sexual intercourse also increased (see table below).

Trends in Teen Sexual Behaviour CCHS Data, 15- to 19-Year-Olds Canada (Excluding Territories), 1996-2005			
	1996/97	2003	2005
Have had sexual intercourse at least once	47% *	45%	43%
Have had multiple partners in the past year†	29%	35%	33%
Used a condom the last time they had intercourse†		72%	75%
† Of those who are sexually active			
* Significantly different from corresponding estimate for 2005 (p < 0.05)			
Source: Rotermann M. Trends in teen sexual behaviour and condom use. <i>Health Reports</i> . 2005; 19(3).			

In terms of B.C.-specific data, the CCHS reports that 40% of 15-19-year-olds have had sexual intercourse at least once, and 77% of sexually active individuals used a condom at last sexual intercourse.¹⁸²

Overall, the area of sexual behaviour in youth seems to be weak in terms of data being reported; thus, while the CCHS and other national surveys on this topic potentially continue to ask about matters such as age of sexual debut, it is not clear that the information is ever compiled and/or made available.

BC Adolescent Health Survey

A British Columbia-specific data source for sexual behaviour data is the Adolescent Health Survey (AHS). According to the 2008 survey results, the majority of youth reported never having had sexual intercourse (78%). Among the 22% who are sexually active, the most common age of first sexual intercourse among this population was 15 years. Notably, 19% of sexually active youth reported first having sex prior to age 14; this finding represents a substantial decline from the first published survey results in 1992 (at 37%).¹⁸³ Unfortunately, the data on age of sexual debut appear to be selectively reported; there is no indication of the proportion of youth initiating sexual activity before the age of 16 years.

¹⁸⁰ Rotermann M. Trends in teen sexual behaviour and condom use. *Health Reports*. 2008; 19(3): 53-7.

¹⁸¹ Deering K, Tyndall M and Koehoorn M. Regional patterns of risk for sexually transmitted infections in British Columbia. *Health Reports*. 2010; 21(3): 37-44.

¹⁸² Rotermann M. Trends in teen sexual behaviour and condom use. *Health Reports*. 2008; 19(3): 53-7. Rotermann M. Trends in teen sexual behaviour and condom use. *Health Reports*. 2008; 19(3): 53-7. Rotermann M. Trends in teen sexual behaviour and condom use. *Health Reports*. 2008; 19(3): 53-7. Rotermann M. Trends in teen sexual behaviour and condom use. *Health Reports*. 2008; 19(3): 53-7.

¹⁸³ A Picture of Health. Highlights from the 2008 BC Adolescent Health Survey (AHS IV). Available at <http://www.mcs.bc.ca/AHS>. Accessed September 2010.

Discussion

Three identified studies focused on physical health outcomes, specifically, based on STI rates in adolescent girls as the outcome measure. There is limited evidence that sexual health interventions (involving multiple maneuvers) may reduce STI rates, especially related to *Chlamydia*. However, none of the studies linked a specific risky sexual behaviour or modification to increased or decreased STI risk, making a prevention policy difficult to formulate.

With only three studies meeting the criteria for inclusion, it is fair to say that the link between sexual behaviour in youth and physical health requires more investigation. There are a number of possible explanations for the literature gap. First, the link between risky sexual practices and potential effects on health may be assumed to be self-evident. For instance, it would not be surprising to find that younger age at first sexual encounter is associated with earlier experience of STI, pregnancy, and abortion.¹⁸⁴

Second, researchers may be reticent to take on correlation studies that are so dependent on self-reported data, especially involving teen respondents. Recall bias is inherent in any self-reported measure, specifically when the way a respondent answers a question is affected by the presumed “correct” answer and by memory gaps. This effect can be substantial. A 2003 study by Graham et al. that examined sexual behaviour found bias rates up to 75% in individuals who attempted to recall behaviours at just one month follow-up; at 3 months, the bias rate can increase to over 90%.¹⁸⁵ The tendency towards bias may be exacerbated by the sensitive and personal aspects of answering questions that pertain to sexual activity and health. Furthermore, there may be a natural reticence among researchers and participants to focus on the impact of behaviour that may involve illegal activity; for instance, the *basic* age of consent for sexual activity is now 16 years (increased from 14 years in 2008), although allowances are made in the statute for sexual relationships between young people close in age.

A final reason for the small number of studies identified in the literature search may be that it represents an artifact of the search criteria. A 2010 narrative review on first heterosexual intercourse lends credence to this suggestion. In fact, half the studies on physical health effects (including age of first pregnancy) dated to before 2000, and therefore fell outside of the timeframe in the search protocol for this project; this set of studies included some of the most intriguing physical health effects, specifically the suggestion that early age at first intercourse may be a risk factor for cervical and prostate cancer.¹⁸⁶ Similarly, this narrative review demonstrated that literature on psychological (as opposed to physical) effects of youth sexual behaviour is both more recent and more extensive.

Nine studies were identified that focused on sexual behavior and non-physical health outcomes. These were categorized according to the following outcome categories: delinquency, postsecondary/tertiary education, and psychological/psychosocial effects.

¹⁸⁴ Hawes ZC, Wellings K, Stephenson J. First heterosexual intercourse in the United kingdom: a review of the literature. *Journal of Sex Research*. 2010; 47(2): 137-52.

¹⁸⁵ Graham CA, Catania JA, Brand Ret al. Recalling sexual behavior: a methodological analysis of memory recall bias via interview using the diary as the gold standard. *Journal of Sex Research*. 2003; 40(4): 325-32.

¹⁸⁶ Hawes ZC, Wellings K, Stephenson J. First heterosexual intercourse in the United kingdom: a review of the literature. *Journal of Sex Research*. 2010; 47(2): 137-52.

The research focusing on delinquency as an outcome measure was interconnected. The more recent study of the two, by Harden et al., was a direct rebuttal of the analysis of Armour and Haynie—as suggested by the study title: “Rethinking timing of first sex and delinquency.” Armour and Haynie found that those experiencing early sexual debut have higher rates of delinquency that persist for a number of years, and that delaying sexual debut has a protective effect. Harden et al. counter by suggesting that “the association between early sex and later delinquency reported by Armour and Haynie could be an artifact of uncontrolled confounders.” In an attempt to control for a number of these confounding factors, Harden et al. chose to focus exclusively on same-sex twins abstracted from the original sample. They found counterintuitive results: “Age at first sex, then, was important for the prediction of later delinquency levels, even after controlling for related genetic and shared environmental differences between families. Surprisingly, however, this effect was in the opposite direction of that found in epidemiological research.” That is, those who had sex earlier demonstrated *lower* levels of delinquency than their same-sex twin. Thus, the authors were able to conclude that “...early sexual timing does not, in and of itself, elevate delinquent behavior.”

When evaluating the impact of sexual debut on postsecondary/tertiary education, both of the pertinent studies found that earlier sexual debut was negatively associated with future education. While Spriggs and Halpern found gender variation, with a particularly strong relationship for females, Parkes et al. found no such differential. These two studies also differed in their interpretation of how pregnancy/partner pregnancy following sexual activity may be involved. Parkes et al. noted that their results “differ from the recent U.S. study on non-initiation of post-secondary education, which found that childbearing ‘explained’ most of the effects of early sexual debut.”

The evidence surrounding sexual behavior and psychological/psychosocial outcomes is mixed. There are a number of possible explanations for the lack of consensus, beginning with the fact that the outcomes measured are heterogeneous, thus making it difficult for comparison. Additionally, as was pointed out by Harden et al., there are a number of confounding factors that are not controlled for when using a longitudinal data set. All of the studies that fell under the “non-physical health outcomes” category used such data sets for their observational research. Only Harden et al. made a concerted effort to control for confounders. The results of observational studies are much weaker than trials, such as the randomized controlled trials often used to study physical health outcomes following interventions. A report from the University of Wisconsin-Madison confirms mixed results in this area, with the author stating that “it appears that first sex can lead to increases in depression and decreases in self-esteem, but not among all adolescents.”¹⁸⁷ Interestingly, the author also noted gender differences, with adolescent girls experiencing greater effects than boys.

Conclusion

Both the CCHS and the B.C. Adolescent Health Survey report on sexual behaviour; however, the unreliability of self-reported information on this topic may compromise its utility as a focus of pediatric health and well-being indicators. Moreover, the evidence is limited for physical health effects arising from being sexually active as a youth. Even a seemingly straightforward area such as early sexual debut and elevated STI rates is marked by

¹⁸⁷ Meier A. *Adolescent sex and subsequent mental health: How sex affects adolescent depression and self-esteem*. 2007. Center for Demography and Ecology: University of Wisconsin-Madison. Available at <http://www.ssc.wisc.edu/cde/cdewp/2002-07.pdf>. Accessed February 2011.

“somewhat equivocal evidence” according to the 2010 narrative review by Hawes et al. that was cited above. The area of non-physical health effects has also produced conflicting evidence that is sometimes further compromised by confounding factors, making the drawing of causal connections very difficult. Nonetheless, based on at least a subset of the studies located in the literature search, an indicator linked to healthy behavioral choices, specifically delaying sexual debut, may have the most utility as a pointer to population health and well-being.

Summary Assessment					
Sexual Debut Before Age 14					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
12-19	18,100	Low	Medium	Medium	Medium

As summarized above, assessments have been applied to the Sexual Behaviour concept, specifically an indicator based on the age of sexual debut. The key question is where the cut-off should be placed in order to generate data that may be tracked, starting with a baseline magnitude. For present purposes, the cut-off is set at age 14 years; this is not meant to suggest that sexual debut in adolescents after age 14 carries no risks to health and well-being, just that there would be little professional debate that preventing debut before that age could have substantial benefits. However, as discussed above, there is difficulty obtaining information on, for instance, the proportion of teens initiating sexual activity before age 16, the current basic age of consent in Canada.

While rate of condom use (driven by sexual health concerns such as STIs) might be an alternate approach to an indicator, the evidence base concerning specific pediatric health mechanisms is somewhat weaker—that is, showing whether early sexual activity is marked by special risks for contracting an STI and/or whether contracting STIs at an earlier age (pediatric vs. young adult or adult) carries more serious health and well-being consequences; moreover, STIs, as well as early pregnancy, are actually covered in their own right as predictors of health and well-being (see the pertinent sections of the report).

The pediatric population **Magnitude** of the potential indicator is assessed as **Low**. Based on 2008 B.C. Adolescent Health Survey (AHS), 22% of adolescents surveyed were sexually active, of which 19% had their sexual debut prior to age 14. Based on these values, an estimated 4.2% of the total pediatric population sexually debuts before aged 14. When this percentage is applied to the pediatric cohort between ages 12 and 19 (the target age in the AHS), a prevalence of 18,100 is estimated. This number is less than 2% (19,000) of the total pediatric cohort, resulting in a Magnitude classification of Low.

The **Significance** of the potential indicator as indicated by the evidence of impact on an individual’s health and well-being is assessed as **Medium**. Sexual behaviours and related sexual health is generally an important area for any age group. The impact on an individual’s health and well-being can be quite variable. With respect to STIs, for example, while many of the infections may be transitory and / or treatable, other STIs (e.g. HIV) can have lifelong serious health consequences. In terms of the proposed indicator, the evidence for early sexual debut in particular creating problems within the pediatric population has been acknowledged as mixed, although there is enough information to certainly warrant caution. Beyond the psychosocial and health effects of STIs being contracted at an early age, there is also the

potential for an early pregnancy and for babies being born to very young mothers, the effects of which have been discussed elsewhere in the report.

The **Modifiability** of the potential indicator is assessed as **Medium**. Modifying sexual behaviour among young people in the present social context, while theoretically possible, is notoriously challenging.

Data Availability/Validity for the potential indicator is assessed as **Medium**. While there are two data sources available which report on sexual behaviour, both rely on self-reported information; in a sensitive area such sexual activity, there is the potential for the validity of the data to be compromised.

Given that all of the assessment rating tended towards low-to-medium, the potential indicator of early sexual debut is **Not Recommended** for consideration as a core indicator of child health and well-being, although it should be added to the list of indicators to consider for future development.

Sexually Transmitted Infections

Background and Context

Sexually transmitted infections (STIs) comprise viral, bacterial, and parasitic agents that have different transmission routes, symptoms, and prognosis. This wide variation, including the unique progression of infection in each individual, creates challenges for monitoring and managing infections at a population-level. If and when detected, many STIs are easily treatable; if left untreated, all such infections can generate substantial health consequences—even premature death.

STI rates in adolescents and young adults are very high. For example, U.S. adolescents have been shown to have the highest rate of STIs of any sexually active age cohort.¹⁸⁸ In British Columbia, the most recent STI surveillance data for females (from 2009) reported that the group aged 15-19 years had:¹⁸⁹

- The highest rate of infectious syphilis of any age group
- The highest rate of gonorrhea of any age group
- The second highest rate of *Chlamydia*, exceeded only by females aged 20-24 years

There are a number of influences that may account for elevated STI rates among adolescents, including physiological, cognitive, behavioral, and sociocultural factors. The Public Health Agency of Canada has identified the following pertinent risk factors for increased incidence of STIs:¹⁹⁰

- Sexual contact with infected person(s)
- A new sexual partner, or more than two sexual partners in the past year
- Serially monogamous individuals who have one partner at present but who have had a series of one-partner relationships over time
- Substance use, including alcohol or chemicals (cannabis, cocaine, ecstasy, crystal meth), especially if associated with sexual activity
- Street involvement, homelessness, etc.
- Anonymous sexual partnering (e.g., in the context of a rave-type party)

In addition to the above individual risk factors, a number of high risk groups have been identified, including men who have sex with men and adolescents of Aboriginal descent.¹⁹¹ While STIs have generally been higher in urban populations, there has been a shift in recent years in British Columbia; rates in the North now exceed the provincial average.¹⁹²

¹⁸⁸ Braverman PK. Sexually transmitted diseases in adolescents. *Medical Clinics of North America*. 2000; 84(4): 869-89, vi-vii.

¹⁸⁹ B.C. Centre for Disease Control. *Annual Surveillance Report: HIV and Sexually Transmitted Infections*. 2010. Available at <http://www.bccdc.ca/default.htm>. Accessed October 2010.

¹⁹⁰ Public Health Agency of Canada. *Canadian Guidelines on Sexually Transmitted Infections*. 2010. Available at: <http://www.phac-aspc.gc.ca/std-mts/sti-its/guide-lignesdir-eng.php>. Accessed October 2010.

¹⁹¹ Devries KM, Free CJ, Morison L et al. Factors associated with pregnancy and STI among Aboriginal students in British Columbia. *Canadian Journal of Public Health*. 2009; 100(3): 226-30.

¹⁹² Deering K, Tyndall M, Koehoorn M. Regional patterns of risk for sexually transmitted infections in British Columbia. *Health Reports*. 2010; 21(3): 37-44.

Not surprisingly, being sexually active is the main risk factor associated with STI diagnoses in individuals less than 20 years of age. Another important pediatric category involves vertical transmission (i.e., from mother to infant) of infections that are otherwise transmitted through sexual contact. When it is known that a pregnant woman is infected with *hepatitis B virus* (HBV) or *human immunodeficiency virus* (HIV), for example, prophylactic measures are routinely applied to protect the infant; an infection rate of zero at the beginning of life is realistically achievable for these and other STIs. This applies to *herpes simplex virus* (HSV) as well. Prevention of neonatal herpes, the most serious physical health outcome of HSV infection, involves giving antiviral medication to all pregnant mothers with a history of herpes infection, and delivering by C-section if an infection is detected just before birth.

A final pediatric category of interest is the tragic situation of STIs being transmitted by sexual abuse. It is understood that a certain proportion of infections such as *human papillomavirus* (HPV) are traceable to sexual interference with a minor.¹⁹³ Fully assessing this area is complicated by the evidence that contact other than sexual interaction may lead to transmission, including vertical transmission from mother to infant during the birth process.

Data Sources and Population Magnitude

There appears to be two types of STI information: survey data related to STIs in general and administrative data related to reportable STIs.

The annual Canadian Community Health Survey (CCHS) asks the sample cohort whether they have ever been diagnosed with a sexually transmitted disease. The proportion of those aged 15-17 and 18-19 years (the specific pediatric populations surveyed on this topic) answering “yes” in 2003 in Canada was 1.8% and 2.4%, respectively.¹⁹⁴ Unfortunately, more recent and B.C.-specific data does not seem to be readily accessible.

The alternate approach would be to track specific STIs, presumably starting with those generating the most population health impacts. In British Columbia, STIs are monitored by the B.C. Center for Disease Control (BCCDC). Reportable STIs include: HIV/AIDS, *Chlamydia*, gonorrhoea, and syphilis. Incidence data on these agents are regularly made available.

While it is difficult to accurately identify the prevalence or incidence of STIs given their propensity to be mildly or non-symptomatic, records of positive test results do offer an indication of relative magnitude and trends over time. The 2009 STI rates from the BCCDC are provided in the table below.

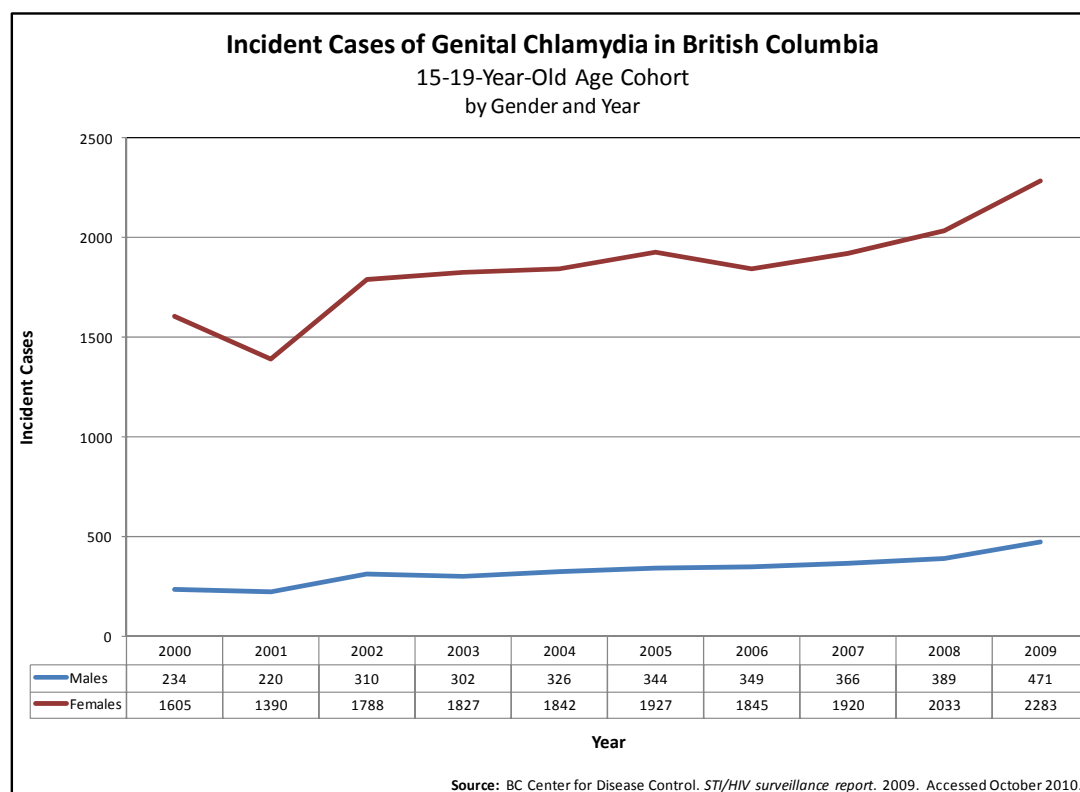
Reported STI Incidence Rates in British Columbia (2009)								
by Infection, Age Group, and Gender								
Rate (per 100,000 population)								
Age	Chlamydia		Gonorrhea		Syphilis		HIV	
	Males	Females	Males	Females	Males	Females	Males	Females
10-14 yrs	3.1	42.5	0.0	6.7	0.0	0.0	0.0	0.0
15-19 yrs	322.8	1669.4	33.6	98.0	6.2	3.7	2.7	2.2

Source: BC Center for Disease Control. STI/HIV Prevention and Control: Annual Report 2009. 2009. Available at: <http://www.bccdc.ca/resources/stats-res/default.htm>. Accessed October 2010.

¹⁹³ Krueger H, Gallagher R, Stuart G, Williams D, Kerner J. *HPV and Other Infectious Agents in Cancer*. New York, NY: Oxford University Press; 2010.

¹⁹⁴ Rotermann M. Sex, condoms and STDs among young people. *Health Reports*. 2005; 16(3): 39-45.

It is apparent that total incidence is dominated by *Chlamydia*, with a 15-fold higher rate than the next closest STI. Of additional interest and relevance is the fact that *Chlamydia* incidence has steadily increased over the past ten years in both males and females (see Figure below).



This upward trend is also observed with gonorrhea and syphilis, while new cases of HIV have remained stable or declined in recent years.

Notably, the two most prevalent STIs, HPV and HSV, are not reported in the BCCDC Annual Surveillance Report. There are two main reasons for this:

1. *High prevalence.* Epidemiological studies suggest that 75% of sexually active people will become infected with HPV at some point in their lifetime;¹⁹⁵ one Canadian jurisdiction estimated the prevalence of the two forms of HSV that are sexually transmitted (type 1 and 2) at 56% and 19%, respectively, among this same population.¹⁹⁶
2. *Asymptomatic or mild symptoms.* This exacerbates the previous point—tracking reported cases would result in an underestimation of overall prevalence, and a more proactive testing system would turn up a vast number of cases with limited health implications; in fact, the great majority of HPV and HSV infections are cleared.

¹⁹⁵ Moscicki AB. Impact of HPV infection in adolescent populations. *Journal of Adolescent Health*. 2005; 37(6 Suppl): S3-9.

¹⁹⁶ Coldman AJ, Phillips N, Olivetto IA et al. Impact of changing from annual to biennial mammographic screening on breast cancer outcomes in women aged 50-79 in British Columbia. *Journal of Medical Screening*. 2008; 15(4): 182-7.

It is important to note that, while HPV and HSV are not tracked in the annual surveillance reports, data on positive test results are occasionally published, as evidenced by the 2008 report entitled *Trends in Herpes Simplex Virus Cases in British Columbia, 1992 – 2006*.¹⁹⁷

Physical Health Effects

As reflected in the section on Major Childhood Infectious Diseases, the presence of infection is by definition a marker of disease; therefore no further evidence of a physical health effect is required for this concept. The two main considerations that remain are the number of cases of each infection (see previous section) and a basic understanding of the disease sequelae of being infected. As noted earlier, both the pattern of transmission and health effects vary with each infectious agent. Some of the most common pediatric STIs and their health effects are listed in the table below.

Pediatric Sexually Transmitted Infections Transmission Routes and Physical Health Effects			
Sexually Transmitted Infectious Agent	Infection Name / Abbreviation	Main Transmission Route(s)	Physical Health Effects with Persistent Infection
Chlamydia trachomatis	Chlamydia	Body fluids/mucous membranes	Men Often asymptomatic Urethritis Discharge from penis Pelvic inflammatory disease (PID) Epididymitis Sexually acquired reactive arthritis Women Often asymptomatic Abdominal pain Intermittent bleeding Increased discharge from vagina Tubal infertility PID Ectopic pregnancy Endometritis
Neisseria gonorrhoeae	Gonorrhea	Body fluids/mucous membranes	Children Blindness Joint infection Blood infection Men Occasionally asymptomatic Urethritis Discharge from penis Swollen testicles Epididymitis Women Often asymptomatic Urethritis Increased vaginal discharge PID

¹⁹⁷ Li X, Hyeong-Jin Kim P and Gilbert M. *Trends in Herpes Simple Virus Cases in British Columbia, 1992 - 2006*. 2008. Available at http://www.bccdc.ca/NR/rdonlyres/11F4B322-54F7-48AC-A116-6D1081449B98/0/STI_Report_TrendsInHSV19922006_20090520.pdf. Accessed October 2010.

Pediatric Sexually Transmitted Infections

Transmission Routes and Physical Health Effects

Sexually Transmitted Infectious Agent	Infection Name / Abbreviation	Main Transmission Route(s)	Physical Health Effects with Persistent Infection
Treponema pallidum	Syphilis	Direct contact with sores	<p>Children</p> <ul style="list-style-type: none"> Syphilis rash (hands and feet) Vesiculobullous eruptions Blood-stained nasal discharge Lymphadenopathy and hepatosplenomegaly Gummatous ulcers Optic atrophy Blindness Interstitial keratitis Sensorineural deafness <p>Men/Women</p> <ul style="list-style-type: none"> Chancre Lymph node swelling Syphilis rash (hands and feet) Fever / sore throat Granuloma development Neuropathic joint disease Neurological symptoms Cardiovascular symptoms
Human immunodeficiency virus	HIV	Blood/body fluids	<p>Children</p> <ul style="list-style-type: none"> AIDS Opportunistic infections with severe symptoms Adverse structural and functional changes in vasculature Prone to CVD Adverse neurological development <p>Men/Women</p> <ul style="list-style-type: none"> AIDS Opportunistic infections with severe symptoms Rapid weight loss Dry cough Recurring fever Profound fatigue Swollen lymph nodes Diarrhea White spots or blemishes on tongue, mouth or throat Pneumonia Memory loss Mortality
Hepatitis B	HBV	Blood/body fluids containing blood	<p>Infants</p> <ul style="list-style-type: none"> Opportunistic infections with severe symptoms Mortality (rare) <p>Men/Women</p> <ul style="list-style-type: none"> Loss of appetite Nausea / vomiting Body aches, mild fever Dark urine Jaundice, liver inflammation Liver cancer Mortality

Pediatric Sexually Transmitted Infections

Transmission Routes and Physical Health Effects

Sexually Transmitted Infectious Agent	Infection Name / Abbreviation	Main Transmission Route(s)	Physical Health Effects with Persistent Infection
Herpes simplex virus	Herpes	Skin contact (with vesicles/ulcers or asymptotically through 'viral shedding')	<p>Infants</p> <ul style="list-style-type: none"> Asymptomatic (68-98% of cases) Skin lesions Eye infection <p>Children</p> <ul style="list-style-type: none"> Skin / eye / membrane herpes External lesions Disseminated herpes Organ involvement (particularly liver) Central Nervous System herpes Seizures and tremors Lethargy Mortality <p>Men/Women</p> <ul style="list-style-type: none"> Asymptomatic (approximately 75% of cases) Red, sensitive skin with sores or blisters Swollen lymph glands Headaches Muscle aches, low back pain Fever
Human papillomavirus	HPV	Skin contact (transmission probability increases with outward symptoms such as warts)	<p>Children</p> <ul style="list-style-type: none"> Recurrent respiratory papillomatosis <p>Men/Women</p> <ul style="list-style-type: none"> Generally asymptomatic Some vaccine-preventable types cause genital warts May result in latent, long-term infection with cancer sequelae, including cervical cancer, anogenital cancers, and head and neck cancers
Trichomonas vaginalis	Trichomonas	Skin contact, body fluids, mucosal membrane contact	<p>Men</p> <ul style="list-style-type: none"> Generally asymptomatic Burning while urinating Discharge from penis <p>Women</p> <ul style="list-style-type: none"> Increased discharge from vagina Itchy genitals and thighs Swollen labia Pain during intercourse
Pubic Lice and Scabies	Crabs	Direct physical contact with infected individual or with towels, sheets, etc. with which they have had contact	<ul style="list-style-type: none"> Itching in pubic area Burning sensation in pubic area Spread from pubic area to armpits/other warm moist areas

Discussion and Conclusion

A global indicator of past or present STI based on CCHS data may have some usefulness, but it would be less sensitive as a monitor of intervention effectiveness than the incidence information available through BCCDC. The limitation to the latter approach is that it requires focusing on one or more specific STIs. However, the global indicator is hampered in another way, specifically by lack of accessible and regular data specific to British Columbia.

Of the four reportable infections, *Chlamydia* appears to be the best one to add to core indicators of pediatric health in BC, as it is the most prevalent – with a rate 15 times that of the next most prevalent reportable infection, gonorrhea. Although the health consequences of *Chlamydia* on an individual basis pale in comparison to HIV or syphilis, when evaluated at a population level the burden becomes more compelling; this is because the prevalence of *Chlamydia* is notably high among those under 20 years of age.

Because of the total health burden involved and the primary prevention potential, it may be tempting to consider tracking HPV infection; however, this would not be a feasible approach, since the majority of people are infected with HPV at some point in their lives, most clear the infection without treatment, and a system to identify persistent infection with vaccine-preventable types would be both complex and costly. For HPV infection, the most serious physical health outcome is cervical cancer in women, and penile and anal cancer in men, which together represent a small proportion of all cancers; most pertinently, the percentage of people infected with HPV that progress to cancer is small. However, there is a considerable impact related to precursor lesions caused by oncogenic HPV types, as well as benign genital warts generated by two vaccine-preventable forms of HPV. This at least partly avoidable burden includes discomfort, inconvenience, and health care costs involved with following up a positive screen (e.g., Pap smears in women) or treating diagnosed disease. Of course, as discussed in the section on immunization rates later in the report, tracking HPV vaccination rates would be an alternate and likely superior indicator in this area.

Summary Assessment <i>Chlamydia</i> Incidence					
Age group (Years)	Est. Incidence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
15-19	2,800	Low	Low	Medium	High

As summarized above, assessments have been applied to the Sexually Transmitted Infections concept, specifically in terms of the indicator with the most compelling support in the literature, namely, *the incidence of Chlamydia infection*.

The pediatric population **Magnitude** of the potential indicator is assessed as **Low**. Based on B.C. Center for Disease Control data, the incidence rate of *Chlamydia* infection among those aged 15-19 years in B.C. is approximately 974 per 100,000 population. Applying this rate to the pediatric cohort of the same age group, results in an annual incidence estimate of 2,800 individuals. For practical purposes, the incidence rate may be equated to the prevalence rate, albeit this may be an overestimation given the potential for rapid treatment and clearance. Whatever adjustments might be made to the total prevalence, it is clear that it will be less than 2% of the total pediatric cohort (19,000), resulting in a Magnitude classification of Low.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **Low**. *Chlamydia* infection is often asymptomatic; causation of the experienced impacts is well-established, but those effects tend towards the acute and treatable rather than the chronic.

The **Modifiability** of the potential indicator is assessed as **Medium**. *Chlamydia* infection is theoretically amenable to prevention (e.g., through condom use), but modifying sexual behaviour in any age group is notoriously challenging.

Data Availability/Validity for the potential indicator is assessed as **High**. *Chlamydia* incidence rates are routinely available through the BCCDC, as it is a reportable infection.

The potential indicator related to *Chlamydia* infection is **Not Recommended** for consideration as a core indicator of child health and well-being. The rationale is the low assessment ratings in the critical categories of Magnitude and Significance.

Teenage Pregnancy

Background and Context

The purpose of this review is to find research evidence of an association between teenage pregnancy and child health and well-being. In this case, the “child” may refer to either the teenage mother or the infant, making this a unique concept among the list being considered in the present report. Teenage pregnancy rates in Canada have been declining since the mid-1970s. In 1995, the rate of pregnancies in females under age 20 was 40.2 per 1,000, compared to a rate of 24.6 per 1,000 in 2005. The rates were similar in British Columbia, translating to over 4,000 teenage pregnancies in 2005 in that province. The decline in this ten-year period coincided with a substantial increase in contraceptive use by sexually active teens.

According to McKay and Barrett, such a decline may also reflect “greater access to reproductive health services, exposure to higher quality sexual health education, and/or a shifting of social norms in a direction that provides greater support for young women’s capacity to exercise reproductive choice.”¹⁹⁸

Teenage pregnancy has been associated with a range of adverse health and socioeconomic outcomes; the focus in this report will be on physical health effects on the mother and/or the infant. Maternal risks identified with pregnancy at a young age include obstetrical complications, sexually transmitted infections (STIs), urinary tract infections, pregnancy-induced hypertension, premature death, postpartum depression and other mental health difficulties, educational underachievement, and poorer economic circumstances. There has been a suggestion that obstetrical complications are more of an issue for younger teens, but this particular sort of age stratification was not identified in this review. Infant adverse outcomes potentially include low birth weight, preterm birth, increased risk of birth defects, and increased risk of death. A subject of much controversy in this area is the root cause of these increased health risks for mother or infant: Are they due to young maternal age per se (i.e., biologically caused), or are they an epiphenomenon of one or more variables commonly associated with teenage pregnancy, such as low socioeconomic status?

Methodology and Provisional Results

Physical Health Outcomes

Review Search Process

For the electronic search for reviews in this area, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-20 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

("Pregnancy in Adolescence"[Majr]) AND

¹⁹⁸ McKay A, Barrett M. Trends in teen pregnancy rates from 1996-2006: A comparison of Canada, Sweden, U.S.A, and England/Wales. *Canadian Journal of Human Sexuality*. 2010; 19(1-2): 43-52.

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Overweight"[Mesh])

It was determined from the search results (examining the 47 located papers) that there were no suitable reviews for this concept, so the decision was made to execute a “Level B” search process involving individual studies.

Study Search Process

A second electronic search was conducted for individual studies in this area. The database used was again PubMed, with the following limits:

Date: 2000-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Clinical Trial, Randomized Controlled Trial, Controlled Clinical trial.

The same search terms were used as in the review search process outlined previously. There were 43 studies identified in this search process.

*While the protocol defines a child as 0-20 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

In addition to the above search method, the following searches were conducted:

- PubMed search using “Related citations” link
- A scan in Google for grey literature and for any obvious articles missed, using terms such as: **(teenage pregnancy) AND children AND health**
- Hand-searching bibliographies of key papers
- Checking for study updates (by author)

Taken together, the various search processes returned 70 articles for consideration.

Preliminary Exclusion

The articles were scanned *by title* by two reviewers working individually, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between teenage pregnancy and physical health outcome(s), then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 32.

Primary Exclusion

The full articles were then reviewed, with articles not pertinent to the research topic being excluded; specifically, if the article did not link teenage pregnancy with physical health outcome(s), it was excluded. Also excluded was any study that focused on a specific subgroup, such as African-Americans, or studies that did not take place in Western developed countries, where there would be a limitation to the generalizability of results across the whole pediatric population in a jurisdiction such as British Columbia. If there was uncertainty as to

whether an article should be excluded, the reviewers discussed the matter further to reach a consensus.

There were 17 articles remaining in the list following the primary exclusion step.

Secondary Exclusion

Studies that were deemed to be of lesser quality or usefulness were excluded. This secondary exclusion step yielded a total of 11 studies, as reflected in the following Volume Report and the subsequent table of results.

Non-physical Health and Well-being Outcomes

Review Search Process

For the electronic search for reviews in this area, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-20 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

("Pregnancy in Adolescence"[Majr]) AND

("Psychological Phenomena and Processes"[Majr] OR "Behavior and Behavior Mechanisms"[Majr])

Similar to the conclusion for physical health outcomes, it was determined from the search results (examining the 29 located papers) that there were no suitable reviews for this concept, so the decision was made to execute a "Level B" search process involving individual studies.

Study Search Process

A second electronic search was conducted for individual studies in this area. The database used was again PubMed, with the following limits:

Date: 2000-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

*While the protocol defines a child as 0-20 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

The same search terms were used as in the review search process outlined previously. There were 372 studies identified in this search process.

Preliminary Exclusion

The articles were scanned *by title* by two reviewers working individually, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between teenage pregnancy and physical health outcome(s), then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 18.

Primary Exclusion

The full articles were then reviewed, with articles not pertinent to the research topic being excluded; specifically, if the article did not link teenage pregnancy with non-physical health outcome(s), it was excluded. Also excluded was any study that focused on a specific subgroup, such as African-Americans, or studies that did not take place in Western developed countries, where there would be a limitation to the generalizability of results across the whole pediatric population in a jurisdiction such as British Columbia. If there was uncertainty as to whether an article should be excluded, the reviewers discussed the matter further to reach a consensus.

There were 3 articles remaining in the list following the primary exclusion step.

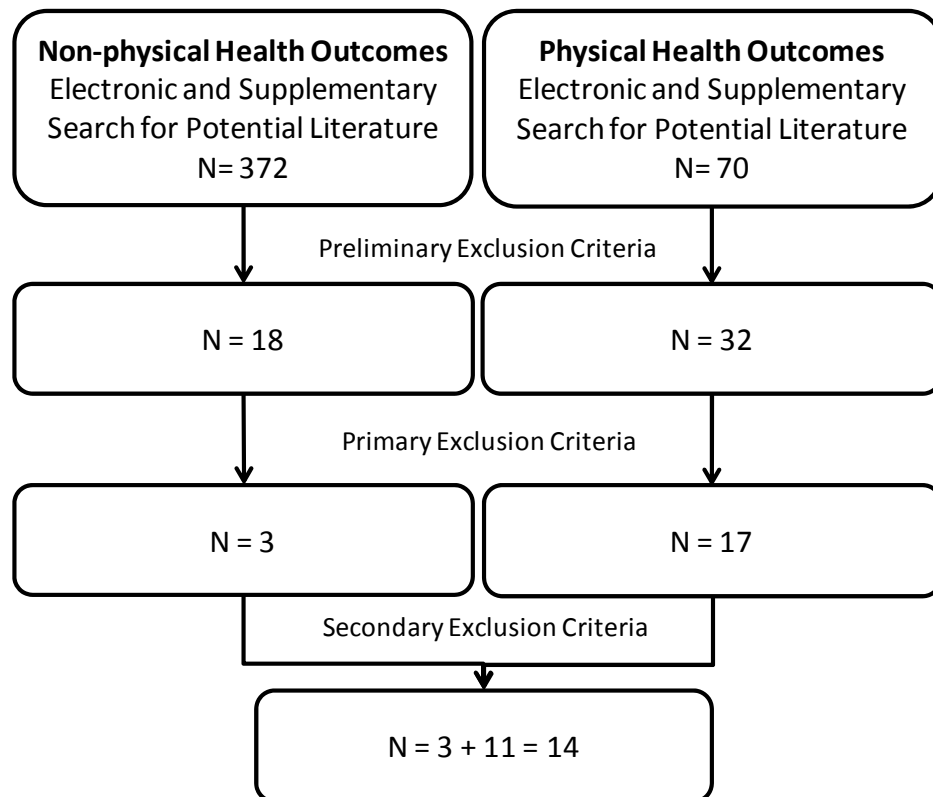
Secondary Exclusion

Studies that were deemed to be of lesser quality or usefulness were excluded. This secondary exclusion step retained a total of 3 studies for non-physical health outcomes.

As reflected in the following Volume Report and the subsequent table of results, a total of 14 studies were identified for the Teenage Pregnancy concept.

Literature Review Volume Report: Individual Studies

Dimension: Physical Health **Concept:** Teenage Pregnancy



Summary of Relevant Studies

Dimension: *Physical Health*

Concept: *Teenage Pregnancy*

Title of Study	Author(s)	Year	Journal	Journal Impact Factor (2005)	Type of Study	Sample Size	Sample Population	Location	Conflict of Interest
Maternal Health									
1 Investigating the relationship between teenage childbearing and psychological distress using longitudinal evidence	Mollborn and Morningstar	2009	Journal of Health and Social Behaviour	2.35	Cross-sectional	5,429	Adolescent females	USA	Not Available
2 Early motherhood and subsequent life outcomes	Boden et al.	2008	Journal of Child Psychology and Psychiatry	4.98	Cross-sectional	515	Adolescent females	New Zealand	None Declared
3 Postpartum depression and social support in adolescents	Logsdon et al.	2005	Journal of Obstetrics, Gynecologic, and Neonatal Nursing	0.95	Intervention	128	Pregnant adolescent females	USA	Not Available
4 Premature death among teenage mothers	Otterblad Olsson et al.	2004	British Journal of Obstetrics and Gynaecology	2.17	Population-based cohort study	460,434	Swedish women born 1950-1964 who had their first infant before age 30	Sweden	Not Available
5 Excessive maternal weight gain patterns in adolescents	Howie et al.	2003	Journal of The American Dietetic Association	2.38	Population-based cohort study	2,796,805	Mothers delivering singletons	USA (excluding California)	Not Available
6 High postpartum rates of sexually transmitted infections among teens: pregnancy as a window of opportunity for prevention	Ickovics et al.	2003	Sexually Transmitted Infections	2.67	Prospective longitudinal study	411	Pregnant and non-pregnant adolescents	Connecticut, USA	Not Available
Infant/child Health									
7 Teenage pregnancy and adverse birth outcomes: a large population based retrospective cohort study	Chen et al.	2007	International Journal of Epidemiology	4.05	Retrospective cohort study	3,886,364	Live singleton births to primiparae <25 years during 1995-2000	USA	Not Available
8 Teenage children of teenage mothers: Psychological, behavioural and health outcomes from an Australian prospective longitudinal study	Shaw et al.	2006	Social Science & Medicine	2.71 (2009)	Prospective study	5,260 mother-offspring pairs	Mothers with 14-year-old offspring	Australia	Not Available
9 Socioeconomic factors and adolescent pregnancy outcomes: distinctions between neonatal and post-neonatal deaths?	Markovitz et al.	2005	BMC Public Health	1.66	Retrospective cohort study	18,954 adolescent women/28,899 older women	Singleton births to women aged 12-17 years and 20-35 years	Missouri, USA	None Declared
10 Maternal age and non-chromosomal birth defects, Atlanta -- 1968-2000: Teenager or thirty-something, who is at risk?	Reefhuis et al.	2004	Birth Defects Research (Part A): Clinical and Molecular Teratology	1.55	Population-based cohort study	1,050,616	Singleton infants born after 20 weeks gestation, without chromosomal defects, with a mother 14-40 years of age	Atlanta, USA	Not Available
11 Young maternal age associated with increased risk of postneonatal death	Phipps et al.	2002	Obstetrics and Gynecology	4.17	Population-based cohort study	1,830,350	Singleton, first births to mothers 12 to 29 years old	USA	Not Available
Maternal and Infant/child Health									
12 How do pregnancy outcomes differ in teenage mothers? A Western Australian study	Lewis et al.	2009	Medical Journal of Australia	2.13	Cross-sectional descriptive analysis	4,896 singleton births (560 to teenage mothers)	Women with singleton pregnancies who delivered between June 2004 and September 2006	Western Australia	None Declared
13 Comparing pregnancy in adolescents and adults: Obstetric outcomes and prevalence of anemia	Briggs et al.	2007	Journal of Obstetrics and Gynaecology Canada		Retrospective chart review	207 adolescents and 415 adults	Patients of a single obstetrician who had a live singleton birth at ≥24 weeks' gestation	Canada	Not Available
14 Does young maternal age increase the risk of adverse obstetric, fetal and neonatal outcomes: A cohort study	de Vienne et al.	2009	European Journal of Obstetrics & Gynecology and Reproductive Biology	1.14	Retrospective cohort analysis	8,514 singleton births to primiparous women	Singleton births of primiparous women aged 14-30 years	France	Not Available

Detailed Results

For the 14 studies identified through the literature search and exclusion process, a summary table was developed, as provided below.

Dimension: *Physical Health Concept: Teenage Pregnancy*

Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
Maternal Health							
Mollborn and Morningstar (2009)	To illuminate the relationship between teenage pregnancy and psychological distress.	Use longitudinal data to answer 4 questions, with the first two being most pertinent: Are teenage mother more distressed? Does teenage childbearing lead to distress? Does distress lead to teenage childbearing? Do relationships between distress and teen childbearing vary across groups?	United States N=5,429 female adolescents	Cross-sectional analysis of longitudinal data from the National Longitudinal Study of Adolescent Health and the Early Childhood Longitudinal Study – Birth Cohort.	Answers to the four questions proposed in the study description. Variables include: - Psychological distress - Teenage childbearing - SES - GPA	Q1: The mean distress level in “wave two” teenagers who were not teenage mothers by wave three was 0.59, compared to 0.77 for their peers who had become adolescent mothers by wave two ($p<0.01$). Q2: Teenage mothers’ high distress scores were the result of distress prior to childbearing rather than the experience of teenage mother itself. Q3: The relationship between psychological distress and subsequent teenage motherhood was spurious, likely a result of underlying factors such as SES, academic achievement, family structure, and sexual behaviour. Q4: High levels of distress were associated with having a household income at or below the poverty line.	Teenage mothers’ distress levels were already higher than their peers before they became pregnant, and remained higher after childbearing and into early and middle adulthood. Distress only increased the likelihood of adolescent childbearing among poor teenagers.
Boden et al. (2008)	To understand how social and family background are associated with early motherhood, and how early motherhood can negatively impact educational and	Use longitudinal data (25 years) and compare with mental health, educational, and related outcomes.	New Zealand N= 515 females	Cross-sectional analysis of longitudinal data from the Christchurch Health and Development Study	- Mental Health - Educational outcomes (tertiary qualification, university degree) - Economic circumstances (welfare dependence, rates of paid employment, personal income, family income at age 25).	- Earlier age of parenthood was associated with increased rates of major depression, anxiety disorder, suicidal ideation, and suicide attempt. - Early motherhood was significantly associated with lower rates of education qualifications, tertiary qualifications, and gaining a university degree. - Early motherhood was also associated with higher rates of	The findings suggest that early motherhood puts young women at risk for educational underachievement and poorer economic circumstances. <i>The linkages between early motherhood and later mental health difficulties can largely be accounted for by childhood, family, and related</i>

Dimension: Physical Health Concept: Teenage Pregnancy
Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
	economic outcomes later in life.					welfare dependence, lower rates of paid employment, lower personal income, and lower family income at age 25. - Early parenthood was significantly associated with lower SES, history of child abuse and family dysfunction, and lower IQ test scores	<i>circumstances that occurred prior to parenthood.</i>
Logsdon et al. (2005)	To determine the effectiveness of a social support intervention delivered to pregnant adolescent girls between 32 and 36 weeks of gestation in preventing symptoms of depression.	Participants completed two depression instruments; they were then randomly assigned to one of four intervention groups (control, pamphlet, video, or both), and re-evaluated at 6 weeks postpartum.	United States N=128 adolescent girls (average age of 16 years, grade 10)	Intervention study, data collected at baseline and 6 weeks postpartum.	- Depression measure: Centre for Epidemiological Studies of Depression (CES-D) instrument.	- 56% of participants showed evidence of depression. - Depression was higher in pregnancy than at 6-weeks postpartum. - There were no differences in outcome variables among treatment groups at 6 weeks postpartum.	Levels of depression among pregnant adolescents are high, but targeted interventions as presented here appear to have no affect on reducing depression at 6 weeks postpartum. This sort of information would be more pertinent if comparisons could be made to rates in non-pregnant teens and/or adult mothers, or if chronic depression could be tracked.
Otterblad Olausson (2004)	Investigate the relationship between maternal age at first birth and risks of total, as well as cause-specific, premature mortality	Follow up of all women born in Sweden from 1950 to 1964, registered in the 1985 Swedish Population and Housing Census, who had their first infant between 1964 and 1989, and before the age of 30 years	Sweden N=460,434 women born 1950-1964 who had their first infant before the age of 30 years	Population-based cohort study	- Maternal age at first birth - Socioeconomic status - Mortality rates by cause of death	Independent of socioeconomic background, teenage mothers faced an increased risk of premature death later in life compared with older mothers (rate ratio 1.6, 95% CI 1.4-1.9). After adjustment for pre-childbearing socioeconomic status, teenage mothers (compared with women aged 20-29 at first birth) faced a more than doubled risk of dying from cervical cancer; a doubled risk of dying from lung cancer; 10-fold increase in risk for death due to inflicted violence; and doubled or more than doubled risks	Teenage mothers, independent of socioeconomic background, face an increased risk of premature death. Strategies to reduce teenage childbearing are likely to contribute to improved maternal and infant health.

Dimension: *Physical Health Concept: Teenage Pregnancy*

Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
						for death due to ischemic heart disease, suicide, and alcohol-related causes.	
Howie (2003)	Examine the correlates of excessive maternal weight gain among adolescent mothers	Data from the Centers for Disease Control & Prevention 2000 natality file were analyzed to examine weight gain among adolescents (≤ 19 years) compared with their older counterparts (≥ 20 years)	United States N=2,796,805 births	Population-based cohort study	- Percentage of mothers with excessive weight gain (>40 lb) by maternal age and other maternal characteristics	Over 27% of adolescent mothers gained excessive weight during pregnancy, compared to 18% of their older counterparts. The association between young maternal age and weight gain was stronger for primiparous women than for multiparous women. Adolescents were more likely to gain excessive weight than their older counterparts in nearly all demographic categories (e.g., race).	Adolescents gain an excessive amount of weight during pregnancy compared with older women. Higher weight gains are associated with subsequent health risks for the mother, such as postpartum obesity, which can lead to serious health effects.
Ickovics (2003)	Identify incidence and predictors of <i>Chlamydia trachomatis</i> and <i>Neisseria gonorrhoeae</i> infection among postpartum adolescents	Subjects were recruited from 10 community-based health clinics. Structured interviews and STI testing were conducted at baseline (third trimester for pregnant adolescents) and at 6 and 12 month follow-up visits (3 and 9 months postpartum for those pregnant at baseline).	Connecticut, USA N=411 (203 pregnant and 208 non-pregnant adolescents aged 14-19 years)	Prospective longitudinal study -Structured, face to face interview that took 60-90 minutes to complete; included demographics, sexual history, and sexual risk behaviour -urine sample for testing for <i>C. trachomatis</i> and <i>N. gonorrhoeae</i>	- Incidence of <i>C. trachomatis</i> and <i>N. gonorrhoeae</i>	Among pregnant teens, new infections of <i>C. trachomatis</i> and <i>N. gonorrhoeae</i> increased from 7.1% at the 6-month follow-up interview to 14.3% at the 12-month follow-up interview; among non-pregnant teens, new infections remained relatively stable over this time period. <i>C. trachomatis</i> and <i>N. gonorrhoeae</i> prevalence was 1.94 times higher among teens 9 months postpartum than among the comparison group of non-pregnant teens, controlling for baseline STI.	Postpartum adolescents are particularly vulnerable to STI infection, most probably because of re-initiation of high risk sexual behaviour. Postpartum adolescents are a high risk subgroup needing additional attention to ensure follow-up screening and treatment.

Infant/Child Health

Dimension: Physical Health Concept: Teenage Pregnancy

Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
Chen (2007)	Determine whether teenage pregnancy is associated with increased adverse birth outcomes independent of known confounding factors	Study data were derived from the 1995-2000 nationally linked birth-infant death data set of the United States, compiled by National Center for Health Statistics and Centers for Disease Control and Prevention	USA N=3,886,364 nulliparous pregnant women <25 years of age with a live singleton birth during 1995-2000	Retrospective cohort study	- Birth outcomes: Very pre-term delivery (live infant delivered at less than 32 weeks' gestation), pre-term delivery (live infant delivered at <37 weeks' gestation), very low birth weight (very LBW=live infant weighing <1500 g at birth), LBW (live infant weighing <2500 g at birth), birth weight < 10 th percentile for sex and gestational age (SGA), very low Apgar score at 5 min (<4), low Apgar score at 5 min (<7), and neonatal death (death of a live birth within 28 days) - Maternal alcohol use, tobacco use, and weight gain during pregnancy	The rates of all adverse birth outcomes were higher in teenage pregnancies. They consistently increased with decreasing maternal age, being highest among infants born to mothers aged 15 years or younger. Results were similar when the analysis was restricted to white married women with age-appropriate education level, adequate prenatal care, and without smoking and alcohol use during pregnancy, in other words, when controlling for some posited confounding factors.	Teenage pregnancy was associated with increased risks of very pre-term delivery, pre-term delivery, very LBW, LBW, SGA, and neonatal mortality, with a general tendency of poorer outcomes in younger teenagers. Restriction of the analysis to white married women with age-appropriate education level, adequate prenatal care, and without smoking and alcohol use during pregnancy did not change the results, suggesting that the increased risk of adverse birth outcomes for teenage pregnancy was less likely to be secondary to socioeconomic factors and prenatal care, and more likely intrinsic to the phenomenon of maternal youth.
Shaw (2006)	Examine the associations of maternal age with outcomes among their 14-year-old offspring in terms of physical health, psychological, and behavioural characteristics	Subjects were participants in the Mater-University study of pregnancy (MUSP) and its outcomes, a prospective study of women and their offspring receiving antenatal care at a major public hospital in South	Australia N=5,260 mother-offspring pairs	Prospective study -interviews with mother at the first antenatal clinic visit, 3-5 days after birth, 6 months after birth, 5 and 14 years after birth -physical examination of	- Child psychological and cognitive behaviour - Health outcomes: self-report of poor health by the teen, maternal report of diagnosis of asthma, any fracture, any accidents requiring medical attention, and >2 admissions to hospital since birth	Maternal age was not associated with most physical health outcomes in the offspring at age 14 years; the exception was that dental fillings were more common among children of younger mothers. The evidence for other dimensions of well-being was more compelling; thus, 14-year-old offspring of mothers aged 18 years and younger at birth were more likely to have disturbed psychological behaviour,	The only health outcome found to be associated with teenage motherhood was dental health. Results suggest that interventions aimed at reducing maternal poverty may be more effective ways of improving childhood outcomes (psychological, behavioural, health, cognitive) than those that

Dimension: Physical Health Concept: Teenage Pregnancy
Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
		Brisbane between 1981 and 1984. Mothers were interviewed pre- and post-birth, and the 14-year-old child was interviewed and physically examined.		and interview with 14-year-old child		poorer school performance, poorer reading ability, been in contact with the criminal justice system, and become regular smokers and consumers of alcohol.	focus on reducing the teenage birth rate.
Markovitz (2005)	Investigate the relationships between infant mortality, socioeconomic status, and maternal age	Population-based cohort study using linked birth-death certificate data for Missouri residents during 1997-1999. Infant mortality rates for all singleton births to adolescent women were compared to those for older women.	Missouri, USA N=18,954 women 12-17 years; 18,954 women 18-19 years; 28,899 women 20-35 years	Retrospective population-based cohort study	Infant mortality rate: Neonatal (0-27 days) mortality and post-neonatal (28-364 days) mortality	The risk of infant, neonatal, and post-neonatal mortality were significantly higher for younger adolescent (12-17 years) than older (20-34 years) mothers. After adjusting for race, marital status, age-appropriate education level, parity, smoking status, prenatal care utilization, and poverty status, the risk of post-neonatal mortality but not neonatal mortality remained significant for younger adolescent mothers.	Socioeconomic factors likely account for most of the young mothers' increased risk of neonatal mortality, but (given the controls applied) not the increase in post-neonatal mortality risk. Further analysis suggests an increased risk of accidental and infectious deaths in these infants, raising questions of maternal maturity and ability to adequately supervise developing infants.
Reefhuis (2004)	Explore the association between maternal age and non-chromosomal birth defects to assess any increased risk associated with maternal age (both younger	Birth defect cases were ascertained by the Metropolitan Atlanta Congenital Defects Program (MACDP).	Atlanta, USA N=1,050,616 singleton infants born after > 20 weeks gestation in metropolitan Atlanta from 1968-2000 who did not have a chromosomal abnormality and	Population-based cohort study	Birth defect categories (not involving chromosomal abnormality) associated with maternal age	Young maternal age (14-19 years) was lined to various birth defects, with the strongest association seen in gastroschisis (adjusted for parity, race, sex of the child, and the year of birth).	Women giving birth under 20 years and over 35 years are at increased risk of having a child with a birth defect. There may be some biological reasons why young mothers are at a higher risk for birth defects, but lifestyle factors (e.g., smoking) seem to be the most likely explanation.

Dimension: Physical Health Concept: Teenage Pregnancy

Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
	and older)		whose mother was 14 to 40 years old				
Phipps (2002)	Determine whether full-term, healthy infants born to early adolescent mothers (15 years old and younger) are at higher risk of postneonatal death compared with infants of adult mothers	Combined data from the comprehensive 1996 and 1997 United States Linked Birth/Infant Death data sets	United States N=1,830,350 singleton, first births to mothers 12-29 years old. Only "healthy" infants were included, defined by gestational age of 37 wks or more, birth weight of 2500 g or greater, and no congenital anomalies.	Population-based cohort study	- Postneonatal mortality rate (deaths more than 28 days after birth but within a year) - Risk of postneonatal death associated with maternal age, adjusting for race and several other factors	The postneonatal mortality rate for infants born to mothers 15 years old and younger was 3.2 per 1000, compared to 0.8 per 1000 for infants born to mothers 23-29 years old. After adjusting for maternal race or ethnicity, prenatal care utilization, and marital status, infants born to early adolescent mothers had a three-fold higher risk of postneonatal death compared with adult mothers.	Infants born to mothers 15 years old and younger are at increased risk of death within the first year after birth compared with infants born to older mothers. The increased risk remaining after adjustments is likely related to unmeasured social factors. Because many of these infant deaths may be preventable, developing and evaluating postnatal support services could have a dramatic effect on the postneonatal mortality rate.
Maternal and Infant/Child Health							
Lewis (2009)	Determine whether teenage pregnancy and indigenous status are associated with increased risk of adverse pregnancy outcomes	Retrospective hospital-based study using computerized perinatal data	Australia N=4896 births (N=560 births to teenage mothers) to nulliparous women with singleton pregnancies who delivered after 22 weeks gestation between June 2004 and September 2006	Retrospective study using cross-sectional descriptive analysis	- Maternal risk factors, pregnancy characteristics, and obstetric and perinatal outcomes for teenage and adult pregnancies	Antenatally, teenagers experienced anemia, urinary tract infection, and pregnancy-induced hypertension more often than adults. They were more likely to smoke and came from more socioeconomically disadvantaged backgrounds. Their babies were at increased risk of having low Apgar scores, low birthweight, lower median birthweight at term, and stillbirth.	Smoking and nutritional status are modifiable factors in pregnancy; teenagers need special attention in terms of innovative, culturally appropriate system-wide services targeted at addressing these health issues in pregnancy.
Briggs (2007)	Characterize the obstetric	Retrospective chart review of patients	Ontario, Canada	Retrospective study	- Obstetric outcomes: mode of delivery,	Adolescents delivered babies with significantly lower birth weight than	Although adolescents delivered infants with lower

Dimension: Physical Health Concept: Teenage Pregnancy

Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
	outcome and prevalence of anemia in primiparous adolescents, comparing them with older primiparous women.	whose prenatal care was provided by a single obstetrician, and who had a live singleton birth at ≥ 24 weeks gestation between 1996 and 2004.	N=207 adolescents and 415 adults		gestational age at delivery, infant birth weight, infant sex - Maternal complications: hypertensive disorders, UTI during pregnancy, anemia	adults; more adolescents delivered preterm than adults. Maternal complication rates were similar between the two groups, except that adolescents were more likely to have a urinary tract infection during pregnancy than adults. Based on hemoglobin measurements at three time points during pregnancy, adolescents were more likely than adults to be anemic at entry into prenatal care and throughout pregnancy.	birth weight than infants born to adults, when factors such as smoking, BMI, anemia, and age were controlled, the difference was not significant. Results suggest that behavioural factors such as smoking rates, rather than maternal age per se, have the greatest impact on infant birth weight. Maternal age ≤ 19 years is an independent risk factor for anemia at 26 to 35 weeks gestation and pre-delivery. Future research focusing on strategies to influence potentially modifiable risk factors such as smoking and anemia will help in achieving the best possible outcomes for both adolescents and their older counterparts.
De Vienne (2009)	Determine whether young maternal age is associated with increased risks of adverse obstetric, fetal and perinatal outcomes	Analysis derived from data of the computerized medical records system of a French University Hospital for the years 1994-2001	France N=8,514 singleton births of primiparous women aged 14-30 years	Retrospective cohort study	Maternal outcomes: anemia during pregnancy, preeclampsia, caesarean section, operative vaginal delivery, and post-partum hemorrhage. Perinatal outcomes: prematurity, LBW, birth weight >4000 g, admission to the neonatal ICU, and fetal	Adjusted relative risk (RR) of anemia increased significantly with lower maternal age. Young maternal age was associated with decreased risks of adverse obstetric outcomes. Crude relative risks of prematurity, LBW, and fetal death increased with lower maternal age; after adjustment for confounding factors, only the association between fetal death and maternal age remained significant.	Younger maternal age was associated with increased risks of fetal death and anemia during pregnancy and lower risks of adverse obstetric outcomes, even after adjustment for confounding factors. The persistence of the effect after adjustment suggests a direct influence of maternal youth.

Dimension: Physical Health Concept: Teenage Pregnancy
Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
					death. For each outcome, adjustment was made for the following factors: ethnic origin, marital status, educational level, history of previous miscarriage or previous abortion, tobacco use, prepregnancy BMI, and prenatal care		

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Summary of Results

A total of 14 studies were identified under the concept of teenage pregnancy that included pertinent research evidence regarding physical and non-physical health outcomes. These studies were classified under the subcategories of maternal health, infant/child health, and health in relation to both mother and offspring.

In the category of teenage mothers, specific studies related to non-physical health and well-being found that: (i) early motherhood puts women at risk for educational underachievement and poorer economic circumstances, but poorer mental health outcomes are largely explicable by circumstances other than pregnancy; (ii) teenage mothers face an increased risk of premature death, independent of socioeconomic background; and (iii) postpartum adolescents are at high risk for STI infection. For each of these areas, no direct causal link has been identified between the health outcome and teen pregnancy per se. For instance, Mollborn and Morningstar noted in their 2009 paper that “teenage mothers had higher levels of distress than their childless adolescent peers and adult mothers, but the experience of teenage childbearing did not appear to be the cause. Rather, teenage mothers’ distress levels were already higher than their peers before they became pregnant....” Boden et al. did report a link between teenage pregnancy and educational underachievement and poorer economic circumstances. However, the directionality of the effect is still questionable; the authors note that “demographic characteristics such as low socioeconomic status, decreased educational attainment, residence with a single parent, and low parental education are highly related to the risk of early sexual activity and adolescent pregnancy.”¹⁹⁹ Based on this evidence, it seems that these sort of characteristics are risk factors for teenage pregnancy, rather than the other way around.

This causality issue arises in the arena of physical health outcomes as well. In the Swedish study that indicated an increased risk of premature death for teenage mothers, the authors found it unlikely that this increased risk was due to maternal age at first birth, but rather caused by unmeasured lifestyle-related factors (e.g., teenage mothers in Sweden including a much higher proportion of daily smokers during pregnancy than older mothers).²⁰⁰ As for increased rates of STI in adolescent mothers, this is likely due to re-initiation of high-risk sexual behaviours rather some direct effect of the pregnancy.²⁰¹ Other studies related to maternal health found that teenagers experienced anemia, urinary tract infection, and pregnancy-induced hypertension during pregnancy more often than older pregnant women. Whereas the study by de Vienne et al. drew a direct link between anemia and young maternal age, Lewis et al. indicated that smoking and poor nutritional status play a significant role in such health outcomes. Finally, the study by Howie et al. determined that adolescents gain an excess amount of weight during pregnancy compared with older women.²⁰²

In the 8 studies relevant to infant/child health, adverse outcomes associated with teenage pregnancy included: increased risks of fetal death, low birth weight, and pre-term delivery; elevated infant mortality; and more frequent birth defects. Only two of the studies concluded that maternal youth had a stronger association with these outcomes than socioeconomic and

¹⁹⁹ Savio Beers LA, Hollo RE. Approaching the adolescent-headed family: A review of teen parenting. *Current Problems in Pediatric and Adolescent Health Care*. 2009; 39(9): 216-33.

²⁰⁰ Otterblad Olausson P, Haglund B, Ringback Weitof G et al. Premature death among teenage mothers. *British Journal of Obstetrics and Gynaecology*. 2004; 111(8): 793-9.

²⁰¹ Ickovics JR, Niccolai LM, Lewis JB et al. High postpartum rates of sexually transmitted infections among teens: pregnancy as a window of opportunity for prevention. *Sexually Transmitted Infections*. 2003; 79(6): 469-73.

²⁰² Howie LD, Parker JD, Schoendorf KC. Excessive maternal weight gain patterns in adolescents. *Journal of The American Dietetic Association*. 2003; 103(12): 1653-7.

other factors.^{203,204} The remaining 6 studies all determined that socioeconomic, behavioural, and/or educational factors have the greatest impact on infant health in the cases where the mother is a teenager. However, this reality does not discount the effects for the infant in the same way as it does for the mother involved (see the Discussion below).

Data Sources for Teenage Pregnancy

There are two data sources from which teenage pregnancy rates in British Columbia may be extracted: Statistics Canada and the BC Adolescent Health Survey (AHS). The first allows for annual tracking, but involves a statistic constructed from two different administrative databases (see below). The AHS provides direct survey data, but only every 5 years; the potential is high for stigma (and therefore invalid answers) attached to questions about (possibly terminated) pregnancies.

Statistics Canada

Statistics Canada publishes annual data on pregnancy outcomes in Canada, partly assembled from information provided by agencies such as BC Vital Statistics. The data set can be restricted to those under 20 years of age, and be targeted to: *total pregnancies*, *live births*, *induced abortions*, and *fetal loss* (which refers to stillbirths). Each of these four outcomes is available as absolute numbers and as a rate per 1,000 females. The most recent data is for the year 2005, which was released in October 2008. The following table summarizes the most current Statistics Canada data available for British Columbia:

Teenage Pregnancy in British Columbia, 2005		
	Total	Rate per 1,000 females
Pregnancies	4120	25.3
Live births	1338	8.2
Induced abortions	2727	16.8
Stillbirths	55	0.3
Source: Statistics Canada, Canadian Vital Statistics, Birth Database and Stillbirth Database; Canadian Institute for Health Information, Hospital Morbidity Database and Therapeutic Abortion Database.		

Not allowing for the possibility of multiple pregnancies in one year, the 4,120 pregnancies to females under age 20 years in 2005 equates to approximately 1.6% of a modified pediatric cohort, specifically females aged 10-19 years in B.C. (on the presumption that no pregnancies occurred in girls under 10 years of age).

The Statistics Canada website indicates the status of this dataset as Ongoing/Available despite the fact that it has been close to two years since the last release of information.²⁰⁵ Information on live births will presumably always be available through annual BC Vital Statistics reports, but this represents only a fraction of teenage pregnancies given the high rate of induced abortions.

²⁰³ de Vienne CM, Creveuil C, Dreyfus M. Does young maternal age increase the risk of adverse obstetric, fetal and neonatal outcomes: a cohort study. *European Journal of Obstetrics & Gynecology and Reproductive Biology*. 2009; 147(2): 151-6.

²⁰⁴ Chen XK, Wen SW, Fleming N et al. Teenage pregnancy and adverse birth outcomes: a large population based retrospective cohort study. *International Journal of Epidemiology*. 2007; 36(2): 368-73.

²⁰⁵ Available at <http://statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=82-224-XIE&land=eng>. Accessed September 2010.

BC Adolescent Health Survey (AHS)

The BC AHS is a British Columbia-specific data source for teen pregnancy.²⁰⁶ According to 2008 survey results, less than 2% of teenage males and females had experienced pregnancy; among sexually active students, 7% had been involved in a pregnancy (8% of males and 6% of females).

Discussion

A wide range of adverse maternal and infant health outcomes has been identified with teenage pregnancy in the literature; while a few studies suggest that there is a direct link between such outcomes and maternal youth, many reports point more towards mediating social, economic, and behavioural factors to explain effects in both mothers and infants. The complex interaction of all of these factors and their relative importance with regard to teenage pregnancy and health is not well understood. As Cunningham remarks, “interventions aimed at reducing teenage pregnancy rates may have very little effect on the frequency of adverse medical outcomes in this population if the socio-economic and behavioural factors are not addressed.”²⁰⁷ The present review found that there is overall weak evidence for a causal link between teenage pregnancy and maternal or infant adverse health and well-being outcomes.

However, a perspective unique to this concept must be brought to bear at this point, namely, the fact that *two* individuals from the pediatric cohort are involved with any teenage pregnancy brought to term: the young mother and the infant. Regardless of whether there is confounding from socio-economic or other factors in terms of impacts on the mother, it is clear that confounding is not of interest to the experience of the infant; if they are born into a high-risk situation, whatever the nature of that risk, then the basic fact of that birth has increased the pediatric burden related to health and well-being deficits. This logic would propel planners towards tracking the infants instead of the mothers as a candidate indicator.

With regard to its utility as an indicator of child physical health, there are other issues that arise with respect to teenage pregnancy rates. First, not all teenage pregnancies result in a live birth. In fact, according to 2005 Statistics Canada data, over half of all teenage pregnancies in Canada (and in B.C.) ended in abortion.²⁰⁸ The teen pregnancy rate, then, does not by itself provide an accurate measure of the number of live infants born to teenage mothers; thus, it is a very qualified representation of potential adverse health outcomes. Furthermore, teenage pregnancy rates in B.C. are only tracked every 5 years in the Adolescent Health Survey, and the data collected is based on self-report and therefore open to question in terms of reliability. Although the Statistics Canada data (based on the combined measures discussed above) would also be of use in evaluating teenage pregnancy rates in B.C., the reported information is not very current, and it is not clear whether it will be consistently updated in the future.

Conclusion

Although there appear to be various adverse physical and non-physical health outcomes associated with teenage pregnancy, there is limited and weak evidence that these outcomes are directly linked to the age of the pregnant female; confounding socioeconomic factors are most often identified as a potential causal force at work. Additionally, there is limited information available concerning teenage pregnancy rates in B.C. The proportion of teenagers involved does appear to be small, albeit the absolute numbers of individuals with potential health effects may be about one-third higher if the infants who are brought to term are included as they

²⁰⁶ See the background description in the Introduction.

²⁰⁷ Cunningham AJ. What's so bad about teenage pregnancy? *Journal of Family Planning and Reproductive Health Care*. 2001; 27(1): 36-41.

²⁰⁸ Available at <http://statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=82-224-XIE&lang=eng>. Accessed September 2010.

should be in the total. From a population health perspective, then, there is at best a weak rationale for using teenage pregnancy as a concept/indicator of child health, though the argument does become stronger if the cohort of interest is restricted to the actual infants that are born.

Summary Assessment					
Children Born to Teenage Mothers					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	27,400	Medium	Medium	Medium	Medium-High

As summarized above, assessments have been applied to the Teenage Pregnancy concept, specifically in terms of a representative indicator, namely, *the number of children born to teenage mothers*. Unlike most of the indicators discussed in this project, it is not possible to say that the evidence stream for the selected indicator is dominant; thus, examining an indicator related to the *prevalence of teenage mothers* would also have been appropriate—but it would have generated the same overall recommendation.

The pediatric population **Magnitude** of the selected indicator is assessed as **Medium**. Based on data from B.C. vital statistics, the combined rate of teenage live births for females aged 14 to 19 years is 8.4 per 1,000 females. This rate was applied to the current female pediatric cohort, yielding an estimate of 1370 live births to teenage mothers in 2010. This number was then multiplied by 20 to determine the estimated absolute number of individuals in the pediatric cohort (male and female aged 0-19 years) that are born to teenage mothers across one generation, and are thus susceptible to adverse health and well-being outcomes. The resulting estimate is 27,400 individuals; this is between 2 and 10% (19,000 and 97,000) of the total pediatric cohort, resulting in a Magnitude classification of Medium.

The **Significance** of the representative indicator as supported by the evidence of impact on the health and well-being of an infant born to a teenage mother is assessed as **Medium**. Evidence from the literature is mixed, in terms of both physical and non-physical health outcomes; it appears likely that certain important associated factors, such as low SES, are risk factors for, rather than effects of, teenage pregnancy. The effects for the infant involved with a live birth are more straightforward, with confounding not entering the equation in the same way.

The **Modifiability** of the indicator is assessed as **Medium**. The reasons are similar to those noted in the previous section on Sexually Transmitted Infections, namely, the fact that sexual behaviour tends to be refractory to public health interventions.

Data Availability/Validity for the indicator is assessed as **Medium-High**. Data on the number of children born to teenage mothers is based on annual vital statistics information, which is very reliable. On the other hand, there does appear to be a “lag-phase” in reporting (e.g., 2005 information was released in 2008), though presumably the data would be more readily available to government agencies.

The representative indicator related to children born to teenage mothers is **Not Recommended** for consideration as a core indicator of child health and well-being. To date there is weak evidence for a causal relationship between teenage pregnancy and adverse physical and non-physical health outcomes for the child. However, given that the observed effects on the infant are technically not subject to the same qualification due to confounding (see the Discussion subsection above), the concept does warrant being placed on the “secondary interest” list.

Immunization Rates

Background and Context

Babies are born with a certain amount of natural protection against infectious diseases, derived from antibodies they acquire from their mothers; however, this protection does not last past the first year of life.^{209,210} Pediatric infectious diseases were a major cause of morbidity and mortality in developed countries prior to the development of effective vaccines and the establishment of routine immunization programs. Childhood immunizations consist of a series of intramuscular or subcutaneous injections or oral doses of inactivated bacteria, toxoids, live attenuated viruses, or inactive viral antigens. The typical infections and diseases targeted in developed countries include: diphtheria, pertussis (whooping cough), tetanus, measles, mumps, rubella (German measles), poliomyelitis, *Haemophilus influenzae* type b, hepatitis B, invasive pneumococcal disease, varicella (chicken pox), and influenza. Today, the immunization of children is often described as the most effective public health intervention in history.²¹¹ It is also one of the most efficient approaches, prompting the World Bank to rank the *Expanded Programme on Immunization* as one of the most cost-effective ways to improve child health; this understanding has inspired major global movements to extend the benefits of pediatric vaccines among developing countries.^{212,213}

While further harmonization of the immunization protocol across Canada would be beneficial, in fact there has been significant improvement since 2003 in program standardization among provinces and territories.²¹⁴ As might be expected, there is generally more practice variety across the country with the newer vaccine programs. The exception involves the most recent pediatric vaccine to be approved, a product designed to protect against two *human papillomavirus* (HPV) types that have been proven to cause the majority of cervical cancer. In fact, all provinces in Canada have implemented publicly-funded HPV vaccination, targeted at females in or around grade 6. In British Columbia, there is also a catch-up program for grade 9 girls who missed the roll-out among the younger cohort that started in 2008; this is the last year for that phase of the work.

Some unique research challenges pertain to the concept of pediatric immunizations. First, the basic value of this intervention in terms of avoiding disease is so well-established that it does not require a long argument; this is true in terms of both efficacy in individuals and population-level effectiveness (defined below). Because pediatric vaccines enjoy such high efficacy rates, simply being immunized is considered to be equivalent to being protected against the infection involved and against the majority of its biological consequences. In other words, the existence of a connection between immunization and physical health is self-evident.

²⁰⁹ Nicoara C, Zach K, Trachsel D et al. Decay of passively acquired maternal antibodies against measles, mumps, and rubella viruses. *Clinical and Diagnostic Laboratory Immunology*. 1999; 6(6): 868-71.

²¹⁰ Leuridan E, Van Damme P. Passive transmission and persistence of naturally acquired or vaccine-induced maternal antibodies against measles in newborns. *Vaccine*. 2007; 25(34): 6296-304.

²¹¹ See, for instance, the bulletin at <http://www.ices.on.ca/informed/periodical/issue/884-vol6issue1.pdf>. Accessed October 2010.

²¹² Peny JM, Gleizes O, Covillard JP. Financial requirements of immunisation programmes in developing countries: a 2004-2014 perspective. *Vaccine*. 2005; 23(37): 4610-8.

²¹³ Shepard CW, Simard EP, Finelli L et al. Hepatitis B virus infection: epidemiology and vaccination. *Epidemiologic Reviews*. 2006; 28: 112-25.

²¹⁴ H. Krueger & Associates and Centre for Health Services and Policy Research. *Establishing Clinical Prevention Policy in British Columbia. Part II. How Best to Implement?* A report prepared for the Clinical Prevention Policy Review Committee, B.C. Ministry of Health, 2007.

A further obstacle for the present reviewers is the fact that the evidence for the effectiveness of pediatric vaccines was sometimes generated so long ago that it does not meet the technical requirements for the literature search in this project. In a sense, the “case is closed” for several pediatric vaccines. Even if there were a desire to re-examine efficacy, the “gold standard” of randomized trials would no longer be appropriate for established immunizations; this is due to the same ethical concern around any study design that involves withholding a proven intervention from the control group. Consequently, the fundamental scientific literature related to efficacy tends to come to an end a few years after the development of a new vaccine. The exceptions involve disease sequela with a long lag time, such as cancer. For instance, the fact that the majority of hepatitis B disease burden in developed countries is delayed at least until adolescence has forestalled any final conclusions on real-world effectiveness of the related vaccine; similarly, a full assessment of the impact of HPV vaccines on cervical and other cancers is still decades away. In fact, efficacy trials on the effect of HPV vaccines against precursor lesions are still occurring.^{215,216}

Overview of Physical Health Effects

Vaccine Effectiveness

Given the background just outlined, this report will not offer a comprehensive review of the effectiveness of pediatric immunization. Instead, an abbreviated strategy seemed appropriate to unpack this concept, involving a concise description of the main potential disease sequela following an infection. The positive physical health impact of immunization may then simply be equated to the *absence* of these disease effects. The following table summarizes this information for the infections that are routinely immunized against among British Columbian children.

²¹⁵ Dillner J, Kjaer SK, Wheeler CM et al. Four year efficacy of prophylactic human papillomavirus quadrivalent vaccine against low grade cervical, vulvar, and vaginal intraepithelial neoplasia and anogenital warts: randomised controlled trial. *British Medical Journal*. 2010; 341: c3493.

²¹⁶ Marra F, Cloutier K, Oteng B et al. Effectiveness and cost effectiveness of human papillomavirus vaccine: a systematic review. *Pharmacoeconomics*. 2009; 27(2): 127-47.

Health Effects and Vaccine Effectiveness

For Infectious Agents Routinely Immunized Against in BC

Infectious Agent	Common Name	Transmission Route	Health Effects		Vaccine Effectiveness ^a
			Short Term	Long Term	
<i>Corynebacterium diphtheriae</i>	Diphtheria	Physical contact or exhaled droplets	Fatigue, fever, nausea, swelling of lymph nodes	Cardiomyopathy, peripheral neuropathy	95%
<i>Clostridium tetani</i>	Tetanus, lockjaw	Cuts and wounds	Muscle spasms, lockjaw		100%
<i>Bordetella pertussis</i>	Whooping cough	Exhaled droplets	Coughing fits	Paroxysm-induced cerebral hypoxia, apnea, pneumonia, encephalopathy, earache, seizures	85%
Poliovirus	Polio	Orofecal	Destruction of motor neurons in 1% of cases	Muscle weakness, acute flaccid paralysis	99%
Hepatitis B		Blood or bodily fluids	Liver inflammation, vomiting, jaundice	Liver cirrhosis, liver cancer	95%
<i>Haemophilus influenzae</i> type B		Exhaled droplets	Ear, eye and sinus infections, pneumonia, meningitis, etc.		95%
<i>Streptococcus pneumoniae</i>		Exhaled droplets	Ear, eye and sinus infections, pneumonia, meningitis, etc.		97% for invasive pneumococcal disease
Morbillivirus	Measles, Rubeola	Exhaled droplets	Rash, fever, diarrhea, pneumonia, encephalitis, corneal ulceration	Corneal scarring	99%
Mumps virus		Exhaled droplets	Swelling of salivary glands, orchitis, rash	Possibility of infertility in men	95%
Rubella virus	German measles	Exhaled droplets, vertical transmission when mother is infected within first 20 weeks of pregnancy	Flu-like symptoms, rash, swollen glands or lymph nodes	Arthropathy (particularly in girls and women)	98%
<i>Neisseria meningitidis</i> C	Meningococcal C	Saliva and exhaled droplets	Fever, headache, neck stiffness, coma		87-100%
Varicella zoster virus	Chickenpox	Physical contact or exhaled droplets	Vesicular rash, fever	Shingles, postherpetic neuralgia	95% against severe forms, 70-90% against milder forms
Human papillomavirus (HPV)		Sexual contact	Genital warts, recurrent respiratory papillomatosis	Cancers of the anogenital region, notably cervical cancer; head and neck cancers	?
Influenza		Exhaled droplets	Fever, headache, coughing, pneumonia		Varies by season

^aSources: Ontario Ministry of Health and Long-Term Care; National Network for Immunization Information

As is clear from the preceding table, the effectiveness rates are consistently quite high. In the case of HPV, the vaccine is too new for population-level effectiveness data to be available; efficacy studies indicate that the vaccine is effective against some vulvar and vaginal precancers and genital warts.²¹⁷ The following is a technical definition of effectiveness:²¹⁸

Reduction in the risk of disease of a randomly selected person from the (partially) vaccinated population, compared to the risk for the same person if the entire population remains unvaccinated. In other words, this is the fraction of disease cases prevented by the vaccination programme.

The term “effectiveness” is often confused with “efficacy.” *Efficacy* is a measure of the maximum protection that a vaccine is capable of providing under ideal conditions, and is usually measured in controlled clinical trials. *Effectiveness*, on the other hand, is measured in larger populations, among which there tends to be underlying medical conditions, allergies, infections, etc. that may reduce the effect of the vaccine. Effectiveness also reflects the mechanism of so-called “herd immunity,” or the protection afforded when an infectious agent has a restricted circulation in a well-vaccinated population. Importantly, because herd immunity confers this sort of indirect protection, the experience of a non-vaccinee is quite different depending on presence and success of any immunization effort; thus, the probability of

²¹⁷ Krueger H, Stuart G, Gallagher R et al. *HPV and Other Infectious Agents in Cancer*. New York, NY: Oxford University Press; 2010.

²¹⁸ Haber M, Ndikuyeze A. Estimation of individual and population vaccination effectiveness from time-to-event data. *Statistics in Medicine*. 1998; 17(22): 2617-23.

individual disease occurring when no immunization program is in place is actually greater than the risk of disease in a non-vaccinated person when a sufficient number of other individuals in the population are vaccinated.

Between the two outcome metrics, the measurement of vaccine *effectiveness* is generally of greater utility from a public health perspective.²¹⁹

Immunization Rates

Most of the support for the effectiveness of pediatric vaccines has come from observational studies, usually comparing disease rates in the pre-vaccine and post-vaccine eras. A compelling example from the U.S. context is provided in the following table:²²⁰

Comparison of Annual Morbidity Pre-vaccine and Year 2001, USA			
Disease	Absolute Morbidity		
	Pre-vaccine	Year 2001	% Decrease
Diphtheria	175,885	2	100.0
Measles	503,282	108	100.0
Mumps	152,209	231	99.8
Pertussis	147,271	5,396	96.3
Polio	16,316	0	100.0
Rubella	47,745	19	100.0
Tetanus	1,314	27	97.9
<i>H. influenzae</i> type B	20,000	183	99.1

Source: Pickering & Orenstein, *Seminars in Pediatric Infectious Diseases*, 2002.

This sort of dramatic story may be repeated for a variety of pediatric immunizations in many countries.

The precise topic of the present concept is immunization *rates*. The sort of observation-based evidence offered above essentially reflects the situation where a jurisdiction moves from a rate of zero immunization to a high rate of coverage. The alternate situation where disease is progressively reduced as the immunization rate rises would represent more nuanced evidence pertinent to the concept as stated. However, such information is usually unavailable due to one simple fact: effective vaccines, specifically the ones that are selected for the routine pediatric immunization schedule, tend to be rolled out in a mass approach; this usually means a high uptake rate in the very first year. One recent exception has been HPV, where the coverage in B.C., for example, was just over 60% at the end of the first year—the second lowest rate in the country.²²¹

For completeness, a literature review was conducted that focused on reviews or studies focusing on the topic of immunization rates, including any indication that less-than-optimal coverage offers reduced population protection.

²¹⁹ Fedson DS. Measuring protection: efficacy versus effectiveness. *Developments in Biological Standardization*. 1998; 95: 195-201.

²²⁰ Pickering LK, Orenstein WA. Development of pediatric vaccine recommendations and policies. *Seminars in Pediatric Infectious Diseases*. 2002; 13(3): 148-154.

²²¹ Summarized at www.bccdc.ca/resourcematerials/newsandalerts/news/HPV_March16.htm?style=print. Accessed October 2010.

Methodology and Provisional Results

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

First Search: Review, Meta-analysis *Second Search:* All papers, including individual studies.

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

“Immunization Rates” is not a MeSH term in PubMed, so two closely related Major Subject Headings were selected instead, as follows

(“Immunization”[Majr] OR “Immunization Programs”[Majr]) **AND**

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr])

As well, a cursory grey literature search was conducted, looking for government and other reports that reviewed the effectiveness of differential immunization rates.

Results

Taken together, the search processes returned 172 reviews for consideration and over 2000 individual studies. Scanning the lists by title, it was quickly determined that, as expected, the specific topic of differential immunization rates has not been examined by researchers for any signs of variable disease prevention effectiveness.

As a consequence, the main agenda remaining is to confirm that there is indeed a high level of pediatric immunization in B.C. for all or most of the infectious agents of concern.

Data Sources on Immunization Rates

Immunization coverage statistics in the province are collected by the BC Centre for Disease Control, as outlined in the following table. Coverage rates range from 73% to 88% for the various vaccines and age groups, with the exception of the newest vaccine – for HPV – which demonstrates an immunization rate of approximately 61%. Comprehensive information on pediatric immunization rates for influenza is not collected or reported in B.C.

BC Immunization Coverage Rates						
Vaccine	Year Introduced	Current Ages of Immunization	BC Immunization Rate (2010)			
			2 yrs (2009)	4-6 yrs	Grade 6	Grade 9
Diphtheria	1929	2, 4, 6, 18 mo, 4-6 yrs, Grade 9	72.9%	77.0%		86.6%
Tetanus	1948	2, 4, 6, 18 mo, 4-6 yrs, Grade 9	72.9%	77.0%		86.6%
Whooping cough	1997	2, 4, 6, 18 mo, 4-6 yrs, Grade 9	72.9%	77.0%		85.3%
Poliomyelitis	1955	2, 4, 6, 18 mo, 4-6 yrs	76.5%	77.0%		
Hepatitis B	1992	2, 4, 6 mo; Grade 6 if not previously immunized	81.6%	88.6%	83.8%	
Haemophilus influenzae type B (Hib)	1986	2, 4, 6, 18 mo	78.0%			
Streptococcus pneumoniae	2003	2, 4, 12 mo	81.3%			
Measles	1969	12, 18 mo	73.7%	88.6%		
Mumps	1981	12, 18 mo	73.7%	88.4%		
Rubella	1970	12, 18 mo	73.7%			
Meningococcal C	2003	2, 12 mo, Grade 6	85.0%		88.1%	
Chickenpox	2005	12 mo; 4-6 yrs and/or Grade 6 if susceptible	81.8%	88.0%	84.4%	
Human papillomavirus (HPV)	2008	Grade 6 or Grade 9 (girls only)			61.4%	60.8%
Influenza	2004	annually between 6 and 23 mo				

Source: BC Centre for Disease Control

Source: BC Centre for Disease Control

Discussion

The effectiveness and efficiency (and, in some cases, vaccine efficacy) related to immunization programs continue to be confirmed. Most importantly, however, is the fact that pediatric immunization generally represents a saturation program (similar to newborn screening, covered under a separate chapter); as such, immunization rates generally have limited value as an indicator of *further* progress in child health and well-being. Of course, it is important to maintain resources, utilization statistics, and disease surveillance to ensure the high rate of immunization is sustained; the goal is always to forestall any sort of outbreaks among subpopulations and threatened reemergence at a population level of diseases that have long been controlled in British Columbia.

The exceptions to the current “saturation” rule are HPV and influenza. The need to track HPV prevention will only intensify if boys are added to the immunization program, as some authorities are recommending—both because of the male-related health effects of HPV and the goal of generating true herd immunity.

While some of the HPV-related malignancies are quite rare, cancer is cancer, with often devastating personal impacts and costs to the health care system; as well, precursor lesions in the cervix preventable by the vaccine occur more frequently than cancer and generate both personal impacts and population-level burdens related to treatment.²²² Furthermore, even so-called benign HPV-related conditions such as genital warts are certainly not inconsequential; importantly, the particular HPV vaccine formulation currently being used in B.C. protects against the majority of genital warts. Finally, HPV does have two direct (but modest) implications for children: (i) infections are picked up by infants from infected mothers during

²²²Krueger H, Gallagher R, Stuart G, Williams D, Kerner J. *HPV and Other Infectious Agents in Cancer*. New York, NY: Oxford University Press; 2010.

the birth process; and (ii) at least one pediatric condition, recurrent respiratory papillomatosis, has proven links to two of the HPV types covered by the vaccine used in B.C.

As for influenza, it is true that the condition may be generally considered on the lower end of the burden spectrum in terms of individual effects. However, high incidence does generate a substantial population-level effect; and death occasionally occurs in the pediatric population, drawing concomitant attention to the importance of prevention through immunization. In short, there may be important policy implications in terms of increasing influenza immunization rates among at-risk cohorts, with a related indicator to track progress.

Conclusion

While it continues to be important to monitor the effectiveness of vaccines in terms of waning immunogenicity over time, the rate of side effects, etc., the essential value of vaccines with respect to physical health is generally beyond debate. Given that it is such a well-established area, only summarized effectiveness data were provided in this chapter.

The two situations where immunization rates do play a practical role in terms of future population health status comprise immunizations for HPV and one or more types of influenza. Indicators tied to the uptake of either these interventions may be useful, though there are limitations, in particular for influenza; in short, there is no reliable data related to pediatric immunization rates for influenza and, in any event, the present recommendations and delivery systems do not represent a comprehensive population program for infants, school-age children, or adolescents.

An alternate approach to tracking immunization rates for influenza is to track pediatric infection cases as they present within the health system (see chapter on Major Childhood Infectious Diseases). This strategy is not as useful for HPV infection, given the multitude of types that occur in humans and the generally poor incidence data. Consequently, the pursuit of a core indicator around HPV immunization offers a more productive option at present.

Summary Assessment					
Eligible Individuals Not Vaccinated against HPV					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
Females, 11-19	125,000	High	Medium	Low	High

As summarized above, assessments have been applied to the Immunization Rates concept, specifically in terms of the indicator with the most compelling support, namely, *number in the eligible cohort not vaccinated against HPV*. This vaccine was chosen for assessment here because the other vaccines already enjoy a high rate of administration and there are no impending situations where “herd immunity” for childhood diseases is imperilled in British Columbia—albeit continued vigilance is required around the impact of general or localized anti-immunization movements. If an indicator related to such vaccines is ever warranted, the most useful would be one or more global measures regarding the percentage of the population before a certain critical age (e.g., two years) that are in fact up-to-date with appropriately-delivered immunizations.

The pediatric population **Magnitude** of the potential indicator is assessed as **High**. B.C. Center for Disease Control data states that about 38.6% of eligible females are receiving the HPV vaccination annually. Given that the program is just completing a three year ‘catch-up’ period, the oldest girls covered are now aged 17, and the youngest are 11 years old. Based on the assumption that 38.6% of females aged 11-17 have received the HPV vaccination, it was

estimated that 125,300 females aged 11-19 have *not* received the vaccination. This is greater than 10% of the total pediatric cohort (97,000), resulting in a Magnitude classification of High.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **Medium**. Although the majority of infections are cleared without intervention, the relatively rare cases of persistent HPV can result in serious (and even deadly) adverse health effects, with the associated diseases ranging from genital warts to cancer; in particular, cervical cancer may result from an HPV infection, though both incidence and mortality rates are relatively low compared to other malignancies in the female population. A further complexity in assessing the significance of the health burden is the fact that a very effective secondary prevention program for cervical tumours does exist, one that must be maintained (and ought to be utilized comprehensively) despite the introduction of the immunization program. Finally, it should be noted that the main HPV-related disease specific to the pediatric period, recurrent respiratory papillomatosis, is a very rare condition.

The **Modifiability** of the potential indicator is assessed as **Low**. It is true that the literature on enhancing immunization rates for typical pediatric vaccines is vast. However, the HPV vaccine is relatively new; as a result, there is little specific evidence of interventions for increasing immunization rates, especially in light of unique resistance to this intervention among some groups of parents. The latter attitude partly reflects the unusual position of HPV vaccines among childhood immunizations: In order to be potentially threatening, the oncogenic forms of the agent need to be transmitted through sexual contact rather by air, and therefore are preventable through clear, albeit not necessarily easy, behaviour modifications.

Data Availability/Validity for the potential indicator is assessed as **High**. HPV immunization rates are routinely reported by the BCCDC, assembled from information provided by public health staff.

The potential indicator related to HPV vaccination is **Not Recommended** for consideration as a core indicator of child health and well-being, but is eligible for the "secondary interest" list. The rationale for this deviation from the expected conclusion (i.e., given the medium-to-high ratings for all but one of the assessment categories) is suggested by the notes provided above concerning the unique profile of HPV infections and their various interventions.

Newborn Screening

Background and Context

The goal of all newborn screening (NBS) programs is to identify babies with a treatable disorder at birth that is detectable through a routine screening protocol. The implication is that, without screening, affected infants may not otherwise be diagnosed soon enough to prevent serious health problems, such as blindness, mental retardation, liver disease, and even death. Early detection and treatment can make the difference between lifelong impairment and relatively healthy development.

In British Columbia, the NBS program is a service of the Provincial Health Services Authority. The screening happens when infants are between 24 and 48 hours old. Blood is collected at all B.C. and Yukon hospitals where babies are delivered, and at a baby's home if a home birth is involved. Blood samples are sent for testing to the Newborn Screening Laboratory at B.C. Children's Hospital.

Universal screening for multiple newborn conditions was first instituted in the Greater Vancouver area in 1971.²²³ As of 2007, the centralized screening laboratory was testing samples from all of the approximately 42,000 newborns each year in British Columbia (and the Yukon). The testing covered four conditions: hypothyroidism, phenylketonuria, galactosemia, and medium chain acyl-CoA dehydrogenase (MCAD) deficiency; the newest screen at that time, for MCAD, had been launched in 2003.²²⁴ As a result of technological developments, and spurred on by the fact that other provinces and countries had broader screening panels, the number of disorders screened in B.C. has been expanded to 20 by recommendation of the Newborn Screening Advisory Committee (NSAC).²²⁵ The most recent additions to the panel, testing for congenital adrenal hyperplasia and trifunctional protein deficiency, occurred in 2010 (see the table below for the current list).

There are many advantages to an expanded newborn screening panel, as detailed in a report prepared for the NSAC:²²⁶

1. Reduced morbidity and mortality for some infants afflicted with a genetic defect; indeed, the hope is held out for avoiding most disease consequences through appropriate therapy and thereby experiencing healthy development.
2. Reduced emotional impacts for many families in the face of news of often devastating conditions, including when the test result turns out to be false positive.
3. As a by-product, providing a good informational base to drive genetic counseling and family planning for parents and the patient (once they are grown and able to conceive).
4. Getting the best use from tandem mass spectrometry equipment in assessing a variety of conditions in a single step.
5. Receiving good value for money, with the possibility in the best case scenario of saving costs in the health system by eliminating expensive long-term treatments if the disorders can be detected early and the worst consequences avoided.

²²³ Hardwick DF, Applegarth DA, Davidson AG et al. Letter: Screening for hereditary metabolic disease. *Canadian Medical Association Journal*. 1975; 112(6): 678-9.

²²⁴ Horvath GA, Davidson AG, Stockler-Ipsiroglu SG et al. Newborn screening for MCAD deficiency: experience of the first three years in British Columbia, Canada. *Canadian Journal of Public Health*. 2008; 99(4): 276-80.

²²⁵ Or 22, if the three sickle cell diseases are counted separately.

²²⁶ H. Krueger & Associates Inc. *Enhanced Newborn Screening Program: Five-Year Business Plan*. 2007. Available at <http://www.krueger.ca/index.asp?Page=News>. Accessed October 2010.

6. Contributing to the Canadian and global knowledge concerning testing accuracy and diagnostic confirmation, incidence, disease course, innovative therapies, and the effectiveness of early intervention.

Physical Health Effects and Magnitude of Problem

Similar to other concepts/indicators investigated for this project, the potential physical health implications of newborn screening are not really under investigation or discussion. A systematic review of evidence is not required, since the condition being screened in each case involves well-understood physical effects for the individual involved, impacts that may be mitigated through timely intervention. The physical effects are summarized in the table below for the 20 newborn conditions that are currently part of the B.C. Newborn Screening Program. It is important to note that other effects exist that are more cognitive or socio-behavioural in nature.

Newborn Disorders Screened in British Columbia Health Effects and Estimated BC Incidence				
Category	Disorder	Physical and Other Health Effects	Estimated BC Incidence	Rate per 100,000 Births
Amino Acid Disorders	• Phenylketonuria	Progressive mental retardation, brain damage, seizures	1 in 12,000	8.33
	• Maple Syrup Urine Disease	Vomiting, dehydration, lethargy, hypotonia, seizures, hypoglycaemia, ketoacidosis, opisthotonus, pancreatitis, coma, sever brain damage	1 in 185,000	0.54
	• Citrullinemia	Vomiting, dehydration, lethargy, muscle weakness, seizures, breathing problems, brain swelling, coma	1 in 60,000 (CIT or ASA)	1.67
	• Argininosuccinic Acidemia	Brittle hair, lethargy, seizures, tremours, developmental delay, coma, mental retardation, progressive liver disease	1 in 60,000 (CIT or ASA)	1.67
	• Homocystinuria	Mental retardation, seizures, psychiatric disease, eye anomalies, vascular disease	1 in 200,000	0.50
	• Tyrosinemia, Type I	Diarrhea, vomiting, jaundice, bleeding, liver and kidney failure, problems of the nervous system, increased risk of liver cancer	1 in 100,000	1.00
Fatty Acid Oxidation Disorders	• Medium-chain Acyl-CoA Dehydrogenase Deficiency	Hypoglycemia, hyperammonemia, vomiting, lethargy, rare cause of SIDS	1 in 12,000	8.33
	• Long-chain Hydroxyacyl-CoA Dehydrogenase Deficiency	Lethargy, hypoglycemia, hypotonia, complications in liver, heart, retina and muscles, peripheral neuropathy, coma, sudden death	1 in 80,000	1.25
	• Trifunctional Protein Deficiency	Feeding difficulties, lack of energy (lethargy), low blood sugar (hypoglycemia), weak muscle tone (hypotonia), liver problems; infants with this disorder are also at high risk for serious heart problems, breathing difficulties, coma, and sudden death.	< 1 in 80,000	~1
	• Very-long Chain AcylCoA Dehydrogenase Deficiency	Hypoglycemia, lethargy, muscle weakness, liver abnormalities, heart problems	1 in 50,000-120,000	0.83 - 2.00
Organic Acid Disorders	• Propionic Acidemia	Progressive encephalopathy, secondary hyperammonemia, cardiomyopathy, basal ganglial stroke	1 in 50,000	2.00
	• Methylmalonic Acidemia	Progressive encephalopathy, secondary hyperammonemia	1 in 75,000 (Cbl disorders or MUT)	1.33
	• Cobalamin Disorders	Pallor, poor head growth, cytopenias, delayed development, encephalopathy, hypotonia, seizures, cognitive decline, megaloblastic anemia	1 in 75,000 (Cbl disorders or MUT)	1.33
	• Glutaric Aciduria, Type I	Brain damage, mental retardation	1 in 120,000	0.83
	• Isovaleric Acidemia	Vomiting, seizures, lethargy, coma	1 in 100,000-200,000	0.50 - 1.00
Galactosemia	• Galactosemia	Hepatomegaly, cirrhosis, renal failure, cataracts, brain damage, ovarian failure	1 in 40,000	2.50
Endocrine Disorders	• Congenital Hypothyroidism	Growth failure, permanent mental retardation	1 in 4000	25.0
	• Congenital Adrenal Hyperplasia	Vomiting, dehydration, hypertension, altered development of sex characteristics, infertility	1 in 16,000	6.25
Hemoglobinopathies	• Sickle Cell Disease & related disorders	Shortened life expectancy, ischaemia, necrosis, organ damage, autosplenectomy, pallor, tachycardia, fatigue, susceptibility to infection	1 or 2 each year	2.00 - 5.00
Cystic Fibrosis	• Cystic Fibrosis	Progressive disability and premature death, difficulty breathing due to lung infections, sinus infections, poor growth, diarrhea, infertility	1 in 3600	27.8

Source: <http://www.bcchildrens.ca/Services/SpecializedPediatrics/NewbornCare/NewbornScreeningProgram/ForFamilies/DisordersScreened/default.htm>

This list is certainly not exhaustive. There are many other, generally rarer disorders, some of which are covered in the screening programs provided by other jurisdictions. Congenital hearing problems are screened at birth in some jurisdictions; this area of concern is currently handled by a separate agency in B.C. (see separate report). As well, checking for developmental

dysplasia of the hip (DDH) could be included here as another type of “testing” performed in the physical examination of newborns.²²⁷ Other features of the initial head-to-toe check after birth include listening to heart and lungs, counting digits, and looking for other gross abnormalities. Most developed countries report an incidence of 1.5 to 20 cases of DDH per 1000 births, with “the variation due in part to differences in diagnostic method and timing of evaluation.”²²⁸ It is clear that the volume of this condition easily eclipses the combined incidence of the metabolic newborn disorders described earlier.

Discussion and Conclusion

Similar to pediatric immunizations, newborn screening is a mature, “saturation” type program; the expectation is that the service, being fully integrated into obstetrical care processes, will be delivered to virtually all newborns. There is little doubt that the present scope of the program will continue to be funded. In reality, an indicator tracking newborn screens per se is not that useful; the number that would be regularly reported for the metric is essentially equivalent to birth incidence. Likewise, a relatively stable incidence of newborn disorders is expected, since there are few primary prevention opportunities among these mostly genetic conditions. Thus, it is not surprising that the incidence observed in the earliest years of the program (0.06%)²²⁹ is of a similar order of magnitude to results tabulated 20 years later,²³⁰ and that both of these earlier eras are consistent with contemporary data.

Possibly beneficial avenues in data tracking might relate to quality measurements of the testing service, communication protocols for professionals and parents, medical follow-up, etc. However, the population-level utility of such efforts is severely mitigated by the absolute numbers involved. The pool of affected individuals is very small, with only about 40 (or 0.1%)²³¹ of the annual birth cohort in British Columbia having one or other of the conditions (see the table above for the detailed incidence breakdown of the various conditions).

In sum, although the conditions involved can have very serious consequences for patients and their families, the absolute population-level impacts remain modest; as well, the potential for modifying physical health for individuals and for the entire affected group is restricted to the (at best) partial benefits derived from secondary prevention. In conclusion, the utility of newborn screening as an indicator of pediatric physical health may be construed as limited.

²²⁷ For B.C. information see <http://www.healthlinkbc.ca/kb/content/mini/hw165967.html>. Accessed October 2010.

²²⁸ Patel H. Preventive health care, 2001 update: screening and management of developmental dysplasia of the hip in newborns. *Canadian Medical Association Journal*. 2001; 164(12): 1669-77.

²²⁹ Wong LT, Hardwick DF, Applegarth DA et al. Review of Metabolic Screening Program of Children's Hospital, Vancouver, British Columbia. 1971--1977. *Clinical Biochemistry*. 1979; 12(5): 167-72.

²³⁰ Applegarth DA, Toone JR, Lowry RB. Incidence of inborn errors of metabolism in British Columbia, 1969-1996. *Pediatrics*. 2000; 105(1): e10.

²³¹ Information available at <http://www.bcwomens.ca/Services/PregnancyBirthNewborns/NewbornCare/NewbornScreeningProgram/ForProfessionals/default.htm>. Accessed October 2010.

Summary Assessment					
Positive Newborn Screen					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	970	Low	High	Low	High

As summarized above, assessments have been applied to the Newborn Screening concept, specifically the indicator related to the number of positive screens. The alternate approach to an indicator would involve tracking the prevalence of the pediatric population that receives such screening; however, the overall utility of that approach would ultimately be assessed in terms of proportion of the population likely to benefit directly, which would then devolve to the Magnitude and other considerations provided below. In other words, evidence for the effectiveness of a screening program is not the same thing as determining the utility of an indicator related to the area.

The pediatric population **Magnitude** of the potential indicator is assessed as **Low**. Based on data from the B.C. Children's Hospital, approximately 0.1% of newborns have a screen-detected condition – that is, currently detected through the existing program. When applied to the entire pediatric cohort aged 0-19 years (representing one generation), it results in a prevalence estimate of 970 individuals; this is undoubtedly a great overestimate due to the high rate of early death related to many congenital conditions. Even as is, it represents less than 2% of the total pediatric cohort (19,000), resulting in a Magnitude classification of Low.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **High**. It is well-established that the conditions detected by newborn screening can have very serious consequences for the health and well-being of the child involved.

The **Modifiability** of the potential indicator is assessed as **Low**. Many of the disorders detected by newborn screening are genetic, and as such cannot be prevented by current medical technology.

Data Availability/Validity for the potential indicator is assessed as **High**. Statistics on for the newborn screening program are routinely available from BC Children's Hospital.

The indicator related to screened conditions is **Not Recommended** for consideration as a core indicator of child health and well-being. The reasons are the low ratings in two of the assessment categories. While interventions to make life better for affected children are certainly available, the potential to change the fundamental population burden is very limited.

Vision and Hearing Screening

Background and Context

Screening procedures for hearing and vision are designed to identify impairments in children, thereby facilitating proper care and minimizing the additional negative side-effects engendered by such conditions. Screening is not a diagnostic tool, and it is not meant to take the place of thorough examinations by medical professionals; rather, it is intended to be a means of efficiently alerting parents or other caregivers when children may require additional attention.

British Columbia has implemented universal early childhood vision and hearing screening programs. The Early Childhood Vision Screening Program is under the jurisdiction of the Ministry of Health Services. Public health staff members (managed by health authorities) provide universal kindergarten vision screening on an annual basis in school settings. The goal is to transition this program to universal screening for children at age 3. Health authorities are conducting pilots for 3-year-old vision screening, using public health clinics, other parent/guardian and toddler programs, preschools, child care settings, child development centres, or other locations frequented by young children and their families in order to receive services. Until this preschool-oriented screening program is fully established, universal screening will continue to focus on kindergarten students.²³²

Universal hearing screening for newborns is now provided by the BC Early Hearing Program (BCEHP), an initiative that was announced in 2005 and implemented between 2007 and 2009. The Ministry of Health Services is the lead ministry for this, with planning and service coordination the responsibility of the Provincial Health Services Authority, in collaboration with B.C.'s five regional health authorities. BCEHP screening takes place in neonatal intensive care units (NICUs) and via well baby examinations in the sort of settings described for the vision screening program (see above). BCEHP screening takes place in neonatal intensive care units (NICUs) and postpartum well-baby units. Diagnostic follow up is provided for infants identified through screening, with the goal to determine diagnostic outcome for children referred by 6 months of age. The program ensures that children born with congenital hearing loss will receive early intervention and treatment and thus optimize their capacity to adapt and learn throughout childhood.²³³

Both programs, it should be noted, are aimed at detecting potential problems as soon as feasible. Although it is possible to develop vision or hearing impairments later in life, and professional examinations are therefore recommended at all ages, the hope implied by screening children at a young age is that proper treatment/correction can be provided to prevent other complications. For example, children with hearing loss have increased difficulty with communication skills, increased behaviour problems, and decreased educational attainment and overall psychological well-being.²³⁴

Health Effects and Magnitude of Problem

As is the case with a few other indicators in this report, the association between ultimate *physical* health effects and a screening service are self-evident and require little discussion. It is obvious

²³² Provincial Vision Screening Training Manual. BC Ministry of Healthy Living and Sport. 2009. Available at http://www.health.gov.bc.ca/library/publications/year/2009/provincial_vision_screening_training_manual_july_29_2009.pdf. Accessed November 2010.

²³³ BC Early Hearing Program Physician Update. 2009. Available at <http://www.phsa.ca/AgenciesAndServices/Services/BCEarlyHearing/ForPhysicians/default.htm>. Accessed November 2010.

²³⁴ US Preventive Services Task Force. Universal screening for hearing loss in newborns: US Preventive Services Task Force recommendation statement. *Pediatrics*. 2008; 122(1): 143-8.

that vision or hearing impairment per se is the direct health effect of concern. Much of the motivation to improve screening programs, however, comes from the secondary effects of vision and hearing impairment that compound the significance/impact of the problem. Vision impairment, for example, can affect language development in a number of ways. As well as introducing an obvious obstacle into the basic challenges of reading (i.e., connecting word meanings with specific objects and actions, and developing vocabulary), vision impairment hinders the imitation process that allows children to learn spoken language. It also has the potential to confuse a child's sense of self and their understanding of their environment at a broad level.^{235,236} Hearing impairment can also have significant impact on language development and communication, including comprehension issues and speech impediments.

In sum, these forms of developmental delay have the potential to affect academic achievement, social functioning and emotional well-being for both the vision and hearing impaired.²³⁷ Other general concerns, such as increased risk of injury, are also of importance for both types of disability. The impacts are particularly unfortunate when impairments that could be remediated are not detected in a timely way.

Because the causes of vision and hearing impairment are quite varied, screening and follow-up approaches are required to distinguish a number of problems that may call for different management strategies in order to minimize morbidity and quality of life impacts. The effectiveness and cost-effectiveness of such screening programs have been reviewed by different study groups.^{238,239} The various reports, including ones commissioned for the B.C. context, continue to suggest the importance of further study. But, ultimately, it is the baseline prevalence of the conditions themselves that provides the way for an initial assessment of pediatric health indicators related to these two concepts.

For vision screening, the conditions include amblyopia (lazy eye), strabismus (crossed eyes), and refractive errors such as hyperopia (farsightedness), myopia (nearsightedness), and astigmatism, each of which requires different corrective approaches.

Hearing impairment can also be caused by a wide range of conditions, with about half of the cases stemming from hereditary factors. In approximately 30% of instances of hereditary hearing loss—or 15% of total cases—the impairment is linked to a known syndrome.²⁴⁰

Data Sources on Vision and Hearing Impairment

Visual impairment and blindness is relatively rare in children. A UK report on severe impairment suggested an incidence rate of 4.0 per 10,000 in the first year, with a cumulative incidence by age 16 years of 5.9 per 10,000.²⁴¹ According to international studies consulted by a B.C. researcher, hearing loss is a relatively common congenital disorder. An estimated 1 to 3 of every 1,000

²³⁵ Strickling C. Impact of visual impairment on development. *Texas School for the Blind and Visually Impaired*. Available at <http://www.tsbi.edu/infants/3293-the-impact-of-visual-impairment-on-development>. Accessed March 2011.

²³⁶ Gunaratne LA. Visual impairment: its effect on cognitive development and behaviour. *Understanding Intellectual Disability & Health*. Available at <http://www.intellectualdisability.info/physical-health/visual-impairment-its-effect-on-cognitive-development-and-behaviour>. Accessed March 2011.

²³⁷ Effects of hearing loss on development. *American Speech-Language-Hearing Association*. Available at <http://www.asha.org/public/hearing/disorders/effects.htm>. Accessed March 2011.

²³⁸ See http://www.health.gov.bc.ca/library/publications/year/2006/Vision_Screening_CADTH_review.pdf

²³⁹ Bamford J, Fortnum H, Bristow K et al. Current practice, accuracy, effectiveness and cost-effectiveness of the school entry hearing screen. *Health Technology Assessment*. 2007; 11(32): 1-168, iii-iv.

²⁴⁰ See the summary at <http://www.phsa.ca/NR/rdonlyres/585C120E-A3C7-4534-A839-8193818E5B58/0/Syndromescommonlyassociatedwithhearingloss1.pdf>.

²⁴¹ See the summary at <http://www.phsa.ca/NR/rdonlyres/585C120E-A3C7-4534-A839-8193818E5B58/0/Syndromescommonlyassociatedwithhearingloss1.pdf>. Accessed November 2010.

²⁴¹ Rahi JS. Childhood blindness: a UK epidemiological perspective. *Eye (London)*. 2007; 21(10): 1249-53.

newborns experience permanent hearing loss, a rate that increases to 1 in every 40 for infants requiring care in NICUs.²⁴²

In Canada, the Canadian Community Health Survey (CCHS), the National Longitudinal Study of Children and Youth (NLSCY), and the Participation and Activity Limitation Survey (PALS) all track vision and hearing impairment. The table below, prepared by McDougall et al., shows the cumulative prevalence of vision and hearing impairment in Canadian children, based on data from the NLSCY.²⁴³

Prevalence of Vision and Hearing Impairment in Children Canada, 1994-1995				
Impairment	Age (Years)	Prevalence (Cases per 1000)		
		Girls	Boys	Total
Vision	6 - 8	5.9	4.7	5.3
	9 - 11	8.1	5.6	6.8
	Total	7.0	5.1	6.0
Hearing	6 - 8	10.4	9.2	9.8
	9 - 11	9.5	10.7	10.1
	Total	10.0	10.0	10.0

Source: Derived by McDougall et al. from National Longitudinal Study of Children and Youth data, 1994-5

There are difficulties in defining sensory impairment as it relates to screening and population surveillance statistics. In McDougall's analysis, vision impairment is defined as not being able to "read ordinary newsprint or recognize a friend on the other side of the street, *even with glasses or contact lenses*," and hearing impairment as the inability to "hear well in a group conversation, *even with a hearing aid*" (emphasis added). By excluding children who can see and hear adequately when assisted by corrective lenses and hearing aids, respectively, the resulting totals will not accurately reflect the true prevalence and the theoretical potential for primary and (especially) secondary prevention. This is because a basic purpose of universal screening is not primarily to detect severe cases of impairment (which are rare and usually detected by other means), but rather to identify milder cases which may go unnoticed by parents or guardians. The ultimate goal is to avoid other problems that develop with undetected impairments.

Another factor complicating the relationship between vision and hearing screening and measurements of impairment later in life involves conditions with onset after screening takes place; this includes injury and certain infections, as well as some cryptic congenital conditions that manifest in adolescence. This phenomenon may help to explain the relatively low rates of hearing impairment detected by the BC Early Hearing Program (see the table below) compared with the analysis offered by McDougall and colleagues.

²⁴² Janssen RM. Permanent childhood hearing impairment and the Universal Newborn Hearing Screening Program in British Columbia. *UBC Medical Journal*. 2010; 2(1): 16-9.

²⁴³ McDougall J, King G, de Wit DJ et al. Chronic physical health conditions and disability among Canadian school-aged children: a national profile. *Disability and Rehabilitation*. 2004; 26(1): 35-45.

BC Early Hearing Program		
Services provided, October 2007 - March 2009		
Babies screened by March 31, 2009	Total	Cases per 1000
Total	49,050	--
Identified with permanent hearing loss	112	2.28
Referred to early intervention services	83	1.69
Fitted with BCEHP hearing equipment	271	5.52

Source: BC Early Hearing Program Information Update

As universal screening programs become established and report their progress, they promise to provide a useful addition to the available population data on vision and hearing impairment.

Discussion

There are undeniable advantages in screening for detectable sensory impairments as early as possible. Before newborn screening, the average age of diagnosis for children with hearing impairment was 44 months. Universal screening in the first year of life promises to reduce this time by at least 75%.²⁴⁴ Likewise, vision problems that would otherwise be identified at the point of reading difficulties can be detected much earlier with screening. In some cases, early detection allows for treatment and cure of a sensory impairment. In other situations, it allows the child to see or hear clearly with the assistance of corrective lenses or hearing aids, respectively. Even when the condition is more severe, adaptive abilities, such as reading Braille or learning sign language, can be acquired at an earlier age.

There is also growing evidence to suggest that some skills that are normally acquired within the earliest developmental window, but that are delayed by visual or hearing impairment, can be learned at a later age. This means that relatively early detection has the potential to help children catch up with their peers, even after a late start. One tool that has been shown to be effective in correcting the speech and language difficulties often associated with hearing impairment is Fast ForWord, published by Scientific Learning. Based on the principles of neuroplasticity, this computer-based program manipulates sounds and words, slowing them down to the point where children who otherwise would not be able to differentiate between various sounds can in fact recognize them. By gradually speeding up the sounds, the program can help to generate adaptive neural connections that otherwise would have developed earlier in life.²⁴⁵ The identification of hearing difficulties is, of course, usually a prerequisite for children to receive such help. In this way and many others, screening for vision and hearing impairments has a large role to play in cognitive development and general well-being for children.

Conclusion

In sum, vision and hearing screening allow children and their families to develop alternate strategies to work around the challenges of the detected physical impairment. As the preceding commentary implies, however, the impetus for screening programs is generally not the physical impairment per se, but the secondary, mostly non-physical effects. While some of the underlying

²⁴⁴ BCEHP. *Report on Program Start-up and Implementation 2005-2008*. Available at <http://www.phsa.ca/NR/rdonlyres/8705F38C-7EA6-4320-B1AC-2B2E4F399023/0/BCEHPPProgressReport2.pdf>. Accessed November 2010.

²⁴⁵ Gillam RB, Loeb DF, Hoffman LM et al. The efficacy of Fast ForWord Language intervention in school-age children with language impairment: a randomized controlled trial. *Journal of Speech, Language, and Hearing Research*. 2008; 51(1): 97-119.

conditions revealed by screening are treatable in some form, few are amenable to primary prevention. So, while their usefulness as a physical health indicator congruent with the main purpose of this report may be limited, uptake of screening programs does contribute to children's health and well-being in other important ways.

Summary Assessment					
Proportion of Children with Impairments Identified by Age 3					
Age group (Years)	Estimated Prevalence Among B.C. Children	Magnitude	Significance/Impact	Modifiability	Data Availability/Quality
0-3	Unclear	Unclear	High	High	Low

As summarized above, assessments have been applied to the Vision and Hearing Screening concept, specifically in terms of the indicator which is most compelling, namely: *proportion of children with vision and/or hearing impairment detected by age three*. Unlike the previous section on Newborn Screening, the potential pool of positive screens is *not* the indicator selected for assessment; instead, the alternate approach proposed involves tracking the proportion of the affected population that receives such screening in a timely way.

The pediatric population **Magnitude** of the potential indicator is assessed as **Unclear**. Data on the proportion of children with vision or hearing impairments are not currently tracked in the province. For this same reason, **Data Availability/Validity** for the potential indicator is assessed as **Low**.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **High**. Vision and hearing impairments have substantial adverse effects on child development and overall well-being, as described herein.

The **Modifiability** of the potential indicator is assessed as **High**. While very few of the underlying conditions that cause vision or hearing impairment are amenable to primary prevention, secondary interventions after a positive screen can certainly be applied to achieve clear beneficial effects. These interventions have the greatest chance to benefit the child when impairment is detected early in life, before development is overly compromised. It is pertinent, then, to note that "there is good evidence that population-based screening, for conditions such as permanent hearing loss, is effective in identifying more children at high-risk for developing disabilities or chronic health conditions than would be the case without screening,"²⁴⁶

The indicator related to screened conditions is **Not Recommended** for consideration as a core indicator of child health and well-being. However, given the high impact that impaired sight or hearing has on the life of the individuals involved, and the availability of effective interventions to make life better for affected children, the indicator should be considered for future development.

²⁴⁶ Poon B. *Preliminary Review of the Evidence Base for Healthy Infant and Early Childhood Development in BC – Newborn Hearing Screening section*.

Oral Health

Background and Context

Oral health plays a unique role in the world of child health and well-being, because it is both an aspect of health and a potential driver of other health issues. The primary purpose of this review is to find research evidence of an association between oral health in children and wider health or well-being outcomes. Oral health practices, such as brushing teeth and visiting the dentist, are also important, as they play a preventive role in achieving oral health, and sometimes stand as a proxy for what oral health fundamentally means.

Although oral health can include many different aspects of health of the mouth, the most common implication among children and adolescents relates to dental caries (or tooth decay). According to the Canadian Health Measures Survey of 2007-2009, 57% of children in Canada aged 6-11 years are affected by one or more instances of dental caries.²⁴⁷ This number is thought to be even higher among younger children.²⁴⁸ Early childhood caries (ECC), in fact, is described by the Canadian Dental Association as the most common childhood chronic disease. It can be accompanied by serious co-morbidities, such as: acute or chronic pain; tooth loss and malocclusion; interference with the child's eating, sleeping, and proper growth; and compromise of general health.²⁴⁹

While the effects of poor oral health make it an important target for prevention efforts among all demographic groups, the variability of oral health in North American society is a particular concern. Rates of tooth decay have been found to vary significantly according to socio-economic status and ethnic background, prompting concerns that some groups are being left behind when it comes to preventive efforts and education. In the U.S., for example, children from poor families miss up to 12 times as many school days as those from higher-income families.²⁵⁰

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

“Oral health” is a concept related to child health and well-being that exhibits a certain ambiguity. In common perception, oral health can refer to oral health practices designed to maintain oral health; this idea maps onto various types of prevention, from personal (e.g.,

²⁴⁷ Health Canada Canadian Health Measures Survey, Oral Health Module. Available at <http://www.hc-sc.gc.ca/hl-vs/pubs/oral-bucco/fact-fiche-oral-bucco-stat-eng.php>. Accessed October 2010.

²⁴⁸ Schroth RJ, Moffatt ME. Determinants of early childhood caries (ECC) in a rural Manitoba community: a pilot study. *Pediatric Dentistry*. 2005; 27(2): 114-20.

²⁴⁹ The Canadian Dental Association: Early Childhood Caries. Available at http://www.cda-adc.ca/_files/position_statements/Early_Childhood_Caries_2010-05-18.pdf. Accessed October 2010.

²⁵⁰ US Surgeon General. National Call to Action to Promote Oral Health. Available at <http://www.ncbi.nlm.nih.gov/books/NBK47472/>. Accessed January 2011.

regular tooth brushing) to health care (e.g., regular dental check-ups) to the public health level (e.g., routine fluoridation of the water supply). Conceivably, indicators could exist for any or all of these categories. As well, oral health can refer to mouth and dental health per se, whether it be an outcome of genetics, oral health practices, etc. Oral health in this latter sense can appear on “either side of the equation,” as both a health outcome or as a driver of broader aspects of the health and well-being of children.

To sum up, the strategy for this concept will involve two literature searches and two indicator investigations:

1. Evidence of a link between oral health practices and oral health; information about indicators of oral health practices.
2. Evidence of a link between oral health and broader health; information about indicators of oral health.

Search One

("Preventive Dentistry"[Majr] OR "Dental Care for Children"[Majr]) **AND** ("Oral Health"[Majr] OR "Tooth Diseases"[Majr] OR "Mouth Diseases"[Majr])

Search Two

("Oral Health"[Majr] OR "Tooth Diseases"[Majr] OR "Mouth Diseases"[Majr]) **AND** ("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Diabetes Mellitus"[Majr])

Taken together, the search processes returned 192 reviews for consideration.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between oral health practices and oral health, or between oral health and overall physical health, then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 71.

Primary Exclusion

The abstracts and/or full versions of the 71 articles were then reviewed. Articles not pertinent to the research topic were excluded; specifically, if the article did not link oral health with physical health outcome(s), or if it was not about children, it was excluded.

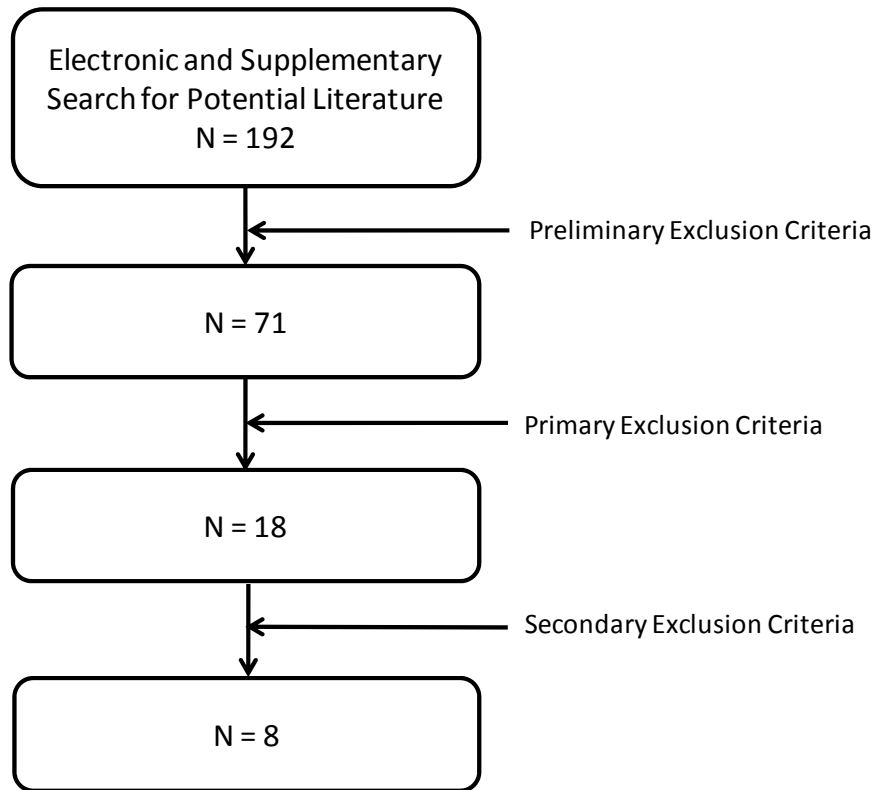
After completing this first exclusion process, the list of articles was reduced to 18.

Secondary Exclusion

Systematic reviews that were deemed to be of lesser quality or usefulness were excluded, yielding a final total of 8 reviews, as indicated in the following Volume Report.

Literature Review Volume Report: Reviews

Dimension: Physical Health **Concept:** Oral Health



Summary of Relevant Reviews

Dimension: *Physical Health*

Concept: *Oral Health*

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	No. of Studies
1	Fluoride toothpastes of different concentrations for preventing dental caries in children and adolescents	Walsh	2010	Cochrane Database of Systematic Reviews	n/a	1955-2008	75
2	Caries preventative effect of fluoride in milk, salt and tablets: a literature review	Espelid	2009	European Archives of Paediatric Dentistry	not available	1978-2008	9
3	Caries prevention with fluoride toothpaste in children: an update	Twetman	2009	European Archives of Paediatric Dentistry	not available	2002-2008	15
4	Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents	Ahovuo-Saloranta	2008	Cochrane Database of Systematic Reviews	n/a	1976-2006	16
5	Pit and fissure sealants in the prevention of dental caries in children and adolescents: a systematic review	Azarpazhooh	2008	Journal of the Canadian Dental Association	0.96 (2009)	2000-2006	38
6	Fluoride varnish in the prevention of dental caries in children and adolescents: a systematic review	Azarpazhooh	2008	Journal of the Canadian Dental Association	0.96 (2009)	2002-2006	7
7	Prevention of early childhood caries (ECC) - review of the literature published 1998-2007	Twetman	2008	European Archives of Paediatric Dentistry	not available	1998-2007	22
8	Chlorhexidine varnish for preventing dental caries in children, adolescents and young adults: a systematic review	Zhang	2006	European Journal of Oral Sciences	1.78	1995-2006	14

Detailed Results

For the 8 reviews identified by the literature search and exclusion process, a summary table of results was developed; this table is provided below.

Dimension: <i>Physical Health</i> Concept: <i>Oral Health</i> Summary Table of Reviews			
Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Walsh (2010)	Fluoride toothpastes of different concentrations for preventing dental caries in children and adolescents	75	The relative caries prevention effects of fluoride toothpastes increase with higher fluoride concentration. The improved benefits in preventing caries in children and adolescents are significant for fluoride concentrations of 1000 ppm and above.
Espelid (2009)	Caries preventative effect of fluoride in milk, salt and tablets: a literature review	9	There is limited evidence that fluoride drops and tablets are effective, and compliance is a key factor in any success.
Twetman (2009)	Caries prevention with fluoride toothpaste in children: an update	15	There is strong evidence that daily use of fluoride toothpaste has a significant caries-preventive effect in children compared with placebo. The effect was boosted by supervised tooth brushing, increased brushing frequency to twice daily, and use of a toothpaste concentration of 1,500 ppm fluoride.
Ahovuo-Saloranta (2008)	Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents	16	After 4.5 years, the sealed permanent molar teeth of children aged 5 to 10 had over 50% reduction in decay on biting surfaces compared to teeth without sealants. Information on the benefits of sealing specific to other types of caries risks is lacking.
Azarpazhooh (2008)	Pit and fissure sealants in the prevention of dental caries in children and adolescents: a systematic review	38	This review confirms the efficacy of dental sealants in preventing dental caries in children, in both primary and permanent teeth.
Azarpazhooh (2008)	Fluoride varnish in the prevention of dental caries in children and adolescents: a systematic review	7	There is clear evidence of the efficacy of fluoride varnish in preventing dental caries in children and adolescents. There is good evidence of the complementary efficacy of preventive strategies such as sealants and varnish, as well as toothbrushing and nutritional counselling. For predominantly high-risk populations, fluoride varnish should be applied twice a year, unless the individual has no risk of caries as indicated by caries history.
Twetman (2008)	Prevention of early childhood caries (ECC) – review of the literature published 1998-2007	22	Fluoride toothpaste is the most cost-effective homecare measure for prevention of ECC, and semi-annual fluoride varnish applications are the best professional method for infants at risk.
Zhang (2006)	Chlorhexidine varnish for preventing dental caries in children, adolescents and young adults: a systematic review	14	It is tentatively concluded that chlorhexidine varnish has a moderate caries-inhibiting effect when applied every 3-4 months.

Bibliography for Table of Reviews

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- Espelid I. Caries preventive effect of fluoride in milk, salt and tablets: a literature review. *European Archives of Paediatric Dentistry*. 2009; 10(3): 149-56.
- Twetman S. Caries prevention with fluoride toothpaste in children: an update. *European Archives of Paediatric Dentistry*. 2009; 10(3): 162-7.
- Ahovuo-Saloranta A, Hiiiri A, Nordblad A et al. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. *Cochrane Database of Systematic Reviews*. 2008.
- Azarpazhooh A and Main PA. Pit and fissure sealants in the prevention of dental caries in children and adolescents: a systematic review. *Journal of the Canadian Dental Association*. 2008; 74(2): 171-7.
- Azarpazhooh A and Main PA. Fluoride varnish in the prevention of dental caries in children and adolescents: a systematic review. *Journal of the Canadian Dental Association*. 2008; 74(1): 73-9.
- Twetman S. Prevention of early childhood caries (ECC)--review of literature published 1998-2007. *European Archives of Paediatric Dentistry*. 2008; 9(1): 12-8.
- Zhang Q, van Palenstein Helderma WH, van't Hof MA et al. Chlorhexidine varnish for preventing dental caries in children, adolescents and young adults: a systematic review. *European Journal of Oral Sciences*. 2006; 114(6): 449-55.

Summary of Results

The reviews identified in the literature search all relate to prevention of dental caries in children through oral health practices at home or in a dentist setting. No review papers were found that addressed children's oral health as a predictor of overall health and well-being, requiring the discussion below to depend on other lines of evidence.

Concerning oral health practices, three reviews found strong evidence that the use of fluoride toothpaste is an effective home care measure for preventing dental caries in children. Fluoride concentrations of 1000-1500 ppm and above were found to be most beneficial.^{251,252,253} Two of the reviews from the literature search confirmed the efficacy of dental sealants in preventing dental caries in children.^{254,255} Sealants are coatings applied by the dental professional, mainly on the grooves of molar teeth. These coatings are intended to prevent the growth of bacteria that promote decay in such grooves. In another review, strong evidence was presented that fluoride varnish is effective in preventing dental caries in children and adolescents. There were two reviews presenting limited evidence of effectiveness of other measures in preventing caries: Zhang et al. "tentatively" concluded that chlorhexidine varnish has a moderate caries-inhibiting effect; and Espelid found limited evidence for the effectiveness of fluoride drops and tablets—with compliance being a key moderating factor.^{256,257}

Data Sources on Oral Health

The Oral Health module of the Canadian Health Measures Survey (CHMS) is intended to be executed every two years in order to gather data on personal oral health care, prevalence of dental caries, and dental visits—in other words, information that bridges the two understandings of "oral health" being pursued in this section. Most recently, Statistics Canada collected data for the CHMS from about 6,000 people randomly selected in 15 communities across Canada between March 2007 and February 2009. Some statistics generated with respect to Canadian children and oral health are as follows:

- 57% of 6-11-year-olds and 59% of 12-19-year-olds have or have had a cavity
- 32% of children aged 6-11 years have one or more sealants to prevent cavities
- 51% of adolescents aged 12-19 years have one or more sealants to prevent cavities
- Among children aged 6-11 years old, 91% make an annual dental visit
- Among adolescents aged 12-19 years old, 84% make an annual dental visit

²⁵¹ Walsh T, Worthington HV, Glenny AM et al. Fluoride toothpastes of different concentrations for preventing dental caries in children and adolescents. *Cochrane Database of Systematic Reviews*. 2010.

²⁵² Twetman S. Caries prevention with fluoride toothpaste in children: an update. *European Archives of Paediatric Dentistry*. 2009; 10(3): 162-7.

²⁵³ Twetman S. Prevention of early childhood caries (ECC)—review of literature published 1998-2007. *European Archives of Paediatric Dentistry*. 2008; 9(1): 12-8.

²⁵⁴ Ahovuo-Saloranta A, Hiiiri A, Nordblad A et al. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. *Cochrane Database of Systematic Reviews*. 2008.

²⁵⁵ Azarpazhooh A, Main PA. Pit and fissure sealants in the prevention of dental caries in children and adolescents: a systematic review. *Journal of the Canadian Dental Association*. 2008; 74(2): 171-7.

²⁵⁶ Zhang Q, van Palenstein Helderman WH, van't Hof MA et al. Chlorhexidine varnish for preventing dental caries in children, adolescents and young adults: a systematic review. *European Journal of Oral Sciences*. 2006; 114(6): 449-55.

²⁵⁷ Espelid I. Caries preventive effect of fluoride in milk, salt and tablets: a literature review. *European Archives of Paediatric Dentistry*. 2009; 10(3): 149-56.

- 73% of Canadians of any age brush twice a day

Unfortunately, the CHMS does not take children under age 6 into account. This means that information about early childhood caries is only available through retrospective studies. As will be discussed below, there are many possible connections between early childhood caries and general health and well-being that would make ECC a potentially useful indicator. Without proper tracking of the condition in this age group, however, the use of such an indicator is limited.

Discussion

The located reviews identify oral health practices that are effective in preventing dental caries in children and adolescents. Dental caries are a significant concern with regard to oral health, particularly in young children; there are potentially serious consequences associated with the disease. The two oral health practices with the strongest evidence for effectiveness were the use of fluoride toothpaste and dental sealants. It should be noted that most of the reviews found good evidence of the complementary efficacy of other preventive strategies, such as nutritional counselling, other aspects of good oral hygiene, and regular dental examinations.

Another preventive strategy is the addition of fluoride to drinking water. Water fluoridation is a cheap and effective means of preventing tooth decay in the general population, but most of the B.C. population does not receive additional fluoride in their tap water. It has been suggested that Vancouver and Victoria, as cities with low levels of fluoride in their drinking water reservoirs, could benefit from additional fluoridation.²⁵⁸

Broader Health Effects of Oral Health

As noted previously, no reviews on the association of children's oral health with overall health were found in the literature search. Emerging evidence, however, has suggested a number of links between oral health and general health later in life. For example, connections have been shown between periodontal (gum) disease and several systemic diseases and conditions in adults, including diabetes mellitus, myocardial infarction, lung diseases such as pneumonia, Alzheimer's disease, obesity, and stroke.^{259,260}

With respect to oral health particular to the pediatric period, ECC is a concern that is sometimes overlooked. Because it occurs early in life, and involves primary dentition that will later be lost, ECC can be viewed as less important than markers of oral health involving permanent teeth later in life. A number of studies, however, have examined hypotheses about the potential long-term effects of poor oral health early in life. The greatest concern is that the infection that causes childhood caries can spread to other areas of the mouth, including the periodontal region, potentially causing cellulitis, adenopathy, and abscesses, as well as doing irreversible damage to adult teeth. Potential indirect effects, such as pronunciation difficulties or aesthetic irregularities leading to psychosocial problems, have also been suggested. Pain

²⁵⁸ BC Ministry of the Environment. Ambient water quality criteria for fluoride. Available at <http://www.env.gov.bc.ca/wat/wq/BCguidelines/fluoride/fluoridetoo-03.html>. Accessed February 2011.

²⁵⁹ Scannapieco FA, Dasanayake AP, Chhun N. Does periodontal therapy reduce the risk for systemic diseases? *Dental Clinics of North America*. 2010; 54(1): 163-81.

²⁶⁰ Seymour RA. Is gum disease killing your patient? *British Dental Journal*. 2009; 206(10): 551-2.

from dental infections can also affect sleep levels, in turn increasing the likelihood of impaired growth and otherwise a poor quality of life.^{261,262}

As mentioned above, tooth decay has been found to vary by socioeconomic status, ethnicity, and other social factors. These connections have the potential to disguise the effects of oral health on general health. This does not necessarily lessen the usefulness of oral health as an indicator of overall health and well-being, but it is a confounding factor that must be taken into consideration.

Finally, as shown above, data on oral health are routinely available through the CHMS. Indicators based on the prevalence or average frequency of children experiencing dental visits, as well as the rate of good tooth brushing habits (e.g., use of fluoride toothpaste, if this information were to be tracked) or use of sealants, may also be beneficial as markers of pediatric oral health.

Potential indicators directly relevant to the emerging scientific evidence about the broader implications of oral health include the following:

- Proportion of children with an experience of dental caries
- Proportion of children by kindergarten with no experience of dental caries

However, because the CHMS does not include information on children below age 6, any information related to ECC would need to be based on observations available through various studies but not routine population-level tracking.

Conclusion

Oral health is an important aspect of physical health in children and adolescents. Dental caries, or tooth decay, is considered to be the most common childhood disease. There are well-established and effective oral health practices that aid in preventing dental caries; these include the use of fluoride toothpaste and dental sealants. Data from the Canadian Health Measures Survey describe oral health practices and outcomes, including use of dental sealants and prevalence of dental caries.

Within oral health, early childhood caries (ECC) is an area of particular importance, because of growing evidence of serious co-morbidities, and concerns about social inequality in prevention efforts.

Although there is growing evidence of connections between oral health and general health at all ages, this area of science would need to be characterized as investigational. On the other hand, oral health in the form of healthy teeth, gums, etc. represents an important aspect of health and well-being in its own right during the pediatric period. Given the present level of data tracking, an indicator based on dental caries in grade-school children and adolescents is the most pertinent one to consider.

²⁶¹ Msefer S. Importance of early diagnosis of early childhood caries. *Journal de l'Ordre des dentistes du Quebec*. 2006; 43(2 Suppl 1): 6-8.

²⁶² Sheiham A. Oral health, general health and quality of life. *Bulletin of the World Health Organization*. Available at: <http://www.who.int/bulletin/volumes/83/9/editorial30905html/en/>. Accessed January 2011.

Summary Assessment					
Ever Having Dental Caries					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
6-19	415,000	High	Medium	High	High

As summarized above, assessments have been applied to the Oral Health concept, specifically in terms of the most pertinent indicator, namely, *prevalence of dental caries*.

The pediatric population **Magnitude** of the indicator is assessed as **High**. Based on the Canadian Health Measures Survey, 59% of children aged 6-19 years have or have had dental caries. When applied to the entire pediatric cohort, it results in an estimated 415,000 individuals. This is greater than 10% of the total pediatric cohort (97,000), resulting in a Magnitude classification of High.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **Medium**. Dental caries itself represents a (usually modest) direct health effect, especially when untreated. While no systematic review was identified that pointed to children's oral health generating broader health and well-being impacts in childhood and adulthood, several such areas have been proposed.

The **Modifiability** of the potential indicator is assessed as **High**. Several oral health practices that are known to be effective, and, if consistently applied, could significantly reduce the incidence of dental caries.

Data Availability/Validity for the potential indicator is assessed as **High**. The Oral Health Module of the Canadian Health Measures Survey is conducted every 2 years, and provides information such as prevalence of cavities. If an indicator on Oral Health Practices were to be selected instead of Oral Health Outcomes, then it is important to know that this same data source offers information on the frequency of dental visits among Canadian children, use of sealants, etc.

The indicator related to the prevalence of dental caries is **Recommended** for consideration as a core indicator of child health and well-being. The reasons are the Medium-to-High rating across all four assessment categories. An indicator tracking dental caries in preschoolers remains as a candidate for further investigation and potential development.

Health Services Accessibility

Background and Context

The purpose of this review is to find research evidence of an association between health services accessibility and the well-being of children—in particular their physical health since aspects of care related to non-physical health are more pertinent to other dimensions of this project.

Health services access is a complex, multi-faceted topic. The political environment can influence how access is understood. Thus, recent U.S. discourse sometimes seems to equate access with having health insurance.^{263,264} Access to health care has also been a major focus in Canada as a whole and in each province in the last decade, especially in the context of reducing wait times for selected priority services. However, barriers to access involve much more than time.

The concept of health services accessibility, which is also known by terms such as *health care access* and *patient access to health services*, has been defined by Andersen et al. in the following terms:²⁶⁵

...those dimensions which describe the potential and actual entry of a given population group into the health care delivery system.

There are many competing factors that influence and ultimately shape an individual's "potential and actual entry" to the health care system, including geographic, architectural, transportation, and financial obstacles. Building on these ideas, the following model of the accessibility concept was devised by the present reviewers according to their expertise in the area of waiting lists²⁶⁶ and other dimensions of health services research.²⁶⁷

²⁶³ Cummings JR, Lavarreda SA, Rice T et al. The effects of varying periods of uninsurance on children's access to health care. *Pediatrics*. 2009; 123(3): e411-8.

²⁶⁴ Cassidy A, Fairbrother G, Newacheck PW. The impact of insurance instability on children's access, utilization, and satisfaction with health care. *Ambulatory Pediatrics*. 2008; 8(5): 321-8.

²⁶⁵ Andersen RM, McCutcheon A, Aday LA et al. Exploring dimensions of access to medical care. *Health Services Research*. 1983; 18(1): 49-74.

²⁶⁶ For example, H. Krueger & Associates Inc. researched and wrote a three-part report for the Canadian Institute of Health Research entitled *Priority Criteria for Hip and Knee Replacement: Addressing Health Service Wait Times*. 2005.

²⁶⁷ Partly adapted from Goddard M, Smith P. Equity of access to health care services: theory and evidence from the UK. *Social Science & Medicine*. 2001; 53(9): 1149-62.; Ensor T, Cooper S. Overcoming barriers to health service access: influencing the demand side. *Health Policy and Planning*. 2004; 19(2): 69-79.; Ricketts TC, Goldsmith LJ. Access in health services research: the battle of the frameworks. *Nursing Outlook*. 2005; 53(6): 274-80.; Zhang X, Andersen R, Saaddine JB et al. Measuring access to eye care: a public health perspective. *Ophthalmic Epidemiology*. 2008; 15(6): 418-25.; and http://www.ices.on.ca/webpage.cfm?site_id=1&org_id=31&morg_id=0&gsec_id=0&item_id=2862

Health Services Accessibility: Categories and Measurements

	Measures of Potential Accessibility	Measures of Actual Access (=Use) as Marker of Accessibility
Core Availability Factors	(A) Numbers of providers or clinics per population (e.g., pediatricians/10,000 children)	(A) Absolute utilization or rate of utilization, with no reference to appropriateness (e.g., number of pediatric surgeries) (A) Proportion of need being met by 'less optimal' service (e.g., rate of hospitalization for pediatric chronic disease)
Other Accessibility Barriers		
<i>Spatial Relationship Between Service + User</i>	(S) Proportion of users or potential users dealing with access barriers (A) Number of particular clinics per geographical area (e.g., pediatric emergency departments) (A) Average distance to a particular service	(S) Rate of non-use of a service due to a spatial or other barrier
<i>Time Relationship Between Service + User</i>	(A) Number on waiting list for a service	(A) Average waiting time (with no reference to appropriateness)
<i>Secondary Needs (e.g., Physical Disability, Cultural, Language, Gender, etc. and Provider Concordance; Privacy Concerns, Low-Income and Transportation, Out of Pocket Expenses,</i>	e.g., Number of facilities with architectural access barriers, language concordant providers per language group, etc.	
Fit Between Need/Demand + Supply	(A) Number of specialty providers per risk factor or disease prevalence	(A) Proportion of population using recommended service (e.g., percentage of young children seen in well-child visits; immunization rates) (A) Proportion of provided service meeting care quality benchmarks (e.g., service within a maximum recommended waiting time)
Fit Between Preference + Supply	(S) User satisfaction with access to service (S) Provider satisfaction with access to service	(S) Rate of unmet need
<i>Adapted from a variety of sources</i>	(A) = Administrative Data Source; (S)= Survey Data Source	

It is clear that access to health services is a complicated concept, though understanding can be helped by classifying the candidate measures as above, that is, in terms of the dual rubric of potential and actual access. The analytic challenge for reviewers is intensified, however, when attempting to apply the concept to the pediatric population, as well as to specific health services—recognizing that one or more of the candidate measures may be applied to *each* type of service. There are distinct age groups and needs from 0 to 19 years, and many different kinds of health services (from primary prevention to screening and treatment to rehabilitation) that are important to each cohort. As well, access may be conceived in terms of special populations, e.g., at-risk youth, sexual orientation, cross-cultural barriers, and special needs such as having a chronic condition. It should be noted that the project leaders were especially interested in the subtopic of adolescent sexual health services.

Research on the theme of health service access per se has been published, sometimes on a narrow subtopic in one jurisdiction, such as pediatric trauma care in the US and rheumatology subspecialty care in British Columbia.^{268,269} It remains to be seen whether the multitude of

²⁶⁸ Nance ML, Carr BG, Branas CC. Access to pediatric trauma care in the United States. *Archives of Pediatric & Adolescent Medicine*. 2009; 163(6): 512-8.

²⁶⁹ Shiff NJ, Abdwani R, Cabral DA et al. Access to pediatric rheumatology subspecialty care in British Columbia, Canada. *Journal of Rheumatology*. 2009; 36(2): 410-5.

potential indicators of access have in fact been measured against health outcomes. The arena of child health services research is still perceived to be in its infancy. Acknowledging this, Forrest et al. have noted that tools are lacking “to monitor the impact of health system change on children’s health and health care.”²⁷⁰

Methodology and Provisional Results

Review Search Process

For the electronic search for reviews in this area, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

(“Health Services Accessibility”[Mesh] OR “Waiting Lists”[Mesh])

AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR “Outcome Assessment (Health Care)”[Mesh] OR “Medicine/statistics and numerical data”[Mesh] OR “Hospital Departments/statistics and numerical data”[Mesh])

Examining the 113 located papers, it was determined that there were no systematic or other reviews pertinent to this concept, so the decision was made to conduct a “Level B” search process focusing on individual studies.

Study Search Process

The electronic search conducted for individual studies in this area again was based on PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

The MeSH terms employed in the search were as follows:

²⁷⁰ Forrest CB, Simpson L, Clancy C. Child health services research. Challenges and opportunities. *Journal of the American Medical Association*. 1997; 277(22): 1787-93.

("Health Services Accessibility"[Mesh] OR "Waiting Lists"[Mesh])

AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Outcome Assessment (Health Care)"[Mesh] OR "Medicine/statistics and numerical data"[Mesh] OR "Hospital Departments/statistics and numerical data"[Mesh])

There were 1622 studies identified in this search process.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between pediatric health services accessibility and physical health outcome(s), then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 21.

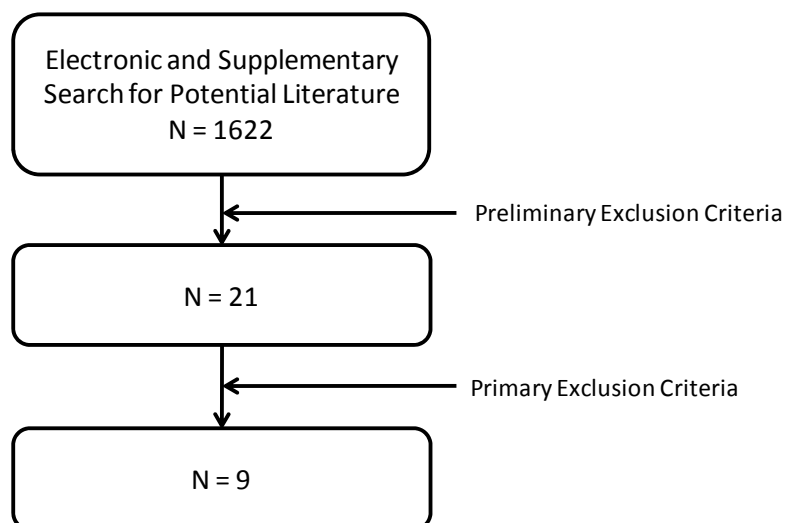
Primary Exclusion

The full articles were then reviewed, with articles not pertinent to the research topic being excluded; specifically, if the article did not link health services accessibility with physical health outcome(s), it was excluded. If there was uncertainty as to whether an article should be excluded, the reviewers discussed the matter further to reach a consensus.

As noted in the Volume Report below, there were 9 articles remaining following the primary exclusion step; a secondary exclusion step was not deemed to be necessary. The bibliography and results of the 9 studies are provided in the tables following the Volume Report.

Literature Review Volume Report: Individual Studies

Dimension: Physical Health **Concept:** Health Services Accessibility



Summary of Relevant Studies

Dimension: *Physical Health*

Concept: *Health Services Accessibility*

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Type of Study	Sample Size	Sample Population	Location	Conflict of Interest
Primary Care and Chronic Disease Management										
1	Primary care physician supply and children's health care use, access, and outcomes: findings from Canada	Guttmann	2010	Pediatrics	4.27	Cross-sectional	Approx. 3 million children	Children aged 0-17 years	Ontario, Canada	None
2	Impact of proximity to comprehensive sickle cell center on utilization of healthcare services among children with sickle cell disease	Shankar	2006	Pediatric Blood & Cancer	1.51					
3	More may be better: evidence of a negative relationship between physician supply and hospitalization for ambulatory care sensitive conditions	Laditka	2005	Health Services Research Journal	2.40	Cross-sectional	20 U.S. States	All ages (broken out by age groups)	U.S. States	Not Stated
4	Are rates of functional limitations associated with access to care? A state-level analysis of the national survey of children with special health care needs	Stein	2005	Maternal and Child Health Journal	1.76	Aggregate of nation-wide administrative data	All children of 50 states and the District of Columbia	Children < 18 years of age	51 U.S. States	Not Stated
Sexual Health										
5	The role of school health centers in health care access and client outcomes	Soleimanpour	2010	American Journal of Public Health	3.57	Multimethod evaluation	7410 (clients)	High school health center attendees	Alameda County,	Not Stated
6	Youth's experiences with STI testing in four communities in British Columbia, Canada	Shoveller	2009	Sexually Transmitted Infections	2.74	Interview	70	Young men and women (15-24)	B.C., Canada	None
Surgery / Trauma										
7	Chen LE, Zamakhshary M, Foglia RP et al. Impact of wait time on outcome for inguinal hernia repair in infants	Chen	2009	Pediatric Surgery International	0.95	Retrospective (using administrative data)	291	Children < 2 years of age	Ontario, Canada	None
8	Risk of incarceration of inguinal hernia among infants and young children awaiting elective surgery	Zamakhshary	2008	Canadian Medical Association Journal	7.40	Retrospective (using administrative data)	1,065 infants	Children < 2 years of age	Ontario, Canada	None
9	The relationship between the location of pediatric intensive care unit facilities and child death from trauma: a county-level ecologic study	Odetola	2005	Journal of Pediatrics	3.84	Cross-sectional	18,337 (deaths)	Children aged 0-14	Contiguous U.S.A.	Not Stated

Detailed Results

For the 9 studies identified by the literature search and exclusion process, a summary table of results was developed; this table is provided below.

Dimension: <i>Physical Health</i> Concept: <i>Health Services Accessibility</i> Summary Table of Studies							
Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
Primary Care and Chronic Disease Management							
Guttmann (2010)	To describe the relationship between physician supply in the primary care setting for children and measures of health access, use, and outcome.	Used administrative data to model the relationship between supply of physicians to recommended primary care visits, ED use, and ambulatory care sensitive conditions in children.	Ontario 2003-2005; All children aged 0-17. (approx. 3 million children; 9,912 GPs and 362 pediatricians)	Population-based cross-sectional study	-overall primary care use -self-reported access to primary care -ED use -admissions for an ACSC.	- areas with lower physician supply had significantly higher percentages of children with no primary care provider (PCP) and newborns without follow-up. -hospitalizations for asthma, diabetes, acute ACSCs and number of appendectomies were highest in regions with low supply of Primary Care Providers. (data all per 1,000 children) -asthma (6.2 vs 10.1) -diabetes (55.3 vs. 91.8) -acute ACSCs (2.4 vs. 4.0) -appendectomies (161.0 vs. 178.6)	Hospitalizations for morbidity measures such as asthma, diabetes and ASCS are higher in regions with lower physician supply.
Shankar (2006)	To determine how medical care utilization and health outcomes differ between children attending comprehensive and non-comprehensive sickle cell centers.	Compared mortality rates, rates of hospitalizations, emergency department visits among cohorts of children (<20 years of age) with sickle cell disease.	Tennessee , U.S.A. 1,214 children with 6,393 person-years of follow up	Population-based cohort study	-total hospitalizations -outpatient visits -ED visits -deaths	-hospitalizations were significantly higher in the region with a Comprehensive Sickle Cell Center (CSCC) -ED visit rates were not statistically different by region -outpatient visits were significantly higher in all age groups in all three regions that lacked a CSCC -death rates were not statistically different between	No clear pattern of improved utilization of medical care services were identified in relation to proximity of residence to a CSCC. It is acknowledged that this cohort is not large enough to detect small differences in death rates.

Dimension: Physical Health Concept: Health Services Accessibility

Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
						regions.	
Laditka (2005)	To empirically test of the relationship between physician supply and hospitalization for ambulatory care sensitive conditions (ACSC)	Determine how physician supply is related to incidence of hospitalizations for ambulatory care sensitive conditions.	20 states, USA Urban and Rural counties	Safety Net Monitoring Initiative of the Agency for Healthcare Research and Quality data.	ACSC rate by age and number of MDs (i.e., physician supply)	For ages 0-17 years in urban areas, standardized estimates indicate that physician supply has the largest negative adjusted relationship with ambulatory care sensitive conditions ($P < 0.0001$)	Physician supply is positively associated with the overall performance of the primary health care system in a large sample of urban counties of the United States, especially with respect to the pediatric population.
Stein (2005)	To examine where rates of functional limitations in Children with Special Health Care Needs (CSHCN) are related to access to care.	Compared proportions of CSHCN with function limitations between geographic regions and see if there is a relationship to barriers to access (proportion of uninsured individuals) or outcomes (unmet healthcare needs). Data was from the National Survey of Children with Special Health Care Needs, conducted between April 2000 and October 2002.	50 American States and the District of Columbia	Population-based cross-sectional survey	-unmet health needs -proportion of individuals with insurance coverage (by state)	higher percentages of CSHCN with functional limitations was correlated to: -higher percentage of uninsured CSHCN ($p < 0.0001$) - higher rates of CSHCN with unmet health needs ($p < 0.0001$)	Higher state-wide proportion of unmet health needs is statistically correlated to a higher proportion of function limitations.
Sexual Health							
Soleimanpour (2010)	To describe the impact of school health centers on adolescents access to care and their mental and physical health outcomes	Compare baseline and post health center consultation sexual behaviours in terms of contraceptive use.	U.S.A. 12 school centers with 7410 clients who made 39,754 visits in 2008-2009	Multi-method evaluation including focus groups, surveys and quantitative data	-self-reported contraceptive use (other than condoms), condoms with another form of birth control, and condom use.	-there was a significant improvement ($p < 0.001$) in the use of birth control other than condoms "always" among female clients. -significant improvement ($P < 0.001$) from baseline to follow-up in the use of condoms with another form	School health centers can increase access to care and improve aspects of contraceptive use among adolescents.

Dimension: Physical Health Concept: Health Services Accessibility

Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
						of birth control. -significant decrease (p<0.001) reported in condom use in the past month "always" using.	
Shoveller (2009)	To analyze the experiences of youth accessing sexually transmitted infection (STI) services and adult service providers in four B.C. communities	Qualitative interviews with young men and women; key informant interviews with service providers; observational visits to health clinics.	Four B.C. communities (Vancouver, Richmond, Prince George, Quesnel) 15-24-year-olds who were currently and/or previously sexually active, N=70	Observational/ interview-orientated study -In-depth (approx. 1 hour) interviews with 70 young men and women -interviews with 22 service providers about their experiences providing STI testing services -Naturalistic observation at 11 clinic sites	-identify factors that shape youth perceptions and possible barriers to access of STI testing.	-three main factors that affect youth experiences related to testing were identified; -social and physical features of the community -characteristics of the clinics -knowledge gaps related to testing.	Youth experience with STI testing is influenced by interacting social-cultural and structural forces.
Surgery / Trauma							
Chen (2009)	To determine if increased wait time for treatment in children who presented with inguinal hernia led to adverse outcomes (such as incarceration)	Compared surgical wait times, incidence of incarceration, and incidence of recurrent incarceration between a Canadian and American pediatric surgical center	Children under the age of 2 who presented with an inguinal hernia to either the emergency department or clinic in 2002 and 2003 at the following locations: One Canadian	Retrospective cohort study	-wait times -incarceration as first clinical presentation -wait time and incarceration -emergency department utilization -other complications	-the duration between surgical consultation and time of hernia repair was longer in the Canadian hospital (p<0.001) -incarceration was more common as first clinical presentation in the Canadian hospital (p<0.001) -infants presenting with incarcerated hernia had a longer wait time in the Canadian hospital (p<0.01) -there was 0.17 visits to the	Prolonged wait time for inguinal hernia repair surgery in infants is associated with a higher rate of incarceration and greater usage of ED resources.

Dimension: Physical Health Concept: Health Services Accessibility

Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
			pediatric surgical center (Toronto; n=154) and one American pediatric surgical center (St. Louis; n=237)			emergency department per infant in American and 0.90 in Canada (P<0.01)	
Zamakhshary (2008)	Examine the relationship between wait times for inguinal hernia surgery and clinical outcomes.	Using the Ontario Discharge Abstract Database, wait times for inguinal hernia surgery were compared with risk of incarceration and emergency department usage.	Ontario All children under 2 years of age who underwent surgical repair of an inguinal hernia between Apr.1 2002 and Mar.31 2004 (n= 1065)	Retrospective cohort study	-rate of hernia incarceration from the time of diagnosis to surgery -wait times and ED usage	-rate of hernia incarceration at wait times were: 10.1% at 35 days 5.2% at 14 days - 11.8% of patients had at least 1 ED visit. 23.8% of these individuals presented with hernia incarceration.	Waiting longer than 14 days for surgery is associated with a doubling of the risk for hernia incarceration among infants and young children with inguinal hernia.
Odetola (2005)	To determine how distance to a Pediatric Intensive Care Unit (PICU) impacts child death from trauma.	Compared county-level data on deaths due to trauma in children 0 to 14 years of age from 1996 to 1998, and linked these data to availability of PICU facilities.	USA n=18,337 childhood deaths from trauma in children 0 to 14 years of age over the study period; 9% of U.S. counties reported PICU facilities.	Cross-sectional ecological study	- child mortality rates	- the presence of PICU facilities was associated with lower mortality from trauma (IRR=0.72 [0.67-0.78]) even after controlling for residence in rural and low-income counties and the presence of adult medicosurgical intensive care units, the association was still observed (IRR = 0.82 [0.75-0.89]).	The presence of PICU facilities is related to lower mortality rates due to traumatic injuries at the county level.

Bibliography for Table of Studies

- Guttmann A, Shipman SA, Lam K et al. Primary care physician supply and children's health care use, access, and outcomes: findings from Canada. *Pediatrics*. 2010; 125(6): 1119-26.
- Shankar SM, Arbogast PG, Mitchel E et al. Impact of proximity to comprehensive sickle cell center on utilization of healthcare services among children with sickle cell disease. *Pediatric Blood & Cancer*. 2008; 50(1): 66-71.
- Laditka JN, Laditka SB, Probst JC. More may be better: evidence of a negative relationship between physician supply and hospitalization for ambulatory care sensitive conditions. *Health Services Research*. 2005; 40(4): 1148-66.
- Stein RE, Silver EJ. Are rates of functional limitations associated with access to care? A state-level analysis of the national survey of children with special health care needs. *Maternal and Child Health Journal*. 2005; 9(2 Suppl): S33-9.
- Soleimanpour S, Geierstanger SP, Kaller S et al. The role of school health centers in health care access and client outcomes. *American Journal of Public Health*. 2010; 100(9): 1597-603.
- Shoveller J, Johnson J, Rosenberg M et al. Youth's experiences with STI testing in four communities in British Columbia, Canada. *Sexually Transmitted Infections*. 2009; 85(5): 397-401.
- Chen LE, Zamakhshary M, Foglia RP et al. Impact of wait time on outcome for inguinal hernia repair in infants. *Pediatric Surgery International*. 2009; 25(3): 223-7.
- Zamakhshary M, To T, Guan J et al. Risk of incarceration of inguinal hernia among infants and young children awaiting elective surgery. *Canadian Medical Association Journal*. 2008; 179(10): 1001-5.
- Odetola FO, Miller WC, Davis MM et al. The relationship between the location of pediatric intensive care unit facilities and child death from trauma: a county-level ecologic study. *Journal of Pediatrics*. 2005; 147(1): 74-7.

Summary of Results

A total of 9 studies were identified that examined the concept of health services accessibility in relation to physical health outcomes in youth. These studies fell under the subcategories of primary care and chronic disease management, sexual health, and surgery/trauma.

Regarding the first category, Guttman et al. found that in Ontario the number of physicians in a particular area was correlated with morbidity measures. As shown in the following table, geographic areas with fewer physicians per child (0-17 years) had higher rates of hospitalizations for asthma, diabetes, and acute ambulatory care-sensitive conditions (ACSCs) in that age group.²⁷¹ The suggestion is that, for any area where the number of children per physician increases, access to an important health service (related to secondary prevention) is reduced.

Morbidity Measures According to Area-Level Primary Care Supply			
Ontario, 2003-2005			
Physician Supply†	Asthma‡	Diabetes§	Acute ACSCs
1500-1999	6.2	55.3	2.4
2000-2499	8.3	90.5	2.5
2500-2999	9.0	91.4	3.0
3000-3500	9.1	96.4	3.3
>3500	10.1	91.8	4.0
† number of children aged 0-17 per physician's overall full-time equivalents			
‡ per 1000 children with asthma (n=560,711)			
§ per 1000 children with diabetes (n=6686)			
Source: Guttman et al., <i>Pediatrics</i> , 2010			

Similar results were reported by Laditka et al, where the level of (potential) service for ambulatory care sensitive conditions, as represented by physician supply, was found to particularly affect the pediatric population. In contrast, Shankar et al. found that death rates did not significantly differ between regions with or without comprehensive sickle cell disease centers.²⁷² However, based on an analysis of 50 states and the district of Columbia, Stein and Silver found that the proportion of children with special health care needs with functional limitations was higher in states identified (by survey) to have higher rates of unmet health needs ($p < 0.0001$).²⁷³ Here, the conclusion is that unmet health needs is a suitable proxy for poor access, with both in turn leading to reduced quality of life because of preventable limitations in function.

²⁷¹ Guttman A, Shipman SA, Lam K et al. Primary care physician supply and children's health care use, access, and outcomes: findings from Canada. *Pediatrics*. 2010; 125(6): 1119-26.

²⁷² Shankar SM, Arbogast PG, Mitchel E et al. Impact of proximity to comprehensive sickle cell center on utilization of healthcare services among children with sickle cell disease. *Pediatric Blood & Cancer*. 2008; 50(1): 66-71.

²⁷³ Stein RE, Silver EJ. Are rates of functional limitations associated with access to care? A state-level analysis of the national survey of children with special health care needs. *Maternal and Child Health Journal*. 2005; 9(2 Suppl): S33-9.

In terms of sexual health services, Soleimanpour and colleagues found that the existence of student health centers can increase adolescent access to care, and that this can result in increased contraceptive use in specific areas.²⁷⁴ This effect was generally dependent upon the type of contraceptive adopted and the gender of the individual, but statistically significant increases were observed for specific practices, including:

- Use of birth control other than condoms “always” among female clients ($p < 0.001$)
- Use of condoms with another form of birth control ($p < 0.001$)

There was, surprisingly, a significant decrease reported among the study participants with respect to “always” using condoms in the past month ($p < 0.001$). Factors affecting access, and ultimately the health of patients, are complex. For instance, Shoveller et al. found that there are three main factors impacting the experience of B.C. youth in relation to STI testing and treatment, and that therefore may moderate the sense of accessibility of such services:²⁷⁵

1. Social and physical features of the community
2. Characteristics of the clinics
3. Knowledge gaps related to testing

In the surgery/trauma subcategory, two studies focused on urgent inguinal hernia surgery in infants (i.e., less than 2 years of age). Chen et al. found that Canadian hospitals have longer wait times for surgery, higher incidence of hernias easily being reduced (a condition known as *incarceration*, which requires surgery), and increased incidence of recurrent incarceration.²⁷⁶ Confirming these findings, Zamakhshary et al. found that a wait time of more than 14 days was associated with double the risk of incarceration.²⁷⁷ On another acute care front, Odetola et al. conducted a study demonstrating that proximity of pediatric intensive care units (PICU) was correlated at the county level with lower mortality rates due to traumatic injuries.²⁷⁸

Data Sources on Health Services Accessibility

Health Services Access Survey

The Health Services Access Survey (HSAS) is a supplement to the Canadian Community Health Survey (CCHS). It is a survey in current use, though publications are irregular and apparently unavailable through the normal data tables generated out of the CCHS program.²⁷⁹ The most recent (2005) report had a special focus on waiting times, an issue that emerged as a special concern following the development of a 10-year plan by First Ministers that aimed at improving access and reducing waiting times. The HSAS gathers information on the use of

²⁷⁴ Soleimanpour S, Geierstanger SP, Kaller S et al. The role of school health centers in health care access and client outcomes. *American Journal of Public Health*. 2010; 100(9): 1597-603.

²⁷⁵ Shoveller J, Johnson J, Rosenberg M et al. Youth's experiences with STI testing in four communities in British Columbia, Canada. *Sexually Transmitted Infections*. 2009; 85(5): 397-401.

²⁷⁶ Chen LE, Zamakhshary M, Foglia RP et al. Impact of wait time on outcome for inguinal hernia repair in infants. *Pediatric Surgery International*. 2009; 25(3): 223-7.

²⁷⁷ Zamakhshary M, To T, Guan J et al. Risk of incarceration of inguinal hernia among infants and young children awaiting elective surgery. *Canadian Medical Association Journal*. 2008; 179(10): 1001-5.

²⁷⁸ Odetola FO, Miller WC, Davis MM et al. The relationship between the location of pediatric intensive care unit facilities and child death from trauma: a county-level ecologic study. *Journal of Pediatrics*. 2005; 147(1): 74-7.

²⁷⁹ See the background description on CCHS in the Introduction.

health care services by Canadians, and self-reported access barriers faced by Canadians aged 15 years and over.

HSAS data are generally presented for Canada as a whole, but some information is available at the provincial level when the sample size is adequate. Unfortunately, the HSAS does not age-stratify data at this point in its development. The concluding line from the 2005 report hints that other aspects of care derived from CCHS data “will be further exploited to better understand the factors associated with long waits and adverse experiences while waiting for specialized services.” It is unclear when this latter information will be released, and whether it will include age-specific data to allow a picture to be developed relevant to the pediatric population.

Wait Time Alliance Report Card

The Wait Time Alliance (WTA) was formed out of concern among Canada's doctors over delayed access to care for their patients, and an interest in working collaboratively with stakeholders to improve wait times. The WTA is comprised of several national medical specialty societies whose members are directly involved in providing care to patients.

-WTA Website²⁸⁰

The WTA report card for 2010 is unique in that it grades wait times in different subspecialties according to standards set by physicians in the area; the grades are based on standards known as Pediatric Canadian Access Targets for Surgery (P-CATS).²⁸¹

As yet there are no B.C.-specific data, only collective information from 15 academic health centers spread across the country. The recent pan-Canadian results are presented in the table below:²⁸²

Pediatric Wait Times in Canada, 2009 by Surgical Subspecialty Grades Based on Degree of Congruence with P-CATS			
Area	Current waiting	Total Completed	Completed Grade
Dentistry	4,680	9,785	D
Ophthalmology	1,764	5,169	D
Plastic surgery	1,653	4,843	C
Cancer surgery	82	1,079	B
Neurosurgery	115	986	B
Cardiac surgery	296	1,570	B
Otolaryngology	5,597	17,616	B
General surgery	1,829	10,380	A
Urology	2,258	6,063	A
Orthopedic surgery	2,099	6,322	A
Gynecology	39	282	A

Source: Wait Time Alliance Report Card, 2010.

²⁸⁰ Available at <http://www.waittimealliance.ca>. Accessed November 2010.

²⁸¹ See http://www.waittimealliance.ca/waittimes/P-CATS-Report_en.pdf. Accessed November 2010.

²⁸² See http://www.waittimealliance.ca/media/2010reportcard/WTA2010-reportcard_e.pdf. Accessed November 2010.

These data are generated by provincial reports, and collated by the Canadian Institute for Health Information.²⁸³ While there appears to be significant momentum behind this initiative, it is not clear whether or when further pediatric-specific data will be published.

Centre for Health Services & Policy Research

Data regarding the number of physicians in British Columbia are available in a Centre for Health Services & Policy Research publication entitled *Who are the Primary Health Care Physicians in British Columbia?*²⁸⁴ Using pediatric population estimates for the various Health Service Delivery Areas (HSDAs) in B.C., the number of children per primary health care physician may be determined. Results for fiscal years 1996/97, 2000/01, and 2004/05 are outlined in the table below.

Trends in Physician Supply in B.C.			
Number of Children Aged 0-19 Years per Primary Health Care (PHC) Physician, by HSDA and HA Fiscal Years: 1996/97, 2000/01, 2004/05			
HSDA	Fiscal Year		
	96/97	00/01	04/05
East Kootenay	292	217	166
Kootenay - Boundary	241	211	160
Okanagan	273	244	210
Thompson - Cariboo	318	294	257
Interior Health Total	284	250	209
Fraser East	373	398	348
Fraser North	292	323	296
Fraser South	402	408	373
Fraser Health Total	350	371	337
Richmond	283	315	291
Vancouver	101	111	119
N. Shore - Coast Gar.	216	216	204
Vancouver Coastal Health Total	141	154	156
South Island	173	157	134
Central Island	281	248	228
North Island	271	264	197
Vancouver Island Health Total	220	199	169
Northwest	304	277	258
Northern Interior	374	341	267
Northeast	475	453	385
Northern Health Total	366	337	285
BC Total	243	243	222
Sources:			
Number of PHC physicians: Watson, DE. et al. <i>Who are the Primary Health Care Physicians in British Columbia? 1996/97-2004/05</i> . Vancouver: UBC Centre for Health Services and Policy Research, 2006. Available at www.chspr.ubc.ca . Pediatric population estimates: BC Stats (http://www.bcstats.gov.bc.ca/); For each fiscal year, population estimates were used for the first year, as it represents two-thirds of the fiscal year.			

²⁸³ See http://secure.cihi.ca/cihiweb/products/wait_times_tables_2010_e.pdf. Accessed November 2010.

²⁸⁴ Watson DE, Black C, Peterson S et al. *Who are the Primary Health Care Physicians in British Columbia?* 2006. Centre for Health Services and Policy Research. Available at <http://www.chspr.ubc.ca/node/435>. Accessed November 2010.

The health authorities (HAs) with a decreasing number of children per PHC over time may be deemed to have improved on this one potentially important metric of pediatric health service access; these jurisdictions include Northern Health, Vancouver Island Health, and Interior Health. The two Lower Mainland HAs appear to have been more stable in terms of this metric since 1996.

Discussion

Access constitutes only one aspect of health service delivery. Delivery mechanisms can be evaluated according to other dimensions, as follows: (1) quality of care, including outcome measures, satisfaction, etc; (2) coordination of care; (3) processes of care; (4) economic impact of different service models; and (5) impact of system changes. However, access continues to be a dominant concern, as noted recently by Graves: “differences in access to healthcare services and the resulting adverse health outcomes are major public health priorities.”²⁸⁵

The specific assignment for this section of the report was to determine whether there was any evidence that one or more measures of access to a pediatric health service was causally correlated with health outcomes. The studies identified for the review fell into three subcategories. Regarding primary care and chronic disease management and surgery/trauma, there was evidence that measures of limited access (e.g., more children per physician or longer wait times for surgery) were correlated with measures of morbidity (i.e., hospitalization rates for chronic conditions). In the third subcategory of sexual health, the available evidence indicated that increased access to care results in improved health outcomes. Overall, the studies reviewed herein indicate that improved access to care for the pediatric population can result in positive health outcomes for children, at least for the selected metrics of pediatric accessibility that have been examined by researchers so far.

Conclusion

In the pediatric context, only five of the many different access metrics have been examined by researchers in terms of health effects. The metrics comprise:

1. Number of children per general practitioner (GP) in an area
2. Number of special clinics per geographical area
3. Access barriers related to secondary needs (specifically, acceptability of sexual health clinics to adolescents)
4. Average waiting time for a particular service (e.g., urgent surgery)
5. Average distance to a particular service (e.g., intensive care)

Data related to B.C. pediatric populations are available only for metrics #1 and #4. The number of children per GP could be developed as an indicator of potential access to a health care resource of known importance, though the precise formulation of the underlying measure may need to be examined; for instance, the approach taken by Guttman et al. produced a quite different “order of magnitude” for physician supply. Another analytic obstacle, as noted below, is the development of cut-offs associated with what would be deemed to be under-supply. Finally, it is unlikely that pediatric surgery wait times will gain much traction as a core indicator of child health and well-being, given the relatively small number of patients

²⁸⁵ Graves BA. Integrative literature review: a review of literature related to geographical information systems, healthcare access, and health outcomes. *Perspectives in Health Information Management*. 2008; 5: 11.

involved and the even smaller proportion of urgent or even elective cases that would experience inappropriate wait times. Of the two preceding options, evaluating physician supply in reference to children would likely have the most traction as an indicator under development.

Summary Assessment					
Children per General Practitioner					
Age group (Years)	Estimated Prevalence Among B.C. Children	Magnitude	Significance/Impact	Modifiability	Data Availability/Quality
-	-	Unclear	Medium	Medium	Low

As summarized above, assessments have been applied to the Health Services Accessibility concept, specifically to a notional indicator related to physical supply relative to the pediatric population (i.e., number of children per general practitioner in a designated area, as the basis for establishing the prevalence of under-serviced children).

The **Magnitude** of the potential indicator is assessed as **Unclear**. The only way for a rate such as children per physician (or vice versa) to be translated into a magnitude figure would be to identify a cut-off for minimal physician coverage and then count up the children in under-serviced areas according to that definition; this analysis has not yet been pursued in B.C.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **Medium**. While there is limited evidence that improved access to the care offered by GPs results in positive health outcomes for children, the results focus on secondary prevention (i.e., limiting the impact of disease) rather than primary prevention, so therefore may be deemed of lesser benefit in improving overall pediatric health.

The **Modifiability** of the potential indicator is assessed as **Medium**. The rationale is that there is good evidence from health planning experience that increasing physician supply can be accomplished, but the economic costs and potential lag time are both high.

Data Availability/Validity for the potential indicator is assessed as **Low**. The reason is that an indicator of under-serviced (and, by implication, low-access) areas still needs to be developed.

The potential indicator related to physician supply is **Not Recommended** for consideration as a core indicator of child health and well-being, but it could be proposed as an area for further investigation and development. One strategic question is whether tracking pediatrician supply relative to the population of children would in fact offer a more sensitive indicator.

Antenatal Care

Background and Context

The purpose of this review is to find research evidence of an association between the concept of antenatal care and physical health and well-being of infants and children. Antenatal (or prenatal) care refers to the regular examinations that women typically receive throughout pregnancy to monitor their health, as well as fetal growth and development. Antenatal care generally involves three major components: risk assessment, risk reduction or treatment for medical conditions, and other educational manoeuvres. Clinical assessments at antenatal care visits usually include fundal height and maternal weight and blood pressure measurements, urine testing for protein and glucose, and questions about fetal movement. The educational aspect of antenatal care may involve information regarding the physiologic changes that occur during pregnancy, as well as counselling regarding proper nutrition, weight gain, exercise, breastfeeding, and genetic testing. The Society of Obstetricians and Gynaecologists of Canada recommends an antenatal visit: every 4 to 6 weeks until 30 weeks gestation; every 2 to 3 weeks until 36 weeks gestation; and then every 1 to 2 weeks until delivery.

The number, timing, and content of antenatal visits depends on the individual needs of each woman and baby. In Canada, almost all women receive some type of antenatal care; according to the Canadian Maternity Experiences Survey, all women had at least one antenatal care visit, with only 1.1% reporting 4 or fewer visits.²⁸⁶ The average number of antenatal care visits for women in Canada was 12.9, compared to 13.1 for women in British Columbia. Antenatal care in British Columbia is most commonly provided by a family physician (51.2%), followed by an obstetrician/gynaecologist (37.8%) and a midwife (9.8%).²⁸⁷

A range of health outcomes for both mother and baby have been associated with intensity of utilization of antenatal care. The effects relating to maternal mortality and morbidity are beyond the scope of this report; the other category of outcomes, related to the health of the child per se, typically includes infant mortality, low birthweight, preterm birth, and postnatal health. Antenatal education with respect to home and vehicle safety and infant care and feeding may directly result in lower incidences of infant injury and disease; some studies have also explored the more indirect impact of any association between antenatal care and pediatric health care use, including uptake of preventive measures (e.g., well-baby care, timely immunizations).²⁸⁸

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

²⁸⁶ What Mothers Say: The Canadian Maternity Experiences Survey. 2009. Available at <http://www.phac-aspc.gc.ca/rhs-ssg/pdf/survey-eng.pdf>. Accessed October 2010.

²⁸⁷ Data Tables – The Canadian Maternity Experiences Survey 2006-2007. Available at <http://www.phac-aspc.gc.ca/rhs-ssg/pdf/tab-eng.pdf>. Accessed October 2010.

²⁸⁸ Alexander GR, Kotelchuck M. Assessing the role and effectiveness of prenatal care: history, challenges, and directions for future research. *Public Health Reports*. 2001; 116(4): 306-16.

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

(Prenatal care **OR** antenatal care) **AND** children **AND** health

The search for review articles returned a sufficient volume (see below) of papers to qualify for a Level A search process; however, after the exclusion process was followed (as outlined below), no pertinent reviews remained. It was then determined that a Level B search process was required, focusing on studies and using similar search terms but adjusting the limits as follows:

Date: 2000-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Randomized controlled trial, Clinical trial, Controlled clinical trial

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

In addition to the above search method, the following searches were conducted:

- PubMed search using “Related citations” link
- A scan in Google for grey literature and for any obvious articles missed, using terms such as: (**prenatal care OR antenatal care**) **AND children AND health**
- Hand-searching bibliographies of key papers
- Checking for study updates (by author)

Taken together, the search processes returned 251 articles for consideration.

Preliminary Exclusion

The articles were scanned *by title*, with those not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between antenatal care and physical health outcome(s), then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 22.

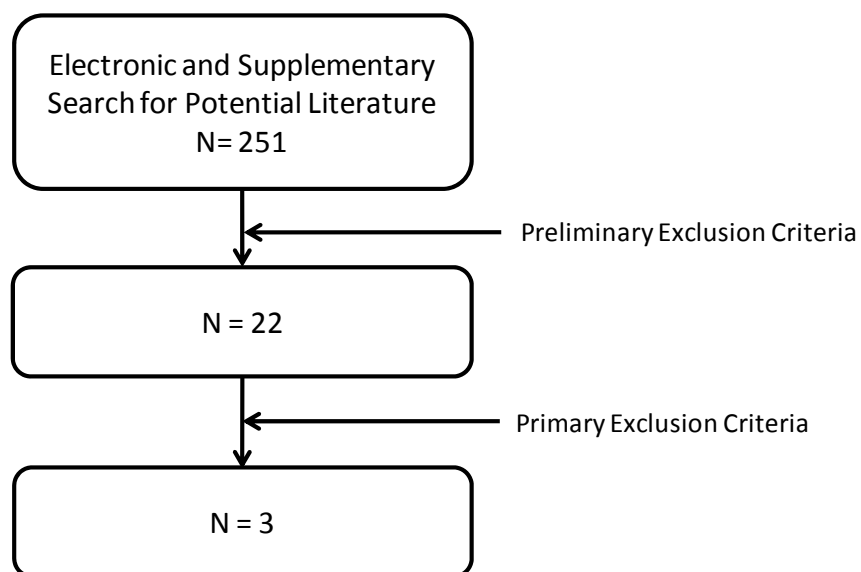
Primary Exclusion

The abstracts and/or full versions of the 22 articles were then reviewed. Articles not pertinent to the research topic were excluded; specifically, if the article did not link antenatal care with physical health outcome(s), it was excluded.

There were 3 studies remaining in the list following the primary exclusion; a secondary exclusion step was not deemed to be necessary.

Literature Review Volume Report: Individual Studies

Dimension: Physical Health **Concept:** Antenatal Care



Summary of Relevant Studies

Dimension: *Physical Health*

Concept: *Antenatal Care*

	Title of Study	Lead Author	Year	Journal	Journal Impact Factor (2005)	Type of Study	Sample Size	Sample Population	Location	Conflict of Interest
1	Inadequate prenatal care and its association with adverse pregnancy outcomes: A comparison of indices	Heaman	2008	BMC Pregnancy and Childbirth	1.72 (2009)	Population-based cohort study	80,989	Women having a hospital-based singleton live birth	Manitoba, Canada	Not Available
2	Group Prenatal Care and Perinatal Outcomes	Ickovics	2007	Obstetrics & Gynecology	4.17	Randomized Controlled Trial	1,047	Pregnant women aged 14-25 years	Connecticut, USA	Not Available
3	The impact of prenatal care on neonatal deaths in the presence and absence of antenatal high-risk conditions	Vintzileos	2002	American Journal of Obstetrics and Gynecology	3.08	Population-based cohort study	10,530,608	Singleton live births 1995-1997	USA	Not Available

Detailed Results

For the 3 studies identified through the literature search and exclusion process, a summary table was developed, as provided below.

Dimension: <i>Physical Health Concept: Antenatal Care</i>							
Summary Table of Studies							
Lead Author (Year)	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
Heaman (2008)	Determine rates of prenatal care utilization; compare two indices of prenatal care utilization; determine the association between inadequate prenatal care and adverse pregnancy outcomes, using each of the indices; and assess whether or not, and to what extent, gestational age modifies this association.	Data sources consisted of a linked mother-baby database and a physician claims file maintained by Manitoba Health. Rates of inadequate prenatal care were calculated using two indices, the R-GINDEX and the APNCU.	Winnipeg, Manitoba N=80,989 hospital-based singleton live births from 1991 to 2000	Population-based cohort study	-rate of inadequate/no prenatal care by maternal age and parity	-rates of inadequate or no prenatal care ranged from 8.3% using APNCU to 8.9% using R-GINDEX -association between inadequate prenatal care and preterm birth and LBW ranged from 1.0 to 1.3 (adjusted odds ratio, or AOR), depending on the index used -both indices had the same strength of association of inadequate prenatal care with small-for-gestational-age (AOR 1.4)	The two indices of prenatal care utilization compared in this study reveal different patterns of prenatal care, and should not be used interchangeably.
Ickovics et al. (2007)	Determine whether group prenatal care improves pregnancy outcomes, psychosocial function, and patient satisfaction; examine potential cost differences	Conducted at two university-affiliated hospital prenatal clinics. Group participants received care in a group setting with women having the same expected delivery month.	New Haven, Connecticut and Atlanta, Georgia USA N=1,047 pregnant women aged 14-25 years	Randomized controlled trial -structured interviews at study entry, during 3 rd trimester, and postpartum	-gestational age at delivery (term vs. preterm = less than 37 weeks) -infant birth weight (normal vs. low = less than 2500 g) -adequacy of prenatal care measured using Kotelchuck Index -Apgar scores at 5 min. -breastfeeding initiation	-women assigned to group care were significantly less likely to have preterm births compared with those in standard care: 9.8% vs. 13.8% -effects were strengthened for African American women: 10.0% compared to 15.8% -there were no differences in birth weight or in costs associated with prenatal care or delivery	Group prenatal care resulted in equal or improved perinatal outcomes at no added cost
Vintzileos (2002)	Determine the association between prenatal care and the neonatal death rate in the presence and	Data derived from the national perinatal mortality data sets for the years 1995 - 1997	USA N=10,530,608 singleton live births	Population-based cohort study	-presence of prenatal care (at least 1 prenatal visit during the course of pregnancy) -rates of neonatal death	-lack of prenatal care increased the relative risk for neonatal death 1.4-fold in African American patients and 1.5-fold in white patients	Prenatal care is associated with fewer neonatal deaths in black and white infants. This beneficial effect

Dimension: *Physical Health* Concept: *Antenatal Care*
Summary Table of Studies

Lead Author (Year)	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/Comments
	absence of antenatal high-risk conditions				(deaths during the first 27 days of life per 1000 live births)	-lack of prenatal care was also associated with increased relative risk for neonatal death among infants born at 24 to 35 weeks; the greatest impact was observed for those infants delivered at ≥ 36 weeks of gestation, where lack of prenatal care was associated with a 2.1-fold increase in neonatal death rate.	was more pronounced for births that occurred at ≥ 36 weeks of gestation

Bibliography for Table of Studies

Heaman MI, Newburn-Cook CV, Green CG et al. Inadequate prenatal care and its association with adverse pregnancy outcomes: a comparison of indices. *BMC Pregnancy and Childbirth*. 2008; 8: 15.

Ickovics JR, Kershaw TS, Westdahl C et al. Group prenatal care and perinatal outcomes: a randomized controlled trial. *Obstetrics & Gynecology*. 2007; 110(2 Pt 1): 330-9.

Vintzileos AM, Ananth CV, Smulian JC et al. The impact of prenatal care on neonatal deaths in the presence and absence of antenatal high-risk conditions. *American Journal of Obstetrics & Gynecology*. 2002; 186(5): 1011-6.

Summary of Results

The study by Heaman et al. compares two indices of antenatal or prenatal care utilization, both of which use the month that care begins and the total number of visits (adjusted by gestational age at delivery) to assign women to categories such as *inadequate*, *intermediate*, *adequate*, and *intensive* prenatal care. The authors reported an association between inadequate antenatal care and preterm birth, low birthweight, and small-for-gestational-age. Ickovics et al. compared group prenatal care with standard care and found that women were significantly less likely to have preterm births if they had participated in group antenatal care. In the third study, Vintzileos reported an association between antenatal care and fewer neonatal deaths.

Data Sources for Antenatal Care

A major source for information regarding antenatal care in Canada is the Maternity Experiences Survey (MES).²⁸⁹ It is a national survey of women's experiences, perceptions, knowledge, and practices before conception and during pregnancy, birth, and the early months of parenthood. The survey was conducted in 2006; it is not clear whether it will be repeated. The MES population consisted of birth mothers 15 years of age and older who had a singleton live birth in Canada during a three-month period preceding the 2006 Census and who lived with their infant at the time of data collection. From a stratified random sample of women deemed to be eligible, 6,421 completed an interview at 5 to 14 months after the birth of their baby. Interviews were administered by female Statistics Canada staff on behalf of the Public Health Agency of Canada. Province- and territory-specific data are available for metrics such as type of antenatal care provider, number of antenatal care visits, timing of the first antenatal or prenatal visit, and whether care could be obtained as early as women preferred.

Discussion

There is a limited volume of evidence in the literature for associations between antenatal care and birth outcomes, but the studies that were located did point to the potential importance of such care for the health of the child. The three studies reviewed herein report positive birth outcomes in association with different types/levels of antenatal care utilization. It should be noted that the broad objectives of antenatal care involve promoting the health and well-being of the pregnant woman, the fetus, the infant, and the family for up to one year after birth. In other words, antenatal care can be beneficial beyond the strict sphere of improving infant and child health.

Although there are indicators available to measure antenatal care in British Columbia, there is little evidence that these specific metrics are associated with the physical health of children. Further studies are needed on the effectiveness of antenatal care before appropriate indicators of child physical health may be selected in this area. On the other hand, uptake of antenatal or prenatal care services appears to already be very high in Canada; thus, while a few studies have observed a detrimental effect of inadequate antenatal care, this is not generally a concern in Canada, thereby limiting the "prevention traction" of the antenatal care concept and any related indicator.

²⁸⁹ What Mothers Say: The Canadian Maternity Experiences Survey. 2009. Available at <http://www.phac-aspc.gc.ca/rhs-ssg/pdf/survey-eng.pdf>. Accessed October 2010.

Conclusion

Antenatal care as an indicator of child health and well-being has low utility due in part to the limited volume of evidence for an association between these two areas, but mostly to the relatively low magnitude of children affected and a lack of routine data. While there have occasionally been data available in Canada for measures of antenatal care, there have not been sufficient studies conducted to clearly determine the differential effectiveness of the various intensities of utilization; even less effort has been directed toward assessing the quality of antenatal care delivered, a factor that can influence the receipt and effectiveness of care, and therefore the potential value of antenatal care for children at the population health level.

Summary Assessment					
Children Born to Mothers with Four or Fewer Physician Visits for Antenatal Care					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	10,700	Low	Medium	Medium	Low

As summarized above, assessments have been applied to the Antenatal Care concept, specifically in terms of the indicator with the most compelling support in the literature, namely, *children born to mothers accessing four or fewer physician visits during pregnancy*.

The pediatric population **Magnitude** of the potential indicator is assessed as **Low**. Based on the Canadian Maternity Experiences Survey, 1.1% of mothers attend four or fewer doctor visits during pregnancy. Applying this percentage across the entire pediatric cohort results in a prevalence estimate of 10,700 children potentially affected. This is less than 2% of the total pediatric cohort (19,000), resulting in a Magnitude classification of Low.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **Medium**. There is limited evidence for an association between antenatal care and the health and well-being of the child involved, especially when focusing on the specific indicator of interest (e.g., frequency of care).

The **Modifiability** of the potential indicator is assessed as **Medium**. The reasons relate to the complexity and cost of reaching and changing behaviour within vulnerable populations of mothers and/or enhancing the pattern of care being offered by the health system.

Data Availability/Validity for the potential indicator is assessed as **Low**. The Maternal Experiences Survey of 2006 does provide self-reported data on antenatal care; however, it is not clear whether this survey will be repeated on a regular basis.

The potential indicator of low access to antenatal care is **Not Recommended** for consideration as a core indicator of child health and well-being. The rationale is simply the low-to-medium rating across all assessment categories.

Birth Weight

Background and Context

The purpose of this review is to find research evidence of an association between the concept of birth weight and pediatric health. For this concept, there are both absolute measures - low birth weight (LBW) and high birth weight (HBW) - and relative measures (small- and large-for-gestational- age).

LBW, defined as $< 2,500$ g, is utilized around the world as an indicator of the health status of newborns and as a predictor of health outcomes in later life. In Canada, the rate of LBW infants increased from 5.6% of in-hospital births in 2001 to 6.0% in 2005; since then, the rate has been relatively stable.²⁹⁰ Increases in the rate of LBW in Canada may be explained by high maternal age, multiple births, the use of assisted reproductive technologies, and smaller maternal stature; in Canada, the proportion of births in each of these categories has indeed increased.

HBW, defined as $\geq 4,500$ g, is also associated with adverse health outcomes for the infants (see below); in addition, maternal weight gains during pregnancy and maternal pre-pregnancy body mass index have both been identified as predictors of HBW. In the Aboriginal population, infants born at high birth weight increased from 17.8% in 1997/98 to 21% in 2002/03. Experts believe that this increase is mainly due to the high prevalence of gestational diabetes among pregnant women in this subpopulation.²⁹¹

The two relative measures - small-for-gestational-age (SGA) and large-for-gestational-age (LGA) - are defined by Statistics Canada as live births involving a birth weight less than the 10th percentile (SGA) or higher than the 90th percentile (LGA) of birth weights of the same sex and the same gestational age in weeks; the fact that these measures are calculated in reference to a cohort of births (rather than an absolute cut-off) is the reason they are characterized as “relative.” The related indicators are usually reported in terms of a percentage of the total cohort born between 22 to 43 weeks in either the small or large category. Tracking these infants is important because of some evidence of health effects, albeit more limited than for the traditional LBW and HBW measures. For instance, children born LGA can experience obstetrical complications, including shoulder and associated brachial plexus injury, perinatal asphyxia, meconium aspiration, hypoglycaemia, and fetal death.²⁹² Long-term risks include obesity, diabetes, and high blood pressure later in life.^{293,294,295} In addition, high birth weight has also been associated with increased future risk of cancer such as leukemia.^{296,297}

²⁹⁰ *Giving Birth in Canada: Regional Trends from 2001-2002 to 2005-2006*. 2007. Canadian Institute for Health Information. Available at

http://secure.cihi.ca/cihiweb/disPage.jsp?cw_page=PG_1412_E&cw_topic=1412&cw_rel=AR_1106_E. Accessed September 2010.

²⁹¹ UNICEF Canada. *Aboriginal Children's Health: Leaving No Child Behind*. 2009. Available at <http://www.unicef.ca/portal/SmartDefault.aspx?at=2063>. Accessed February 2011.

²⁹² Boulet SL, Alexander GR, Salihu HM et al. Macrosomic births in the united states: determinants, outcomes, and proposed grades of risk. *American journal of obstetrics and gynecology*. 2003; 188(5): 1372-8.

²⁹³ Harder T, Roepke K, Diller N et al. Birth weight, early weight gain, and subsequent risk of type 1 diabetes: systematic review and meta-analysis. *American Journal of Epidemiology*. 2009; 169(12): 1428-36.

²⁹⁴ Oldroyd J, Renzaho A, Skouteris H. Low and high birth weight as risk factors for obesity among 4 to 5-year-old Australian children: does gender matter? *European journal of pediatrics*. 2010;

²⁹⁵ Hemachandra AH, Howards PP, Furth SL et al. Birth weight, postnatal growth, and risk for high blood pressure at 7 years of age: results from the Collaborative Perinatal Project. *Pediatrics*. 2007; 119(6): e1264-70.

²⁹⁶ Schuz J, Forman MR. Birthweight by gestational age and childhood cancer. *Cancer Causes & Control*. 2007; 18(6): 655-63.

The biggest analytic challenge is that the definitions of SGA (and the parallel versions for LGA) vary widely in the literature.²⁹⁸ Some studies define SGA in terms of stature or length rather than birth weight, and the cut-off is sometimes the 3rd, 5th, or another percentile than the 10th. As the current Canadian definition is generally not the same as those used to generate evidence in the literature, it is not possible to conclude that monitoring the indicator as conceived in Canada will be associated with the same effect on child health and well-being.

Partly due to the heterogeneity of the size or weight measures related to gestational age, SGA and LGA have not supplanted LBW or HBW as the dominant guiders of public health surveillance and prevention programming. Working with an absolute cut-off, as in the measure for LBW, is certainly more straightforward, since any effects observed empirically can be more generalizable at the population level.

There are a wide variety of physical and mental health outcomes associated with LBW and/or HBW, including impaired growth and development and increased risk of chronic diseases such as heart disease and adult-onset diabetes. In extreme cases, infant mortality may occur. A major “cause” of LBW is intrauterine growth restriction (IUGR), which could be interpreted, by definition, as virtually a synonym for LBW. The condition of IUGR, where a fetus does not reach its genetically-determined potential size, can be caused by a variety of maternal risk factors (essentially overlapping with the factors listed for LBW), as well as congenital or chromosomal defects, infections during pregnancy, and placental or umbilical abnormalities. While there is substantial research interest in the adult effects of fetal growth restriction and other abnormal intrauterine phenomenon, most of the proposed associations remain at an investigational stage; this area of study is commonly referred to as the “developmental origins of health and disease hypothesis.”²⁹⁹

LBW is also an important marker of population health disparities, since the condition occurs more frequently in disadvantaged groups. Specific predictors of LBW include low socioeconomic status, poor maternal nutrition and/or smoking while pregnant, consumption of drugs and alcohol while pregnant, overall maternal health, experiencing abuse while pregnant, and both low and high maternal age. Clearly, there is a strong overlap between the sub-concept and teenage pregnancy, the primary prevention aspects of antenatal care, and pregnancy outreach services and targets (see the relevant sections of the report on these concepts).

Conceptual Scoping

A final obvious predictor of LBW is preterm birth. This introduces a complicating factor, since being preterm has its own consequences apart from weight/size, and in fact being small when born early may not be that much of a concern; evaluating how small is “small” is best handled through the relative “gestational age” measures introduced above. In British Columbia in 2009, 70% of LBW infants were born preterm.³⁰⁰ As already suggested, this subset is not the main focus when investigating the concept of LBW. Preterm births are associated with a different set of predictors, as well as unique health outcomes compared to

²⁹⁷ Caughey RW, Michels KB. Birth weight and childhood leukemia: a meta-analysis and review of the current evidence. *International Journal of Cancer*. 2009; 124(11): 2658-70.

²⁹⁸ Saenger P, Czernichow P, Hughes I et al. Small for gestational age: short stature and beyond. *Endocrine Reviews*. 2007; 28(2): 219-51.

²⁹⁹ Krechowec S, Thompson N, Breier B. Fetal growth restriction and the development origins of adult disease hypothesis. *Pediatric and Adolescent Medicine*. 2009; 13: 26-43.

³⁰⁰ Vital Statistics Agency. *Selected Vital Statistics and Health Status Indicators*. 2010. Available at <http://www.vs.gov.bc.ca/stats/annual/2009/index.html>. Accessed February 2011.

the broader category of LBW; arguably, the category of preterm birth could have its own value as a concept/ indicator, though it was not assigned as part of the work for the present project.

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

Electronic Search Keywords

("Birth Weight" [Majr] OR "Infant, Low Birth Weight" [Majr]) **AND**

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Overweight"[Mesh] OR "Thinness"[Mesh])

Note that, in order to provide as targeted a search as possible, Medical Subject Headings (MeSH) were applied, qualified by subheadings and whether or not it was a Major term (Majr) for the article. It is also important to mention that small-for-gestational-age is automatically captured under the term "low birth weight" in MeSH, and that all versions of high birth weight are included under one of the "birth weight" subcategories, specifically, "fetal macrosomia."

The search for review articles ultimately returned a sufficient volume (see below) of papers to qualify for a Level A search process. As well, a selective approach to the supplementary search was deemed to be all that was necessary. This involved a scan in Google for grey literature and for any obvious articles missed, using terms such as: **(low birth weight OR small-for-gestational-age) AND children AND health**. Finally, as the most recent systematic review of the association of physical activity with health was dated 2010, and included primary studies as recent as 2008, an update covering the most recent studies was not pursued.

Taken together, the search processes returned 150 review papers for consideration.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between birth weight and physical health outcome(s), then it was excluded. Additionally, articles about low birth weight as an epiphenomenon of preterm birth were excluded, as preterm birth is a separate category with a different epidemiological profile that introduces confounding factors.

After completing this first exclusion process, the list of articles was reduced to 45.

Primary Exclusion

The abstracts and/or full versions of the 45 articles were then reviewed. Articles not pertinent to the research topic were excluded; specifically, if the article did not link birth weight with physical health outcome(s), it was excluded. Also excluded was any review that focused on preterm infants, instead of small-for-gestational age or high/low birth weight infants as a general category.

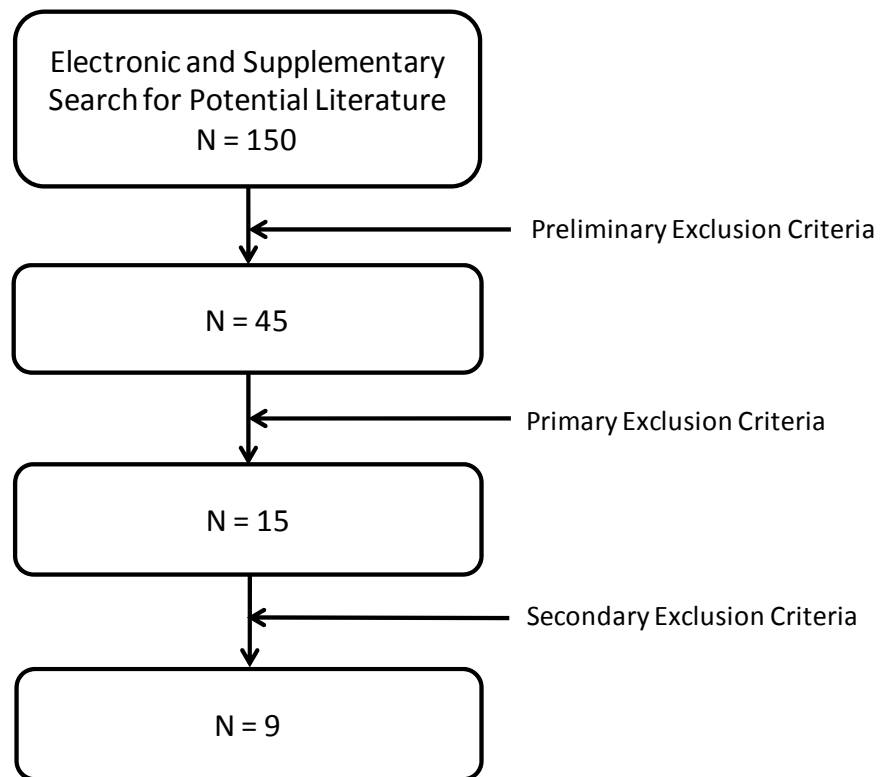
There were 15 reviews remaining in the list following the primary exclusion.

Secondary Exclusion

Upon closer examination of the methodology of papers, reviews that were not systematic, or systematic reviews that were deemed to be of lesser quality or usefulness, were excluded. This yielded a final total of 9 reviews, as indicated in the following Volume Report. The list of review papers is then provided in the table that follows.

Literature Review Volume Report: Reviews

Dimension: Physical Health **Concept:** Birth Weight



Summary of Relevant Reviews

Dimension: *Physical Health*

Concept: *Birth Weight*

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	Number of Studies Reviewed
1	Birth weight and risk of neuroblastoma: a meta-analysis	Harder	2010	International Journal of Epidemiology	4.05	1985-2008	11
2	Motor development in very preterm and very low-birth-weight children from birth to adolescence	de Kieviet	2009	Journal of the American Medical Association	23.33	1995-2009	41
3	Birth weight, early weight gain, and subsequent risk of Type 1 Diabetes: Systematic review and meta-analysis	Harder	2009	American Journal of Epidemiology	5.07	1992-2007	11
4	Is low birth weight an antecedent of CKD in later life? A systematic review of observational studies	White	2009	American Journal of Kidney Diseases	4.41	1992-2008	30
5	Birth weight and subsequent risk of childhood primary brain tumors: A meta-analysis	Harder	2008	American Journal of Epidemiology	5.07	1991-2003	8
6	Birth weight and the risk of testicular cancer: A meta-analysis	Michos	2007	International Journal of Cancer	4.7	1983-2004	13
7	Quality of life of formerly preterm and very low birth weight infants from preschool age to adulthood: A systematic review	Zwicker	2007	Pediatrics	4.27	1994-2006	15
8	Is birth weight a risk factor for ischemic heart disease in later life?	Huxley	2007	American Journal of Clinical Nutrition	5.85	1993-2005	17
9	Fetal origins of adult disease	Morley	2006	Seminars in Fetal & Neonatal Medicine	2.74 (2009)	1996-2005	10

Detailed Results

For the 9 reviews remaining after the literature search and exclusion process, a summary table of results was developed, as follows.

Dimension: <i>Physical Health</i> Concept: <i>Birth Weight</i> Summary Table of Reviews			
Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Harder (2010)	Birth weight and risk of neuroblastoma: a meta-analysis	11	Elevated birth weight is associated (to a high degree of reproducibility) with increased risk of neuroblastoma. The association with low birth weight was less robust, and deserves further study.
de Kieviet (2009)	Motor development in very preterm and very low-birth-weight children from birth to adolescence	41	Being born with very low-birth-weight (or preterm) is associated with significant motor impairment persisting throughout childhood.
Harder (2009)	Birth weight, early weight gain, and subsequent risk of Type 1 Diabetes: Systematic review and meta-analysis	11	High birth weight is significantly associated with an increased risk of developing type 1 diabetes in later life. Rapid weight gain during the first year of life is also associated with later type 1 diabetes, though there are limited studies reporting this phenomenon.
White (2009)	Is low birth weight an antecedent of CKD in later life? A systematic review of observational studies	30	Individuals with low birth weight have a 70% greater risk of developing chronic kidney disease (CKD) in later life.
Harder (2008)	Birth weight and subsequent risk of childhood primary brain tumors: A meta-analysis	8	Birth weight is related to the development of childhood brain tumours; in particular, high birth weight appears to be a risk factor for the two most common types of brain tumours.
Michos (2007)	Birth weight and the risk of testicular cancer: A meta-analysis	13	A U-shaped association was observed between birth weight and the risk for testicular cancer; men born with low and high birth weight were at a marginally higher risk for developing testicular cancer than men born with normal birth weight.
Zwicker (2007)	Quality of life of formerly preterm and very low birth weight infants from preschool age to adulthood: A systematic review	15	Preterm birth and/or very low birth weight demonstrate an effect on health-related quality of life at various age groups. The impact of low birth weight (and gestational age) is greatest during the younger years, but the influence does extend into adolescence and adulthood.
Huxley (2007)	Is birth weight a risk factor for ischemic heart disease in later life?	17	There is an inverse association between size at birth and the subsequent development of ischemic heart disease, with a 10-20% lower risk observed per 1 kg higher birth weight.
Morley (2006)	Fetal origins of adult disease	10	Regarding adult disease risk in relation to birth weight, there is evidence for an inverse association with hypertension, adult-onset diabetes, coronary heart disease, and stroke.

Bibliography for Table of Reviews

- Harder T, Plagemann A and Harder A. Birth weight and risk of neuroblastoma: a meta-analysis. *International Journal of Epidemiology*. 2010; 39(3): 746-56.
- de Kieviet JF, Piek JP, Aarnoudse-Moens CS et al. Motor development in very preterm and very low-birth-weight children from birth to adolescence: a meta-analysis. *Journal of the American Medical Association*. 2009; 302(20): 2235-42.
- Harder T, Roepke K, Diller N et al. Birth weight, early weight gain, and subsequent risk of type 1 diabetes: systematic review and meta-analysis. *American Journal of Epidemiology*. 2009; 169(12): 1428-36.
- White SL, Perkovic V, Cass A et al. Is low birth weight an antecedent of CKD in later life? A systematic review of observational studies. *American Journal of Kidney Diseases*. 2009; 54(2): 248-61.
- Harder T, Plagemann A and Harder A. Birth weight and subsequent risk of childhood primary brain tumors: a meta-analysis. *American Journal of Epidemiology*. 2008; 168(4): 366-73.
- Michos A, Xue F and Michels KB. Birth weight and the risk of testicular cancer: a meta-analysis. *International Journal of Cancer*. 2007; 121(5): 1123-31.
- Zwicker JG and Harris SR. Quality of life of formerly preterm and very low birth weight infants from preschool age to adulthood: a systematic review. *Pediatrics*. 2008; 121(2): e366-76.
- Huxley R, Owen CG, Whincup PH et al. Is birth weight a risk factor for ischemic heart disease in later life? *American Journal of Clinical Nutrition*. 2007; 85(5): 1244-50.
- Morley R. Fetal origins of adult disease. *Seminars in Fetal & Neonatal Medicine*. 2006; 11(2): 73-8.

Summary of Results

Of the 9 reviews selected for this report, there was just one that covered a variety of health outcomes in relation to birth weight; the 2006 narrative review by Morley included selected, larger studies and other reviews of the evidence for the association of birth weight with adult disease risk. There is an indication in the literature of elevated risk for hypertension and adult-onset diabetes with LBW. As well, evidence points to a protective effect of increasing birth weight, that is, where there is progression away from a condition of LBW; in particular, the studies showed a reduced risk of coronary heart disease and stroke.

Various specific types of health outcome are the focus in the remaining eight reviews. In the category of LBW, White et al. report that individuals with LBW have a 70% greater risk of developing chronic kidney disease in later life. A meta-analysis found that both LBW and HBW in men result in marginally increased risk of testicular cancer. There were two reviews that focused on very-low-birth-weight children (≤ 1500 g); they reported that significant motor impairment and reduced quality of life occurred in this cohort, affecting subgroups ranging from preschool-aged children to those up the age of 15 years. Huxley et al. reviewed birth weight as a risk factor for ischemic heart disease in later life, and concluded that there is a 10-20% lower risk per 1 kg increase in birth weight.

An important caveat pertains to the summaries offered by Morley and Huxley, namely, that there may be an upper limit to the health-improving increases in birth weight. Three reviews, all with Harder as lead, found an association between HBW and adverse health outcomes in the realm of metabolism and cancer. They reported that HBW is a risk factor for type 1 diabetes, for the two most common types of brain tumours, and for neuroblastoma (the most common malignancy in infancy).

Data Sources on Birth Weight

Annual birth weight data are available for B.C. through a Vital Statistics database. The most recent release was for 2009. The available information allows for stratification of live births based on birth weight and relationship to accepted definitions of a “term” birth. This is important, because the subset of low or high birth weight of greatest interest as a public health driver includes precisely those births occurring within a normal term; in other words, as discussed earlier, a low birth weight for a preterm (also known as a premature infant) is of course expected, and only of interest from a health risk perspective if it also may be characterized (by one definition or another) as SGA. With these qualifications in mind, the most recent data on LBW and HBW in British Columbia are found in the following table.

Live Births in British Columbia, 2009		
Classified by Birth Weight and Preterm/Term		
	#	% of Total Births
Low Birth Weight*		
Preterm †	1,818	4.0%
Term	681	1.5%
Normal Birth Weight*		
Preterm †	1,523	3.4%
Term	39,911	88.9%
High Birth Weight*		
Preterm †	2	0.0%
Term	920	2.0%
Not Stated	53	0.1%
Total	44,908	100.0%
* Birth weight classifications are: Low Birth Weight (<2,500 g), Normal Birth Weight (2,500 - 4,499 g), High Birth Weight (≥4,500 g). (Statistics Canada definition).		
† Preterm birth is defined as birth at < 37 weeks gestation. (Statistics Canada definition).		
Source: B.C. Vital Statistics Agency, Selected Vital Statistics		

Other data available annually from the Vital Statistics source include incidence of SGA and LGA, but these are not the measures being adopted for this concept.

Discussion

LBW is commonly considered a main determinant of infant morbidity and mortality; it is used globally as an indicator of both pediatric and general population health. The review papers identified for this report did not discuss the effect of birth weight on infant mortality; much of the published evidence for this association is older, lying outside the date range specified for the present project. Nonetheless, it is useful to note the conclusion of reviewer Ashdown-Lambert, who stated that “there is compelling evidence at global, national and local levels that indicates substantial increased risk to infant health because of multiple morbidity and earlier mortality where LBW is a precursor [emphasis added].”³⁰¹

Whatever the mortality implications, the review papers discussed herein do present strong evidence for an association between LBW/HBW and morbidity, specifically with respect to impaired function and quality of life in childhood and increased risk of chronic diseases later in life. It should be noted that, in the case of later disease onset, theories of causation are made complicated by a variety of socioeconomic and behavioural factors associated with LBW; thus, while many adverse health outcomes appear to be associated with LBW, a causal pathway is difficult to confirm or elucidate. However, the possible confounding effects do not automatically negate the utility of birth weight as an indicator of child physical health. If the policy-level or more direct behavioural interventions (such as improved nutrition) that can change the rate of LBW *also* operate in the family after the child is born (and thereby produce positive health effects in that individual), then LBW becomes a type of proxy indicator for other population-level improvements in child well-being. In fact, this is the very function that the measure of LBW serves around the world.

³⁰¹ Ashdown-Lambert JR. A review of low birth weight: predictors, precursors and morbidity outcomes. *Journal of the Royal Society for the Promotion of Health*. 2005; 125(2): 76-83.

A fuller discussion of the concept of birth weight would require moving beyond physical health concerns. In reality, any incentive to focus on LBW in particular as an indicator perhaps should be more related to sub-dimensions such as cognitive delay, speech delay, and behavioural problems in preschool years.³⁰² Finally, a counterargument for the utility of tracking LBW is the fact that the evidence for the modifiability of LBW at a population level actually remains equivocal.³⁰³

The observed linkage between HBW and certain pediatric cancers may provide even more robust support for the value of tracking this aspect of birth weight. However, its significance for the present discussion is muted by the rarity of the implicated cancers; for example, pediatric brain cancers occur in only three and neuroblastoma in one out of 100,000 children.^{304,305}

Conclusion

There is strong research evidence indicating that a range of adverse physical health outcomes are associated with high and low birth weight. There is also a range of known etiologies and socioeconomic and maternal risk factors for LBW in particular. Despite the potential confounding factors, LBW may be deemed a “strong indicator of the existence of many complex health and social problems worldwide”³⁰⁶ and thus as an appropriate (albeit indirect) monitor of the health effects of new policies or interventions that are designed to impact a family before and after birth. Helpfully, there are current and relevant birth weight data available from Vital Statistics for British Columbia; however, the rationale for use of a birth weight indicator is somewhat weakened by the relatively low baseline percentage of live births in a risky weight range.

³⁰² Ashdown-Lambert JR. A review of low birth weight: predictors, precursors and morbidity outcomes. *Journal of the Royal Society for the Promotion of Health*. 2005; 125(2): 76-83.

³⁰³ Morley R. Fetal origins of adult disease. *Seminars in Fetal & Neonatal Medicine*. 2006; 11(2): 73-8.

³⁰⁴ Bunin G. What causes childhood brain tumors? Limited knowledge, many clues. *Pediatric Neurosurgery*. 2000; 32(6): 321-6.

³⁰⁵ Stiller CA, Parkin DM. International variations in the incidence of neuroblastoma. *International Journal of Cancer*. 1992; 52(4): 538-43.

³⁰⁶ Ashdown-Lambert JR. A review of low birth weight: predictors, precursors and morbidity outcomes. *Journal of the Royal Society for the Promotion of Health*. 2005; 125(2): 76-83.

Summary Assessment					
Low or High Birth Weight (at Term)					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	34,600	Medium	High	Medium	High

As summarized above, assessments have been applied to the Birth Weight concept, specifically in terms of the indicator with the most compelling support in the literature, namely, *the proportion of children born at term with low and high birth weight*. The reasons for less momentum around alternate measures such as SGA and LGA are provided in the Background and Context subsection above.

The pediatric population **Magnitude** of the potential indicator is assessed as **Medium**. In 2009 1.5% and 2.0% of live births in B.C. were low and high birth weight, respectively, excluding those that were preterm. Applying these percentages to the current pediatric cohort yields an estimate of 14,700 children who were born at low birth weight, and 19,900 children who were born at high birth weight over one generation. The combined estimated prevalence is then 34,600 individuals. The resulting estimate is between 2 and 10% (19,000 and 97,000) of the total pediatric cohort, resulting in a Magnitude classification of Medium.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **High**. There is strong evidence that both low and high birth weight is associated with adverse outcomes related to child health and well-being.

The **Modifiability** of the potential indicator is assessed as **Medium**. The risk factors contributing to low or high birth weight at term are theoretically amenable to prevention, but the trend of increasing prevalence of low birth weight in recent times suggests that it is a challenging area in which to pursue improvements.

Data Availability/Validity for the potential indicator is assessed as **High**. The pertinent information is available from B.C. Vital Statistics on an annual basis.

The potential indicator is **Recommended** for consideration as a core indicator of child health and well-being. The combination of routinely available, reliable data, and strong evidence that both low and high birth weight are associated with adverse health outcomes in children makes this a strong candidate for selection as a core indicator in the province.

Pregnancy Outreach Services and Targets, Including FASD

Background and Context

Outreach services for pregnant women and for the postpartum phase comprise a range of programs, such as prenatal classes, group support, referrals to community resources, and health information and counselling; consistent with the goal of “outreach,” the services are usually targeted at high-risk pregnant women, such as low-income families, teenagers, and substance abusers. The purpose of this review is to focus on several pregnancy health issues that are normally addressed in the counselling offered through outreach service agencies and that are of particular concern with regard to child health: these include maternal smoking and maternal exposure to environmental tobacco smoke, using street drugs, and alcohol consumption during pregnancy. The latter topic naturally fits with another of the concepts assigned in this part of the project, namely, Fetal Alcohol Spectrum Disorder.

While it could have been categorized under another concept (e.g., tobacco use, environmental exposures, or even antenatal care), it was convenient to also handle the subtopic of environmental tobacco smoke (ETS) in this part of the report, where the focus is on *the impacts that adult behaviours have on child health*. One argument to include ETS at this point is the fact that the momentum and strategy behind prenatal interventions to avoid fetal exposure to tobacco smoke are similar to those that may be applied in family settings where pediatric exposure becomes the focus of concern; thus, for example, ETS is quite distinct from other classic environmental pollutants where the agent is typically not an individual caregiver. The main venues of prevention interest with respect to ETS and children have been the home and private motor vehicles; in fact, legislation has been passed in some jurisdictions making it an offence to smoke while transporting children in an automobile.³⁰⁷ Different pediatric health concerns have been raised in reference to ETS and intensive child exposures in family contexts; the potential effects include asthma, reduced lung function, and thyroid-associated ophthalmopathy.^{308,309}

Tobacco use leading to fetal exposures is considered the single most important modifiable cause of adverse pregnancy outcomes. Maternal cigarette smoking has been associated with intrauterine growth restriction, preterm birth, spontaneous abortion, stillbirth, sudden infant death syndrome, childhood obesity, childhood respiratory diseases, and various neurobehavioural effects on the child.^{310,311} Exposure of pregnant women to environmental tobacco smoke, or secondhand smoke, is also linked with adverse birth outcomes such as low birthweight and preterm birth.³¹²

In 2000-2001, 17.7% of Canadian women who reported giving birth in the previous 5 years reported smoking during their pregnancy, compared with 13.4% in 2005.³¹³ According to another source, 8.5% of mothers in British Columbia surveyed in 2006-2007 reported smoking during the last three months of pregnancy (combining daily and occasional

³⁰⁷ Jarvie JA, Malone RE. Children's secondhand smoke exposure in private homes and cars: an ethical analysis. *American Journal of Public Health*. 2008; 98(12): 2140-5.

³⁰⁸ Carlsen KH, Lodrup Carlsen KC. Parental smoking and childhood asthma: clinical implications. *Treatments in Respiratory Medicine*. 2005; 4(5): 337-46.

³⁰⁹ Krassas GE, Perros P. Prevention of thyroid associated-ophthalmopathy in children and adults: current views and management of preventable risk factors. *Pediatric Endocrinology Reviews*. 2007; 4(3): 218-24.

³¹⁰ Rogers JM. Tobacco and pregnancy. *Reproductive Toxicology*. 2009; 28(2): 152-60.

³¹¹ Canadian Maternity Experiences Survey. Available at <http://www.phac-aspc.gc.ca/rhs-ssg/survey-eng.php>. Accessed October 2010.

³¹² Rogers JM. Tobacco and pregnancy. *Reproductive Toxicology*. 2009; 28(2): 152-60.

³¹³ Canadian Perinatal Health Report 2008 Edition. Available at <http://www.phac-aspc.gc.ca/publicat/2008/cphr-rspc/index-eng.php>. Accessed October 2010.

smoking); for all of Canada, this statistic was 10.5%.³¹⁴ While maternal smoking rates clearly have declined in the past decade, smoking during pregnancy is still a serious public health concern. Maternal exposure to second-hand smoke has also substantially declined. The most recent rates are reported in the Canadian Perinatal Health Report of 2008, based on data from the Canadian Community Health Survey; in 2005, 14.1% of women who gave birth in the previous five years reported exposure to second-hand smoke during their pregnancy, compared to 22.4% in 2000-2001.³¹⁵

Prenatal exposure to alcohol can result in range of adverse effects on the child, including cognitive, behavioural, neurodevelopmental, physiological, or physical impairments.^{316,317,318,319} This set of conditions is normally referred to by the acronym FASD, for fetal alcohol spectrum disorder; the most severe of the diagnostic conditions within this spectrum is fetal alcohol syndrome (FAS). The specific outcomes of prenatal alcohol exposure vary with the timing of the exposure, the amount of alcohol consumed, the frequency and pattern of consumption, as well as genetic, social, and environmental factors. According to the Canadian Maternity Experiences Survey, 10.5% of women surveyed reported drinking (frequently and infrequently) during pregnancy in 2006-2007; in British Columbia, the proportion was lower at 7.7%.³²⁰ There is clear overlap between this sub-topic and the concept of Teenage Pregnancy, given the involvement of alcohol use in unplanned conception and the potential for a high rate of continued drinking among at-risk teenagers who are pregnant.³²¹

Limited data are available on the incidence and prevalence of FASD in Canada, due in part to challenges involved with diagnosing the condition. Clinical signs of FASD are not easily recognized in infants, resulting in either a missed diagnosis, or a delay in identifying the disorder until grade school or even adolescence.³²² The prevalence of FASD in the United States has been estimated as 9 per 1000 live births; for the more serious condition of FAS, the estimate is 1 to 3 per 1000 live births.³²³ The B.C. Health Status Registry received reports of 167 cases with FASD between 2001 and 2003, which positions the province at the low end of the incidence range that has been suggested by Canadian clinicians (i.e., 1.38 per 1000 live births).^{324,325}

³¹⁴ Canadian Maternity Experiences Survey. Available at <http://www.phac-aspc.gc.ca/rhs-ssg/survey-eng.php>. Accessed October 2010.

³¹⁵ Canadian Perinatal Health Report 2008 Edition. Available at <http://www.phac-aspc.gc.ca/publicat/2008/cphr-rspc/index-eng.php>. Accessed October 2010.

³¹⁶ Welch-Carre E. The neurodevelopmental consequences of prenatal alcohol exposure. *Advances in Neonatal Care*. 2005; 5(4): 217-29.

³¹⁷ Kodituwakku PW. Defining the behavioral phenotype in children with fetal alcohol spectrum disorders: a review. *Neuroscience and biobehavioral reviews*. 2007; 31(2): 192-201.

³¹⁸ Nash K, Sheard E, Rovet J et al. Understanding fetal alcohol spectrum disorders (FASDs): toward identification of a behavioral phenotype. *TheScientificWorldJournal*. 2008; 8: 873-82.

³¹⁹ Guerri C, Bazinet A, Riley EP. Foetal Alcohol Spectrum Disorders and alterations in brain and behaviour. *Alcohol and alcoholism*. 2009; 44(2): 108-14.

³²⁰ Canadian Maternity Experiences Survey. Available at <http://www.phac-aspc.gc.ca/rhs-ssg/survey-eng.php>. Accessed October 2010.

³²¹ Allard-Hendren R. Alcohol use and adolescent pregnancy. *American Journal of Maternal Child Nursing*. 2000; 25(3): 159-62.

³²² Public Health Agency of Canada. Fetal Alcohol Spectrum Disorder (FASD) – Data collection and reporting. Available at <http://www.phac-aspc.gc.ca/fasd-etcaf/pdf/factsheet5-fasd-etcaf-eng.pdf>. Accessed October 2010.

³²³ Abel EL, Sokol RJ. A revised conservative estimate of the incidence of FAS and its economic impact. *Alcoholism, Clinical and Experimental Research*. 1991; 15(3): 514-24.

³²⁴ Health Status Registry Report 2005. British Columbia Ministry of Health Statistics Agency. Available at <http://www.vs.gov.bc.ca/stats/hsr/2005/index.html>. Accessed November 2010.

³²⁵ Niccols A. Fetal alcohol syndrome and the developing socio-emotional brain. *Brain and cognition*. 2007; 65(1): 135-42.

Recreational drug abuse is on the increase worldwide; a marked rise has been noted among young women especially in the past three decades.³²⁶ Drugs most commonly abused during pregnancy include cocaine, marijuana, and opioids. The neonatal consequences of prenatal illegal drug use are not as well-established or consistent as those found in maternal smoking and alcohol consumption. One research challenge is that illegal drug use is highly correlated with other health behaviours, such as smoking and alcohol use and lack of prenatal health care; attributing health outcomes to drug use thus becomes confounded. Of illegal substances, cocaine has been studied the most extensively; as pointed out by Schempf, “although still highly controversial, the neonatal impact of cocaine use, particularly on fetal growth, is more consistently observed than for other illicit substances.”³²⁷ Specifically, maternal cocaine use has been associated with low birth weight, although other studies report no relation between cocaine use and birth outcome, even after controlling for confounding factors. Obtaining accurate data for drug use during pregnancy is also difficult; an issue pertaining to data accuracy is the unreliability of self-reported drug usage on surveys. The illegal nature of the activity and its general social undesirability both contribute to under-reporting. In the Maternity Experiences Survey, 1.0% of pregnant women in the country reported using “street drugs” during pregnancy; for reasons just noted, this is considered an underestimate of the true proportion.

Methodology and Provisional Results

Review Search Process

For the electronic search for reviews in this area, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

(“Maternal Exposure”[Majr] OR “Pregnancy Complications”[Majr] OR “Maternal-Fetal Exchange”[Majr]) AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR “Pregnancy Outcome”[Majr] OR “Infant, Low Birth Weight”[Majr] OR “Birth Weight”[Majr] OR “Growth and Development”[Majr] OR “Premature Birth”[Majr])

It is important to note that the concept related to fetal alcohol effects is completely captured under Pregnancy Complications; furthermore, the pertinent papers for this concept that were located, while not qualifying as systematic reviews, did cover important non-physical health effects; these are discussed briefly in the Summary of Results section below.

³²⁶ Kuczkowski KM. The effects of drug abuse on pregnancy. *Current Opinion in Obstetrics and Gynecology*. 2007; 19(6): 578-85.

³²⁷ Schempf AH. Illicit drug use and neonatal outcomes: a critical review. *Obstetrical and Gynecological Survey*. 2007; 62(11): 749-57.

A second, targeted search was also conducted for the subtopic of environmental tobacco smoke, as follows:

"Tobacco Smoke Pollution"[Majr] **AND**

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Pregnancy Outcome"[Majr] OR "Infant, Low Birth Weight"[Majr] OR "Birth Weight"[Majr] OR "Growth and Development"[Majr] OR "Premature Birth"[Majr])

In addition to the above search methods, the following searches were conducted:

- PubMed search using "Related citations" link
- A scan in Google for grey literature and for any obvious articles missed, using terms such as: **(maternal smoking OR environmental tobacco smoke) AND children AND health**
- Hand-searching bibliographies of key papers
- Checking for study updates (by author)

The search for review articles ultimately returned a sufficient volume (see below) of papers to qualify for a Level A search process. Finally, since the most recent systematic reviews of the association of maternal behaviours with infant/child health were published in 2010, an update covering the most recent studies was not pursued.

Taken together, the various search processes returned 784 articles for consideration.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between maternal smoking, alcohol use, or drugs and infant/child health, then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 123.

Primary Exclusion

The full articles were then reviewed, with articles not pertinent to the research topic being excluded.

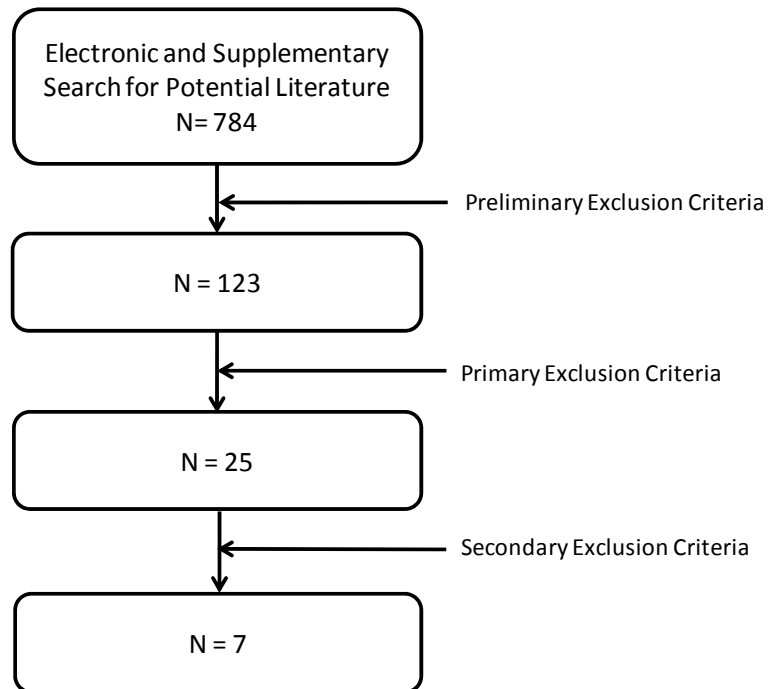
There were 25 articles remaining in the list following the primary exclusion step.

Secondary Exclusion

Articles that were deemed to be of lesser quality or usefulness were excluded. This secondary exclusion step yielded a total of 7 reviews, as reflected in the following Volume Report and the subsequent table of results. The list of review papers is then in the table that follows.

Literature Review Volume Report: Reviews

Dimension: Physical Health **Concept:** Pregnancy Outreach Services



Summary of Relevant Reviews
Dimension: *Physical Health*
Concept: Pregnancy Outreach Services

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	No. of Studies
<i>Tobacco Smoke (Prenatal)</i>							
1	Maternal smoking during pregnancy and offspring obesity: Meta-analysis	Ino	2010	Pediatrics International	0.67	2002-2007	17
2	Environmental tobacco smoke and fetal health: systematic review and meta-analysis	Leonardi-Bee	2008	Archives of Disease in Childhood. Fetal and Neonatal Edition	2.49 (2009)	1967-2007	58
3	Maternal smoking during pregnancy and child overweight: Systematic review and meta-analysis	Oken	2008	International Journal of Obesity	4.48	2002-2006	14
<i>Drugs</i>							
4	A review of the effects of prenatal cocaine exposure among school-aged children	Ackerman	2010	Pediatrics	4.27	2002-2007	6
5	Prenatal Drug Exposure: Infant and toddler outcomes	Bandstra	2010	Journal of Addictive Diseases	1.23 (2009)	2001-2008	9
<i>Environmental Tobacco Smoke (Postnatal)</i>							
6	Developing asthma in childhood from exposure to secondhand tobacco smoke: insights from a meta-regression	Vork	2007	Environmental Health Perspectives	5.34	1982-2001	38
7	Parental smoking and children's respiratory health: independent effects of prenatal and postnatal	Pattenden	2006	Tobacco Control	2.42	1988 - 1998	12

Detailed Results

For the 7 reviews remaining after the literature search and exclusion process, a summary table of results was developed, as follows.

Dimension: *Physical Health Concept: Pregnancy Outreach Services*
Summary Table of Reviews

Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Ino (2010)	Maternal smoking during pregnancy and offspring obesity: Meta-analysis	17	A statistically significant, positive association was found between maternal smoking during pregnancy and childhood obesity. Maternal smoking during pregnancy may cause future cases of obesity and metabolic syndrome.
Leonardi-Bee (2008)	Environmental tobacco smoke and fetal health: systematic review and meta-analysis	58	Exposure of non-smoking pregnant women to ETS reduces mean birth weight by 33 g or more, and increases the risk of birth weight below 2500 g by 22%, but has no other clear effect on gestation, including the risk of being small for gestational age.
Oken (2008)	Maternal smoking during pregnancy and child overweight: Systematic review and meta-analysis	14	Children whose mothers smoked during pregnancy were at elevated risk for overweight (OR 1.50) at ages 3-33 years, compared with children whose mothers did not smoke during pregnancy.
Ackerman (2010)	A review of the effects of prenatal cocaine exposure among school-aged children	6	Despite significant differences in weight, height, and head circumference at birth, there were few significant growth differences at school age related to prenatal exposure to cocaine.
Bandstra (2010)	Prenatal drug exposure: Infant and toddler outcomes	9	Only one study showed a direct cocaine-related effect on Psychomotor Development Index scores in longitudinal analyses spanning 12 through 36 months.
Vork (2007)	Developing asthma in childhood from exposure to secondhand tobacco smoke: insights from a meta-regression	38	Exposure to secondhand tobacco smoke in childhood may be a more important factor that brings about asthma. Secondhand smoke could be a more fundamental and widespread cause that previously thought.
Pattenden (2006)	Parental smoking and children's respiratory health: independent effects of prenatal and postnatal exposure	12	Asthma was strongly associated with maternal smoking during pregnancy, postnatal exposure to smoking showed independent associations with a range of other respiratory problems.

Bibliography for Table of Reviews

Ino T. Maternal smoking during pregnancy and offspring obesity: meta-analysis. *Pediatrics International*. 2010; 52(1): 94-9.

Leonardi-Bee J, Smyth A, Britton J et al. Environmental tobacco smoke and fetal health: systematic review and meta-analysis. *Archives of Disease in Childhood. Fetal and Neonatal Edition*. 2008; 93(5): F351-61.

Oken E, Levitan EB and Gillman MW. Maternal smoking during pregnancy and child overweight: systematic review and meta-analysis. *International Journal of Obesity*. 2008; 32(2): 201-10.

Ackerman JP, Riggins T and Black MM. A review of the effects of prenatal cocaine exposure among school-aged children. *Pediatrics*. 2010; 125(3): 554-65.

Ino T. Maternal smoking during pregnancy and offspring obesity: meta-analysis. *Pediatrics International*. 2010; 52: 94-9.

Bandstra ES, Morrow CE, Mansoor E et al. Prenatal drug exposure: infant and toddler outcomes. *Journal of Addictive Diseases*. 2010; 29(2): 245-58.

Vork KL, Broadwin RL and Blaisdell RJ. Developing asthma in childhood from exposure to secondhand tobacco smoke: insights from a meta-regression. *Environmental Health Perspectives*. 2007; 115(10): 1394-400.

Pattenden S, Antova T, Neuberger M et al. Parental smoking and children's respiratory health: independent effects of prenatal and postnatal exposure. *Tobacco Control*. 2006; 15(4): 294-301.

Summary of Results

Although there were four outreach service targets identified (treating ETS as a separate subtopic), only three of them appear in the summary table. There were no systematic review papers identified for maternal alcohol use that met the inclusion criteria. Much of the literature in this particular area was published prior to the year 2000; it is a well-established fact that alcohol is teratogenic.

Similarly, with respect to the health effects of FASD, only narrative reviews were identified. Many of the studies in this area were published prior to the year 2000 and thus did not meet the criteria to be included here. As introduced in the Background and Context section, it is well-established that FASD is associated with physical, neurological, and functional abnormalities; the diagnostic criteria for FASD actually *include* various features that fall under these categories.³²⁸ Some of the non-physical effects associated with the disorder include attention problems, learning difficulties, and deficits in memory and executive functions.³²⁹ In fact, the conditions on the more serious end on the spectrum, including FAS, are now recognized as the most common preventable causes of cognitive or intellectual disability that have been identified so far.^{330,331}

Two of the reviews identified for the subtopic of smoking during pregnancy reported an association between maternal smoking during pregnancy and childhood obesity. Many other effects of maternal smoking on child health are well-established, such as reduced fetal growth, the onset of asthma, 40% elevation in risk of infant mortality, and a 2-fold increase in the incidence of sudden infant death syndrome; however, apart from the meta-analytic work of Pattenden et al. on respiratory effects, there were no systematic reviews identified for other health outcomes in the date range mandated by the search protocol.³³²

In the review by Leonardi-Bee et al., exposure of non-smoking pregnant women to environmental tobacco smoke was shown to increase the risk of low birth weight. As for the topic of children exposed to ETS in family contexts, the two pertinent reviews confirmed that ETS is a factor in pediatric respiratory disorders—especially asthma. Added to this phenomenon is the well-known *indirect* health effect of teenagers in homes where smoking occurs being more prone to take up the habit themselves.^{333,334}

³²⁸ Welch-Carre E. The neurodevelopmental consequences of prenatal alcohol exposure. *Advances in Neonatal Care*. 2005; 5(4): 217-29.

³²⁹ Niccols A. Fetal alcohol syndrome and the developing socio-emotional brain. *Brain and cognition*. 2007; 65(1): 135-42.

³³⁰ Niccols A. Fetal alcohol syndrome and the developing socio-emotional brain. *Brain and cognition*. 2007; 65(1): 135-42.

³³¹ Daily DK, Ardinger HH, Holmes GE. Identification and evaluation of mental retardation. *American Family Physician*. 2000; 61(4): 1059-67, 70.

³³² Salihu HM, Wilson RE. Epidemiology of prenatal smoking and perinatal outcomes. *Early Human Development*. 2007; 83(11): 713-20.

³³³ Wakefield MA, Chaloupka FJ, Kaufman NJ et al. Effect of restrictions on smoking at home, at school, and in public places on teenage smoking: cross sectional study. *British Medical Journal*. 2000; 321(7257): 333-7.; Szabo E, White V, Hayman J. Can home smoking restrictions influence adolescents' smoking behaviors if their parents and friends smoke? *Addictive Behaviour*. 2006; 31(12): 2298-303.

³³⁴ Szabo E, White V, Hayman J. Can home smoking restrictions influence adolescents' smoking behaviors if their parents and friends smoke? *Addictive Behaviour*. 2006; 31(12): 2298-303.

For the final outreach service target – drug use during pregnancy – both of the relevant reviews report on the effects of prenatal cocaine exposure. Bandstra et al. determined that only one of nine studies that evaluated the effects of prenatal cocaine exposure on infant and toddler motor development found a direct cocaine-related effect. Significant but subtle neurobehavioural and cognitive effects were associated with prenatal cocaine exposure, and there is a growing body of research suggesting that language development is also adversely affected. In the review by Ackerman et al. of effects of prenatal cocaine exposure among school-aged children, the association with physical growth was small and confounded by environmental variables. However, a significant negative association was identified between prenatal cocaine exposure and sustained attention and behavioural self-regulation among school-aged children.

Data Sources for Pregnancy Outreach Services and Targets

An important source for information regarding smoking, alcohol use, and street drug use during pregnancy in Canada is the Maternity Experiences Survey (MES).³³⁵ This national survey of Canadian women's experiences, perceptions, knowledge and practices before conception and during pregnancy, birth, and the early months of parenthood is described further in the chapter on antenatal care.

The Canadian Perinatal Health Report is a second source of information for rate of maternal smoking during pregnancy, rate of maternal exposure to second-hand smoke, and rate of maternal alcohol consumption during pregnancy. The data is based on results of the Canadian Community Health Survey (CCHS), and data is given for 2000-2001, 2003, and 2005.

The CCHS³³⁶ also asks questions that allow the proportion of children exposed to ETS in the home or in vehicles to be calculated. The most recent information is provided in the following table.

Exposure to Environmental Tobacco Smoke in B.C. At Home and in Vehicles in the Last Month by Gender, Children aged 12-19 2003-2009						
Year	<i>Exposure to Second-Hand Smoke at Home</i>			<i>Exposure to Second-Hand Smoke in Vehicles, in the Past Month</i>		
	Males	Females	Total	Males	Females	Total
2003	15.1%	13.3%	14.2%	16.5%	16.7%	16.6%
2005	13.1%	16.1%	14.5%	10.6%	14.7%	12.6%
2007	15.4%	11.0%	13.3%	14.0%	15.6%	14.8%
2008	10.2%	10.3%	10.3%	8.2%	11.3%	9.7%
2009	10.1%	8.8%	9.4%	9.0%	11.3%	10.1%
Source: Canadian Community Health Survey, 2009.						

A further resource for information on smoking and pregnancy in Canada is the Canadian Tobacco Use Monitoring Survey (CTUMS). CTUMS was developed to provide Health Canada and its partners with timely, reliable and continual data on tobacco use and related

³³⁵ What Mothers Say: The Canadian Maternity Experiences Survey. 2009. Available at <http://www.phac-aspc.gc.ca/rhs-ssg/pdf/survey-eng.pdf>. Accessed October 2010.

³³⁶ See the background description in the Introduction.

issues. The survey's primary objective is to track changes in smoking status and amount smoked, especially for the 15- to 24-year-old cohort that is most at risk for taking up smoking. Most recently, CTUMS collected data from 20,121 respondents from February to December 2009. Among women aged 20-44 years who had been pregnant in the previous 5 years, 8.7% reported smoking regularly during their most recent pregnancy.³³⁷

Discussion

The evidence is well-established for physical health outcomes of prenatal smoking and alcohol use; however, the present review did not identify much of this evidence due to the constraints on publication dates in the literature search process. In the area of prenatal smoking, for example, much of the literature pointing to effects, such as increased risk of infant mortality, was published prior to the year 2000. There are many adverse health impacts on the child due to maternal alcohol use, including FASD; though there undoubtedly is an organic base to such conditions, most of the observed effects may be classified as cognitive or behavioural rather than physical per se. There is very limited evidence of prenatal cocaine use resulting in physical effects manifesting after birth; there is greater evidence for neurobehavioural and cognitive effects, although these effects are small, especially in the context of other exposures among at-risk pregnant women that may potentiate any impacts.

Data availability is very good for rates of maternal smoking, prenatal environmental tobacco smoke exposure, pediatric ETS exposure, and maternal alcohol use. CTUMS presents the most up-to-date data for maternal smoking, and the other indicators are covered in the MES, the Canadian Perinatal Health Report, and CCHS. Although the MES does report on street drug use during pregnancy in Canada, this self-reported information is highly unreliable. Additionally, the numbers of such drug users are relatively low, and the data cannot be attributed to any specific drug (or its potential effects).

Conclusion

Based on evidence of physical health outcomes for the child, as well as overall health outcomes, exposure to maternal smoking, ETS, and alcohol are potentially key targets for outreach services to pregnant women. There is recent and reliable information available on such indicators for Canada as a whole and for British Columbia. For street drug use during pregnancy, however, information on usage rates is likely to be inaccurate due to the unreliability of self-reporting on this subtopic.

³³⁷ CTUMS 2009 Supplementary Tables. Available at http://www.hc-sc.gc.ca/hc-ps/tobac-tabac/research-recherche/stat/_ctums-esutc_2009/ann-eng.php#7. Accessed October 2010.

Summary Assessment					
Exposure to At-Risk Pregnancy					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	137-296,000	High	High	Medium	Medium

As summarized above, assessments have been applied to the Pregnancy Outreach Services and Targets concept, specifically in terms of the indicators with the most compelling support in the literature, namely, *children exposed to an at-risk pregnancy*, specifically, *maternal smoking, environmental tobacco smoke exposure, and/or alcohol consumption during pregnancy*. **FASD** could be a useful indicator, but more progress would need to be made on solving the diagnostic problems; this would then enable the development of a more comprehensive surveillance system in B.C., and a better assessment of magnitude. The pediatric population **Magnitude** of the potential indicator is assessed as **High**. During pregnancy, 8.7% of women regularly smoke, 14.1% are exposed to environmental tobacco smoke, and 7.7% consume alcohol at some point (based on three separate surveys). Given that there is very likely an overlap between these risk factors, a range between 14.1% (complete overlap) and 30.5% (no overlap) was used to calculate prevalence. Applying these two extremes across the entire pediatric cohort resulted in a prevalence estimate of 136,800 to 296,000 affected children. This entire range is greater than 10% of the total pediatric cohort (97,000), resulting in a Magnitude classification of High.

The **Significance** of the potential indicators as supported by the evidence of impact on an individual's health and well-being is assessed as **High**. There is strong evidence for adverse effects of fetal exposure to tobacco smoke products and alcohol on child health, and causation is well-established.

The **Modifiability** of the potential indicators is assessed as **Medium**. The rationale is the general complexity of reaching and changing behaviour within vulnerable populations of pregnant females.

Data Availability/Validity for the potential indicators is assessed as **Medium**. The CCHS is the main source of data for maternal smoking and alcohol use, as well as maternal exposure to environmental smoke. While these data are routinely collected, the information is self-reported and may have some stigma attached, so it could have questionable validity.

Based on the indicated assessment, the potential indicators (taken together as at-risk pregnancy) are **Recommended** for consideration as a core indicator of child health and well-being. The reasons are the medium-to-high rating across all assessment categories, especially the critical areas of magnitude and significance. As an additional note, the specific outreach target of **FASD** is **Not Recommended** as it represents a challenging area for comprehensive diagnosis and therefore for building an indicator with validity; although it could be considered an investigational area and a matter for further development, in the meantime the (by definition) direct risk factor of alcohol consumption during pregnancy will already be captured by the more global *at-risk pregnancy* indicator that has been recommended.

Disease, Vital Statistics, and Health Status

There are several concepts assigned to this project that fall under the heading of descriptive epidemiology of major diseases or the heading of vital statistics. These include:

- Major chronic diseases
- Cause-specific disability
- Major childhood infectious diseases
- Cause-specific mortality

Two characteristics distinguish this list, and account for them being treated together in this chapter of the report.

First, there are substantial overlaps between the four concepts. Thus, chronic diseases are key drivers of disability in children and adults; and both chronic and infectious diseases contribute to pediatric mortality.

Second, as with other concepts considered in this project, the implication of these concepts for health and well-being is self-evident; in short, no elaborate review of evidence is required. The only pertinent issues relate to the population-level impact of the various physical conditions and their degree of preventability—in other words, calling for a basic assessment of the utility of the concept in terms of an indicator of childhood physical health. Such an assessment will now be pursued for each of the four concepts listed above.

Finally, **self-rated health** represents another broad assessment of health and well-being that fits well with the concepts contained in this part of the report, whether they are more objective (e.g., disease diagnosis) or more subjective (e.g., experience of disability). The concept of self-rated health has therefore been included here as well.

Major Chronic Diseases

Few studies have investigated the physical health impacts (or even more general well-being effects) of chronic disease considered as a class. Not surprisingly, when studies on this topic have been pursued, they have confirmed that measures of physical health (such as acute hospitalization rates), psychosocial health (such as depression), and more general well-being (such as quality of life) are associated with the presence of physical health problems.^{338,339,340}

There is a slightly wider literature tracking such effects in terms of individual chronic conditions. What is pertinent to consider in this regard is open to question. The way diseases are identified under headings such as “major” and “chronic” shows great variety. The focus on childhood/adolescence contributes another filter: some chronic diseases are unique to this age group, and some adult chronic diseases are in fact not prevalent in younger ages.

Some papers found in the literature offer direction on building an inventory of pediatric chronic disease.^{341,342,343,344} A major resource for this specific task is the list of chronic diseases embedded in the questions used in population health surveys in Canada (see section below under Cause-Specific Disability). Based on this and other information gleaned through grey literature searches (e.g., pediatric disease and disability advocacy websites), an inventory was constructed. It represents an attempt to identify the pediatric chronic diseases that may be reasonably categorized under the heading “physical health.” The following “exclusions” were then applied to the full inventory in order to identify major chronic diseases of interest:

1. Removing diseases and conditions covered under other chapters in the report
2. Removing diseases that are genetically-driven or idiopathic (where the cause is unknown), and thus of low prevention potential, and/or characterized as being not very common and/or of low health impact in individuals; this series of qualifications may be summed up as removing chronic diseases where there is a low potential for making gains related to the population health burden among children

An example of a disease group that is eliminated based on the latter criteria is pediatric cancer; as devastating as such disease can be for any age group, it must be acknowledge that it is very rare among children (see the following table).

³³⁸ Dosa NP, Boeing NM, Ms N et al. Excess risk of severe acute illness in children with chronic health conditions. *Pediatrics*. 2001; 107(3): 499-504.

³³⁹ Turkel S, Pao M. Late consequences of chronic pediatric illness. *Psychiatric Clinics of North America*. 2007; 30(4): 819-35.

³⁴⁰ Waters E, Davis E, Nicolas C et al. The impact of childhood conditions and concurrent morbidities on child health and well-being. *Child Care, Health and Development*. 2008; 34(4): 418-29.

³⁴¹ See <http://www.cdc.gov/mmwr/preview/mmwrhtml/00038522.htm>

³⁴² Newacheck PW, Taylor WR. Childhood chronic illness: prevalence, severity, and impact. *American Journal of Public Health*. 1992; 82(3): 364-71.

³⁴³ Fishman PA, Shay DK. Development and estimation of a pediatric chronic disease score using automated pharmacy data. *Medical Care*. 1999; 37(9): 874-83.

³⁴⁴ Valentine J, Maynard C, Christakis DA et al. Pediatric hospitalization patterns for selected chronic health conditions using hospital abstract reporting system data: methods and findings. *Health Services & Outcomes Research Methodology*. 2000; 1(3): 335-50.

Childhood Cancer (Aged 0-14) in Canada by Cancer Type ASIR and ASMR* (per 1,000,000) per Year 2000-2004		
	ASIR	ASMR
I. Leukemia	49.3	6.4
Lymphoid	39.0	2.4
Acute myeloid	6.3	1.8
III. Central Nervous System	28.9	6.9
Ependymoma	3.2	0.7
Astrocytoma	12.5	1.4
Intracranial and intraspinal embryonal	7.3	2.0
II. Lymphoma	16.9	1.1
Hodgkin lymphoma	5.5	0.1
Non-Hodgkin lymphoma	5.2	0.3
Burkitt lymphoma	3.1	0.3
IV. Neuroblastoma and Other PNC	11.4	2.9
Neuroblastoma	11.3	2.9
IX. Soft Tissue	9.0	1.5
Rhabdomyosarcoma	4.7	1.0
VI. Renal Tumours	8.5	1.2
Nephroblastoma	7.9	0.9
XI. Other Malignant Epithelial	6.1	0.3
Thyroid	2.0	0.0
Malignant Melanoma	1.5	0.0
VIII. Malignant Bone Tumours	6.0	1.5
Osteosarcoma	2.8	0.5
Ewing's sarcoma	2.6	0.9
X. Germ Cell and Other Gonadal	4.7	0.3
Malignant gonadal germ cell	1.8	0.1
V. Retinoblastoma	3.9	0.1
VII. Hepatic Tumours	2.6	0.4
XII. Other and Unspecified Cancers	2.1	0.3
*ASIR = Age-standardized incidence rate; ASMR= Age-standardized mortality rate.		
Source: Canadian Cancer Society, <i>Canadian Cancer Statistics 2008</i> .		

Applying the information provided in the table to the B.C. context suggests that less than 145 cases of cancer will be detected each year among children, generating about 20 premature deaths. The high rate of second cancers among the pool of survivors adds to the overall sense of burden,³⁴⁵ but not so much that this area could ever be conceived as a high priority as an indicator of population health improvement; adding to this caution is the weak potential for prevention, especially compared to the large percentage of “lifestyle-related” cancers among adults.

Taking into consideration the various criteria for exclusion, the following table was ultimately developed.

³⁴⁵ Krueger H, McLean D, Williams D. *The Prevention of Second Primary Cancers*. Basel: Karger; 2008.

Partial Inventory of Pediatric Chronic Diseases and Conditions Categorized by Population Indicator Potential

Possible utility as indicator

- Asthma
- Cerebral palsy
- Diabetes mellitus type 2
- Hypertension
- Severe pain (e.g., migraine, fibromyalgia)

Low potential for making gains related to population health burden (i.e., low prevention potential and/or low population health burden)

- Acne
- Allergies (food, respiratory, and other)
- Autism
- Cancers
- Chronic respiratory diseases (e.g., bronchitis, emphysema)
- Congenital diseases with vascular implications
- Diabetes mellitus type 1
- Down syndrome
- Eczema and other skin conditions
- Gastrointestinal disorders (e.g. gastric acid disorders, inflammatory bowel disease)
- Growth hormone deficiency
- Hepatitis
- Immunodeficiencies, primary
- Malnutrition disorders
- Multiple sclerosis
- Muscular dystrophy
- Renal and other urinary tract diseases
- Rheumatic diseases (including pediatric arthritides)
- Seizure disorders (including epilepsy)
- Sickle cell disease
- Spina bifida

Covered in other chapters of report

- Cystic fibrosis
- Fetal alcohol spectrum disorders
- Immunodeficiencies, acquired (esp. HIV-related)
- Inborn errors of metabolism (e.g., amino acid disorders, thyroid conditions, congenital adrenal hyperplasia)
- Major injury
- Overweight/obesity
- Eating disorders (e.g., anorexia, bulimia)

This categorization process generated a very short list of “sentinel” diseases that arguably could be considered as modifiable indicators of population-level physical health in children and adolescents.

Chronic Disease Data Sources and Population Magnitude

As noted earlier, population health surveys managed by Statistics Canada do track chronic disease rates through self-reported information. For example, McDougall et al. estimated that 30% of children aged 6 to 11 had one or more chronic physical health conditions or

impairments, according to the 1994-5 National Longitudinal Survey of Children and Youth (NLSCY).³⁴⁶ By comparison, the National Population Health Survey of 1996-7 found about 35% of younger teens and 45% of older teens reported having a chronic condition.³⁴⁷ Generally, reports from other countries have been of a similar order of magnitude, though tending towards a lower range.^{348,349}

The main analytic complexity is the definition applied to the chronic diseases surveyed; variation enters in when chronic diseases that arguably represent lesser morbidity are included or excluded. Thus, the inclusion of allergies, acne, and non-acne skin conditions likely accounts for the “double digit” rates of chronic disease found in national surveys (see above). This would need to be contrasted the Adolescent Health Survey conducted by the McCreary Centre Society among grade 7-12 students in B.C. The 2003 results suggested that 6% of males and 7% of females had a chronic condition or disability; clearly, only the more serious conditions are being included.³⁵⁰

In sum, the wide variation between national and provincial survey sources underlines the limitation of self-reported data and the different approaches to conceptualizing and defining pediatric chronic disease.³⁵¹ Furthermore, given the large number and variety health conditions included in combined figures, the prevention-related utility of a global indicator would actually be quite weak.

While a case may be made for a disease-specific focus for this concept, the specific pediatric conditions tend not to be routinely tracked in most jurisdictions. A clear exception is congenital anomalies (also known as birth defects); when the individual survives beyond infancy, most of these conditions manifest as a chronic disease. In British Columbia, a large variety of genetic and other disorders generally manifesting in infancy or early childhood have been tracked by BC Vital Statistics as far back as the 1950s, and specifically in a database named the Health Status Registry (HSR) since 1992; reportable conditions have been added from time to time, including autism spectrum disorder in 2002. The HSR was accepted as a full member of the International Clearinghouse for Birth Defects Monitoring Systems in 2001; as well, in 2002, it began contributing to the newly formed Congenital Anomalies Surveillance Network under the umbrella of the Canadian Perinatal Surveillance System.³⁵² In order to assist the cause of national and international surveillance, the HSR passes along counts of B.C. diagnoses drawn from a number of facilities and databases that

³⁴⁶ McDougall J, King G, de Wit DJ et al. Chronic physical health conditions and disability among Canadian school-aged children: a national profile. *Disability and Rehabilitation*. 2004; 26(1): 35-45.

³⁴⁷ Summarized in Canadian Institute of Child Health. *The health of Canada's children: A CICH profile*. 2000. Available at http://www.cich.ca/Publications_monitoring.html. Accessed November 2010.

³⁴⁸ Newacheck PW, Taylor WR. Childhood chronic illness: prevalence, severity, and impact. *American Journal of Public Health*. 1992; 82(3): 364-71.

³⁴⁹ Turkel S, Pao M. Late consequences of chronic pediatric illness. *Psychiatric Clinics of North America*. 2007; 30(4): 819-35.

³⁵⁰ The McCreary Center Society. *A Retrospective, 1992-2003*. 2005. Available at <http://mcs.bc.ca/pdf/AHS-Trends-2005-report.pdf>. Accessed November 2010.

³⁵¹ van der Lee JH, Mokkink LB, Grootenhuys MA et al. Definitions and measurement of chronic health conditions in childhood: a systematic review. *Journal of the American Medical Association*. 2007; 297(24): 2741-51.

³⁵² Public Health Agency of Canada. *Congenital anomalies surveillance in Canada: Results of a 2006-2007 survey on availability of selected data variables in Canadian provinces and territories*. 2010. Available at <http://www.phac-aspc.gc.ca/ccasn-rsac/sac-cas/ccasn-rsac-pub-eng.php>. Accessed November 2010.

are related to child health.³⁵³ Annual data on congenital conditions in B.C. appears to have been made available only up to the early 2000s. However, the lack of more recent information related to this area of chronic disease is not that critical for reasons that echo comments made about inborn (i.e., genetic) errors of metabolism in the separate chapter on Newborn Screening:

1. Congenital conditions are, by definition, mostly not preventable (there are important exceptions to this rule, such as fetal alcohol spectrum disorder and conditions such as neural tube defects that can sometimes be avoided by folic acid supplementation)
2. Consequently, the incidence of specific disorders, whether low or high, is often relatively stable, as illustrated in the following table:

Selected Congenital Anomalies by Year of Birth British Columbia, 1991-2000										
Diagnosis	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Transposition of great vessels	36	25	17	22	39	37	41	45	37	49
Ventricular septal defect	132	193	132	165	207	225	190	186	139	167
Cleft palate/lip	178	163	153	154	142	172	176	170	151	166
Pyloric stenosis	48	51	27	50	64	63	46	51	57	48
Cystic kidney disease	30	40	40	34	41	49	33	47	27	48
Anomalies of spine	30	31	24	26	22	28	25	25	22	27
Varus, valgus, clubfoot	317	326	203	257	308	285	283	242	277	294
Down syndrome	79	55	78	75	80	81	91	71	57	81
Turner's syndrome	10	13	10	8	10	14	11	8	9	11
Other chromosomal anomalies	67	91	40	74	93	91	94	99	76	84

Source: Health Status Registry, BC Vital Statistics

Moving beyond congenital conditions to chronic disease with onset later in childhood, the incidence data generally become more difficult to assess on a routine basis. In B.C., this pattern is in the process of being changed, at least with respect to pediatric diabetes mellitus, types 1 and 2 (T1DM and T2DM). Work is being pursued on behalf of Child Health BC that is aimed at improving both the quality of and access to health care for children and youth with diabetes and other complex chronic disease. In this context, B.C. Children's Hospital, in partnership with the Ministry of Healthy Living and Sport, is conducting a health services research study to describe the burden of pediatric diabetes in the province. Based on a validated algorithm designed for the study, a report has been recently prepared (with peer-reviewed publications currently in process) that identifies the incidence and trends related to pediatric diabetes.³⁵⁴ From the point of view of prevention potential, T2DM is the most important.

Considered on its own, it is not clear that T2DM qualifies as a major chronic disease in terms of the magnitude of the affected population; however, the trend-line is a growing concern. Previous studies and anecdotal reports indicate an increasing incidence in T2DM that

³⁵³ See background on the HSR at http://www.vs.gov.bc.ca/stats/hsr/2005/pdf/vsa026_introduction.pdf. Accessed October 2010.

³⁵⁴ Amed S, Nuernberger K, McCrea P et al. *Status Report on the British Columbia Paediatric Diabetes Program*. 2010. With consulting and writing support from H. Krueger & Associates Inc.

parallels the increasing rates of childhood obesity. The data in the recent B.C. work indicates a similar increasing trend in the incidence of childhood T2DM in the province. The number of children in B.C. diagnosed with T2DM rose from 30 in 1998/99 (an age-standardized incidence rate of 0.033 / 1,000 population) to 52 in 2006/07 (an age-standardized incidence rate of 0.055 / 1,000 population). Another notable result in B.C. is the fact that, in females aged 15-19, the incidence rate of T2DM has now surpassed that of T1DM. Correlation does not prove causation; it is not clear whether pediatric obesity is directly driving T2DM onset, or whether there are common causes of both conditions that should be the true focus of primary prevention efforts.

As the most common chronic disease in children, asthma is arguably the most important disease on the “short list” of indicators to evaluate.³⁵⁵ It is closely related to a number of other disorders, including eczema and food allergies; asthma may in fact be an umbrella term for a number of conditions, each with a different causal pathway and prevention potential. This complex set of diseases generally appears in early childhood and has generally increased in incidence, although the numbers may have recently reached a plateau in some countries and may even be reversing in Canada.^{356,357} In children, the age of onset is often before the age of six. Hessel and colleagues found that 20% of children with asthma were diagnosed by age one, 57% by age four, and 67% by age five.³⁵⁸

An estimated 8% of children and teens in Canada have asthma, according to the latest NLSCY information.³⁵⁹ Considering that just a decade ago, so-called *active* asthma (defined as being physician-diagnosed and either taking medication during the last 12 months or experiencing symptoms such as attacks in the past 12 months) was pegged at 10%, there is some signs that the rate of asthma may be declining.³⁶⁰

The absolute numbers of children with two of the potential sentinel diseases, asthma and hypertension, were identified in a B.C. government summary published in the early 2000s (see below).³⁶¹ Deriving and publishing this information, presumably based on health care administrative sources, does not appear to have been pursued on a regular basis, despite the large number of asthma sufferers among children and the fact that, like T2DM and obesity, pediatric hypertension is apparently on the rise.

³⁵⁵ Schönberger HJ, Dompeling E, Knottnerus JA et al. The PREVASC study: the clinical effect of a multifaceted educational intervention to prevent childhood asthma. *European Respiratory Journal*. 2005; 25(4): 660-70.

³⁵⁶ Eder W, Ege MJ, von Mutius E. The asthma epidemic. *New England Journal of Medicine*. 2006; 355: 2226-35.

³⁵⁷ Thomas EM. Recent trends in upper respiratory infections, ear infections and asthma among young Canadian children. *Health Reports*. 2010; 21(4): 47-52.

³⁵⁸ Hessel PA, Sliwkanich T, Michaelchuk D, et al. Asthma and limitation of activities in Fort Saskatchewan, Alberta. *Canadian Journal of Public Health*. 1996; 87(6): 397-400.

³⁵⁹ Thomas EM. Recent trends in upper respiratory infections, ear infections and asthma among young Canadian children. *Health Reports*. 2010; 21(4): 47-52.

³⁶⁰ The National Asthma Control Task Force. *The Prevention and Management of Asthma in Canada: A Major Challenge Now and in the Future*. 2000.

³⁶¹ B.C. Ministry of Health. *Number of People with Specific Chronic Disease, by Age Group*. 2003/2004. Available at: <http://www.health.gov.bc.ca/cdm/research/index.html>. Accessed October 2010.

Pediatric Cases of Asthma and Hypertension British Columbia, 2003/04				
	Age Group (Years)			
	0-4	5-9	10-14	15-19
Asthma	0	43,604	45,440	38,072
Hypertension	178	285	471	831

Source: *Number of People with Specific Chronic Disease*, BC Ministry of Health, 2003/04.

The final two potential indicators are cerebral palsy and chronic syndromes involving pain. Cerebral palsy (CP) is relatively common, occurring in 2.7 per 1000 live births in B.C. according to a 2008 study.³⁶² The great majority of these cases are associated with a congenital etiology, but a few do involve a preventable cause. It is unclear whether the latter area generates enough cases to qualify as a population health concern. Nonetheless, a CP register for B.C. has been recommended by some authorities, a tool that presumably could facilitate tracking, for example, the cases caused by medical error; however, it may be difficult to pursue this direction, given the controversy involved and the potential for litigation.

Headache is a frequent pain-related complaint in childhood and adolescence, with incidence generally increasing with age.³⁶³ According to U.S. data, up to 75% of children reporting the experience of at least one notable headache by the age of 15 years; pediatric migraine is the most frequent form of recurrent headache, occurring in up to 28% of older teenagers.³⁶⁴ Canadian population health surveys have revealed more conservative results, with migraine being reported by 2.4% of youth aged 12-14 years and 5.0% aged 15-19 years according to an analysis from 1996-7.³⁶⁵ The primary prevention of migraine syndromes remains elusive for all age groups; it is likely more productive to think in terms of secondary prevention of migraine *attacks*. Fortunately, investigations of pharmacologic and non-pharmacologic interventions for pediatric migraine have increased in recent years.^{366,367}

Conclusion

Given the range of conditions, impacts, and preventability involved, a global chronic disease score for the pediatric population would have limited utility. As an alternate, one or more disease-specific incidence rates could act as a suitable indicator of child health and well-being in B.C. A broad perspective on the meaning of health only reinforces this conclusion, given

³⁶² Smith L, Kelly KD, Prkachin G et al. The prevalence of cerebral palsy in British Columbia, 1991-1995. *Canadian Journal of Neurological Sciences*. 2008; 35(3): 342-7.

³⁶³ Lewis DW. Pediatric migraine. *Neurologic Clinics*. 2009; 27(2): 481-501.

³⁶⁴ Hershey AD. Current approaches to the diagnosis and management of paediatric migraine. *Lancet Neurology*. 2010; 9(2): 190-204.

³⁶⁵ Gordon KE, Dooley JM, Wood EP. Prevalence of reported migraine headaches in Canadian adolescents. *Canadian Journal of Neurological Sciences*. 2004; 31(3): 324-7.

³⁶⁶ Papetti L, Spalice A, Nicita F et al. Migraine treatment in developmental age: guidelines update. *The Journal of Headache and Pain*. 2010; 11(3): 267-76.

³⁶⁷ Damen L, Bruijn J, Koes BW et al. Prophylactic treatment of migraine in children. Part 1. A systematic review of non-pharmacological trials. *Cephalalgia*. 2006; 26(4): 373-83.

that there is a growing appreciation of the psychological co-morbidities and social impacts that are associated with chronic physical conditions.^{368,369}

Asthma might be a good place to begin such surveillance, especially as it likely relates to other important aspects of child health rooted in their environment, socioeconomic status, etc. On the other hand, authorities have wrestled with the fact that measures aimed at preventing or delaying the development of asthma have shown such disappointing results. Van Schayck and co-authors suggest that “the most likely explanation is that the development of a multi-factorial disease, such as asthma, is extremely difficult, if not impossible, to prevent by eliminating only one risk factor.”³⁷⁰ As with migraines, secondary prevention may be a more realistic target; this would mean tracking the rate of actual asthmatic attacks, perhaps through hospital data.

The only other chronic pediatric conditions that rival asthma in terms of population magnitude are acne and allergies. Of the two, allergies generate greater physical health effects; however, in terms of causes and physiopathology, allergies represent an even broader phenomenon than asthma, so its usefulness as the basis of a modifiable pediatric health indicator is moot. In addition, as shown by how they were classified in the earlier table of chronic diseases, allergies, acne and like disorders tend to be marked by lower levels of morbidity.

Summary Assessment					
Asthma					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	77,600-127,000	High	Medium	Low	Low

As summarized above, assessments have been applied to the Major Chronic Diseases concept, specifically in terms of the indicator with the most compelling support in the literature, namely, *proportion of children with asthma*. Two (relatively rare) chronic conditions that appear to be on the rise among children, namely, hypertension and T2DM, have not had *routine* prevalence information available, though that situation is reportedly changing in B.C., at least for diabetes.

The pediatric population **Magnitude** of the potential indicator is assessed as **High**. Based on the latest NLSCY data, 8% of children aged 2-7 years in B.C. have asthma. Applying this percentage to the current total pediatric cohort (age 0-19 years) resulted in a prevalence estimate of 77,600 individuals. It should be noted that this estimated total is considerably lower than the administrative information reported by the Ministry of Health in B.C. in 2003/04 (at about 127,000); the different total derived from the NLSCY is a possible reflection of the unreliability of self-report, especially regarding a condition such as asthma with its heterogeneous severity. For present purposes, the magnitude estimate is expressed as a range, 77,600 to 127,000, with the upper end driving the rating of High.

³⁶⁸ Vessey JA. Psychological comorbidity in children with chronic conditions. *Pediatric Nursing*. 1999; 25(2): 211-4.

³⁶⁹ Turkel S, Pao M. Late consequences of chronic pediatric illness. *Psychiatric Clinics of North America*. 2007; 30(4): 819-35.

³⁷⁰ van Schayck OC, Maas T, Kaper J et al. Is there any role for allergen avoidance in the primary prevention of childhood asthma? *Journal of Allergy and Clinical Immunology*. 2007; 119(6): 1323-8.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **Medium**. Asthma is a chronic disease with typically moderate health effects; however, because of its complexity and the various disorders encompassed by this disease category, the total burden on health and well-being is difficult to ascertain.

The **Modifiability** of the potential indicator is assessed as **Low**. Attempts to delay or prevent the development of asthma have not been successful; asthma is likely a multifactorial disease, making primary prevention a complex task. The modifiability of the *experience* of asthma is another matter; secondary prevention can moderate the severity of symptoms and reduce the frequency of attacks, including the most serious variety that often leads to hospitalization. It may be preferable to develop an indicator based on reduced severity among asthma cases rather than reduced prevalence, perhaps using a proxy such as the level of health services utilization by patients with asthma.

Data Availability/Validity for the potential indicator is assessed as **Low**. While there are routine sources of survey data for prevalence of asthma among B.C. children, the complexity around disease presentation makes obtaining valid information very challenging—which accounts for the large disconnect between sampling data and the one-time administrative data tracked by the Ministry of Health in B.C. Re-establishing a registry that tracks physician visits, medications, and/or hospitalization for asthma may generate a more valid measure, one that would inevitably focus on the more serious cases of asthma that probably should be the main focus anyway. Registry development costs tend to be front-loaded, related to building and validating an algorithm, but then it becomes a relatively inexpensive “gift that keeps on giving” in terms of very reliable data. Finally, it should be noted that the more serious cases of asthma will also be reflected in the global disability measure described in the next section of the report, though not in cause-specific manner.

The potential indicator of asthma prevalence among children is **Not Recommended** for consideration as a core indicator of child health and well-being. Asthma is the most prevalent of the chronic physical conditions among children, and therefore can serve as a marker of population health that offers a potentially important pointer to environmental impacts on developing biological systems; in other words, asthma prevalence can act like a “canary in the mine shaft” that says something about the preventable air quality problems (local or atmospheric) and other environmental exposures of children, even though their etiologic force in asthma may not yet be fully elucidated. It is also true that some the ratings under the assessment categories are higher; however, as noted above, the decision as to whether a primary or secondary prevention focus should be adopted remains outstanding, as is the commitment to adopt a registry-based data system (capturing “diagnosed asthma”) that would be superior to survey information. At present, it is most appropriate to retain this potentially important sub-concept under the category of “secondary interest.”

Cause-Specific Disability

*Every examination of disability among children must first grapple with definition of disability.*³⁷¹

This section examines disability where the cause may be characterized as physical; as noted earlier, disability is, by definition, a concept related to health and well-being. While no further evidence is required to establish this linkage on the causal side of the equation, it is still useful to point out the substantial physical effects associated with disability. In particular, three major correlates or consequences of disability in children were identified through a cursory scan of the literature.³⁷²

1. Secondary physical conditions are known to be elevated, including obesity^{373,374}
2. Injuries occur more frequently than in other age groups³⁷⁵
3. There are adult physical outcomes, reflecting in part the reality that an increasing proportion of disabled children are surviving to adulthood^{376,377,378}

Of course, this list only represents the “tip of the iceberg.” The greatest impact of disability on well-being is experienced in realms that move beyond physical disorders. Reduced abilities and the attendant functional or activity limitations obviously can exert a substantial influence on life satisfaction/quality of life—a reality that researchers attempt to measure by means of a variety of instruments.³⁷⁹ Recently, there has been a growing appreciation of the environmental and psychosocial mediators of such effects, as well as the subjective perspective brought to the equation by disabled persons themselves.³⁸⁰

Despite the fact that it represents an intuitively transparent idea, a major area of investigation and intervention in the developed world, both defining and measuring disability remain very challenging tasks.^{381,382,383,384,385,386,387,388} There are several complicating factors involved, including:

³⁷¹ Mudrick NR. The prevalence of disability among children: paradigms and estimates. *Physical Medicine and Rehabilitation Clinics of North America*. 2002; 13(4): 775-92.

³⁷² This search was facilitated by the fact the “disabled children” is in fact a MeSH term in PubMed.

³⁷³ Turk M. Secondary conditions and disability In: Field M, Jette A, Martin L, eds. *Workshop on disability in America: A new look - summary and background papers*. Washington, DC: The National Academy of Science; 2006, Turk M. Secondary conditions and disability In: Field M, Jette A, Martin L, eds. *Workshop on disability in America: A new look - summary and background papers*. Washington, DC: The National Academy of Science; 2006.

³⁷⁴ Chen AY, Kim SE, Houtrow AJ et al. Prevalence of obesity among children with chronic conditions. *Obesity (Silver Spring)*. 2010; 18(1): 210-3.

³⁷⁵ Behmardi P, Olsen L. *Injury Prevention Experiences of Parents of Children with Disabilities and Chronic Health Conditions*. [Available online; search by title.]

³⁷⁶ Roebroek ME, Jahnsen R, Carona C et al. Adult outcomes and lifespan issues for people with childhood-onset physical disability. *Developmental Medicine & Child Neurology*. 2009; 51(8): 670-8.

³⁷⁷ Malleon PN. Pain syndromes, disability, and chronic disease in childhood. *Current Opinion in Rheumatology*. 1991; 3(5): 860-6.

³⁷⁸ Turkel S, Pao M. Late consequences of chronic pediatric illness. *Psychiatric Clinics of North America*. 2007; 30(4): 819-35.

³⁷⁹ Cowan J, Baker GA. A review of subjective impact measures for use with children and adolescents with epilepsy. *Quality of Life Research*. 2004; 13(8): 1435-43.

³⁸⁰ Rosenbaum P. Children's quality of life: separating the person from the disorder. *Archives of Disease in Childhood*. 2008; 93(2): 100-1.

³⁸¹ MacKenzie A, Hurst M, Crompton S. Statistics Canada. Living with disability series. Available at <http://www.statcan.gc.ca/pub/11-008-x/2009002/article/11024-eng.htm>. Accessed October 2010.

- The various biological, philosophical, and sociopolitical meanings of “normal” ability
- The degree of departure from an “able” state that is required before being characterized as disabled
- As a corollary to the latter point, the general understanding that there are different levels of disability rather than a single discrete state
- Establishing criteria, whether intrinsic (e.g., experience of pain) or extrinsic (e.g., the oft-used category of “activity limitation”), to guide and inform self-reports of disability
- The difficulty, as with all self-reported measures, in aggregating personal assessments of disability into a true measure of population burden
- The temptation to solve such problems by moving towards more objective measures (e.g., diagnosed chronic disease) as a proxy for disability—the problem being that experience of disability is not always traceable to a clear disease, and all chronic conditions do not generate the same level of disability; as well, there are general philosophical objections to linking disability with disease and the so-called “medical model”—as opposed to alternatives such as a more “social model” or the perspective that looks at the degree of support required for “special needs”
- The most ascertainable criteria of all, namely, the presence of some kind of traditionally-recognized physical impairment such as genetic defects, vision loss, or paralysis and/or the routine use of assistive devices, may lead to reliable data but they also tend to represent too small an umbrella to cover what people typically think of as disability

The subtleties suggested in the preceding list are consistent with the rather abstract understanding of disability promoted by the World Health Organization (WHO):³⁸⁹

Disability is a complex phenomenon, reflecting an interaction between features of a person's body and features of the society in which he or she lives.

Unfortunately, the conceptual and practical challenges only increase when sharpening the focus to pediatric disability.³⁹⁰ This is because children and youth are in the midst of a developmental flux, with bodies constantly changing, so it is sometimes difficult to establish

³⁸² DesMeules M, Turner L, Cho R. Morbidity experiences and disability among Canadian women.

³⁸³ Setting research priorities for childhood disability. Available at <http://www.canchild.ca/en/ourresearch/priorities.asp>. Accessed October 2010.

³⁸⁴ Human Resources Development Canada. *Defining Disability: A Complex Issue*. 2003. Ottawa: Government of Canada.

³⁸⁵ Stein R. Trends in disability in early life. In: Field M, Jette A, Martin L, eds. *Workshop on disability in America: A new look - summary and background papers*. Washington, DC: The National Academy of Science; 2006.

³⁸⁶ Barbotte E, Guillemin F, Chau N. Prevalence of impairments, disabilities, handicaps and quality of life in the general population: a review of recent literature. *Bulletin of the World Health Organization*. 2001; 79(11): 1047-55.

³⁸⁷ Masala C, Petretto DR. From disablement to enablement: conceptual models of disability in the 20th century. *Disability & Rehabilitation*. 2008; 30(17): 1233-44.

³⁸⁸ Simeonsson RJ, Lollar D, Hollowell J et al. Revision of the International Classification of Impairments, Disabilities, and Handicaps: developmental issues. *Journal of Clinical Epidemiology*. 2000; 53(2): 113-24.

³⁸⁹ See the webpage at <http://www.who.int/topics/disabilities/en/>. Accessed October 2010.

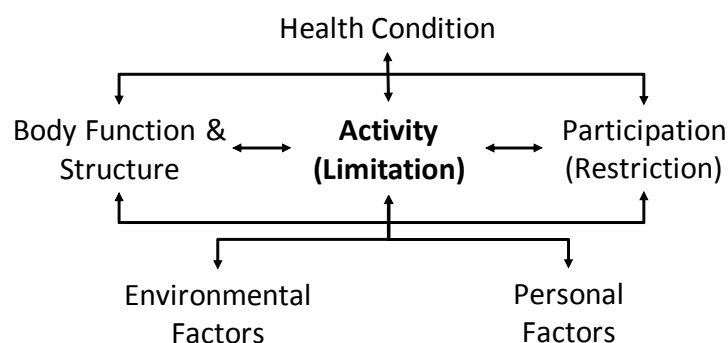
³⁹⁰ Colver A. A shared framework and language for childhood disability. *Developmental Medicine & Child Neurology*. 2005; 47(11): 780-4.

when a presenting condition has settled into the sort of chronic state that normally is associated with the idea of disability.³⁹¹

For the purposes of this project, the definition of disability will be guided by the most common core idea proposed by health and advocacy groups: To be disabled means to experience at least one activity limitation, that is, the personal reality where difficulty is encountered in executing one or more tasks or actions. It is true that some type of disease condition and/or physical impairment usually creates the disability; it is also true that, depending on environmental factors, activity limitation(s) may affect a person's participation in one or more broader aspects of society. However, these various ideas will be deemed to be secondary.

An elaborated World Health Organization (WHO) understanding of disability is reflected in its 10-year-old International Classification of Functioning, Disability and Health (ICF). The ICF defines functioning and disability as multi-dimensional concepts; each major component is associated with a hierarchy of codes similar to the well-known International Classification of Diseases and Related Health Problems (or ICD). The fact that the interconnected ideas are ultimately centered on daily activities and their limitation is made clear in the following diagram:

Interactions Between Components of the ICF



Source: WHO 2001, International Classification of Functioning, Disability and Health.

The ICF has been very influential in the thinking of countries such as Canada and the U.S., with its basic structure being progressively incorporated into plans for disability surveillance.^{392,393,394} This has been seen most dramatically in the *Participation and Activity Limitation Survey* (PALS), Canada's principal national survey focusing on persons with disabilities (see further details in the next section). Undoubtedly, the ICF will continue to

³⁹¹ Simeonsson R. Defining and classifying disability in children. In: Field M, Jette A, Martin L, eds. *Workshop on disability in America: A new look - summary and background papers*. Washington, DC: The National Academy of Science; 2006.

³⁹² Howard D, Nieuwenhuijsen ER, Saleebey P. Health promotion and education: application of the ICF in the US and Canada using an ecological perspective. *Disability and Rehabilitation*. 2008; 30(12-13): 942-54.

³⁹³ Simeonsson R. Defining and classifying disability in children. In: Field M, Jette A, Martin L, eds. *Workshop on disability in America: A new look - summary and background papers*. Washington, DC: The National Academy of Science; 2006.

³⁹⁴ McDougall J, King G, de Wit DJ et al. Chronic physical health conditions and disability among Canadian school-aged children: a national profile. *Disability and Rehabilitation*. 2004; 26(1): 35-45.

have a major impact as the survey instrument is being refined for use after the 2011 Canadian census.

Data Sources and Population Magnitude

The actual concept being considered in this section is “cause-specific disability.” Alternate approaches do exist. Similar to chronic diseases in the previous section, one can conceive of a *global* measure of disability (i.e., the rate of disabled persons in a population) as determined by self-report in a census or survey. Whereas this did not make much sense for chronic disease, it could be more useful in the case of disability. The problem with determining a global chronic disease rate is first identifying the chronic conditions that will be included. In contrast, once disability is defined in terms of limited activity or function then the categories are not as hard to pin down, potentially leading to pediatric survey data that are comparable across time periods and jurisdictions. In Canada, ten arenas of disability are generally recognized in instruments such as PALS: hearing, seeing, communication, mobility, agility, pain, learning, memory, developmental, and emotional.³⁹⁵ This list is very similar to the eight components of the Health Utility Index (HUI): hearing, vision, speech, ambulation, dexterity (i.e., hand function), pain, cognition, and emotion.³⁹⁶ The HUI, an inventory originally developed at McMaster University for pediatric health assessment, has also been influential in the development of Canadian population health surveys.

The sort of disability categories suggested here seem relatively straightforward at a conceptual level, but in practice a wide variation has still been observed in disability rates estimated through pediatric surveys and other techniques; in fact, the estimate has ranged from 2 to 30% in different European and North American settings.^{397,398,399,400} Recent Canadian estimates have spanned a narrower range (4 to 8%), but still indicate enough variation to raise questions about their utility.⁴⁰¹ This provides further incentive to prefer cause-specific disability as the foundation for a series of potentially more reliable indicators.

Choosing “cause-specific disability” as the focus allows the present task to be narrowed considerably. The research question may be restated as follows: What physical health conditions are associated with substantial levels of disability in pediatric population? This approach enables a picture to be developed of potential high-leverage targets for prevention efforts, whether primary, secondary, or tertiary (i.e., rehabilitation); conceivably, it would also allow overall disability to be assessed (by aggregating over selected causes). Another

³⁹⁵ MacKenzie A, Hurst M, Crompton S. Statistics Canada. Living with disability series. Available at <http://www.statcan.gc.ca/pub/11-008-x/2009002/article/11024-eng.htm>. Accessed October 2010.

³⁹⁶ Kopec JA, Williams JI, To T et al. Measuring population health: correlates of the Health Utilities Index among English and French Canadians. *Canadian Journal of Public Health*. 2000; 91(6): 465-70.

³⁹⁷ American Academy of Pediatrics Committee on Children With Disabilities and Committee on Psychosocial Aspects of Child and Family Health. Psychosocial risks of chronic health conditions in childhood and adolescence. *Pediatrics*. 1993; 92(6): 876-8.

³⁹⁸ Boyce WF, Davies D, Raman SR et al. Emotional health of Canadian and Finnish students with disabilities or chronic conditions. *International Journal of Rehabilitation Research*. 2009; 32(2): 154-61.

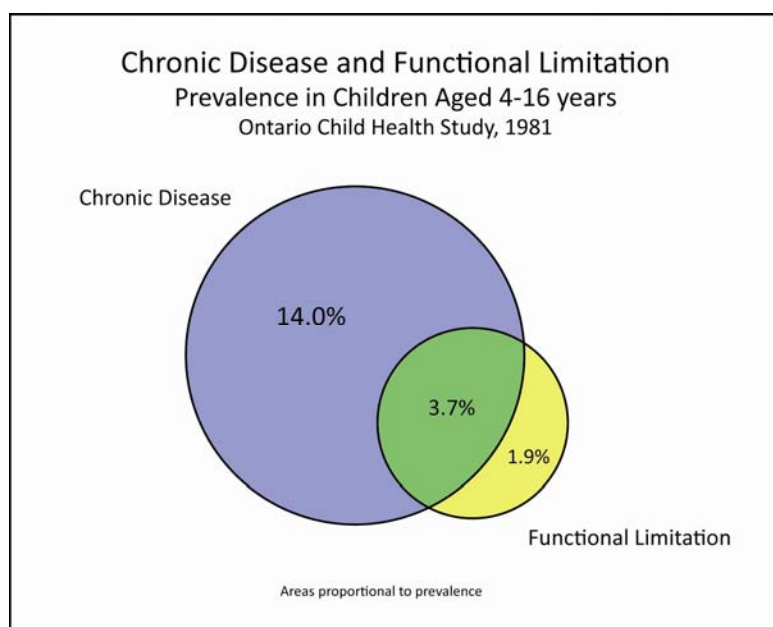
³⁹⁹ Stein R. Trends in disability in early life. In: Field M, Jette A, Martin L, eds. *Workshop on disability in America: A new look - summary and background papers*. Washington, DC: The National Academy of Science; 2006.

⁴⁰⁰ Blackburn CM, Spencer NJ, Read JM. Prevalence of childhood disability and the characteristics and circumstances of disabled children in the UK: secondary analysis of the Family Resources Survey. *BMC Pediatrics*. 2010; 10: 21.

⁴⁰¹ Simpson F. Access to respite care for parents who have children with disabilities in B.C. Available at http://www.kbas.citymax.com/f/Final_Capstone%5B1%5D.pdf. Accessed October 2010.

reason to at least start with data related to underlying causes is the fact that the trends for each cause have sometimes “gone in different directions and make it hard to provide a single message about what is happening with childhood disability.”⁴⁰²

A caveat is in order: cause-specific disability cannot be equated with counting up the instances of each causal factor. The reason is simple: past diagnosis of a disease does not always imply the presence of disability—apart from personal and environmental factors that affect the experience of disability, there is always the possibility of remission, rehabilitation, or even a cure. This phenomenon can be dramatically illustrated at the aggregate level. Thus, even if the problems involved with estimating an aggregate chronic disease rate could be solved (see previous chapter), such rates will generally exceed disability rates. For example, McDougall et al. estimated that 30% of Canadian children aged 6 to 11 years report one or more chronic physical health diseases or impairments, including conditions such as allergies and skin conditions that, generally speaking, have relatively small impacts on daily functioning; this accounts for the fact that only about 4% of respondents in the survey examined by McDougall reported having activity-limiting conditions.⁴⁰³ This is consistent with the results found in an older survey of Ontario families, as seen in the following diagram.⁴⁰⁴ About 17.7% of children aged 4-16 years reported a chronic illness or condition, again including relatively minor disorders, but only 3.7% of that cohort also reported functional limitations.



⁴⁰² Stein R. Trends in disability in early life. In: Field M, Jette A, Martin L, eds. *Workshop on disability in America: A new look - summary and background papers*. Washington, DC: The National Academy of Science; 2006. Stein R. Trends in disability in early life. In: Field M, Jette A, Martin L, eds. *Workshop on disability in America: A new look - summary and background papers*. Washington, DC: The National Academy of Science; 2006.

⁴⁰³ McDougall J, King G, de Wit DJ et al. Chronic physical health conditions and disability among Canadian school-aged children: a national profile. *Disability and Rehabilitation*. 2004; 26(1): 35-45.

⁴⁰⁴ Cadman D, Boyle MH, Offord DR et al. Chronic illness and functional limitation in Ontario children: findings of the Ontario Child Health Study. *Canadian Medical Association Journal*. 1986; 135(7): 761-7.

A similar pattern has been reported in the U.S. context.^{405,406} This consistent phenomenon reflects the clear fact that only a subset of the cases of each disease is associated with experienced disability (i.e., activity limitation) at a particular time; details related to selected major chronic conditions are provided in the following table, based on the work of McDougall et al. Estimated cases with actual activity limitation have been calculated for each condition by multiplying the total cases of each condition by the percentage of those cases associated with activity limitations.

Prevalence of Pediatric Chronic Conditions and Activity Limitation									
By Age Group, Canada, 1994-1995									
Condition	Cases per 1000			% with Associated Activity Limitations			Estimated Cases per 1000 With Activity Limitations		
	<i>Age 6-8</i>	<i>Age 9-11</i>	<i>Total</i>	<i>Age 6-8</i>	<i>Age 9-11</i>	<i>Total</i>	<i>Age 6-8</i>	<i>Age 9-11</i>	<i>Total</i>
Allergies	175.6	199.0	187.4	8.5%	10.3%	9.5%	14.9	20.5	17.8
Asthma	68.2	59.9	64.0	23.2%	22.1%	22.7%	15.8	13.2	14.5
Bronchitis	39.0	30.6	34.8	14.0%	11.0%	12.7%	5.5	3.4	4.4
Heart disease	11.6	9.3	10.4	n/a	n/a	15.1%	-	-	1.6
Kidney disease	6.8	2.0	4.4	n/a	n/a	18.7%	-	-	0.8
Epilepsy	2.0	4.3	3.2	n/a	n/a	47.7%	-	-	1.5
Pain (e.g., headache)*	17.4	19.4	18.4	31.5%	33.3%	32.5%	5.5	6.5	6.0
Any other	45.5	58.2	51.9	25.4%	24.1%	24.7%	11.6	14.0	12.8
*Often of unknown origin									
Source: Derived by McDougall et al. from National Longitudinal Study of Children and Youth data, 1994-5									

The only conditions noted in the McDougall paper but omitted here are: vision and hearing impairments, as they are covered in another chapter of this report; and speech, as it lies outside the scope of this report.

McDougall and colleagues derived their information from the *National Longitudinal Survey of Children and Youth*. In fact, there are at least two other information sources that allow for chronic conditions to be tracked as well as associated rates of (cause-specific) disability. The three sources generating routinely available Canadian data of this sort will be briefly described below.

National Longitudinal Survey of Children and Youth (NLSCY)

This survey has been conducted biennially since 1994, with the latest available data from 2006-2007; respondents are between the ages of 0 to 11 years at selection, and are tracked until age 21 years. The NLSCY differs from the CCHS (see below) in being a longitudinal investigation of a cohort over time, and of course in focusing on children younger than 12 years (thereby covering the population not included in the CCHS). The survey covers a wide range of topics related to the development of children, including child behaviour, education, and health and well-being. The health section asks specifically about diagnosed chronic

⁴⁰⁵ American Academy of Pediatrics Committee on Children With Disabilities and Committee on Psychosocial Aspects of Child and Family Health. Psychosocial risks of chronic health conditions in childhood and adolescence. *Pediatrics*. 1993; 92(6): 876-8.

⁴⁰⁶ Msall ME, Avery RC, Tremont MR et al. Functional disability and school activity limitations in 41,300 school-age children: relationship to medical impairments. *Pediatrics*. 2003; 111(3): 548-53.

medical conditions, as well as about activity limitations, allowing associations to be identified and cause-specific disability rates to be determined. As with the information derived from other survey instruments, the term “cause” is used loosely here; associations are suggestive when combined with other information, but do not in fact prove causation.

Canadian Community Health Survey (CCHS)

CCHS information has been collected biennially since 2000/2001, although its predecessor, the National Population Health Survey (NPHS), dates back to 1994. The CCHS gathers data concerning a wide range of health topics at a sub-provincial level (including Health Authorities and Health Service Delivery Areas), making it useful for tracking B.C.-specific indicators. The survey questions include an extensive section on chronic conditions. Since the main target group is individuals aged 12 years and over, the CCHS paints only a partial picture of pediatric chronic conditions, disability, etc. In addition to two general questions related to activity and functional limitations, there is one question in the CCHS that does explore a cause-specific aspect of disability, namely, the existence of a level of pain or discomfort that prevents activities; however, this information was not reported for children, apparently due to unreliability of the data.

The disability-related CCHS data for B.C. adolescents in 2009 is provided in the following table:

Population Measures Related to Disability in B.C.		
Youth Aged 12-19		
by Gender, CCHS		
	Male	Female
Participation and activity limitation, sometimes or often	10.1%	14.4%
Functional health, less than good	15.5%	12.4%
Source: Canadian Community Health Survey, 2009.		

Participation and Activity Limitation Survey (PALS)

The predecessor instrument known as the Health and Activity Limitation Survey (HALS) collected data in 1986 and 1991 before being reshaped and renamed PALS in 2001.⁴⁰⁷ The intention of these surveys continues to be the gathering of high-quality information about disability in Canada every five years; thus, the most recent available data dates from 2006.

Participation and Activity Limitation is a post-censal survey. Its sample audience is selected from those who answer “yes” to at least one of two general census “filter” questions concerning activity and functional limitations. Data collected by PALS have been used to determine the prevalence of disability in broad terms across the country; for instance, the

⁴⁰⁷ Statistics Canada. *A new approach to disability data: Changes between the 1991 Health and Activity Limitation Survey (HALS) and the 2001 Participation and Activity Limitation Survey (PALS)*. 2002. Available at <http://www.statcan.gc.ca/bsolc/olc-cel/olc-cel?catno=89-578-X&CHROPG=1&lang=eng>. Accessed November 2010.

2006 results confirmed that activity limitation prevalence rates increase steadily with age, from less than 5% in people under 25 years to over 55% in those over 75 years.⁴⁰⁸

It is important to note that associations between disease “causes” and the subset of cases with actual disability are not readily available through any of the data sources; instead, such results represent information derived through a secondary analysis similar to that performed by McDougall and co-investigators (see the table above). The only such analyses found for the NPHS and PALS did not break the data down to specific causes, but did provide the following aggregate information for pediatric populations:

- In the Canadian context, the NPHS from 1996-7 showed that rates of chronic disease among those aged 12-19 years ranged from 35 to 45%, whereas the rate of disability (defined as activity limitation) was only about 8% for children 0- 19 years old.⁴⁰⁹
- The most recent information for the B.C. context, derived from PALS 2006, suggests that there are 3980 children aged 0-4 years (a rate of 2%) and 22,540 (about 5%) aged 5-14 years with disabilities; furthermore, some 65% of such cases may be traced in whole or in part to chronic physical conditions—a figure that is remarkably consistent with Ontario results from 25 years earlier (see diagram above).⁴¹⁰

Conclusion

Although modest in comparison with rates seen in the elderly, the absolute number of disabled children and (especially) adolescents in B.C. is enough to position this concept as a potential priority for tracking. When thinking of the policy implications of a concept such as pediatric disability, there appear to be two overarching strategies for population-level improvement:

- Address disability indirectly either through primary prevention that will reduce the incidence of underlying chronic conditions or through screening/treatment of early disease
- Address disability directly in terms of rehabilitation services, assistive devices, support resources, and environmental adaptations for various physical impairments, thereby decreasing the population burden of limitation created by disease

The first approach is consistent with the concept as detailed for this project, that is, cause-specific disability; it is a way of approaching the concept that substantially overlaps with the immediately preceding section on chronic disease, *with the proviso that the ultimate focus needs to be on the proportion of chronic disease cases with manifest disability* (as illustrated by the work of McDougall et al. cited herein). If such information was available, it could be useful in shaping cause-specific prevention targets; however, the most recent analysis appears to date back to the first NLSCY in 1994-5.

⁴⁰⁸ An Overview of PALS 2006. Available at http://www.utoronto.ca/rdc/files/Eng_PALS_Toronto.pdf. Accessed October 2010.

⁴⁰⁹ Summarized in Canadian Institute of Child Health. *The health of Canada's children: A CICH profile*. 2000. Available at http://www.cich.ca/Publications_monitoring.html. Accessed November 2010.

⁴¹⁰ Schiariti V, Miller A, O'Donnell et al. Pediatric profile of disability in British Columbia (Abstract). Available at <http://www.pulsus.com/cps2008/abs/054.htm>. Accessed October 2010.

Given this serious data limitation, the only “off the shelf” option available to health planners is a combination of two *global* (rather than cause-specific) indicators of pediatric disability for B.C. that are available, based on PALS for younger children and on CCHS for adolescents. Again, the only way to shift from this global approach to one or more indicators related to a specific cause of pediatric disability would be to establish a system to routinely track a high-prevalence condition such as asthma *in terms of the cases that actually generate activity limitation*. This data analysis system does not appear to exist at present in B.C.

Summary Assessment					
Global Measure of Disability/Activity Limitation					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	72,600	Medium	High	Medium	Low

As summarized above, assessments have been applied to the Cause-specific Disability concept, specifically in terms of the indicator with the most compelling support in the literature, namely, *a global measure of disability, defined in terms of activity limitation*.

The pediatric population **Magnitude** of the potential indicator is assessed as **Medium**. Based on a combination of two data sources (PALS and CCHS), approximately 7.5% of children aged 0-19 years have a general disability, which are likely to generate participation or activity limitations. When this percentage is applied to the entire pediatric cohort, the resulting estimate is 72,600 individuals; this is between 2 and 10% (19,000 and 97,000) of the total pediatric cohort, resulting in a Magnitude classification of Medium.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual’s health and well-being is assessed as **High**. Disability by its very definition implies impact on an individual’s well-being by hampering their ability to function in everyday activities and/or within society.

The **Modifiability** of the potential indicator is assessed as **Medium**. Two main ways of lowering the prevalence of cause-specific disability would be through primary prevention—by reducing the incidence of underlying chronic conditions or through screening/treatment of early disease—or through rehabilitation services, assistive devices, support resources, and environmental adaptations for various physical impairments, thereby decreasing the limitation created by disease. In many cases, such efforts would be both challenging and costly.

Data Availability/Validity for the potential indicator is assessed as **Low**. Canadian data on disability are available through three main self-report sources, the National Longitudinal Survey of Children and Youth, the Canadian Community Health Survey, and the Participation and Activity Limitation Survey (PALS). Of these three, PALS is the most directly geared towards disability; it is important to note that none of the sources track the specific causes of disability, thus making them most useful as drivers of a *global* disability indicator. The rationale for a Low rating for this assessment category is the lack of cause-specific information, and the fact that a comprehensive indicator integrating various disabilities across the pediatric cohort requires combining two different survey data streams, which automatically introduces concerns about validity.

Especially because of the data deficits, the potential indicator of global pediatric disability is **Not Recommended** for consideration as a core indicator of child health and well-being, although the concept should be retained on the “secondary interest” list. Ultimately, cause-specific disability (which would require a number of statistics to be developed and tracked) may be preferred to the broader measure of disability discussed here.

Major Childhood Infectious Diseases

Infectious disease once caused a great degree of morbidity and mortality in what is now known as the developed world, and continues to do so in the developing world.⁴¹¹ A little over a century ago, the childhood mortality rate before 5 years of age in the U.S. was 20%, as was the infant mortality rate.⁴¹² The dramatic shift from this (now inconceivable) situation in the U.S., Canada, and many other countries has been achieved through primary prevention initiatives, especially involving immunization (see separate chapter on this concept) and sanitation/hygiene measures.

There are five main categories of infections that are pertinent to children and/or adolescents in British Columbia:

- Vaccine-preventable (e.g., Pertussis)
- Transmitted by contact and respiratory routes (e.g., Tuberculosis)
- Sexually transmitted (e.g., Chlamydia)
- Enteric, food, and waterborne (e.g., Salmonellosis)
- Vectorborne (e.g., Rabies)

The category of sexually transmitted infections (STIs) is covered in a separate chapter of the report. As will be seen below, two categories stand out among the rest of the infectious agents.

Data Sources and Population Magnitude

The BC Centre for Disease Control tracks statistics on infectious disease. According to the latest available information, the following reportable pediatric infectious disease cases are found in the province:⁴¹³

⁴¹¹ Stein CE, Inoue M, Fat DM. The global mortality of infectious and parasitic diseases in children. *Seminars in Pediatric Infectious Diseases*. 2004; 15(3): 125-9.

⁴¹² Stern AM, Markel H. The history of vaccines and immunization: familiar patterns, new challenges. *Health Affairs*. 2005; 24(3): 611-21.

⁴¹³ BC Center for Disease Control. *British Columbia annual summary of reportable diseases 2009*. 2010. Available at <http://www.bccdc.ca/util/about/annreport/default.htm>. Accessed November 2010.

Pediatric Infection in British Columbia
Incidence by Age Group and Infection, 2009

Infections	< 1 year	1-4 years	5-9 years	10-14 years	15-19 years	Totals
Diseases preventable by vaccination						
<i>Haemophilus influenzae</i> type b (Hib), invasive	1					1
Hepatitis B (all chronic or unknown)	4	4	2	9	11	30
Influenza	169	560	837 *	937 *	1089 *	3593
Meningococcal disease, invasive	5	2	1	1		9
Pertussis	19	44	27	29	7	126
Pneumococcal disease, invasive	8	17	8	5	4	42
Sexually transmitted and bloodborne pathogens	16	2	2	68	2982	3070
Diseases transmitted by direct contact and respiratory routes						
Streptococcal disease, invasive, group A	2	4	2	3	5	16
Tuberculosis		4	1		7	13
Enteric, food and waterborne diseases						
Amebiasis		6	3	6	9	24
Campylobacteriosis	9	85	58	45	94	291
Cryptosporidiosis	1	12	13	2	8	36
Cyclosporiasis		1	1		3	5
Shigatoxigenic <i>E. coli</i> (STEC) Infection		32	19	8	11	70
Giardiasis		58	44	29	28	159
Hepatitis A		1	1		2	4
Listeriosis	1				2	3
Salmonellosis	27	77	51	43	73	271
Shigellosis	2	5	6	5	5	23
Yersiniosis	5	36	18	15	11	85
Vectorborne and other zoonotic diseases						
Malaria			3			4
Rabies, exposure incidents	2	7	12	8	17	46
Environmental Fungi						
<i>Cryptococcus gattii</i>					1	1
Total Infections	271	957	1109	1213	4375	7928
Total Population	44601	175054	220188	246668	286632	973143
Infection Rate (per 100,000 population)	608.7	546.8	503.5	491.9	1526.4	814.7

Infection totals from BC Centre for Disease Control; population totals from Demography Division, Statistics Canada, Ottawa.

* Absolute numbers calculated from reported incidence rates

It is clear from this table that most individual conditions are quite rare. Among the more frequent infections, only STIs and influenza appear to demonstrate morbidity that would qualify as a population-level concern at this time.

Physical Health Effects

The counterargument to focusing on pediatric influenza as a core indicator entails moving beyond basic incidence information to actual health impacts. While it is surely inconvenient and unpleasant to contract influenza, it very rarely progresses to the level where the physical health of children is seriously affected. As proof of this, the next chapter highlights that there

are less than 10 annual pediatric deaths across the province *from all infectious agents combined*. On the other hand, there is a substantial seasonal use of health care resources by children who contract influenza.⁴¹⁴ The latter reality buttresses any decision to add influenza as a core indicator, thereby allowing the province to track any reduction in the 3600 annual cases among children.

An alternate indicator in this field would involve tracking pediatric influenza immunization coverage for all age subgroups, or at least for ages 6 to 23 months where (along with seniors) public campaigns most intensely focus. However, as indicated in the separate chapter on immunization rates, any attempt to improve the rate of influenza immunization among children, and thereby further reduce morbidity if not mortality related to that infection, is impeded by the apparent lack of data on present coverage.

Discussion and Conclusion

As with many other public health areas, British Columbia has been at the forefront of infectious disease research and control, and committed to making continued advances in the field.^{415,416} The sure sign of success for the various primary prevention efforts related to infectious disease is the fact that, unlike in previous eras, there are very few cases of infection among the pediatric population. There are two categorical exceptions: STIs (which are covered in a separate chapter) and influenza. There are enough cases of influenza among children to potentially establish an indicator marking progress in reducing incidence, but improvements in data concerning pediatric influenza immunization may be more pertinent to this (generally modest) health threat. Despite the data gap, it is reassuring that the children most at risk from contracting influenza are definitely targeted by current immunization campaigns in B.C. This may account for the very low mortality related to influenza among children in the province.

Rating pediatric infectious disease as a low priority to add to the list of core indicators (possibly with the exception of one or more STIs) does not suggest complacency in this field. Contemporary prevention approaches need to be maintained in order to forestall outbreaks of infectious disease now maintained at very low levels. As well, given the continual emergence of new infectious threats through international travel, mutation, etc., there will always be a need for vigilance, development of new prevention efforts, and possibly a temporary indicator to monitor any disease that reaches a level of concern at the population level. This was recently demonstrated in the H1N1 (swine flu) virus pandemic of 2009, which led to an appreciable number of deaths in Canada, including a small number among children.^{417,418,419}

⁴¹⁴ Sebastian R, Skowronski DM, Chong M et al. Age-related trends in the timeliness and prediction of medical visits, hospitalizations and deaths due to pneumonia and influenza, British Columbia, Canada, 1998-2004. *Vaccine*. 2008; 26(10): 1397-403.

⁴¹⁵ Patrick DM, Remple VP, Kendall P et al. Needs, gaps and opportunities for infectious disease research in British Columbia: a perspective from population and public health. *Canadian Journal of Public Health*. 2006; 97 (Suppl 3): S24-32, S27-36.

⁴¹⁶ Janjua NZ, Skowronski DM, Hottes TS et al. Seasonal influenza vaccine and increased risk of pandemic A/H1N1-related illness: first detection of the association in British Columbia, Canada. *Clinical Infectious Diseases*. 2010; 51(9): 1017-27.

⁴¹⁷ Campbell A, Rodin R, Kropp R et al. Risk of severe outcomes among patients admitted to hospital with pandemic (H1N1) influenza. *Canadian Medical Association Journal*. 2010; 182(4): 349-55.

⁴¹⁸ Pourbohloul B, Ahued A, Davoudi B et al. Initial human transmission dynamics of the pandemic (H1N1) 2009 virus in North America. *Influenza and Other Respiratory Diseases*. 2009; 3(5): 215-22.

Summary Assessment					
Incidence of Infections					
Age group (Years)	Est. Incidence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	7,900	Low	Medium	Medium	Medium

As summarized above, assessments have been applied to the Major Childhood Infectious Diseases concept, specifically in terms of an indicator built around the *prevalence of infections among children*.

The pediatric population **Magnitude** of the potential indicator is assessed as **Low**. Based on B.C. Center for Disease Control data, the incidence of pediatric infection is approximately 815 / 100,000 individuals. Applying this rate the entire pediatric cohort results in a prevalence estimate of 7,900 individuals (assuming a general pattern of clearance within a year, so that incidence may be equated to annual prevalence). The total is less than 2% of the total pediatric cohort (19,000), resulting in a Magnitude classification of Low.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **Medium**. Childhood infectious diseases typically have moderate and sometimes serious acute effect on health, with certain cases leading to chronic effects and even death.

The **Modifiability** of the potential indicator is assessed as **Medium**. The category of modifiability integrates two issues in this project, the availability of effective interventions and the degree to which effective interventions have already been applied (i.e., whether the "low hanging fruit" of the most preventable cases has already been harvested). The rationale for a Medium rating is that immunization programs for the key childhood infections are already substantially deployed.

Data Availability/Validity for the potential indicator is assessed as **Medium** due to variations in the tracking of information on childhood infections. Data on reportable infectious diseases are routinely collected by the BCCDC; the infections fall into two general categories, those that are reportable when detected by staff wherever they are located in the health care system (including laboratories, public health nurses, physicians, etc.), and those that are only reportable when identified in laboratories. Not all infections are reportable. For example, in the case of pneumonia, an umbrella term for inflammatory respiratory conditions that have a number of causal agents, only some of the implicated infections (e.g., *Haemophilus influenzae*, *Streptococcus pneumoniae*) are reportable. Influenza infections are reportable by type when identified by a laboratory; thus, a substantial volume of suspected pediatric influenza cases seen by physicians will not be reported to BCCDC, requiring an alternate method of data collection were this ever to be considered a priority.

Based on the indicated assessment, the potential indicator of prevalence of pediatric infections is **Not Recommended** for consideration as a core indicator of child health and well-being. The main rationale is the consistent medium rating for most of the assessment categories, and the Low rating for Magnitude.

⁴¹⁹ Bettinger JA, Sauve LJ, Scheifele DW et al. Pandemic influenza in Canadian children: a summary of hospitalized pediatric cases. *Vaccine*. 2010; 28(18): 3180-4.

Cause-Specific Mortality

Pediatric mortality rate, and especially infant mortality rate, is a sentinel indicator of child health and well-being in a global context; reducing such rates is still an intense focus for the majority of the world's nations.⁴²⁰ Through prevention measures noted in this chapter and elsewhere in the report, British Columbia has gradually reduced its pediatric mortality rate to a very low level. This is not to say that more progress could not be made, or that some form of mortality indicator may not be useful as part of tracking improvements in child health.

Data Sources and Population Magnitude

Death statistics are collected and reported by the BC Vital Statistics Agency, as well as being passed along to national surveillance databases managed by Statistics Canada. The latest data for British Columbia dates from 2008, as summarized in the following table:

Pediatric Mortality in British Columbia Incidence by Age Group and Cause, 2008						
Causes	Age (years)					Total
	< 1	1-4	5-9	10-14	15-19	
Certain conditions originating in the perinatal period	80		1		1	82
External causes*		2	4	12	53	71
Congenital anomalies	35	3	2	1	1	42
Neoplasms	4	4	4	7	9	28
Diseases of the nervous system	3	7	3		5	18
Endocrine/nutritional/metabolic diseases	4				5	9
Certain infectious and parasitic diseases	2	1	1	1	2	7
Diseases of the circulatory system		1		3	2	6
Diseases of the respiratory system	2	1			1	4
Diseases of blood and blood-forming organs	1	1		1		3
Diseases of the digestive system	2				1	3
Mental and behavioural disorders					1	1
Diseases of the genitourinary system		1				1
Symptoms, signs and ill-defined conditions, unknown causes	32	9	10	3	37	91
Total Deaths	165	30	25	28	118	366
* Accidental death, homicide, suicide						
Source: BC Vital Statistics Annual Report, 2008						

Of the 275 deaths among infants, children, and adolescents in 2008, 71 (25.8%) were due to external causes—defined as transport unintentional injuries (numbering 27), other unintentional injuries (23), homicide (6), and suicide (14). The fact that these causes account

⁴²⁰ For example, Victora CG, Barros FC. Infant mortality due to perinatal causes in Brazil: trends, regional patterns and possible interventions. *Sao Paulo Medical Journal*. 2001; 119(1): 33-42.; Baird J, Ma S, Ruger JP. Effects of the World Bank's maternal and child health intervention on Indonesia's poor: Evaluating the safe motherhood project. *Social Science & Medicine*. 2010: E-pub ahead of print.

for almost half of older teen deaths is not unexpected. There is clearly an opening for prevention in this subcategory of mortality, as highlighted in the chapter on major injuries.

A further 15.3% of pediatric deaths are due to congenital anomalies; as discussed in an earlier section of this chapter, many defects present at birth are not amenable to prevention, but some secondary prevention related to severity is possible, with the potential for avoiding or delaying related mortality. The same comments apply to another of the larger categories, death due to childhood cancer (see the section Major Chronic Diseases for an inventory of cancers with pediatric onset).

There is more such opportunity afforded in the largest mortality subcategory, namely, conditions arising in the perinatal period. Both of the major types of causes involved, maternal factors and prematurity/postmaturity/growth disorders, comprise potential for modification.

Conclusion

There is a subset of pediatric death that is definitely avoidable in British Columbia, albeit the absolute numbers involved are relatively small. However, given the dire nature of mortality as an outcome, there may still be an argument to link a core indicator to pediatric mortality. An important consideration moderating any momentum to adopt a mortality-related indicator is the fact that the main causes of pediatric death—*unintentional injuries* and *perinatal conditions* (often traceable to maternal health)—are covered by other potential indicators examined for this project.

Summary Assessment					
Pediatric Deaths					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	366	Low	High	Low	High

As summarized above, assessments have been applied to the Cause-specific Mortality concept, evaluated for convenience in terms of *a global measure of pediatric mortality*.

The pediatric population **Magnitude** of the potential indicator is assessed as **Low**. Based on B.C. Vital Statistics data, the rate of pediatric mortality (aged 0-19) is approximately 28 per 100,000 population. Applying this rate to the current pediatric cohort results in a prevalence estimate of 270 individuals; this is substantially less than 2% of the total pediatric cohort (19,000), resulting in a Magnitude classification of Low.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **High**—for reasons that need no explanation!

The **Modifiability** of the potential indicator is assessed as **Low**. The reasons are that only a small percentage of childhood deaths are feasibly preventable.

Data Availability/Validity for the potential indicator is assessed as **High**. Essentially 100% of pediatric mortality is captured by, and available through, BC Vital Statistics.

The potential indicator of pediatric mortality is **Not Recommended** for consideration as a core indicator of child health and well-being. The rationale is that, notwithstanding the absolute *significance* of death, the absolute *numbers* involved are very low, and the preventable cases even more limited.

Self-Rated Health

Background and Context

The purpose of this review is to find research evidence of an association between the self-rated health and other (objective) measures of physical health of children. Self-rated health is a commonly used health indicator; most surveys assessing health ask respondents for a global evaluation—usually a rating along a 4- or 5-point scale from poor to excellent. Many studies of the validity of self-rated health have been conducted among adult populations; it has been found to be a good predictor for morbidity, mortality, and the use of health services among adults. There has been far less consideration of the validity of self-reported health as an indicator among youth. Of significance for this report is the fact that self-reported health in adults and youth is commonly influenced by their overall sense of functioning, including both physical and non-physical health dimensions. This report gauges the extent to which self-reported health in youth is associated with *physical* health in particular, and thus assesses whether this measure is a useful indicator for physical health in youth.

Methodology and Provisional Results

Review Search Process

For the electronic search for reviews in this area, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-20 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Search Keywords

("self-rated health" OR "self-reported health" OR "subjective health status" OR "self-perceived health" OR "perceived health")

AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and numerical data"[Majr])

It was determined from the initial search process that there were no suitable reviews for this concept, so the decision was made to execute a “Level B” search process involving individual studies.

Study Search Process

Three further electronic searches were conducted for individual studies in this area. The database used was again PubMed, with the following limits:

Date: 2000-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

*While the protocol defines a child as 0-20 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

The same search terms were used as outlined previously for the review search process. There were 247 studies identified in this search.

Another search was conducted, with the same limits as above but with the following (more streamlined) search terms:

("self-rated health" OR "self-reported health" OR "subjective health status") AND (child OR adolescent OR youth) AND (Canada OR "British Columbia")

There were 73 studies identified in this search.

Finally, a search for non-physical outcomes was conducted with the same limits as the previous searches, and using the following search terms:

("self-rated health" OR "self-reported health" OR "subjective health status" OR "self-perceived health" OR "perceived health")

AND

("Psychological Phenomena and Processes"[Majr] OR "Behavior and Behavior Mechanisms"[Majr])

This search identified 653 studies.

In addition to the above search method, the following searches were conducted:

- PubMed search using "Related citations" link
- A scan in Google for grey literature and for any obvious articles missed, using terms such as: **(self-rated health) AND children AND physical health**
- Hand-searching bibliographies of key papers
- Checking for study updates (by author)

Taken together, the various search processes returned 1183 articles for consideration, although some studies were likely counted twice due to overlap between categories.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between self-rated health and physical health outcome(s), then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 155.

Primary Exclusion

The abstracts and/or full articles were then reviewed, with articles not pertinent to the research topic being excluded; specifically, if the article did not link self-rated health with physical health outcome(s) in children, it was excluded. If there was uncertainty as to whether an article should be excluded, the reviewers discussed the matter further to reach a consensus.

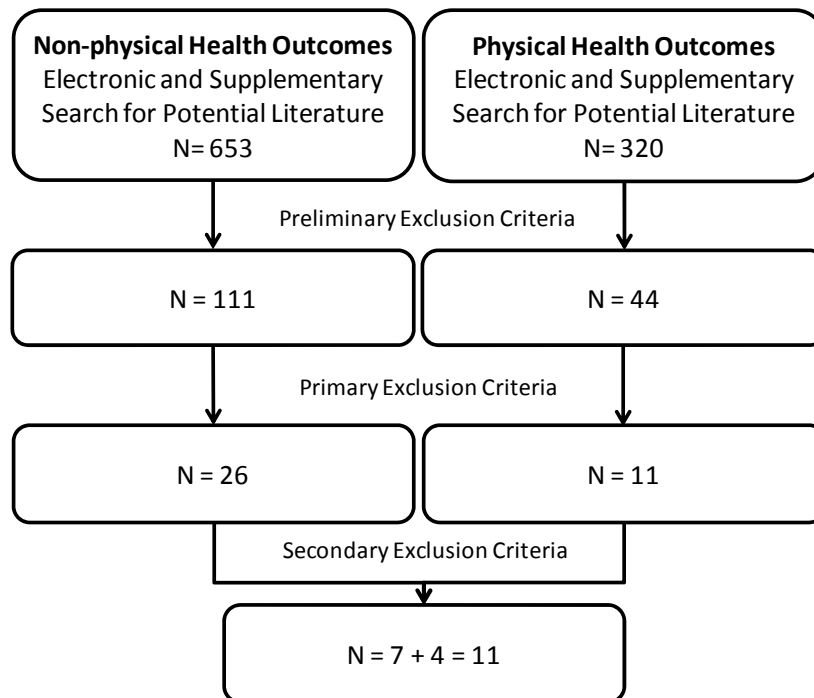
There were 37 articles remaining in the list following the primary exclusion step.

Secondary Exclusion

Studies that were deemed to be of lesser quality or usefulness were excluded. This secondary exclusion step yielded a total of 11 studies, as reflected in the following Volume Report and the subsequent table of results.

Literature Review Volume Report: Individual Studies

Dimension: Physical Health **Concept:** Self-Rated Health



Summary of Relevant Studies

Dimension: *Physical Health*

Concept: *Self-Rated Health*

	Title of Study	Lead Author	Year	Journal	Journal Impact Factor (2005)	Type of Study	Sample Size	Sample Population	Location	Conflict of Interest
Predictors and Physical Health Outcomes of Self-Rated Health										
1	Validity and stability of self-reported health among adolescents in a longitudinal, nationally representative survey	Fosse	2009	Pediatrics	4.27	Cross-sectional	8,984	12-16-year-olds	USA	Not Available
2	Self-rated health in adolescence: a multifactorial composite	Breidablik	2008	Scandinavian Journal of Public Health	0.73	Cross-sectional	2,741	16-20-year-olds	Norway	Not Available
3	Family, school and health in children and Adolescents	Karademas	2008	Journal of Health Psychology	1.68 (2009)	Cross-sectional	3,034	11-17-year-olds	Greece	None Declared
4	The relationship between self-rated health status and the overall quality of dietary intake of US	Goodwin	2006	Journal of the American Dietetic Association	2.38	Cross-sectional	1,504	11-18-year-olds	USA	Not Available
5	Factors related to adolescents' self-perceived health	Tremblay	2003	Health Reports	--	Cross-sectional	12,715	12-17-year-olds	Canada	Not Available
6	Self-rated health and mortality among young men: what is the relation and how may it be explained?	Larsson	2002	Scandinavian Journal of Public Health	0.73	Longitudinal	49,231	18-20-year-old young men	Sweden	Not Available
7	Predictors of adolescent self-rated health	Vingilis	2002	Canadian Journal of Public Health	--	Cross-sectional	1,493	12-19-year-olds	Canada	Not Available
Non-physical Health Outcomes										
1	Adolescents' health and health behaviour as predictors of injury death. A prospective cohort follow-up of 652,530 person-years	Mattila	2008	BioMed Central Public Health	1.66	Prospective Cohort	57,407	14-18-year-olds	Finland	None Declared
2	Self-rated health as predictor of medicine use in adolescence	Holstein	2008	Pharmacoepidemiology and Drug Safety	1.77	Cross-sectional	4,824	Fifth, seventh and ninth graders	Denmark	None Declared
3	Adolescent health-related quality of life and perceived satisfaction with life	Zullig	2004	Quality of Life Research	1.92	Cross-sectional	4,914	13-18-year-olds	USA	Not Available
4	Health behaviours and health in adolescence as predictors of educational level in adulthood: a	Koivusilta	2003	Social Science & Medicine	2.62	Longitudinal	11,149	12-16-year-olds	Finland	Not Available

Detailed Results

For the 11 studies identified through the literature search and exclusion process, a summary table was developed, as provided below.

Dimension: <i>Physical Health</i> Concept: <i>Self-rated Health</i> Summary Table of Studies							
Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/ Comments
Predictors and Physical Health Outcomes of Self-Rated Health							
Fosse (2009)	To assess the stability of self-reported health among a nationally representative sample of adolescents over a period of 6 years; to assess the concordance of self-reported health between parents and children; to assess the validity of self-reported health across a range of physical and emotional indicators of adolescent well-being.	Data derived from the National Longitudinal Survey of Youth, 1997 Cohort.	United States N= 8,984 youth aged 12-16 years	Longitudinal survey Asked the question "In general, how is your health?" 5 response options ranging from "excellent" to "poor"	- Stability of self-reported health of adolescents and concordance between parent(s) and child - Association of self-reported health with presence or absence of chronic health conditions, emotional problems, being overweight or obese, sensory limitations, and deformity	Youth self-reported health was associated with the presence of chronic health conditions, emotional problems, and with being overweight or obese, but not with sensory conditions or physical deformity.	Youth self-reported health was an indicator of a range of objective measures of physical health.
Breidablik (2008)	To examine the relationships between self-rated health and a broad spectrum of structural, medical, psychological, and social variables.	Cross-sectional data from the Young-HUNT II study	Norway N= 2,741 students aged 16-20 years	Cross-sectional study -self-administered questionnaire included questions on somatic and mental health, lifestyle, quality of life, use of medication and health services, reading and writing difficulties, and pubertal status.	- Association of different predictor variables with lower self-rated health	Significant associations with self-rated health included medical health parameters as well as psychological measures, health behaviours (e.g., smoking, lack of exercise), experience of divorce in the family, and relationship to school.	Adolescents conceptualize health as an integrated construct related to medical, psychological, social, and lifestyle factors.
Karademas (2008)	To examine the association between	Data were derived from the Greek	Greece	Cross-national survey with clustered	- Subjective health and well-being	Family and school factors are related to subjective health and	Family and school factors are crucial for

Dimension: Physical Health Concept: Self-rated Health
Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/ Comments
	family, school, and subjective health in a large representative sample of children and adolescents	component of the Health Behaviour in School-aged Children (HBSC) Study, 2006	N= 3,034 students aged 11-17 years	sampling design	- School climate - Family climate - Subjective economic climate	well-being across all age groups. Family and school are associated with self-rated health.	young people's subjective health. Policy makers should take into consideration factors such as poor family relationships, lack of support and supervision, and disliking school or feeling pressured by schoolwork.
Goodwin (2006)	To compare the quality of overall dietary intake of US adolescents with self-rated health (SRH) status	Data from the Continuing Survey of Food Intakes by Individuals 1994-96	USA N=1,504 adolescents aged 11-18 years	Cross-sectional survey	- Dietary health with respect to self-rated health	- Increased vegetable consumption among adolescents with high SRH - Increased fat consumption among adolescents with low SRH	While certain dietary components showed positive results, self-perception of health status is not significantly related to the quality of the adolescent diet when considered in global terms
Tremblay (2003)	To examine self-perceived health among Canadian adolescents, and factors associated with ratings of very good/excellent health.	Data are from cycle 1.1 of the 2000/01 Canadian Community Health Survey, conducted by Statistics Canada.	Canada N= 12,715 adolescents aged 12-17 years	Cross-sectional survey	- Associations between very good/excellent self-reported health and selected characteristics	- Odds of reporting very good/excellent health were significantly lower for teens who were daily smokers, episodic heavy drinkers, physically inactive during leisure time, infrequent consumers of fruit and vegetables, or obese - Lower levels of income and educational attainment in a household were also associated with lower probability of reporting very good/excellent health	No single factor accounts for an adolescent's self-perceived health. The presence of chronic conditions and depression reduced the odds of reporting very good/excellent health. Adolescents' self-perceived health is also linked to socio-economic factors.
Larsson (2002)	To examine the relation between self-rated health and mortality among young men	Data from nationwide military conscription survey in 1969-70	Sweden N= 49,231 young men aged 18-20	Longitudinal study, 27 year follow up	- Poor self-rated health at conscription found to correspond with increased mortality during follow up period	- Self-rated health most strongly related to alcohol- and drug-related mortality	Increased mortality mediated by psychological factors (emotional control, psychiatric diagnosis at

Dimension: Physical Health Concept: Self-rated Health
Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/ Comments
			years				conscription, and self-reported medication for nervous problems) in 84% of cases
Vingilis (2002)	To investigate predictors of adolescent self-rated health	Based on the longitudinal National Population Health Survey	Canada N= 1,493 adolescents aged 12-19 years	National survey with a two-staged, stratified, random sampling procedure	- Sex, age, grade, family structure, income, disability, chronic health problems, social supports, social involvement, school/work involvement, smoking, alcohol bingeing, physical activities, BMI, and psychological health status -Self-rated health was regressed on all predictors	Youth in the top quintile of BMI and who were current or previous smokers had lower health ratings. Overall health status rating had the largest effect of any variable on self-rated health. Higher psychological distress was associated with lower self-rated health. Income was an important predictor of self-rated health.	Self-assessments of health are based on physical health status as well as on non-physical determinants.
Non-Physical Health Outcomes							
Mattila (2008)	To study associations between adolescents' perceived health and health behaviour and injury death	Data from the Adolescent Health and Lifestyle Survey between 1979 and 1997	Finland N=57,407 adolescents aged 14-18 years	Prospective cohort followed an average of 11.4 years	- Poor self-rated health associated with intentional injury death	Youth with poor self-rated health were 80% more likely to experience intentional self injury than those with excellent self rated health.	Promotion of healthy lifestyle among adolescents may contribute to (especially self-inflicted) injury prevention in adolescence and adulthood
Holstein (2008)	To examine the association between self-rated health and medicine use for common complaints such as headache and stomach-ache	Data from Health Behaviour in School-aged Children (HBSC) Survey 2002	Denmark N=4,824 fifth, seventh and ninth graders	All students present in specified grades from 68 selected schools across Denmark	- Poor or fair self-rated health (SRH) associated with higher medicine use	- Boys with low SRH had a much higher frequency of medicine use for headache and stomach-ache - Girls with low SRH had a much higher frequency of medicine use for headache and stomach-ache, as well as difficulties getting to sleep	Associations remained significant when adjusted for frequency of complaints
Zullig (2004)	To explore the relationship between perceived life satisfaction and self-rated health in	Data from the Centers for Disease Control Youth Risk Behavior Survey (CYBS)	USA N=4,914 adolescents aged 13-18	Cross-sectional survey	- Significant relationship between self-rated health and overall quality of life	-Poor self-rated health was associated with poor quality of life for students independent of gender or race	The established association may be even stronger than determined here, due to conservative

Dimension: *Physical Health Concept: Self-rated Health*
Summary Table of Studies

Lead Author	Study Objective	Study Description	Setting/ Participants	Design/ Data Collection	Outcomes	Results	Conclusions/ Comments
	adolescents		years				analysis techniques
Koivusilta (2003)	To determine whether health and health behaviours at age 12-16 predict educational level in early adulthood	Data from the Adolescent Health and Lifestyle Survey (1981,'83,'85) linked to Register of Completed Education (1998)	Finland N=11,149 adolescents aged 12-16 years	Longitudinal study, 13-17 year follow up	- Poor perceived health in adolescence predicted low educational level in adulthood	- Both perceived health and health activities were found to predict educational achievement. Smoking is the single strongest predictor of educational careers	Perceived health is a crucial marker of the perception of health-related and other resources needed to pursue education

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Summary of Results

The studies reviewed here used survey data collected from youth aged 11-20 years. The younger cohorts were not represented; survey data from children aged 10 years or younger is often considered less reliable due in part to poor recall ability. The surveys used in the included studies questioned adolescents regarding their self-rated health, as well as a range of other physical, psychological, social, emotional, and structural variables. Most of the studies then set the latter factors as independent variables and examined to what extent they were predictors of self-reported health ratings. All of the studies concluded that adolescent self-reported health is based not only on physical health phenomena but also on a variety of non-physical determinants, including socioeconomic, psychological, social, and family-related factors. There were very few studies that reported the association in the “opposite” (and more useful) direction, i.e., setting low self-reported health status as the independent variable and determining to what extent it predicted, for example, objective physical health status.

Of the studies that did report on the possible outcomes of adolescent self-rated health on health and well-being, there were useful findings in a number of areas. Goodwin et al., for example, found that self-rated health predicted the quality of specific dietary components in adolescents. Youth with high self-rated health were found to consume more vegetables, and those with poor self-rated health consumed more fatty foods. The authors suggest that, while adults rate their health according to physical functioning and chronic health problems, adolescents may be more prone to rating their health according to recognized healthy activities.⁴²¹ Larsson et al. found poor self-rated health in a cohort of young Swedish men aged 18-20 years to be a predictor of future mortality, a result that may be generalizable to the older end of the age range in this project.⁴²² Similarly, Mattila et al. determined that poor subjective health predicted mortality through intentional self-harm. In both cases, mortality was mediated by psychological factors and alcohol use.⁴²³ As a further note, the latter study was actually classified under non-physical outcomes since the deaths of significance were self-inflicted, that is, clearly the product of a disturbed mental or emotional state.

Other non-physical outcomes were also important, and generally paralleled findings in adult populations. Holstein et al. determined that self-rated health was a predictor of medicine use in school-aged children, even after controlling for frequency of health complaints, and Zullig et al. found a correlation between self-rated health and overall quality of life measurements.^{424,425} Finally, it was determined by Koivusilta et al. that perceived health in adolescence was a useful indicator for future educational participation and achievement.⁴²⁶

Data Sources on Self-Rated Health

A British Columbia-specific data source for teen health data is the BC Adolescent Health Survey (AHS), first conducted by the McCreary Centre Society in 1992; the inaugural work was followed by three more surveys in 1998, 2003, and 2008.⁴²⁷ The AHS is designed to

⁴²¹ Goodwin DK, Knol LL, Eddy JM et al. The relationship between self-rated health status and the overall quality of dietary intake of US adolescents. *Journal of the American Dietetic Association*. 2006; 106(9): 1450-3.

⁴²² Larsson D, Hemmingsson T, Allebeck P et al. Self-rated health and mortality among young men: what is the relation and how may it be explained? *Scandinavian Journal of Public Health*. 2002; 30(4): 259-66.

⁴²³ Mattila VM, Parkkari J, Koivusilta L et al. Adolescents' health and health behaviour as predictors of injury death. A prospective cohort follow-up of 652,530 person-years. *BioMed Central Public Health*. 2008; 8: 90.

⁴²⁴ Holstein BE, Hansen EH, Andersen A et al. Self-rated health as predictor of medicine use in adolescence. *Pharmacoepidemiology and Drug Safety*. 2008; 17(2): 186-92.

⁴²⁵ Zullig KJ, Valois RF, Huebner ES et al. Adolescent health-related quality of life and perceived satisfaction with life. *Quality of Life Research*. 2005; 14(6): 1573-84.

⁴²⁶ Koivusilta L, Rimpela A, Vikat A. Health behaviours and health in adolescence as predictors of educational level in adulthood: a follow-up study from Finland. *Social Science & Medicine*. 2003; 57(4): 577-93.

⁴²⁷ Information available at <http://www.mcs.bc.ca/AHS>. Accessed September 2010.

provide a comprehensive picture of the physical and emotional health of B.C. youth. The survey focuses on self-perception of current physical and emotional health, risky behaviours, health-promoting practices, and broader issues such as family connectedness, school safety, and peer relationships. Teens are asked to give their overall self-reported health status, with possible responses of poor, fair, good, or excellent. In the 2008 survey results, 84% of youth reported that their health was good or excellent.

The AHS is completed by B.C. public school students in grades 7-12; in the 2008 survey, 50 of 59 school districts participated, for a total of 29,440 students. Participation in the survey is voluntary, with parental consent procedures being determined by the individual school districts. The AHS is administered by trained public health nurses in classroom settings. Funding for the process is provided by the Ministry of Children and Family Development and the Ministry of Health, with additional support from other government departments.

An alternate source of information for the same age group is the Canadian Community Health Survey (CCHS), which reported in 2009 that 68% of youth indicated that their perceived overall health (physical, mental, and social well-being) was very good or excellent. This compares with 58.6% in the general population of British Columbia. While a survey such as the AHS developed and managed “at home” in B.C. may be understood as a reliable source, the CCHS has the advantage of generating annual data to populate an indicator for this concept.

Discussion

For the adult population, it is acknowledged that self-rated health assessments are based on factors that extend beyond physical status per se.⁴²⁸ Among adolescents, an even broader and more complex view of health seems to be reflected in such ratings; in addition to physical health, health status measures have been found to embrace personal, socio-environmental, behavioural, and psychological factors.

While the located studies found do show predictive connections between self-rated health and a number of physical and non-physical outcomes, some of these outcomes, mortality in particular, appear to be driven primarily by other important factors, including ones such as alcohol use and psychological health that are considered elsewhere in this project. Recognized positive health behaviours such as diet also appear to be taken into account by adolescents when reporting their health—in other words, “I live healthy so I am healthy.” Healthy behaviours (rather than the presence of disease) are an understandable proxy for health in this population, given that there is not enough lag time for most chronic conditions to develop in youth. With this proviso, it appears that self-rated health is a reasonable indicator of psychosocial well-being, equal if not superior to its potential for predicting objective physical health.

Data on the self-rated health of youth in the province are available from the B.C. Adolescent Health Survey and the CCHS. While this metric may indeed be a reasonable indicator of the overall health and well-being of children and adolescents, especially taking into account the many aspects of non-physical health that can be implicated, the fact that a large proportion of youth already rate their health as good or excellent may call into question the usefulness of this indicator as a marker of “room for improvement” and therefore a measurement of progress. On the other hand, the almost 70,000 adolescents reporting “poor” or “fair” health is still a cohort that bears attention.

⁴²⁸ Shields M, Shooshtari S. Determinants of self-perceived health. *Health Reports*. 2001; 13(1): 35-52.

Conclusion

Self-rated health data are not collected for younger children. Among teens, it would likely be of limited utility as an indicator of physical health per se. As concluded by Vingilis et al., “adolescent perceptions of health are framed not only by their physical health status but also by personal, socio-environmental and behavioural factors.”⁴²⁹ Self-rated health may thus be most useful as a measure of the *overall* health and well-being of children and adolescents, with good evidence supporting it as an indicator of healthy behaviours, psychological and emotional well-being.

Summary Assessment					
Self-rating Health as “Less than Good”					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
12-19	69,200	Medium	Medium	Unclear	Medium-High

As summarized above, assessments have been applied to the Self-rated Health concept, specifically in terms of the indicator with the most compelling support in the literature, namely, *self-rated health of “less than good.”*

The pediatric population **Magnitude** of the potential indicator is assessed as **Medium**. Based on 2008 B.C. Adolescent Youth Health Survey data, 16% of adolescents (those aged 12-19 years) rate their own health “less than good.” Applying this percentage to the proportion of the pediatric cohort of the same age results in a prevalence estimate of 69,200 individuals; this total falls between 2 and 10% (19,000 and 97,000) of the total pediatric cohort, resulting in a Magnitude classification of Medium.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual’s health and well-being is assessed as **Medium**. The rationale is that the preponderance of research unfortunately treats self-rated health as an outcome rather than a predictor, so that the most pertinent evidence base is limited; most studies of self-rated health as a predictor of outcomes were related directly or indirectly to non-physical aspects of well-being. An example of indirect linkage to mental/emotional health is the sign that elevated mortality with poor self-rated health is actually mediated by chronic or acute forms of self-harm.

The **Modifiability** of the potential indicator is assessed as **Unclear**. Because self-rated health is subjective and reflects a complex interaction of innate, socio-environmental, and behavioural factors, it is difficult to project how feasible it would be to instigate modifications through public health interventions.

Data Availability/Validity for the potential indicator is assessed as **Medium-High**. The reason is that survey data are regularly available for the indicator, either annually or, in the case of the home-grown AHS source, every 5 years.

The potential indicator of self-rated health being “less than good” is **Not Recommended** for consideration as a core indicator of child health and well-being. While the assessment ratings were of moderate strength, the key prevention options remain unclear. Self-rated health is recognized as an accessible measure that has a shown good utility in the adult population; further developing the evidence base related to outcomes and interventions for the pediatric

⁴²⁹ Vingilis ER, Wade TJ, Seeley JS. Predictors of adolescent self-rated health. Analysis of the National Population Health Survey. *Canadian Journal of Public Health*. 2002; 93(3): 193-7.

population (especially adolescents) would offer the possibility of making comparisons between adults and youth. It is most appropriate to categorize the indicator as a candidate for potential development.

Major Childhood Injuries

A comprehensive evaluation of the burden of major pediatric injuries needs to account for both hospitalizations and mortality. In B.C. such data are recorded in separate registries. In terms of mortality, B.C. Vital Statistics is the best source of information; there are a number of options to track hospitalizations, including the B.C. Trauma Registry and the B.C. Injury Reporting System. The B.C. Trauma Registry records only the most severe of pediatric injuries, sharing these data with the National Trauma Registry, managed by the Canadian Institute of Health Information (CIHI). There are nine trauma facilities collecting and passing on the pertinent information in the province; this means that any significant injuries that do not require such a facility will be missing from the database. The B.C. Injury Reporting system has the advantage of reporting on all injuries that require hospitalization. Therefore, it represents the most comprehensive source of information on major childhood injuries, superior to both the trauma registry and any emergency department statistics that may be tracked by one or more of the health authorities in British Columbia.

The B.C. Injury Research and Prevention Unit (BCIRPU), a non-governmental organization, helpfully assembles information on unintentional injuries among B.C. children and adolescents, combining mortality data from the B.C. Vital Statistics Agency and hospital separation data from the Injury Reporting System described above.⁴³⁰ Information has in fact been compiled for deaths and hospitalizations due to unintentional injuries among children aged 0-19 years from 2001-2008. The following table summarizes these statistics:

Deaths and Hospitalizations Due to Unintentional Injury in British Columbia				
Ages 0-19 Years, 2001-2008				
Year	Number of Deaths	Rate per 100,000 population	Number of Injury Hospitalizations	Rate per 100,000 population
2001	107	10.65	7013	698
2002	110	11.06	6257	629
2003	108	10.98	6307	641
2004	80	8.2	6027	618
2005	70	7.21	5748	592
2006	74	7.63	5755	593
2007	74	7.61	5443	560
2008			4955	509

Source: BC Injury Research and Prevention Unit

The most current data for the number of deaths are from 2007; in that year, 74 deaths among those aged 0-19 years were attributed to unintentional injury in BC. The number of injury-related hospitalizations for this age group was 4955 in 2008. It is apparent from the table above that there has been a decrease in the past decade in the absolute number of deaths and hospitalizations, as well as in the corresponding rates per 100,000 population.

According to a 2005 BCIRPU report, the leading cause of mortality due to injury for individuals less than 25 years old in British Columbia between 1989 and 2000 was motor vehicle traffic injuries, at 61% of all injury-related deaths; drowning/submersion (9%) and poisoning (8%) are a distant second and third in terms of causation.⁴³¹

⁴³⁰ BC Injury Research and Prevention Unit. Available at <http://www.injuryresearch.bc.ca/DataAnalysis.aspx>. Accessed November 2010.

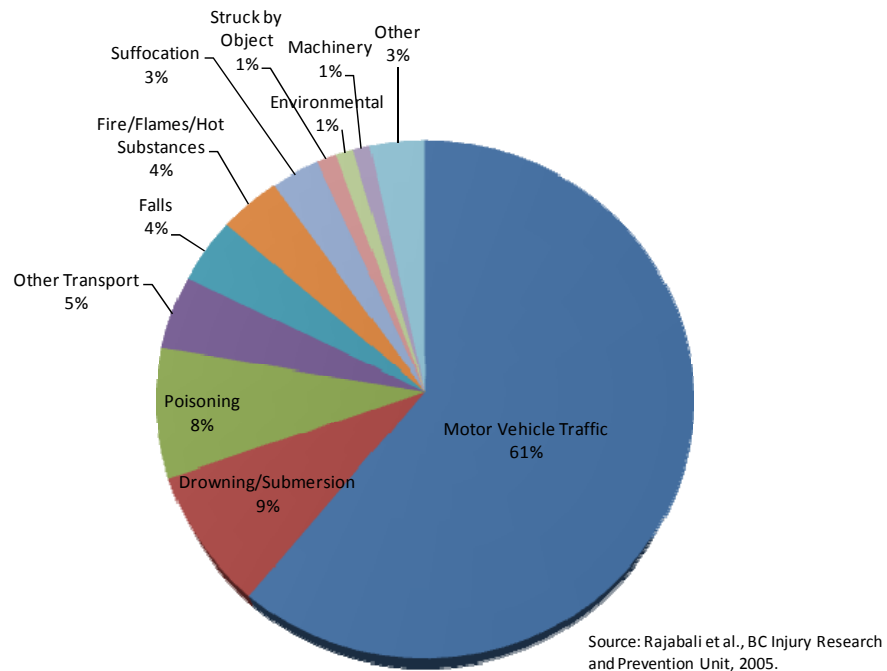
⁴³¹ Rajabali F, GuangHon H, Artes S et al. Unintentional Injuries in British Columbia: Trends & Patterns Among Children & Youth. 2005. BC Injury Research & Prevention Unit. Available at <http://www.injuryresearch.bc.ca/categorypages.aspx?catid=3&subcatid=5&catname=Library&subcatname=Publications%20and%20Reports#factsheets>. Accessed November 2010.

(footnote continued)

These and various other types of injuries causing death are summarized in the following pie chart:

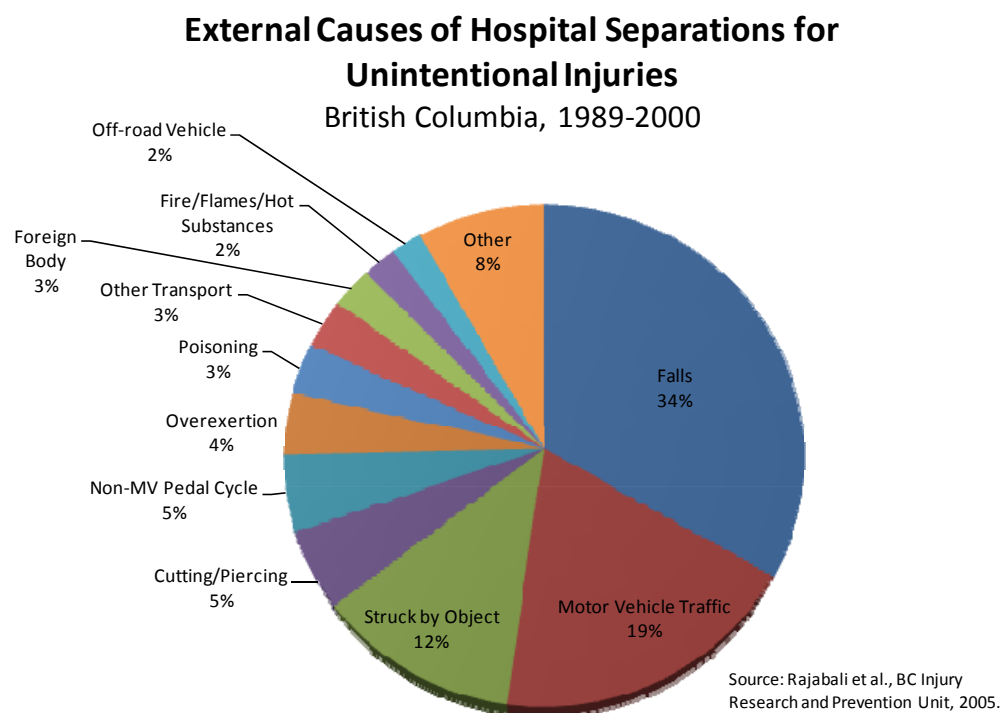
External Causes of Death Due to Unintentional Injuries

British Columbia, 1987-2000



For hospital separations due to unintentional injury, falls were the leading cause, at 34% of all such hospitalizations in the under 25 age group. This subcategory was followed by motor vehicle traffic injuries (19%) and being struck by an object (12%), as summarized in the pie

chart below.



Given that causation data are clearly available, it raises the question: *Should the indicator for this concept evaluate pediatric injuries generally or by focusing on the more dominant causes, such as motor vehicle accidents?* However, since the assigned concept in this case is Major Childhood Injuries—which implies a more global indicator—the remainder of this section will lean towards that sort of indicator.

Methodology to Locate General Information

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-20 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

"Wounds and Injuries/epidemiology"[Majr] AND (Canada OR "British Columbia")

The search processes returned 9 reviews for consideration. A further search using the same search terms was conducted for all types of articles (removing the limits of Review and Meta-Analysis); this search returned 234 studies. *The results of these processes, as well as a grey literature scan, were only used to generate general information on the concept.*

Discussion and Conclusion

Childhood injury is a significant global public health priority; the World Health Organization published a *Global Call to Action* in 2005 to call attention to the area of child and adolescent

injury prevention.⁴³² While the vast majority of unintentional childhood injury deaths occur in low- and middle-income countries, it is still an important health concern in Canada, involving as it does several hundred cases each year. Unintentional injuries are in fact the leading cause of death among Canadian youth aged one to 19 years, and the third leading cause of hospitalizations.

Childhood injury data collection and analysis are key to understanding the burden of injury among Canada's children and youth; such work helps to guide identification of prevention priorities and the appropriate allocation of resources. In fact, the Canadian Injury Indicators Development Team: Children and Youth, a multidisciplinary group funded by the Canadian Institutes of Health Research, is currently working to address "gaps in injury surveillance through the development of a set of national injury indicators for Canadian children and youth which reflect and monitor identified prevention priorities."⁴³³ Prevention of unintentional injuries has become a focus in the public health realm, as many of these injuries are indeed avoidable. Furthermore, solutions to reduce the burden of injuries have been effective in the past, including the use of child safety seats, automobile airbags, and bicycle helmets.⁴³⁴

Reliable and recent pediatric injury data are available for British Columbia from BC Vital Statistics (for mortality data) and the BC Injury Reporting System (for hospital separations data); as noted in the introduction, both of these data streams are utilized and reported by the BC Injury Research and Prevention Unit.⁴³⁵ Although the data presented in this report includes all children aged 0-19 years, the information is also available for narrower age groups.

Due to the self-evident health and well-being impact of major injuries on individual children and the availability of provincial data on this topic, major childhood injuries (defined in terms of the need for hospitalization) would potentially offer utility as a core indicator of child health and well-being in British Columbia.

⁴³² Child and Adolescent Injury Prevention: A Global Call to Action. 2005. World Health Organization. Available at http://whqlibdoc.who.int/publications/2005/9241593415_eng.pdf.

⁴³³ Measuring Injury Matters. 2010. Canadian Injury Indicators Development Team. Available at <http://www.injuryresearch.bc.ca/categorypages.aspx?catid=3&subcatid=5&catname=Library&subcatname=Publications%20and%20Reports#factsheets>. Accessed November 2010.

⁴³⁴ Schnitzer PG. Prevention of unintentional childhood injuries. *American Family Physician*. 2006; 74(11): 1864-9.

⁴³⁵ BC Injury Research and Prevention Unit. Available at <http://www.injuryresearch.bc.ca/DataAnalysis.aspx>. Accessed November 2010.

Summary Assessment					
Hospitalization for Childhood Injury					
Age group (Years)	Est. Incidence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
0-19	4,900	Low	Medium	High	High

As summarized above, assessments have been applied to the Major Childhood Injuries concept, specifically to the indicator *rate of hospitalization for injury*. The only cases that would be missed by this statistic are the rare instances of major injury that bypassed the hospital system; this would include a small number of “roadside” deaths following motor vehicle crashes each year. Notwithstanding the usefulness of a global indicator of major injury, there clearly could be some value in prevention planning to stratify into multiple indicators driven by etiology: thus, an indicator for injuries due to motor vehicle crashes, falls, etc.

The pediatric population **Magnitude** of the potential indicator is assessed as **Low**. Based on B.C. Injury Prevention Unit data, the rate of hospitalization for injury among children aged 0-19 years is 509 per 100,000. When applied to the current pediatric cohort this results in a annual incidence estimate of 4,900 individuals; this is less than 2% of the total pediatric cohort (19,000), resulting in a Magnitude classification of Low. While a subset of these cases will experience chronic effects and thus contribute to an expanded pool of survivors generating an ongoing burden, for practical purpose the annual incidence may be equated to prevalence.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual’s health and well-being is assessed as **Medium**. Typically, major childhood injuries have substantial acute *or* moderate chronic effects. On the other hand, it should be acknowledged that in a minority of such cases do have *substantial* chronic effects (e.g., spinal cord injury).

The **Modifiability** of the potential indicator is assessed as **High**. It is apparent that many of the unintentional injuries that result in hospitalizations are quite preventable. This is particularly noticeable in the dominant categories of falls, motor vehicle crashes, and being struck by objects in various ways.

Data Availability/Validity for the potential indicator is assessed as **High**. The proposed indicator, which makes use of two administrative data sources (B.C. Vital Statistics and the B.C. Injury Reporting System) that are both objective and comprehensive (where attendance at a hospital may be taken as a reasonable proxy for an injury being characterized as *major*).

The potential indicator of rate of rate of hospitalization for injury is **Not Recommended** for consideration as a core indicator of child health and well-being, mainly driven by the low rating for Magnitude. On the other hand, the potential utility of the indicator is suggested by its high ratings in the two categories related to feasibility—and especially the one pointing to the potential for prevention; therefore, it is appropriate to retain it on the list related to “secondary interest.”

Cause-Specific Emergency Department Use

Background and Context

Concerted efforts have been made for at least a decade to improve the tracking of emergency department statistics in Canada.⁴³⁶ Based on the information currently gathered, it is clear that children present at emergency departments in Canada in large absolute numbers, and account for a large proportion of the total of such visits across all age groups. The most comprehensive information on pediatric emergency department (ED) visits in Canada is available for Ontario; the following statistics were reported in that province for 2005-6:⁴³⁷

- Almost one-quarter (23%) of all ED visits in Ontario were made by children, defined as newborn to 17 years
- Just over 685,000 (or 25% of) Ontario children made more than one million visits to EDs; of these children, 31.8% made two or more visits in the year
- Children aged 1 to 4 years were seen most often in the ED—30.1% of all pediatric visits were made by children in this age group
- Newborns and babies in the age group 0 to 364 days had the highest rate of visits per 1,000 children (at 802); notably, 42.6% of this specific cohort came to the ED more than once in the year

Assuming that the pattern is similar in British Columbia, it is clear that from a health services perspective that tracking data related to this phenomenon would be of considerable interest. However, the relevance of such information to a population-level understanding of child health and well-being would still require further consideration.

Methodology and Results

“Cause-specific emergency department use” represents a special category of child health concept being investigated under the dimension of physical health. Similar to the concept “major childhood injuries” (see separate chapter), the key research questions driving the review (and this report) must be modified. This is because the main question that initially arose with other concepts, namely, identifying the evidence of a connection between the concept and physical health, does not really apply in this case. It is self-evident that a large (if not dominant) proportion of pediatric visits to an emergency department are driven by physical health concerns per se. So a review, systematic or otherwise, that proves this point would be redundant.

This means that the assignment devolves to investigating more directly the indicator related to emergency department (ED) use by children. The pertinent questions may be refined as follows:

- What is the *magnitude* of ED visits by children, and for what causes, in British Columbia and/or other comparable jurisdictions in Canada and the developed world?
- Can the dominant causes of ED visits related to physical health be reasonably characterized as *serious*?
- Are validated data regularly available on pediatric ED visits in British Columbia? And, if not, should they be?

⁴³⁶ Innes G, Murray M, Grafstein E. A consensus-based process to define standard national data elements for a Canadian emergency department information system. *Canadian Journal of Emergency Medicine*. 2001; 3(4): 277-84.

⁴³⁷ Emergency Departments and Children in Ontario. Canadian Institute for Health Information. 2008. Available at <https://secure.cihi.ca/estore/productSeries.htm?pc=PCC413>. Accessed November 2010.

The best approach to the present concept is to start at the end of this list of questions. If there is a routinely-populated, comprehensive database of information on B.C. pediatric visits, then the task is easily brought to completion. The short answer is that there is only a partial inventory of such data for the B.C. context. In fact, only the province of Ontario is collecting and reporting information across all 166 of its EDs. This is accomplished by means of the National Ambulatory Care Reporting System (NACRS), managed by the Canadian Institute for Health Information (CIHI).

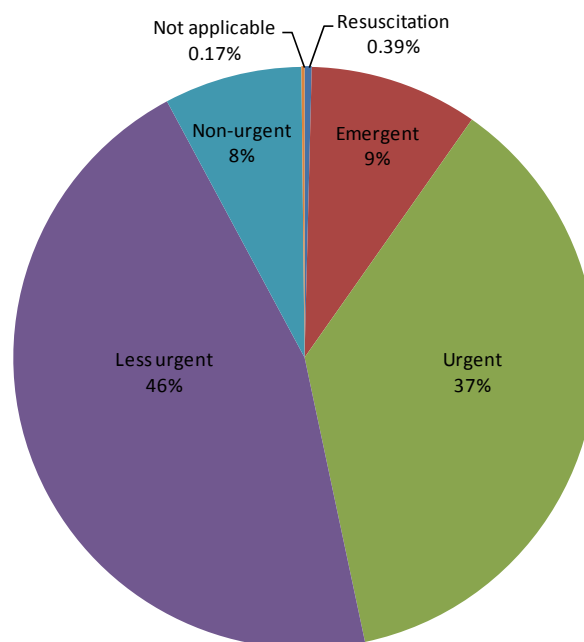
CIHI provides an annual *Executive Summary* of current pan-Canadian results in this area (the most recent being for 2008/09). As well, NACRS data are available on-line at the CIHI website, configured according to different interrogative categories, such as the main problem causing the visit and the age/sex of patient. The on-line system does not allow the latter two categories to be correlated, but such information is provided in occasional special reports published by CIHI, including a summary of pediatric ED visit data from Ontario in 2005-06 that was cited earlier.

NACRS contains data for hospital-based and community-based ambulatory care, including day surgery, outpatient clinics and emergency departments. Currently, data submission to NACRS has been comprehensively mandated in Ontario for ED, day surgery, dialysis, cardiac catheterization, and oncology. Some facilities in B.C., the Yukon, P.E.I, Nova Scotia, and Manitoba are also submitting data. Alberta and Saskatchewan began contributing ED information in 2010. B.C. currently only submits information from three hospital EDs, specifically the Royal Jubilee in Victoria and two smaller centres, Prince Rupert and Vernon; these facilities had voluntarily signed on to the system by 2003. In 2004, a report from the office of the Provincial Health Officer recommended adoption of NACRS across B.C., but there apparently has been a slow response. Indeed, based on a recent review conducted in the *Canadian Journal of Emergency Medicine*, B.C. is not as advanced as other provinces in terms of its internal ED statistics collection.⁴³⁸

Although it is only a partial inventory, the NACRS data do provide useful pointers to the severity profile of ED visits by children, and to the reasons for such visits. For instance, the following chart graphs the severity levels of pan-Canadian visits identified at triage for children aged 0-19. Almost half (46%) of ED visits are classified as Urgent or Emergent, with the remainder mainly Non-urgent or Less urgent.

⁴³⁸ Rowe BH, Bond K, Ospina MB et al. Data collection on patients in emergency departments in Canada. *Canadian Journal of Emergency Medicine*. 2006; 8(6): 417-24.

Canadian Emergency Department Visits by Triage Level Ages 0-19 Years, 2008-2009



Source: National Ambulatory Care Reporting System; Canadian Institute for Health Information.

The reasons behind pediatric ED visits are even more pertinent from a prevention perspective. NACRS data for Canada indicate that trauma – which includes falls and motor vehicle collisions – dominates the picture for 0-19-year-olds (415,613 visits), followed by asthma (30,656 visits) and pneumonia (20,547 visits); more detailed data is not available from this source. At the provincial level, data regarding types and causes of presenting problems in the ED does not appear to be available. Other countries do provide a high level of detail on diagnoses and reasons for visits to EDs, but it is less common to find data on the actual cause of the presenting problem.^{439,440} As is made clear in the separate chapter on major childhood injuries, the trauma that may present at EDs is mainly comprised of unintentional injuries; there is a wide range of injury causes, but in the case of NACRS data on ED visits only the two largest subcategories are tracked, motor vehicle collisions and falls. More complete data on unintentional injuries among BC children is available in injury databases such as that provided by the BC Injury Research and Prevention Unit.⁴⁴¹

Recognition of the important overlap between injuries and ED visits by children opens up another route of information for both the Canadian context and specific provinces. Thus, the Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) tracks statistics on ED visits specifically related to injuries.⁴⁴² The main facilities involved with the system are children's hospitals. Pertinent to the present topic, these hospitals include B.C. Children's

⁴³⁹ Gorelick MH, Alpern ER, Alessandrini EA. A system for grouping presenting complaints: the pediatric emergency reason for visit clusters. *Academic Emergency Medicine*. 2005; 12(8): 723-31.

⁴⁴⁰ Acworth J, Babl F, Borland M et al. Patterns of presentation to the Australian and New Zealand Paediatric Emergency Research Network. *Emergency Medicine Australasia*. 2009; 21(1): 59-66.

⁴⁴¹ BC Injury Research and Prevention Unit. Available at <http://www.injuryresearch.bc.ca/DataAnalysis.aspx>. Accessed November 2010.

⁴⁴² Child and Youth Injury in Review 2009 Edition – Spotlight on Consumer Product Safety. 2009. Public Health Agency of Canada. Available at <http://www.phac-aspc.gc.ca/publicat/cyi-bej/2009/index-eng.php>. Accessed November 2010.

Hospital (BCCH), the province's tertiary level care centre for children. A report from that institution summarized information from 1997-2000, noting that the incidence of injury-related visits for children aged 0-19 years was relatively stable, at about 7,500 per year.

Discussion and Conclusion

As noted above, there is substantial overlap between the topic of emergency department visits and major injuries. Another significant category of ED visits is pneumonia, for which data are available from the BC Centre for Disease Control (BCCDC). While the BCCDC information would provide a more complete picture of pneumonia incidence in the province (since not all cases need to present at an ED), it still represents far less than a comprehensive inventory of pediatric pneumonia. The third category covered in the NACRS dataset is asthma. For this chronic condition, an ED visit would generally occur when there is a serious incident such as a flare-up. In this sense, it is actually the ED visits that are of greatest public health concern for this condition, and therefore such data could be useful in the surveillance of the severity of asthma among a population.^{443,444}

With regard to data availability, pediatric ED visit data for BC/Canada is not provided in as much detail as would be necessary to offer good utility as an indicator of child health and well-being. More complete data is available from other sources for the major ED visit categories, with the exception of severe asthma/asthma attacks as noted above. Additionally, the data that NACRS provides is compiled from EDs across Canada – the majority from Ontario – and it includes only three EDs from the province of B.C.

Overall, pediatric ED visit data has low utility as an indicator of child health and well-being. Different concepts (e.g., injuries, infectious disease) overlapping with this area of health care are covered in greater detail in other chapters, generally drawing on more complete data sources to inform planners about prevalence, priorities, etc. Thus, while *cause-specific* ED visit information may be of interest in terms of analyzing health care efficiency (e.g., avoiding ambulatory-care sensitive visits⁴⁴⁵), there does not seem to be a strong argument to develop such targeted information to promote a program of primary prevention and pediatric population health improvement per se.

⁴⁴³ Mannino DM, Homa DM, Akinbami LJ et al. Surveillance for asthma--United States, 1980-1999. *MMWR Surveillance Summaries*. 2002; 51(1): 1-13.

⁴⁴⁴ Taylor BW, Maxwell D, Al-Hertani W. The emergency department as an asthma surveillance tool at the community level: a decline in the burden of pediatric asthma in halifax, Canada. *Journal of Asthma*. 2005; 42(8): 679-82.

⁴⁴⁵ Oster A, Bindman AB. Emergency department visits for ambulatory care sensitive conditions: insights into preventable hospitalizations. *Medical Care*. 2003; 41(2): 198-207.

Summary Assessment					
Visits for Selected Causes					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
-	-	Unclear	Medium	High	Low

As summarized above, assessments have been applied to the Cause-specific Emergency Department Visits concept.

The pediatric population **Magnitude** of the potential indicator is assessed as **Unclear**. Comprehensive information on pediatric ED visits in British Columbia for any or all causes is simply not available, not even on a one-time basis in order to offer a baseline “snapshot” for a potential indicator in the future.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual’s health and well-being is assessed as **Medium**. It is clear that causes of many ED visits, such as major injuries (see the previous section of the report), can represent substantial health impact, at least in the short-term. On the other hand, the true proportion of such visits representing chronic and/or degenerating conditions is not clear at all.

The **Modifiability** of the potential indicator is assessed as **High**. Emergency department visits by their very nature are unpredictable but preventable; this includes visits traceable to chronic conditions, where disease progression or flare-up is amenable to care in other health care settings (e.g., the general practitioner’s office). In fact, the issue of chronic disease and the emergency department (or other acute care settings) is complex from the point of view of any modifiability that would actually improve pediatric health and well-being. Thus, even if the data on this subset of visits were available, the most usual policy implication would not be primary prevention or even more effective secondary prevention, but simply attempting to shift the required care to a setting that is more efficient for the health system; while the effort to avoid costs may be of *indirect* benefit to citizens of any age group, it does not do much for population health and well-being in any direct sense.

Data Availability/Validity for the potential indicator is assessed as **Low**. Data currently compiled by the NACRS only cover three emergency departments in B.C., and only provide information on one cause, severe asthma or asthma attacks, a condition which has already been discussed under Major Chronic Diseases.

A measure related to Cause-Specific Emergency Department Use is **Not Recommended** for consideration as a core indicator of child health and well-being. This is largely based on the fact that current data do not allow for accurate (or even approximate) determination of the magnitude of cause-specific ED visits among B.C. children. Moving towards more comprehensive reporting to the national database by EDs in the province would improve the potential utility of a related indicator (global or cause-specific). An argument in the other direction involves the fact that the causes for ED visits that involve a substantial health burden are actually captured under other indicators examined in this report. Overall, it is appropriate to retain ED utilization by children as a matter for future development.

Environmental Exposures

Background and Context

The purpose of this review is to find research evidence of an association between environmental exposures and physical health of children. Environmental exposures may include indoor or outdoor air pollution, pesticides (both prenatal and childhood exposure), chemical emissions, and water contamination. Prenatal exposures related to smoking, alcohol consumption, and other maternal behavioural risk factors during pregnancy, as well as exposure to environmental tobacco smoke, are discussed previously in the section on outreach services to pregnant women and mothers.⁴⁴⁶

Child physical health outcomes that have been linked to environmental exposures include cancers (e.g., leukemia) and respiratory conditions (e.g., asthma). The etiology of asthma has been a growing focus among researchers and the media, reflecting the rising prevalence of both adult and childhood asthma in Canada in recent decades. In 1994/1995, 11% of Canadian children aged 0 to 11 years had been diagnosed with asthma; by 2000/2001, the prevalence rate had risen to more than 13%.⁴⁴⁷ Environmental pollutants represent one area being pursued in the effort to understand the cause of this important chronic condition of the respiratory tract.

Methodology and Provisional Results

Initial Search Process

For the **main electronic search**, the database used was PubMed, with the following limits:

Date: 2005-present *Language:* English *Subjects:* Human *Age:* 0-18 years*

Type of Article: Review, Meta-analysis

*While the protocol defines a child as 0-19 years of age, the search limit available in PubMed for All Child is 0-18 years, so this approximation was used.

Electronic Search Keywords

In order to provide as targeted a search as possible, Medical Subject Headings (MeSH) were applied, qualified by subheadings and whether or not it was a Major term (Majr) for the article. The details are provided below:

("Environmental Exposure"[Majr] OR "Environmental Pollutants"[Majr] OR "Environmental Pollution"[Majr])

AND

("Health/statistics and numerical data"[Mesh] OR "Health Status Indicators"[Mesh] OR "Risk Factors"[Mesh] OR "Health Status/statistics and numerical data"[Mesh] OR "Physical Fitness"[Majr] OR "Diseases Category/prevention and control"[Majr] OR "Phenomena and Processes Category/prevention and control"[Majr] OR "Diseases Category/statistics and

⁴⁴⁶ While environmental tobacco smoke is often considered under the topic of environmental exposures, there are good reasons to categorize it with individual parental behaviours that have an impact on children. See the chapter on Pregnancy Outreach Services and Targets.

⁴⁴⁷ Statistics Canada Catalogue no. 82-003-X Health Reports. Changes in the prevalence of asthma among Canadian children. Available at <http://www.statcan.gc.ca/pub/82-003-x/2008002/article/10551-eng.pdf>. Accessed September 2010.

numerical data"[Majr] OR "Phenomena and Processes Category/statistics and numerical data"[Majr] OR "Asthma"[Majr])

The search for **review articles** ultimately returned a sufficient volume (see below) of papers to qualify for a Level A search process. As well, a selective approach to the supplementary search was deemed to be all that was necessary. This involved a scan in Google for grey literature and for any obvious articles missed, using terms such as: **(environmental pollution OR environmental exposure) AND children AND health**. Finally, as the most recent systematic review of the association of environmental exposure with health was dated 2009, an update of the very latest studies was not pursued.

Taken together, the search processes returned 169 reviews for consideration.

Preliminary Exclusion

The articles were scanned *by title*, with articles not pertinent to the research topic being excluded; specifically, if the article did not appear to be investigating the association between environmental exposure and physical health outcome(s) in children, then it was excluded.

After completing this first exclusion process, the list of articles was reduced to 90.

Primary Exclusion

The abstracts and/or full versions of the 90 articles were then reviewed. Articles not pertinent to the research topic were excluded; specifically, if the article did not link environmental exposure with physical health outcome(s), or if it was not about children, it was excluded. Also, reviews that were not systematic or meta-analyses were excluded.

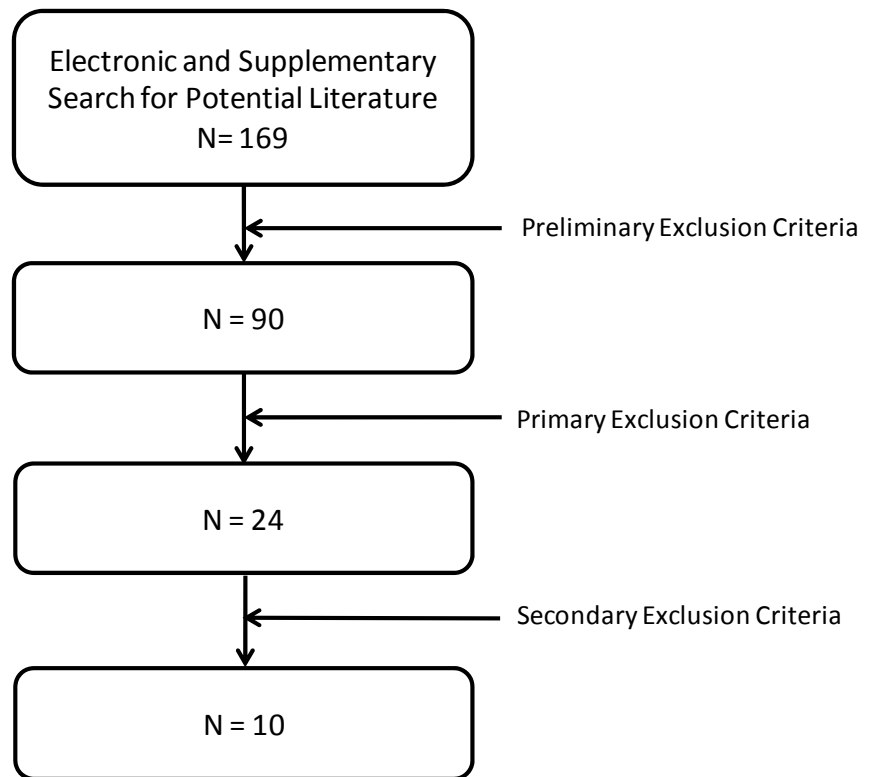
There were 24 reviews remaining in the list following the primary exclusion.

Secondary Exclusion

Reviews that were deemed to be of lesser quality or usefulness were excluded, yielding a final total of 10 reviews, as indicated in the following Volume Report. The review papers that were ultimately selected are then identified in the table that follows.

Literature Review Volume Report: Reviews

Dimension: Physical Health ***Concept:*** Environmental Exposures



Summary of Relevant Reviews

Dimension: *Physical Health*

Concept: *Environmental Exposure*

	Title of Review	Lead Author	Year	Journal	Journal Impact Factor (2005)	Year Range of Studies	Number of Studies Reviewed
1	A systematic review and meta-analysis of childhood leukemia and parental occupational pesticide exposure	Wigle	2009	Environmental Health Perspectives	5.34	1974-2008	31
2	Chlorination disinfection by-products in drinking water and congenital anomalies	Nieuwenhuijsen	2009	Environmental Health Perspectives	5.34	1993-2008	15
3	Does traffic exhaust contribute to the development of asthmas and allergic sensitization in children: findings from recent cohort studies	Braback	2009	Environmental Health	2.48 (2009)	2002-2008	15
4	Levels of pollutants in indoor air and respiratory health in preschool children: A systematic review	Fuentes-Leonarte	2009	Pediatric Pulmonology	1.59	1997-2006	14
5	Environmental exposures and adverse pregnancy outcomes: A review of the science	Stillerman	2008	Reproductive Sciences	2.30 (2009)	1991-2006	38
6	Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: a systematic review and meta-analysis	Dherani	2008	Bulletin of the World Health Organization		1982-2007	24
7	Indoor residential chemical emissions as risk factors for respiratory and allergic effects in children: a review	Mendell	2007	Indoor Air	0.98	1989-2005	21
8	Air pollution and childhood cancer: A review of the epidemiological literature	Raaschou-Nielsen	2006	International Journal of Cancer	4.7	1979-2004	15
9	Environmental factors and childhood acute leukemias and lymphomas	McNally	2006	Leukemia & Lymphoma	1.3	1998-2005	41
10	Exposure to pesticides and childhood cancer risk: Has there been any progress in epidemiological studies?	Jurewicz	2006	International Journal of Occupational Medicine and Environmental Health	0.96	1998-2005	17

Detailed Results

For the 10 reviews identified by the literature search and exclusion process, a summary table of results was developed; this table is provided below.

Dimension: <i>Physical Health</i> Concept: <i>Environmental Exposure</i> Summary Table of Reviews			
Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Wigle (2009)	A systematic review and meta-analysis of childhood leukemia and parental occupational pesticide exposure	31	There was an overall association between childhood leukemia and prenatal maternal occupational pesticide exposure; associations with paternal occupational exposure were weaker and less consistent. Precautionary public policies that will minimize such exposures may be warranted, especially with regard to prenatal maternal exposure.
Nieuwenhuijsen (2009)	Chlorination disinfection by-products in drinking water and congenital anomalies: Review and meta-analyses	15	There is limited evidence of an association between chlorination by-products and congenital anomalies.
Braback (2009)	Does traffic exhaust contribute to the development of asthma and allergic sensitization in children: findings from recent cohort studies	15	All studies reported associations with at least some respiratory symptoms, with the outcome varying according to the age of the child. There are very few cohort studies on the effects of traffic-related air pollutants on allergic sensitization, and the findings that are available are inconsistent.
Fuentes-Leonarte (2009)	Levels of pollutants in indoor air and respiratory health in preschool children: A systematic review	14	Exposure to indoor air pollutants during the first few years of life may increase the risk of developing respiratory diseases. Nitrogen dioxide is the most widely studied indoor air pollutant; in most of the studies, a positive correlation was found between NO ₂ and respiratory effects. Other pollutants included volatile organic compounds (benzene, toluene), airborne particulates, phthalates, and carbon dioxide. Due to the small number of studies found, the diversity of the pollutants, and the heterogeneous methodology, it is not possible to say that the evidence linking these pollutants to respiratory problems is conclusive.
Stillerman (2008)	Environmental exposures and adverse pregnancy outcomes: A review of the science	38	There are a variety of links between environmental pollutants and a range of adverse birth and pregnancy outcomes, as follows: Neurodevelopmental effects of lead, mercury, and PCBs (established); occupational exposure to solvents and birth defects (likely); air pollution and adverse birth outcomes (likely, with a higher degree of uncertainty); water contamination from disinfection by-products and pregnancy loss (suggestive, further study required).
Dherani (2008)	Indoor air pollution from unprocessed solid fuel use and pneumonia risk in children aged under five years: A systematic review and meta-analysis	24	Risk of pneumonia in young children is increased by exposure to the combustion products of unprocessed solid fuels (by a factor of 1.80. Solid fuels include wood, animal dung, crop wastes, and coal, all of which are used for cooking and heating in different parts of the world.

Dimension: Physical Health Concept: Environmental Exposure
Summary Table of Reviews

Lead Author	Review Title	Number of Studies Reviewed	Conclusions/Comments
Mendell (2007)	Indoor residential chemical emissions as risk factors for respiratory and allergic effects in children: A review	21	Many associations have been reported between indoor residential chemical emissions and respiratory or allergic effects in infants or children. The following risk factors have a statistically significant odds ratio (OR): Formaldehyde (OR 8.2); aromatic chemicals (OR 11.2); aliphatic chemicals (8.1); plastics and plasticizers (OR 3.4); and paint (OR 5.6).
Raaschou-Nielsen (2006)	Air pollution and childhood cancer: A review of the epidemiological literature	15	The evidence for an association between traffic-related air pollution and childhood cancer is weak; There are a limited number of studies, methodological problems, and inconsistent results.; consequentially, it is not possible to draw a firm conclusion concerning effects.
McNally (2006)	Environmental factors and childhood acute leukemias and lymphomas	41	Environmental risk factors for childhood leukemia include: Exposure to magnetic fields >0.4 micro Tesla; exposure to pesticides, solvents, benzene, and other hydrocarbons; and contaminated drinking water. However, exposure to these risk factors is generally rare. Etiology of childhood leukemia or lymphoma likely involves both a genetic predisposition and one or more environmental exposures; the risk conferred by a single risk factor appears to be small.
Jurewicz (2006)	Exposure to pesticides and childhood cancer risk: Has there been any progress in epidemiological studies?	17	Leukemia, brain cancer, non-Hodgkin's lymphoma, and neuroblastoma are potentially associated with pesticide exposure among children. However, evidence is limited due to weakness of research methodology; there are problems with exposure assessment, small numbers of exposed subjects, and a limited number of studies on most subtopics.

Bibliography for Table of Reviews

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Raaschou-Nielsen O and Reynolds P. Air pollution and childhood cancer: a review of the epidemiological literature. *International Journal of Cancer*. 2006; 118(12): 2920-9.

McNally RJ and Parker L. Environmental factors and childhood acute leukemias and lymphomas. *Leukemia & Lymphoma*. 2006; 47(4): 583-98.

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Summary of Results

The reviews discussed herein may be divided into several categories, based on the health outcome studied. These include respiratory and allergic effects, cancer (especially leukemia), and pregnancy outcomes (i.e., congenital anomalies, low birth weight, etc.).

The reviews on respiratory and allergic effects (notably, asthma onset or attack) report on the associations with indoor air pollution, including residential chemical emissions, and traffic-related pollution. For the broad exposure categories (i.e., indoor and outdoor), a positive correlation with respiratory and allergic effects in children was suggested, but the evidence is ultimately inconclusive due to limited studies and various methodological issues. With regard to the particular topic of indoor residential chemical emissions, statistically significant associations were reported for chemicals such as formaldehyde, aromatic chemicals, aliphatic chemicals, and plastics. One review determined that there is an increased risk of pneumonia in children due to exposure to unprocessed solid fuels; this type of exposure is predominantly found in developing countries, but it may have some bearing in rural or remote areas of British Columbia.

Studies of the association between childhood cancer and environmental exposures examined the effects of traffic-related air pollution, pesticides, contaminated drinking water, and magnetic fields. For most of these studies, the association with childhood cancer has been difficult to demonstrate, due either to rarity of the exposure or to methodological issues. In the case of prenatal occupational pesticide exposure via the mother, there was an overall association with childhood leukemia, though the evidence was again limited.

There were two reviews of more immediate pregnancy outcomes in association with environmental exposures. Nieuwenhuijsen and colleagues reported on chlorination disinfection by-products in drinking water and congenital anomalies, while Stillerman et al. examined a variety of prenatal maternal exposures, including outdoor air pollution, pesticides, and organic solvents. According to the former review, while some studies suggest an association with pregnancy outcomes, the evidence is very limited. Stillerman et al., on the other hand, determined that the link between occupational exposure to solvents and birth defects is likely; they also determined that the neurodevelopmental effects of lead, mercury, and PCBs ought to be considered established. The latter subtopic, where it extends into matters related to cognition and intelligence, lies outside the scope of this report.

Data Sources on Environmental Exposures

National and regional population-level data for a variety of air pollutants are available from Environment Canada; in particular, the National Air Pollution Surveillance Program monitors sulphur dioxide, nitrogen dioxide, ozone, fine particulate matter, and carbon monoxide. However, as discussed above, there is no conclusive evidence for an association between air pollutants and child health outcomes. Most of the other environmental exposures discussed herein do not apply to the population-wide context; in any event, there is generally not enough evidence of an association with child physical health outcomes to be concerned with tracking such exposure data.

Discussion

Overall, there is limited and/or weak evidence for an association between multiple types of environmental exposures and various adverse physical health outcomes in children. In many cases, there are too few studies related to a specific type of exposure, or there are

methodological limitations or inconsistent results. Although some types of exposures, such as prenatal maternal occupational pesticide exposure or indoor air pollution from unprocessed solid fuel use may show a stronger association with child health, these do not qualify as population-level exposures in an urbanized society such as Canada; as such, they generate limited potential as indicators of child health and well-being in B.C.. There are some types of prenatal maternal exposures that have not been discussed here, including smoking, alcohol consumption, nutrition, etc.; these topics are covered in separate chapters on antenatal care and outreach services to pregnant women and mothers.

Conclusion

Among the reviews identified for this report, limited evidence was presented for associations between environmental exposures and child physical health. Of the few topics with stronger evidence, there were none that involved population-level exposures. Thus, it appears that environmental exposures as an indicator of pediatric health and well-being would be of low utility in the British Columbia context.

Summary Assessment					
Rate of Exposure to Selected Environmental Risks					
Age group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude	Significance/Impact	Modifiability	Data Availability/Validity
-	-	Unclear	Medium	Low	Low

As summarized above, assessments have been applied to the Environmental Exposure concept.

The pediatric population **Magnitude** of the potential indicator is assessed as **Unclear**. Given the currently available measures of environmental exposure among the pediatric population, it is not possible to ascertain the prevalence of children experiencing such exposure.

The **Significance** of the potential indicator as supported by the evidence of impact on an individual's health and well-being is assessed as **Medium**. There was limited evidence in the literature pointing to mostly a small risk of health effects.

The **Modifiability** of the potential indicator is assessed as **Low**. The reasons are the complexity of societal forces involved with creating pollutants and other exposures, and the cost of remediating "natural" sources of health risk such as radon gas.

Data Availability/Validity for the potential indicator is assessed as **Low**. There are limited data available on environmental exposures; the most substantial information is for air pollution.

An indicator related to Environmental Exposures is **Not Recommended** for consideration as a core indicator of child health and well-being. One of the greatest obstacles is poor data availability, not allowing for an estimate of the magnitude of affected children; moreover, the cut-offs that enable "affected" to be defined in the first place are not very clear.

Summary and Conclusion

This final section of the report is intended to efficiently pull together the large volume of information gleaned for the dimension of physical health. The ultimate purpose of this report and the others in this series is to support the overall project in recommending a set of core, high-leverage indicators of child health and well-being. “High-leverage” reflects a combination of: (i) the population magnitude or prevalence of the risk-generating condition(s) of most interest for each candidate concept; and (ii) the level of health effects caused in individuals by such conditions. *Feasibility* of application in the real world is another important consideration; it comprises both prevention potential and the ability to populate the indicator with valid data and thereby track prevention progress.

It is useful to re-emphasize several provisos concerning the feasibility of application at this point:

- Prevention potential here refers to the proportion of an indicator’s underlying factor that can conceivably be prevented (e.g., where it is not genetically driven or related to an unknown cause) and/or the existence of interventions of proven effectiveness; while it was not possible in the scope of the present report to conduct a literature review on the latter (major) side topic, reviewer expertise was applied to achieve at least a high-level assessment of the availability of interventions with real-world application.
- Effective interventions need to be considered in the real world context; in particular, the assessment of effectiveness needs to take into consideration the nature of the *remaining* unreached subpopulation, which may in fact be resistant to standard maneuvers because the “low hanging fruit” of realistically preventable cases has already been “picked.”
- On the other hand, it is important to note that prevention *potential* as qualified above is *not* the same thing as prevention *capacity*—in other words, assessing whether there is any theoretical “room for improvement” related to a particular concept or indicator, or whether it is already being covered in the public health system at a “saturation” level (e.g., the situation with most pediatric immunizations); the fact is that prevention capacity is already fully captured under the Magnitude (or prevalence) category of assessment.
- Rating a concept as infeasible in terms of prevention potential and/or indicator data availability/validity is not necessarily a final assessment; where the area is deemed to be high-leverage in terms of population burden, the conclusion may be that research into effective interventions and/or establishing pertinent data ought to be made high priorities—in other words, the indicator is a candidate for potential development.

As noted in the Introduction to the report, the four assessment categories applied to each potential indicator are summed up under the following headings: magnitude; significance/impact; modifiability; and data availability/validity. The category of magnitude could be ascertained more objectively, according to calculations detailed in Annex F-1; if an estimate of prevalence was not possible, it was labelled Unclear. The other three categories were assessed qualitatively in terms of a rating of Low, Medium, or High; for convenience, the meaning of these ratings is provided in the following table (first seen in the Introduction).

Key to Summary Assessments by Evaluation Category				
	Magnitude <i>Estimated prevalence of affected B.C. children</i>	Significance / Impact <i>Physical and other health effects</i>	Modifiability <i>Expert assessment of prevention potential</i>	Data Availability/Validity <i>B.C.-specific information sources</i>
Low	< 19,000 (<2% of total pediatric cohort)	Minimal effects and/or little indication of direct causation	Underlying risk factor not well-identified or not amenable to further prevention	Data not routinely collected and reported
Medium	19,000 - 97,000 (2-10% of total pediatric cohort)	Substantial acute effects or moderate chronic effects; causation still not well-established	Medium Underlying risk factor theoretically amenable to further prevention, but potential interventions not yet proposed in the literature	Medium Data routinely collected but not easily accessible and/or of potentially questionable validity (e.g., mostly self-reported topics with stigma attached)
			Medium-High Underlying risk factor amenable to prevention, but identified interventions have not been well-tested and/or have shown mixed evidence of effectiveness	Medium-High Data routinely collected via sources based on self-reported information of high validity (e.g., the Census)
High	>97,000 (>10% of total pediatric cohort)	Substantial chronic effects and/or elevated mortality; strong evidence, with causation well-established	Underlying risk factor amenable to prevention, and identified interventions have been shown to be effective	Annual data routinely collected and reported via administrative sources or (objective) physical measurement methods

Carefully consideration of the information in the assessment categories in an aggregate manner would allow certain concepts/indicators to rise to the top of the priority list for a set of core metrics that could be integrated into a progress report related to child health and well-being. Thus, it would be surprising if a concept/indicator rated High in all four assessment categories was *not* considered a very strong candidate for a suite of core indicators; likewise, a Low rating in all four categories should automatically propel the indicator to the bottom of the list.

Some “exceptions to the rule” have already been suggested above.

- A Low rating for data availability/validity but higher ratings for the other categories; in such instances, the indicator could be seen as part of a list for future exploration and development.
- If the modifiability category is rated Low because effective interventions are not yet identified, then the indicator again could be placed on the development list, subject to the pursuit of more scientific evidence. On the other hand, if the Low rating for modifiability is due to the fact that the easily preventable subsets of the relevant target population have already been successfully covered by existing interventions, then the concept typically should be excluded even from the “potentially develop” list.

Based on the considerations described above, a total of seven concepts/indicators rose to the surface for priority consideration in the ultimate suite of core indicators of child health and well-being. In addition to the unqualified Not Recommended classification (which, incidentally, is generally marked by a Low rating for Magnitude), two intermediate stratifications were created as part of the summary assessment process, as follows:

- *Indicator of Secondary Interest* - these are indicators of potential usefulness, but with overall less compelling assessment ratings than the seven indicators ultimately recommended for the core list

- *Indicator to Potentially Develop* - these are indicators that could be considered for a core indicator inventory if data sources and/or evidence of effective interventions were enhanced in the future

Gathering together the information provided at the end of each section of the report, the following table summarizes the assessments made across all of the concepts/indicators.

Child Health and Well-being Summary Assessment of Concepts/Indicators for Physical Health Dimension							
Concept	Indicator	Age Group (Years)	Est. Prevalence Among B.C. Children (2010)	Magnitude <i>Proportion of B.C. child/youth population to which concept/indicator applies</i>	Significance / Impact <i>Association between concept and health/well-being dimension</i>	Modifiability <i>Degree the concept/indicator(s) be reasonably changed through public policy or other intervention</i>	Data Availability/Validity <i>Existence and validity of information for the component indicator(s) for each concept</i>
Recommended as Core Indicator							
Proper Nutrition	Not Exclusively Breastfed for At Least 6 Months	0-19	644,000	High	Medium	Medium	High
Oral Health	Ever Having Dental Caries	6-19	415,000	High	Medium	High	High
Pregnancy Outreach Services and Targets	Exposure to At-Risk Pregnancy	0-19	137-296,000	High	High	Medium	Medium
Physical Activity	Low Physical Activity Level	12-19	104,000	High	Medium	Medium-High	Medium-High
Alcohol Use	Binge Drinking	12-19	65,300	Medium	High	Medium-High	Medium
Tobacco Use	Current Smoking	12-19	37,200	Medium	High	High	Medium-High
Birth Weight	Low or High Birth Weight (at Term)	0-19	34,600	Medium	High	Medium	High
Indicator of Secondary Interest							
Immunization Rates	Eligible Individuals Not Vaccinated Against HPV	F: 11-19	125,000	High	Medium	Low	High
Major Chronic Diseases	Asthma	0-19	77,600-127,000	High	Medium	Low	Low
Cause-specific Disability	Global Measure of Disability/Activity Limitation	0-19	72,600	Medium	High	Medium	Low
Healthy Weight	Unhealthy Weight	12-17	55,800	Medium	Medium	Medium	Medium
Teenage Pregnancy	Children Born to Teenage Mother	0-19	27,400	Medium	Medium	Medium	Medium-High
Major Childhood Injuries	Hospitalization for Childhood Injury	0-19	4,900	Low	Medium	High	High
Indicator to Potentially Develop							
Sleep Levels	Less than 10 Hours of Sleep	0-19	115,100	High	Medium	High	Low
Drug Use	Ever-Use of Marijuana	12-17	93,800	Medium	Medium	Medium	Low
Self-rated Health	Self-Rating Health as 'Less than Good'	12-19	69,200	Medium	Medium	Unclear	Medium-High
Sexual Behavior	Sexual Debut Before Age 14	12-19	18,100	Low	Medium	Medium	Medium
Fetal Alcohol Spectrum Disorder	FAS	0-19	1,300	Low	High	High	Low
Vision and Hearing Screening	Proportion of Children with Impairments Identified by Age 3		N/A	Unclear	High	High	Low
Health Services Accessibility	Children per General Practitioner		N/A	Unclear	Medium	Medium	Low
Cause-specific Emergency Department Use	Visits for Selected Causes		N/A	Unclear	Medium	High	Low
Not Recommended for Secondary Interest or Development							
Antenatal Care	Children Born to Mother with Four or Fewer Physician Visits During Pregnancy	0-19	10,700	Low	Medium	Medium	Low
Major Childhood Infectious Diseases	Incidence of Infections	0-19	7,900	Low	Medium	Medium	Medium
Sexually Transmitted Infections	<i>Chlamydia</i> Incidence	10-19	2,800	Low	Low	Medium	High
Newborn Screening	Positive Newborn Screen	0-19	970	Low	High	Low	High
Cause-specific Mortality	Pediatric Deaths	0-19	366	Low	High	Low	High
Environmental Exposures	Rate of Exposure to Selected Environmental Risks		N/A	Unclear	Medium	Low	Low

The selection of the precise “sentinel” indicator for each concept may be questioned after the fact. For instance, why was breastfeeding duration chosen for the concept of Proper Nutrition over the consumption of healthy and unhealthy food groups in childhood (e.g., fruits and vegetables, sugary drinks, etc.)? The main reason is that the health outcomes evidence is generally more compelling for breastfeeding duration, and the related indicator data are both available and of high validity; although based on surveys, the respondents are directly-involved adults, namely breastfeeding mothers, who are reporting on a positive behaviour where there is low potential of recall bias or underestimation.

An additional consideration is the possibility of a leveraging effect, where one indicator can stand for more than one physical health factor; thus duration of breastfeeding may represent a proxy for other positive nutrition decisions in the family as the child grows. This sort of leveraging potential will be revisited at the end of the project in the context of the overall synthesis of recommendations across all the indicators.

As an ultimate reassurance in the face of the recommendations made herein, it is important to recall that the final list of core indicators is supposed to be a highly selective monitoring tool, that is, a *representative* list rather than a *complete* inventory of the prevention targets and manoeuvres that ought to be pursued among children in the province of British Columbia.

Annex F-1: Details of Magnitude Estimates

Magnitude Summary for Selected Child/Youth Indicators

Concepts / Indicator	Age Group	Incidence (I) or Prevalence (P)	Source Year	Source	2010 B.C. Population*	Absolute Number	
Proper Nutrition							
Breastfeeding (Not initiated)	0-19	I	2.7%	2009	Canadian Community Health Survey	970,428 ‡	26,202
Breastfeeding (Not exclusive @ 6 months)	0-19	I	66.4%	2009		970,428 ‡	644,364
Inadequate Fruit and Vegetable Consumption	12-19	P	52.0%	2009		432,716	225,012
Oral Health							
Dental Caries ^	6-19	P	59%	2007-2009	Canadian Health Measures Survey	703,098	414,828
Pregnancy Outreach Services and Targets							
Smoking Regularly During Pregnancy ^	0-19	P	8.7%	2009	Canadian Tobacco Use Monitoring Survey	970,428 ‡	84,427
Exposure to 2nd Hand Smoke During Pregnancy ^	0-19	P	14.1%	2008	Canadian Perinatal Health Report	970,428 ‡	136,830
Alcohol Consumption (Frequently or Infrequently) ^	0-19	P	7.7%	2006-2007	Canadian Maternity Experiences Survey	970,428 ‡	74,723
Total (Low)		14.1%				970,428 ‡	136,830
Total (High)		30.5%				970,428 ‡	295,981
Immunization Rates €							
HPV: No Vaccination (Females)	11-17	P	38.6%	2010	B.C. Center for Disease Control	174,479	67,349
	18-19	P	0.0%	2010		57,909	57,909
Total		P	53.9%			232,388	125,258
Sleep Levels							
Males (<10 hours) ^	0-19	P	12.3%	2006	Chaput et al. <i>International Journal of Obesity</i> , 2006.	501,203	61,648
Females (<10 hours) ^	0-19	P	11.4%	2006		469,225	53,492
Total		P	11.9%			970,428	115,140
Physical Inactivity							
Males	12-19	P	17.7%	2009	Canadian Community Health Survey	223,243	39,514
Females	12-19	P	30.6%	2009		209,473	64,099
Total		P	23.9%			432,716	103,613
Major Chronic Diseases							
Asthma ^	0-19	P	8.0%	2000	National Longitudinal Survey of Children and Youth	970,428 ‡	77,634
Drug Use							
Marijuana: Ever Use	12-17	P	30.0%	2008	B.C. Adolescent Health Survey	312,499	93,750
Disability (Global Measure)							
General Disability Measure	0-4	P	2.0%	2008	Schiariti V, Miller A, O'Donnell et al. Pediatric profile of disability in British Columbia (Abstract). (Based on PALS)	223,659	4,473
General Disability Measure	5-14	P	5.0%	2008		462,770	23,139
Functional Health: Less Than Good							
Males	12-19	P	15.5%	2009	Canadian Community Health Survey	223,243	34,603
Females	12-19	P	12.4%	2009		209,473	25,975
Participation and Activity Limitations							
Males	12-19	P	10.1%	2009		223,243	22,548
Females	12-19	P	14.4%	2009		209,473	30,164
0-19		P	7.5% *			970,428	72,642
Self-rated Health							
Less Than Good	12-19	P	16.0%	2008	B.C. Adolescent Health Survey	432,716	69,235
Alcohol Use							
Binge Drinking ^o	12-19	P	15.1%	2009	Canadian Community Health Survey	432,716	65,340
Healthy Weight							
Males (Overweight + Obese)	12-17	P	22.6%	2009	Canadian Community Health Survey	160,935	36,371
Females (Overweight + Obese)	12-17	P	12.8%	2009		151,564	19,400
Total		P	17.8%			312,499	55,772
Tobacco Use							
Current Smokers	12-19	P	8.6%	2009	Canadian Community Health Survey	432,716	37,214
Birth Weight							
Low Birth Weight	0-19	I	1.5%	2009	B.C. Vital Statistics Agency 2009 Report (Table 13)	970,428	14,716
High Birth Weight	0-19	I	2.0%	2009		970,428	19,881
Total		3.6%				970,428 ‡	34,596
Small for Gestational Age: Male	0-19	I	7.8%	2005-2007	Statistics Canada, Table 102-4304.	501,203	39,094
Large for Gestational Age: Male	0-19	I	12.0%	2005-2007		501,203	60,144
Small for Gestational Age: Female	0-19	I	7.5%	2005-2007		469,225	35,192
Large for Gestational Age: Female	0-19	I	11.8%	2005-2007		469,225	55,369
Total		19.6%				970,428 ‡	189,799
Sexual Behaviour							
Sexual Debut Before Age 14	12-19	P	4.2%	2008	B.C. Adolescent Health Survey. 2008.	432,716	18,088

Magnitude Summary for Selected Child/Youth Indicators (continued)

Concepts / Indicator	Age Group	Incidence (I) or Prevalence (P)			Source Year	Source	2010 B.C. Population*	Absolute Number	
Teenage Pregnancy									
Live Births	14	I	0.5	/1,000 females	2005	Statistics Canada, Canadian Vital Statistics, Birth Database and Stillbirth Database; Canadian Institute for Health Information, Hospital Morbidity Database and Therapeutic Abortion Database.	500,440	250	
	15-17	I	4.9	/1,000 females	2005		1,590,640	7,794	
	18-19	I	16.7	/1,000 females	2005		1,158,180	19,342	
	Total		8.4	/1,000 females			3,249,260 †	27,386	
Stillbirths	14	I	0.0	/1,000 females	2005		500,440	-	
	15-17	I	0.3	/1,000 females	2005		1,590,640	477	
	18-19	I	0.6	/1,000 females	2005		1,158,180	695	
Abortions	14	I	1.8	/1,000 females	2005		500,440	901	
	15-17	I	12.7	/1,000 females	2005		1,590,640	20,201	
	18-19	I	29.7	/1,000 females	2005		1,158,180	34,398	
	Total	I	25.9	/1,000 females		3,249,260	84,058		
Antenatal Care									
Four or Less Doctor Visits ^	0-19	P	1.1%		2009	Canadian Maternity Experiences Survey	970,428 ‡	10,675	
Major Childhood Infectious Diseases									
Pediatric Infection	0-19	I	814.70	/100,000 population	2009	B.C. Center for Disease Control	970,428	7,906	
Major Childhood Injuries									
Hospitalizations	0-19	I	509.00	/100,000 population	2008	B.C. Injury Research and Prevention Unit	970,428	4,939	
Sexually Transmitted Infections									
Chlamydia Males	15-19	I	322.80	/100,000 population	2009		146,558	473	
	Females	15-19	I	1,669.40	/100,000 population	2009		137,441	2,294
		Total		974.49	/100,000 population		283,999	2,768	
Fetal Alcohol Spectrum Disorder									
	0-19	I	1.38	/1,000 live births	2001-2003	B.C. Vital Stats (FASD/Total Live Births)	970,428 Ø	1,339	
Newborn Screening									
	0-19	I	0.1%		2010	B.C. Childrens Hospital	970,428 ‡	970	
Cause-specific Mortality									
Pediatric Mortality	0-19	I	37.71	/100,000 population *	2008	B.C. Vital Statistics Annual Report	970,428	366	
Health Services Accessibility									
Cause-specific Emergency Department Visits									
Environmental Exposure									
Vision and Hearing Impairment									
*Generally, population estimates are taken from BC Stats (available at: http://www.bcstats.gov.bc.ca).									
† In order to calculate the absolute number affected, incidence rates of live births for adolescent girls aged 14-19 were used and applied across 20 times the current female population of the same age. This results in an absolute number affected that is 20 times the current (2010) population of live births to teenage (14-19) mothers - a more accurate reflection of the entire 0-19 year age cohort that is susceptible to adverse health effects due to teenage pregnancy.									
‡ Incidence data for both low and high birth weight is only for those individuals who were not born preterm. This data was derived from BC Vital Statistics for the 2009 birth cohort. In order to calculate the absolute number affected, the incidence rate was applied to the entire pediatric population aged 0-19 years from 2010 (970,428). The assumption in this case is that the percentage of low and high birth weight infants (not born preterm) has not changed significantly over the past 19 years.									
^ Based on National rather than B.C.-specific incidence data; The concept of Sleep Levels is based solely on Quebec study data.									
Q Defined as 5 or more drinks on one occasion, at least once a month in the past year.									
# General disability data from PALS and the 'participation and activity limitation' data from the CCHS were used to calculate the estimated prevalence among children aged 0-19. Due to the reliance on two data sources to capture the full 0-19 age cohort, the three years of overlap from PALS were removed from the 5-14 age group by assuming individuals were evenly distributed in each of the age years. That is, 30% of the overall population was removed.									
E Estimated absolute prevalence was calculated by assuming the current 2010 HPV vaccination rate in the 11-17 year old age cohort. This cohort was used because the current program is just completing a three year 'catch-up' period for grade 9 students, the oldest of which are now in grade 11 (age 17 years). Those aged 18 and 19 were assumed to have a 0% vaccination rate.									
¥ Rate calculated by taking total pediatric mortality in 2008 (275) and converting based on 2008 BC population aged 0-19.									
Ø Rate calculated by taking total reported FASD cases for 2001-2003 (167) and dividing by total live births in years 2001/02,2002/03,2003/04 (120,600).									

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