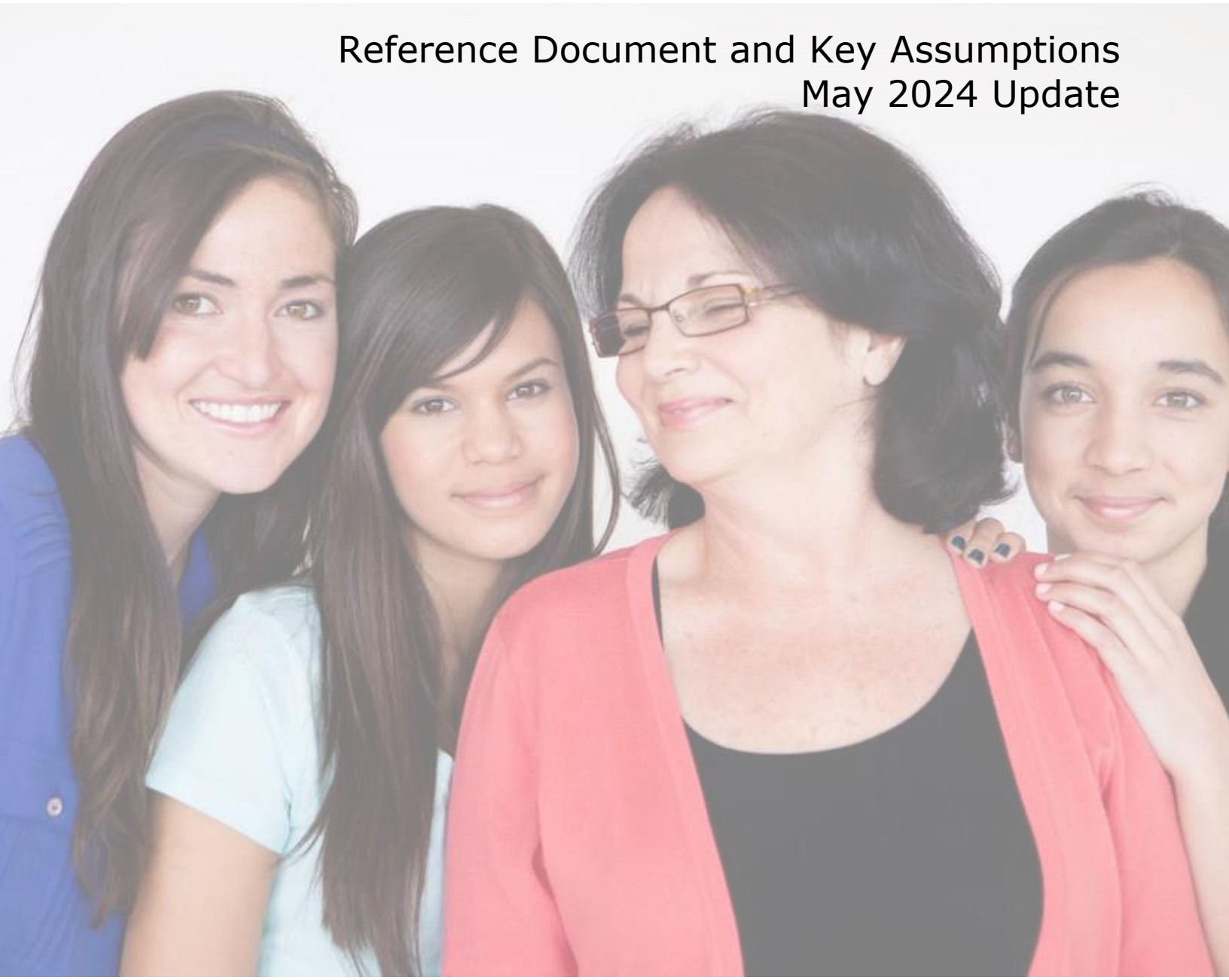
Establishing Priorities among Effective Clinical Prevention Services in British Columbia

Reference Document and Key Assumptions
May 2024 Update



BRITISH COLUMBIA

Acknowledgments

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Table of Contents

Establishing Priorities among Effective Clinical Prevention Services in British Columbia: *Reference Document and Key Assumptions*

Introduction

The report, *A Lifetime of Prevention*, was published by the Clinical Prevention Policy Review Committee (CPPRC) in December of 2009.[1] A key goal of the CPPRC was to determine which clinical prevention services are worth doing in British Columbia (BC), culminating in a proposed Lifetime Prevention Schedule (LPS). Clinical prevention services were included on the LPS if they were considered to be effective, had a significant positive impact on population health and were cost-effective.

Clinical prevention services (CPS) are defined as:

> *Manoeuvres pertaining to primary and early secondary prevention (i.e., immunization, screening, counselling and preventive medication/device) offered to the general population (asymptomatic) based on age, sex and risk factors for disease and delivered on a one-provider-to-one-client basis, with two qualifications:*
>
> > *(i) the provider could work as a member of a care team or as part of a system tasked with providing, for instance, a screening service; and*
> >
> > *(ii) the client could belong to a small group (e.g. a family, a group of smokers) that is jointly benefiting from the service.*

This definition does not refer to the type of provider or the type of funding. This allows for the evaluation of the appropriate implementation of the service as a separate program planning matter.

Since 2009, a total of 31 CPS have been reviewed by the Lifetime Prevention Schedule Expert Committee (LPSEC) for potential inclusion in the LPS.

This document is a companion document to *Establishing Priorities among Effective Clinical Prevention Services in British Columbia*. It provides a record of all key model assumptions in one location.

This document (*Reference and Key Assumptions*) is divided into the following sections:

- A brief **overview of the process** for reviewing CPS to determine whether or not the LPSEC will recommend the inclusion or exclusion of the CPS on the lifetime prevention schedule.
- An overview of the **key assumptions** made throughout the project.
- A **reference section** in which **specific assumptions** are considered in more detail and the impact of individual disease states in terms of their impact on life expectancy, quality of life and costs are identified and described. The reference section, for

[1] Clinical Prevention Policy Review Committee. *A Lifetime of Prevention: A Report of the Clinical Prevention Policy Review Committee*. 2009. Available at http://www.health.gov.bc.ca/library/publications/year/2009/CPPR_Lifetime_of_Prevention_Report.pdf. Accessed July 2017.

example, includes information on CPS intervention rates, how costs are converted into 2022 Canadian dollars, how a disease state affects an individual's quality of life (QoL) and how to calculate this in the models, and the ongoing costs of care for disease state survivors.

An Overview of the Process

The process for evaluating clinical prevention services in British Columbia is carried out in four sequential steps and includes addressing the following four questions.

STEP 1 – Is the Service Effective?

To answer this question we depend on thorough reviews completed by other respected agencies, primarily the work by the Canadian Task Force on Preventive Health Care (CTFPHC) and the US Preventive Services Task Force (USPSTF).

If these agencies find that the prevention service works (i.e. effectively achieves what it is intended to achieve), then we move on to STEP 2. For example, in 2016 the CTFPHC recommended universal screening for colorectal cancer between the ages of 50 and 74.[2] The 2021 USPSTF recommended universal screening for colorectal cancer between the ages of 45 and 75.[3] For modelling purposes, when a difference in recommendations occurs, we tend to follow the recommendation based on the most current evidence.

In British Columbia, there were 2,945 new colorectal cancer cases and 1,115 deaths from colorectal cancer in 2018.[4] Research by the CTFPHC indicates that screening for colorectal cancer between the ages of 50 and 74 would result in a 22% reduction in mortality from colorectal cancer and an 18% reduction in the incidence of late stage colorectal cancer.[5]

STEP 2 – What is the Impact on the British Columbia Population of Implementing the Service?

To answer this we calculate what we call the clinically preventable burden (CPB) associated with implementing the service. The CPB is defined as the total quality-adjusted life years that could be gained if the clinical preventive service were delivered at recommended intervals to a British Columbia birth cohort of 40,000 individuals over the years of life that a service is recommended.

When calculating the CPB, two key drivers are considered. First, how much of the population does the service impact? If it only impacts a small proportion of the population, the CPB would be small. In the case of screening for colorectal cancer, the population impacted is everyone living in British Columbia between the ages of 45-75. Furthermore, colorectal cancer is a fairly common cancer, with approximately 3,000 new cases identified annually in British Columbia.

Second, what is the effect size of the service? For example, if a service reduced the risk of death by 1%, its effect size would be 1/10th of a service that reduced the risk of death by 10%. As noted above, the effect size for screening for colorectal cancer is a 22% reduction in mortality from colorectal cancer and an 18% reduction in the incidence of late stage colorectal cancer. If the service impacts a larger proportion of the population but the effect is minimal, then the CPB would also be small.

The services with the highest CPB are those that impact a large segment of the population and have a relatively large effect.

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[2] Canadian Task Force on Preventive Health Care. Recommendations on screening for colorectal cancer in primary care. *Canadian Medical Association Journal*. 2016; 188(5): 340-8.

[3] US Preventive Services Task Force. Screening for colorectal cancer: US Preventive Services Task Force Recommendation statement. *JAMA*. 2021; 325(19): 1965-1977.

[4] See http://www.bccancer.bc.ca/statistics-and-reports-site/Documents/Cancer_Type_Colorectal_2018_20210305.

[5] Canadian Task Force on Preventive Health Care. Recommendations on screening for colorectal cancer in primary care. *Canadian Medical Association Journal*. 2016; 188(5): 340-8.

In calculating the CPB, we try and compare what is currently happening in British Columbia with other regions of the world for the service under consideration. We find a region that has done the best possible job of implementing the service and compare this "best-in-the-world" result to the current provision of this service in British Columbia. This gives a sense of how much service improvement is possible (i.e. the gap between the current British Columbia service and "best-in-the-world"). For example, current screening rates for colorectal cancer between the ages of 50 and 74 in British Columbia are approximately 50%.[6] Screening in the US state of Massachusetts, however, has achieved rates of 77%.[7]

The CPB is calculated using a measure called a quality-adjusted life year (QALY). In calculating CPB both benefits and harms associated with the service are taken into account. Note that not all services have identified harms associated with them.

If we are able to achieve colorectal cancer screening rates of 77% in a British Columbia birth cohort of 40,000, then our calculations suggest that we could add 3,588 QALYs or a CPB of 3,588.

STEP 3 – Is the Service Cost-Effective?

To answer this we calculate the cost per QALY added associated with implementing the service. The first part of this process, namely the calculation of the CPB as the net gain in QALYs, has been calculated during STEP 2. In STEP 3, we focus on estimating the costs associated with implementing the service, including the costs associated with screening and any interventions needed.

When looking at time costs, we include the time costs of both clinicians and the individuals receiving the service. Placing a monetary value on patient time costs is important as we are asking otherwise healthy individuals to engage with the health care system even though, in the long term, they may not be the ones who benefit.

In estimating the overall cost of the service, we take into account both costs resulting from the service as well as costs that might be avoided as a result of the service. For example, the costs associated with screening for colorectal cancer in a BC Birth cohort of 40,000 are estimated at $113.3 million. Since screening for colorectal cancer reduces the number of new colorectal cancers and deaths, we would also expect a reduced cost of $77.7 million in caring for these individuals. The net costs would therefore be $35.6 million ($113.3 million – $77.7 million).

At the end of STEP 3, we calculate the cost per quality-adjusted life year. In our example this means dividing the $35.6 million in net costs by the 3,588 QALYs for a cost per quality-adjusted life year of $9,921.

We refer to this cost per quality-adjusted life year as the cost-effectiveness of providing the service. More specifically, cost-effectiveness is defined as the average net cost per quality-adjusted life year gained in typical practice by offering the clinical preventive service at recommended intervals to a British Columbia birth cohort over the recommended age range.

STEP 4 – How Does the Service Compare with Other Effective Services?

In the final step we compare all the services that have gone through STEPS 1-3. By this stage we have calculated a unique CPB value and cost-effectiveness ratio for each service. The CPB and cost-effectiveness for each service is used to locate that service on the grid in Figure 1 below. Services that fall within the upper right hand segment have the highest population

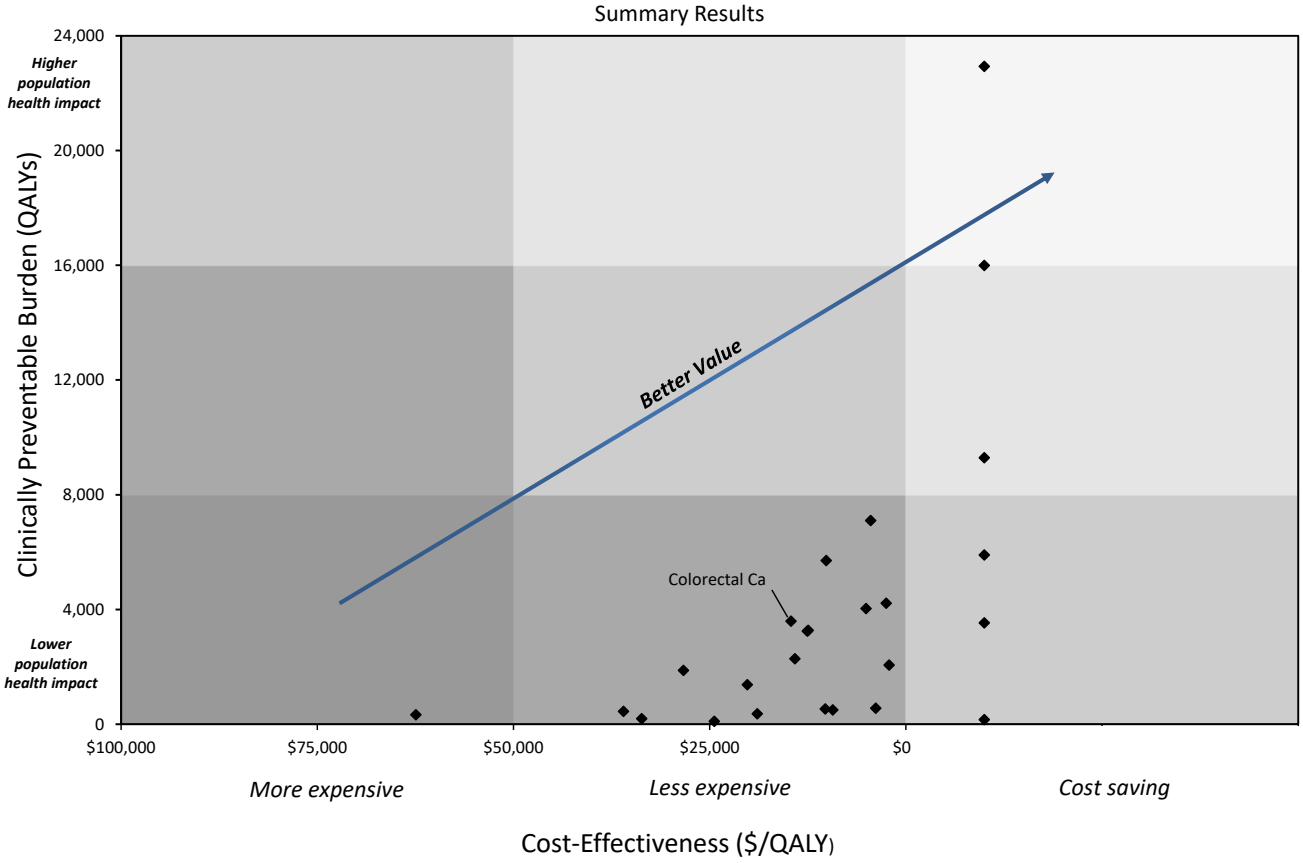
[6] Singh H, Bernstein C, Samadder J et al. Screening rates for colorectal cancer in Canada: a cross-sectional study. *Canadian Medical Association Journal Open*. 2015; 3(2): E149-57.
[7] National Cancer Institute. *Screening and Risk Factors Table*. 2017. Available at https://statecancerprofiles.cancer.gov/risk/index.php. Accessed August 2017.

health impact (based on their clinically preventable burden) and are cost-saving. Services that fall within the lower left hand segment have the lowest population health impact and are relatively expensive to implement.

Screening for colorectal cancer between the ages of 45 and 75 in a British Columbia birth cohort of 40,000 results in an estimated clinically preventable burden of 3,588 and a cost-effectiveness of $9,921. This places the service in the lower row with respect to clinically preventable burden and the middle column with respect to cost-effectiveness (see Figure 1).

Figure 1: **Establishing Priorities Among Effective Clinical Prevention Services in BC**

Combining Clinically Preventable Burden and Cost-Effectiveness
Summary Results



The results generated through this process are a key step in determining which current clinical prevention services in British Columbia require a concerted focus and which new clinical prevention services should be implemented. These results, however, should not be used in isolation. Any changes to service provision should be undertaken only when this research is supplemented by additional analyses, including a business plan and budget impact analysis. These supplementary analyses are important in addressing additional questions required in decision-making, such as the feasibility and total costs of enhancing current services or implementing new services.

Acknowledgement

The process for evaluating clinical prevention services in British Columbia was initially based on the process developed by the HealthPartners Research Foundation in the United States.[8,9] In 2008 the HealthPartners Research Foundation provided the Lifetime Prevention Schedule Expert Committee with a number of models assessing the clinically preventable burden and cost-effectiveness of various clinical prevention services in the US. The Lifetime Prevention Schedule Expert Committee updated these models using British Columbia-specific data. The process in both British Columbia and the US has since evolved. All British Columbia models, for example, are now 'homegrown'. In the US, the renamed HealthPartners Institute continues to assess clinical prevention services using more sophisticated modelling approaches.[10] They are also one of a number of groups in the US providing modelling support to the United States Preventive Services Task Force in assessing the effectiveness of various clinical prevention services.[11,12]

[8] Coffield A, Maciosek M, McGinnis J et al. Priorities among recommended clinical preventive services. *American Journal of Preventive Medicine*. 2001; 21(1): 1-9.
[9] Maciosek M, Coffield A, Edwards N et al. Priorities among effective clinical preventive services: results of a systematic review and analysis. *American Journal of Preventive Medicine*. 2006; 31(1): 52-61.
[10] Maciosek M, LaFrance A, Dehmer S et al. Updated priorities among effective clinical preventive services. *The Annals of Family Medicine*. 2017; 15(1): 14-22.
[11] Owens D, Whitlock E, Henderson J et al. Use of decision models in the development of evidence-based clinical preventive services recommendations: methods of the US Preventive Services Task Force. *Annals of Internal Medicine*. 2016; 165(7): 501-8.
[12] Dehmer S, Maciosek M, Flottemesch T et al. Aspirin for the primary prevention of cardiovascular disease and colorectal cancer: a decision analysis for the US Preventive Services Task Force. *Annals of Internal Medicine*. 2016; 164(12): 777-86.

Key Assumptions

The following key assumptions have been made throughout this project.

Duplication of Effort

In order to prevent duplicate evidence reviews, the Lifetime Prevention Schedule Expert Advisory Committee decided to refer any recommendations regarding immunizations to the Immunization Programs and Vaccine Preventable Diseases Service of the British Columbia Centre for Disease Control[13] and any recommendations regarding prenatal care, intrapartum care and immediate postpartum care (up to 8 weeks) to the Perinatal Services BC (PSBC) guidelines.[14] Note, however, that universal screening of newborns in BC for critical congenital heart defects, severe combined immune deficiency, biotinidase deficiency and carnitine uptake disorder has been assessed using the LPS methodology.

Delivery Mechanism(s)

The definition of clinical prevention is independent of delivery mechanism(s) or provider type(s). Determining which delivery mechanism or provider type would be most suitable for each service will be assessed in subsequent phases of the policy cycle where decisions will be made on whether and, if so, how to implement. Further evidence reviews may be undertaken during these phases as well as in operational planning.

For the purposes of this project, we have had to make assumptions about delivery mechanisms and provider type in order to estimate the costs of providing the service. Estimating costs is required in calculating cost-effectiveness. For consistency and comparability between the various preventive services, we chose to use a general physician's office as the delivery mechanism and provider type whenever appropriate. That is, if an established delivery mechanism is not in place, then we assumed, for costing purposes, that it would take place in a general physician's office. For example, no program currently exists in BC for screening and interventions to reduce falls in community-dwelling elderly, so we assumed this would take place in a general physician's office.

Patient Costs

CPS are offered to the asymptomatic general population. As such, people are being asked to give up some of their time for a service which has a (relatively small) chance of detecting a clinically relevant issue. Alternatively, they may be asked to give up some of their time for a behavioural counselling intervention that has a modest potential for success. As such, it is important to value this time and include it in the base case analysis in an assessment of the cost-effectiveness of the intervention. Increasingly, groups such the US Second Panel on Cost-effectiveness in Health and Medicine are recommending the inclusion of both patient and caregiver time and effects in economic evaluations (see below).

For the purposes of consistency and comparability, we have assessed this time by including travel time to and from the intervention as well as time during the intervention and then valued this total time based on average wage rates for the BC population. In the sensitivity analysis for each service, we have excluded patient costs so that the impact of these costs on the cost-effectiveness of the service can be more easily determined.

[13] See http://www.bccdc.ca/health-professionals/clinical-resources/communicable-disease-control-manual/immunization. Accessed September 2017.
[14] See http://www.perinatalservicesbc.ca/health-professionals/guidelines-standards. Accessed September 2017.

Spillover Effects

Spillover effects occur when the illness of a child or family member has an economic or quality of life impact on the broader family or caregiver(s).

Few of the economic evaluation guidelines emanating from international health technology assessment agencies specifically mention spillover effects. They do, however, make broader recommendations of which costs and effects to include, often depending on the perspective of the analysis.

The Canadian Agency for Drugs and Technologies in Health (CADTH) *Guidelines for the Economic Evaluation of Health Technologies*[15] document, for example, recommends that the reference case take the perspective of the public health care payer with a more limited inclusion of costs and effects. If the perspective is a societal one, however, then "the impact of the intervention on time lost from paid and unpaid work by both patients and informal caregivers as a result of illness, treatment, disability or premature death should be included in an additional non-reference case analysis" (pg. 21). These guidelines do mention spillover effects, but only tangentially. They note that there "may be health states for which the estimation of utilities is particularly challenging, due to both limited data and the lack of consensus on methods (e.g., health states for individuals with disabilities, states affecting vulnerable populations, temporary health states, states with spillover effects on informal caregiving). Given the dearth of information with which to estimate utilities for such health states, the analysis of uncertainty will be especially important" (pg. 47).

The UK National Institute for Health and Care Excellence (NICE) *Guide to the Methods of Technology Appraisal*[16] is silent on the specific issue of spillover effects but does note that "the perspective on outcomes should be (the inclusion of) all direct health effects, whether for patients or other people" (pg. 34).

The recommendations from the US Second Panel on Cost-effectiveness in Health and Medicine[17] indicate that "all cost-effectiveness analyses should report 2 reference case analyses: one based on the health care sector and another based on the societal perspective" (p.1093). Furthermore, the analysis conducted from the societal perspective should consider "all parties affected by the intervention and (count) all significant outcomes and costs that flow from it, regardless of who experiences the outcomes or bears the costs" (p. 1095). The detailed recommendations from the US Second Panel indicate that "(i)f spillover effects on family/caregivers are likely to represent an important category of health outcomes associated with an intervention that averted or reduced the severity of an illness of a family member, an attempt should be made to value these effects and incorporate them into the CEA. Further, these spillover effects should be included in reference case analyses for both the health care sector and societal perspectives" (p. 188).[18] A reference case is "a set of standard methodological practices that all cost-effectiveness analyses should follow to improve comparability and quality."[19]

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[15] Canadian Agency for Drugs and Technologies in Health Methods and Guidelines. *Guidelines for the Economic Evaluation of Health Technologies: Canada*. 2017. Available at https://www.cadth.ca/guidelines-economic-evaluation-health-technologies-canada-4th-edition. Accessed June 2017.

[16] National Institute for Health and Care Excellence. *Guide to the methods of technology appraisal 2013*. 2013. Available at https://www.nice.org.uk/process/pmg9. Accessed August 2017.

[17] Sanders G, Neumann P, Basu A. et al. Recommendations for conduct, methodological practices, and reporting of cost-effectiveness analyses: second panel on cost-effectiveness in health and medicine. *Journal of the American Medical Association*. 2016; 316(10): 1093-103.

[18] Neumann PJ, Sanders GD, Russell LB, et al, editors. *Cost-Effectiveness in Health and Medicine.* 2nd ed. New York: Oxford University Press; 2017.

[19] Sanders G, Neumann P, Basu A. et al. Recommendations for conduct, methodological practices, and reporting of cost-effectiveness analyses: second panel on cost-effectiveness in health and medicine. *Journal of the American Medical Association*. 2016; 316(10): 1093-103.

As noted earlier, one of the key assumptions is that patient costs should be part of the reference case and that the more narrow perspective of the health care system (*excluding* these patient costs) be included in a secondary sensitivity analysis. This same assumption should apply to spillover effects. The nascent nature of research on spillover effects, however, precludes their inclusion in the current analysis.

In making this assumption, the committee recognizes that while there is a large academic literature acknowledging the existence of spillover effects, there is a much smaller literature on how to measure such effects, and even less literature actually measuring the effects.[20,21,22,23,24,25,26,27,28]

The one exception in the current modelling is the inclusion of parental time costs associated with caring for a child with spina bifida in the sensitivity analysis of the *Folic Acid Supplementation in Reproductive-age Women for the Prevention of Neural Tube Defects* model.

Broader Societal Costs

In general, the reference case includes known costs to the health care system and the patient. It has been argued that broader societal costs outside of the healthcare system, such as those in education or social services, should also be taken into account to detect possible cost shifting between sectors.[29] These broader costs have been taken into account in three models in which they are readily known and have a significant impact on the modelling. In addition to the inclusion of parental time costs associated with caring for a child with spina bifida in the sensitivity analysis of the *Folic Acid Supplementation in Reproductive-age Women for the Prevention of Neural Tube Defects* model, we also included special education and developmental service costs. For the *Alcohol Misuse Screening and Brief Intervention* model we included costs associated with law enforcement, fire and traffic accident damage and so on. These costs are estimated to be higher than the direct medical care costs.[30] For the *Screening and Interventions to Reduce Unhealthy Drug Use* model, we included criminal justice and accident damage costs.

[20] Basu A and Meltzer D. Implications of spillover effects within the family for medical cost-effectiveness analysis. *Journal of Health Economics*. 2005; 24(4): 751-3.
[21] Wittenberg E, Ritter G and Prosser L. Evidence of spillover of illness among household members: EQ-5D scores from a US sample. *Medical Decision Making*. 2013; 33(2): 235-43.
[22] Wittenberg E, Saada A and Prosser L. How illness affects family members: a qualitative interview survey. *The Patient-Centered Outcomes Research*. 2013; 6(4): 257-68.
[23] Lavelle T, Wittenberg E, Lamarand K et al. Variation in the spillover effects of illness on parents, spouses, and children of the chronically ill. *Applied Health Economics and Health Policy*. 2014; 12(2): 117-24.
[24] Tilford J and Payakachat N. Progress in measuring family spillover effects for economic evaluations. *Expert Review of Pharmacoeconomics & Outcomes Research*. 2015; 15(2): 195-8.
[25] Al-Janabi H, Van Exel J, Brouwer W et al. Measuring health spillovers for economic evaluation: a case study in meningitis. *Health Economics*. 2016; 25(12): 1529-44.
[26] Prosser L, Lamarand K, Gebremariam A and Wittenberg E. Measuring family HRQoL spillover effects using direct health utility assessment. *Medical Decision Making*. 2015; 35: 81-93.
[27] Wittenberg E and Prosser L. Health as a family affair. *New England Journal of Medicine*. 2016; 374(19): 1804-6.
[28] Wittenberg E and Prosser L. Disutility of illness for caregivers and families: a systematic review of the literature. *Pharmacoeconomics*. 2013; 31(6): 489-500.
[29] Byford S and Raftery J. Perspectives in economic evaluation. *British Medical Journal*. 1998; 316(7143): 1529-30.
[30] Rehm J, Gnam W, Popova S et al. The costs of alcohol, illegal drugs, and tobacco in Canada, 2002. *Journal of Studies on Alcohol and Drugs*. 2007; 68(6): 886-95.

Discounting

In the economic appraisal of health programs or interventions, costs and benefits that are spread over time are usually weighted according to when they are experienced. The further in the future, the less heavily they are weighted or the more they are discounted. This can be particularly challenging for interventions in which costs are current and benefits are further in the future (e.g. prevention). The impact of discounting is most noticeable for preventive services in children and youth, given that costs are generally current, whereas benefits and potential costs avoided may stretch over the lifetime of the individual.[31,32,33,34]

From a health economics perspective, the usual approach is to discount both costs and benefits when calculating cost-effectiveness. However, discounting may fail to reflect a value we as a society might hold for the future of our children. The Netherlands, for example, require that a discount rate of 1.5% be applied to benefits while a discount rate of 4% be applied to costs.[35] It would thus be important to explicitly understand the impact of discounting in the current project. To do so, we use a 1.5% discount rate in the base case with a 3% and a 0% discount rate in the sensitivity analysis. A 0% discount rate is equivalent to not discounting. A 1.5% discount rate for the base case is currently (as of July 2017) recommended by both CADTH in Canada[36] and NICE in the UK.[37]

Incorporating Information on Current Coverage

A number of the preventive services assessed in this project have an established history in the province while others may only be provided in a limited, fairly random approach (as 'random acts of kind prevention'). With this in mind, we set out to assess CPB and CE from two perspectives. First, assuming that the service had no current coverage in the province (i.e. that the service had not yet been established in the province). Second, assessing the gap between current coverage in the province and what arguably could be considered the best possible coverage (based on information on "best-in-the-world" coverage for the service).

Incorporating Key Recent Evidence

The USPSTF is currently attempting to update their evidence review and recommendations every five years. It is possible that seminal research has been published during the interval between updates and that this research may alter recommendations. To take this into account, we considered evidence reviews from other organizations (e.g. the Cochrane Collaboration and NICE in the UK) for any USPSTF or CTFPHC recommendations published more than four years ago.

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[31] Parsonage M and Neuburger H. Discounting and health benefits. *Health Economics*. 1992; 1(1): 71-6.

[32] Brouwer WB, Niessen LW, Postma MJ et al. Need for differential discounting of costs and health effects in cost effectiveness analyses. *British Medical Journal*. 2005; 331(7514): 446-8.

[33] Claxton K, Sculpher M, Culyer A et al. Discounting and cost-effectiveness in NICE – stepping back to sort out a confusion. *Health Economics*. 2006; 15(1): 1-4.

[34] Gravelle H, Brouwer W, Niessen L et al. Discounting in economic evaluations: stepping forward towards optimal decision rules. *Health Economics*. 2007; 16(3): 307-17.

[35] Tan S, Bouwmans C, Rutten F et al. Update of the Dutch manual for costing in economic evaluations. *International Journal of Technology Assessment in Health Care*. 2012; 28(2): 152-8.

[36] Canadian Agency for Drugs and Technologies in Health Methods and Guidelines. *Guidelines for the Economic Evaluation of Health Technologies: Canada*. 2017. Available at https://www.cadth.ca/guidelines-economic-evaluation-health-technologies-canada-4th-edition. Accessed July 2017.

[37] NICE. *Methods for the Development of NICE Public Health Guidance (Third Edition)*. Available online at https://www.nice.org.uk/process/pmg4/chapter/incorporating-health-economics. Accessed July 2017.

Focus on the Best Available Evidence for a Conservative Approach to Implementation

An important assumption of this project is to focus on the highest level of available evidence. Given the limited capacity in the health care system, it is better to take a conservative approach by focussing on a limited number of preventive interventions that are clearly proven to be effective, will have an important impact on the health of the entire population of BC and are likely to be cost-effective. The focus should be on achieving potential coverage and an effective dose for a limited number of preventive services rather than incomplete coverage of a larger number of preventive services.

Reference Section

CPS Intervention Rate

This section of the report provides an overview of the 31 CPS reviewed by the LPSEC to date. The section begins with a one-page summary including the name of the CPS, the relevant cohort and the frequency with which the service is to be provided. In addition, an estimated rate of coverage for the service in British Columbia and the best rate in the world is provided.

Following the summary is a brief section on each of the 31 CPS. Each of these sections begins with a recommendation regarding the provision of the service. The recommendations are most frequently those of the USPSTF or the CTFPHC. In all cases, the source of the recommendation is identified in the footnotes. The last two subsections for each CPS provide available data and sources for the rate of coverage for that CPS in BC and the best rate in the world.

Summary

Potential Clinical Prevention Services in B.C.
Summary of the Applicable Cohort, Service Frequency and Coverage

Clinical Prevention Services	Cohort / Timing	Frequency / Intensity	Estimated Coverage B.C.	'BiW'(1)
Screening for Asymptomatic Disease or Risk Factors - Children/Youth (C/Y)				
Vision screening for amblyopia	Ages 3-5	At least once	93%	93%
Screening for depression	Ages 12 - 18	Annually	Unknown	57%
Screening for anxiety	Ages 8 - 18	Annually	Unknown	57%
Behavioural Counseling Interventions - Children/Youth (C/Y)				
Growth monitoring and healthy weight management in children and youth	Ages 6 - 17	Screening - At all appropriate primary care visits	Unknown	13%
		Intervention - Attendance at >70% of ten 2-hour sessions.	7.2%	7.2%
Promotion of breastfeeding	During pregnancy and after birth	Multiple sessions	Unknown	46%
Preventing tobacco use (school-aged children & youth)	Ages 6 - 17	Annually	Unknown	53%
Preventive Medication / Devices - Children				
Dental sealants	On permanent teeth at time of tooth eruption (ages 6 - 12)	4 times (on 1st and 2nd bicuspids & molars)	Unknown	59%
Screening for Asymptomatic Disease or Risk Factors - Adults				
Screening for breast cancer	Ages 50 - 74	Every 2 -3 years	52%	88%
Screening (cytology-based) for cervical cancer	Ages 25 - 69	Every 3 years	69%	69%
Screening (HPV-based) for cervical cancer	Ages 25 - 69	Every 5 years	0%	69%
Screening for colorectal cancer	Ages 45 - 75	FIT every 2 years	50%	77%
Screening for lung cancer	Ages 55 - 74 with a 30 pack-year smoking history	Annually for 3 consecutive years	Unknown	6%/60%
Screening for hypertension	Ages 18 and older	Screening - At least once every 2 years	Unknown	88%
Screening for cardiovascular disease risk and treatment (with statins)	Ages 40 -74	Screening - Once every 5 years	Unknown	48%
		Management - Ongoing	Unknown	30%
Screening for prediabetes / type 2 diabetes	Ages 35 - 70 with overweight or obesity	Every 3 years	Unknown	81%
Screening for depression	Nonpregnant adults ages 18+	At least once	Unknown	12%
Screening for depression	Pregnant and postpartum women	At least once per birth by 8 weeks postnatally	Unknown	39%
Screening for fragility fractures	Females age ≥ 65	Every 8 years	Unknown	58%
Screening for abdominal aortic aneurysm	Males age 65 who have ever smoked	One-time	Unknown	86%
Screening for Sexually Transmitted Infections and Blood Borne Pathogens - Adults				
Screening for human immunodeficiency virus	Ages 15 - 65	Low risk - Once	20%	45%
		Increased risk - Every 3 - 5 years		63%
		Very high risk - Every year		83%
		During all pregnancies	96%	97%
Screening for hepatitis C virus	Adults born between 1945 - 1965	One-time	31%	83%
Behavioural Counseling Interventions - Adults				
Prevention of sexually transmitted infections (STIs)	All sexually active adolescents and adults who are at increased risk for STIs	30 min to ≥2 hours of intensive behavioral counseling	Unknown	29%
Counselling and interventions to prevent tobacco use	Ages 18 and older	Up to 90 min of total counseling time, during multiple contacts	19%	51%
Alcohol misuse screening and brief counseling	Ages 18 and older	Screening - Annually during primary care visits	Unknown	93%
		Screening - Pregnant women	Unknown	97%
		Brief Intervention - Three 10-minute sessions (30 minutes)	Unknown	41%
Screening and interventions to reduce unhealthy drug use	Ages 18 and older	Simple screen annually	Unknown	40%
		If simple screen positive, detailed screen	Unknown	15%
		If detailed screen positive, brief intervention	Unknown	33%
Screening for and management of obesity	Ages 18 and older	Screening - Ongoing	Unknown	73%
		Management - At least one-time of 12 - 26 sessions in a year	Unknown	33%
Preventing falls	Community–dwelling elderly ages 65+	Screening for risk - Every year	Unknown	18%
		Exercise or physical therapy - At least 150 minutes of moderate intensity / week	Unknown	Unknown
		Vitamin D supplementation - 800 IU / day for at least 12 months	Unknown	61%
Preventive Medication / Devices - Adults				
Folic acid supplementation for the prevention of neural tube defects	Reproductive-age females	0.4 to 0.8 mg (400 - 800µg) of folic acid daily	Unknown	34%

(1) 'BiW' = best in world; (2) CPB = clinically preventable burden; (3) CE = cost-effectiveness

Vision Screening

For all children at least once between the ages of 3 and 5 years, to detect the presence of amblyopia or its risk factors.[38]

In British Columbia

An average of 92.7% of kindergarten children were screened between 2007/08 and 2009/10 through the BC Early Childhood Vision Screening Program.[39]

Best in the World

In South Korea, a large sample of families with children aged 3 to 5 were mailed a home vision screening test in 2001. Of the 36,973 children receiving the invitation to screen, 97.1% (35,894) completed and returned the test with 95.3% (35,226) completing the test correctly.[40]

For the purposes of this project, we have assumed that BC's current screening rate of 93% is essentially equivalent to the best in the world.

Screening for Major Depressive Disorder – Children/Youth

Annually for all children/youth ages 12 to 18.[41]

In British Columbia

The rate of screening for MDD in children/youth ages 12 to 18 in BC is unknown.

Best in the World

A large pediatric primary care network in the US was able to achieve annual screening rates for depression of 81.5% in adolescents ages 12 – 17 after they expanded their universal depression screening guideline to encompass all well-visits for adolescents ages 12 and older.[42]

For the purposes of this project, we have assumed that a screening rate of 81.5% of adolescents who see a primary care provider is equivalent to the best in the world.

Screening for Anxiety – Children/Youth

Annually for all children/youth ages 8 to 18.[43]

In British Columbia

The rate of screening for MDD in children/youth ages 12 to 18 in BC is unknown.

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[38] U.S. Preventive Services Task Force. Vision screening in children 6 months to 5 years: US Preventive Services Task Force Recommendation statement. *Journal of the American Medical Association*. 2017; 318(9): 836-44.
[39] Early Childhood Screening Research & Evaluation Unit. *BC Early Childhood Vision Screening Program - Final Evaluation Report*. 2012. University of British Columbia. Available at http://www2.gov.bc.ca/assets/gov/health/managing-your-health/women-children-maternal-health/bc-early-childhood-vision-screening-program.pdf. Accessed July 2017.
[40] Lim HT, Yu YS, Park SH et al. The Seoul Metropolitan Preschool Vision Screening Programme: results from South Korea. *British Journal of Ophthalmology*. 2004; 88(7): 929-33.
[41] Siu AL. Screening for depression in children and adolescents: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine.* 2016; 164(5): 360-6.
[42] Davis M, Jones J, So A et al. Adolescent depression screening in primary care: Who is screened and who is at risk? *Journal of Affective Disorders*. 2022; 299: 318-25.
[43] US Preventive Service Task Force. US Preventive Services Task Force Recommendation Statement. Screening for anxiety in children and adolescents: US Preventive Services Task Force recommendation statement. *JAMA*. 2022; 328(14): 1438-44.

Best in the World

A large pediatric primary care network in the US was able to achieve annual screening rates for depression of 81.5% in adolescents ages 12 – 17 after they expanded their universal depression screening guideline to encompass all well-visits for adolescents ages 12 and older.[44]

For the purposes of this project, we have assumed that a screening rate of 81.5% of adolescents who see a primary care provider is equivalent to the best in the world.

Interventions to Support Breastfeeding

Provide interventions during pregnancy and after birth to support breastfeeding. Interventions include professional support, peer support and formal education. Most successful interventions include multiple sessions and are delivered at more than one point in time.[45,46]

In British Columbia

A review of breastfeeding practices and programs in BC notes that health authorities are to proactively support breastfeeding exclusively for a 6-month period and that "most regions have established policies and/or guidelines on breastfeeding."[47] Furthermore, public health staff contact new mothers, primarily by phone, within 24 to 48 hours of hospital discharge. Ongoing breastfeeding support is provided "by all health authorities to mothers during breastfeeding clinics, public health clinics, immunization clinics, by appointment with public health staff or through telephone support."[48]

Best in the World

In Sweden, all parents are invited to parental groups organized by the child health service. In 2012, 46% of parents attended (61% of first-time parents and 33% of parents with more than one child).[49] A further study in Sweden found that 49% of all mothers sought help and support related specifically to breastfeeding.[50]

For the purposes of this project, we have assumed that a 46% participation rate in a structured antepartum educational program and/or postpartum support to promote breastfeeding initiation and duration is the best rate in the developed world (based on evidence from Sweden in 2012).

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[44] Davis M, Jones J, So A et al. Adolescent depression screening in primary care: Who is screened and who is at risk? *Journal of Affective Disorders*. 2022; 299: 318-25.

[45] Palda VA, Guise J-M and Wathen CN. Interventions to promote breastfeeding: applying the evidence in clinical practice. *Canadian Medical Association Journal*. 2004; 170(6): 976-8.

[46] Bibbins-Domingo K, Grossman D, Curry S et al. Primary care interventions to support breastfeeding: US preventive services task force recommendation statement. *Journal of American Medical Association*. 2016; 316(16): 1688-93.

[47] British Columbia Ministry of Health. *Review of Breastfeeding Practices and Programs: British Columbia and Pan-Canadian Jurisdictional Scan*. 2012. Available at http://www.health.gov.bc.ca/library/publications/year/2012/breastfeeding-jurisdictional-scan.pdf. Accessed July 2017.

[48] Ibid.

[49] Lefèvre Å, Lundqvist P, Drevenhorn E et al. Parents' experiences of parental groups in Swedish child health-care: do they get what they want? *Journal of Child Health Care*. 2016; 20(1): 46-54.

[50] Ellberg L, Lundman B, Persson MEK et al. Comparison of health care utilization of postnatal programs in Sweden. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*. 2005; 34(1): 55-62.

Screening For Growth Monitoring and Healthy Weight Management – Children/Youth

Screen children and adolescents ages 6 to 17 years for obesity at all appropriate primary care visits and offer or refer children/youth with obesity (and their primary caregiver) to a comprehensive, intensive (≥26 hours of contact over a period of 2 to 12 months) behavioral intervention to promote improvement in weight status.[51,52]

In British Columbia

We are unable to find any information on the proportion of 6 to 17-year-olds that are screened for obesity in the province. Some screening (whether documented or not) clearly takes place as children are being referred to two weight management programs in the province.

Between April 2013 and June 2015, 625 children participated in MEND (Mind, Exercise, Nutrition, Do It!) BC with 12 active sites across the province. MEND is a community based program for children who are working with their families towards a healthy lifestyle and a healthy weight.[53] Criteria for program entry include (a) age 5-13 years, (b) BMI > 85th percentile for age and no contraindications for participating in physical activity and (c) parent or caregiver participation. Physicians may recommend MEND, but a referral is not required for program entry.

Between January 2013 and June 2015, 1,071 children and their parents were referred to Shapedown BC and almost 300 completed the program.[54] Shapedown BC is a multidisciplinary, weight-management program that provides medical, nutritional and psychological support for children and youth who are working with their families to recognize and overcome challenges to active living and healthy eating.[55] Shapedown BC is a family-based, obesity-reduction initiative for children and adolescents. Criteria for program entry to Shapedown BC includes (a) physician referral, (b) age 6-17 years, (c) BMI > 97th percentile for age (according to growth chart) or BMI >85th percentile and co-morbidities or other complex medical or psychosocial profiles and (d) parent or caregiver participation.

In 2017, there are an estimated 578,600 children and youth ages 6-17 living in BC (see following table). The majority of these children and youth would be eligible for growth monitoring. Based on *measured height and weight* as calculated for the 2004 Canadian Community Health Survey (CCHS), 6.6% (37,913 of 578,600) of BC children and youth ages 6-17 are obese.[56] The 37,913 children and youth with obesity are most likely to be offered structured behavioural interventions aimed at healthy weight management. Based on the 1,071 children and their parents who were referred to Shapedown BC between January 2013

[51] Canadian Task Force on Preventive Health Care. Recommendations for growth monitoring, and prevention and management of overweight and obesity in children and youth in primary care. *Canadian Medical Association Journal*. 2015; 187(6): 411-21.

[52] US Preventive Services Task Force. Screening for obesity in children and adolescents: US Preventive Services Task Force Recommendation Statement. *Journal of American Medical Association*. 2017; 317(23): 2417-26.

[53] Bradbury J, Day M, & Scarr J. *British Columbia's Continuum for the Prevention, Management, and Treatment of Health Issues Related to Overweight and Obesity in Children and Youth*, BC: Childhood Obesity Foundation & Child Health BC: October 2015. Available online at http://childhoodobesityfoundation.ca/wp-content/uploads/2016/07/ChildhoodObesity_report_webMRsingle_fnl-1.pdf. Accessed July 2017.

[54] HealthyFamiliesBC. *Provincial Management and Evaluation Report Cycles I-VII: January 2013 – June 2015*. September 2015.

[55] Bradbury J, Day M, & Scarr J. *British Columbia's Continuum for the Prevention, Management, and Treatment of Health Issues Related to Overweight and Obesity in Children and Youth*, BC: Childhood Obesity Foundation & Child Health BC: October 2015. Available online at http://childhoodobesityfoundation.ca/wp-content/uploads/2016/07/ChildhoodObesity_report_webMRsingle_fnl-1.pdf. Accessed July 2017.

[56] Statistics Canada. Canadian Community Health Survey (CCHS) - Nutrition, 2004 Public Use Microdata file (Catalogue number 82M0024GPE). 2004: All computations, use and interpretation of these data are entirely that of H. Krueger & Associates Inc.

and June 2015, at least 2.8% (1,071 of 37,913) of children and youth with obesity in BC have been referred to a comprehensive, intensive behavioral intervention.

Estimated Number of Children and Youth With Obesity In British Columbia
By Sex and Age, 2017
Prevalence Based on 2004 CCHS Data

	Male	Female	Total
Population			
6 to 8	73,200	68,100	141,300
9 to 13	122,600	114,600	237,200
14 to 17	103,100	97,000	200,100
Total	**298,900**	**279,700**	**578,600**
Prevalence of Obesity			
6 to 8	2.2%	13.6%	7.7%
9 to 13	6.1%	4.7%	5.4%
14 to 17	10.1%	3.8%	7.1%
Total	**6.6%**	**6.5%**	**6.6%**
# of Individuals with Obesity			
4 to 8	1,634	9,274	10,908
9 to 13	7,536	5,336	12,872
14 to 17	10,425	3,709	14,133
Total	**19,595**	**18,319**	**37,913**

Best in the World

Research evidence suggests that growth monitoring in children and youth is, at best, inconsistent in paediatric practice. Dorsey et al. found that BMI was documented in only 3 of 600 (0.5%) charts they reviewed. Of the 239 children/youth at risk of being overweight or obese, 41 (17%) had documented treatment recommendations, usually consisting of general advice regarding diet and exercise.[57]

Barlow and colleagues noted that only 6.1% of charts they reviewed contained a plot of BMI. They conclude, however, that "despite low BMI curve use, paediatricians recognized most overweight/obese children with a BMI at or above the 95th percentile. BMI plotting may increase recognition in mildly overweight children." [58]

Based on self-report, an estimated 11% of Community Paediatricians and 7% of Family Physicians across Canada routinely assess their paediatric patients for obesity. Furthermore, only 60% of Community Paediatricians and 30% of Family Physicians across Canada use recommended methods for identifying paediatric obesity.[59]

Based on a review of medical records in the US, only 5.5% of physicians documented BMI and 4.3% plotted BMI. Residents were more likely to document (13.0% vs 3.0%) and plot (9.0% vs 2.7%) BMI than attending physicians.[60]

[57] Dorsey KB, Wells C, Krumholz HM et al. Diagnosis, evaluation, and treatment of childhood obesity in pediatric practice. *Archives of Pediatrics & Adolescent Medicine*. 2005; 159(7): 632-8.
[58] Barlow SE, Bobra SR, Elliott MB et al. Recognition of childhood overweight during health supervision visits: Does BMI help pediatricians? *Obesity*. 2007; 15(1): 225-32.
[59] He M, Piché L, Clarson CL et al. Childhood overweight and obesity management: a national perspective of primary health care providers' views, practices, perceived barriers and needs. *Paediatrics & Child Health*. 2010; 15(7): 419-26.
[60] Hillman JB, Corathers SD and Wilson SE. Pediatricians and screening for obesity with body mass index: does level of training matter? *Public Health Reports*. 2009; 124(4): 561-7.

For the purposes of this project, we have assumed that screening rates of 13% are equivalent to the best in the world (based on rates observed for US physician residents).

Estimating the best in the world rate for the proportion of children with obesity who have been referred to a comprehensive, intensive behavioral intervention is challenging. In the UK, MEND has been implemented on a national scale since 2007.[61] Between 2007 and 2010, 21,132 families were referred to MEND 7-13 in that country.[62] We were unable to find more recent estimates. In 2016, there were 5,328,000 children ages 7-13 in the UK[63] with a 19% rate of obesity[64] (or 1,012,320 7-13-year-olds with obesity). The 21,132 families thus represents approximately 2.1% of children with obesity in the UK.

For the purposes of this project, we have assumed that a referral rate of approximately 3% of children/youth with obesity to a comprehensive, intensive behavioral intervention (as observed in BC) is equivalent to the best rate in the world.

Education or Brief Counseling to Prevent Initiation of Tobacco Use and to Treat Tobacco Smoking – Children / Youth

The CTFPHC recommends asking children and youth (age 5–18 years) or their parents about tobacco use by the child or youth and offering brief information and advice, as appropriate, during primary care visits to prevent tobacco smoking among children and youth and to treat tobacco smoking among children and youth. These are both weak recommendations based on low-quality evidence.[65]

The USPSTF also recommends that primary care clinicians provide interventions, including education or brief counseling, to prevent initiation of tobacco use in school-aged children and adolescents. This is a "B" recommendation.[66]

E-Cigarette Use

The 2017 CTFPHC report states that "this guideline does not address smokeless tobacco or e-cigarettes".[67] They note, however, that "the number of children and youth trying e-cigarettes is increasing, and one in five youth 15-19 years of age have tried them."[68]

The 2020 USPSTF report does include the use of e-cigarettes in its updated guidelines, noting that "although conventional cigarette use has gradually declined among children in the US since the late 1990s, tobacco use via electronic cigarettes (e-cigarettes) is quickly rising and is now more common among youth than cigarette smoking. E-cigarette products usually contain nicotine, which is addictive, raising concerns about e-cigarette use and nicotine addiction in children. Exposure to nicotine during adolescence can harm the developing brain, which may

[61] Aicken C, Roberts H and Arai L. Mapping service activity: the example of childhood obesity schemes in England. *BioMed Central Public Health*. 2010; 10(1): 310.
[62] Fagg J, Chadwick P, Cole T et al. From trial to population: a study of a family-based community intervention for childhood overweight implemented at scale. *International Journal of Obesity*. 2014; 38(10): 1343-49.
[63] Ibid.
[64] Arai L, Panca M, Morris S et al. Time, monetary and other costs of participation in family-based child weight management interventions: qualitative and systematic review evidence. *PloS ONE*. 2015; 10(4): 1-12.
[65] Canadian Task Force on Preventive Health Care. Recommendations on behavioural interventions for the prevention and treatment of cigarette smoking among school-aged children and youth. *Canadian Medical Association Journal*. 2017; 189 (8): E310-16.
[66] Moyer VA. Primary care interventions to prevent tobacco use in children and adolescents: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2013; 159(8): 552-7.
[67] Canadian Task Force on Preventive Health Care. Recommendations on behavioural interventions for the prevention and treatment of cigarette smoking among school-aged children and youth. *Canadian Medical Association Journal*. 2017; 189 (8): E310-16.
[68] Ibid.

affect brain function and cognition, attention, and mood; thus, minimizing nicotine exposure from any tobacco product in youth is important."[69]

Furthermore, the 2020 USPSTF report notes that "most of the evidence on behavioral counseling interventions to prevent tobacco use focused on prevention of cigarette smoking. Given the similar contextual and cultural issues currently surrounding the use of e-cigarettes in youth and the inclusion of e-cigarettes as a tobacco product by the FDA, the USPSTF concludes that the evidence on interventions to prevent cigarette smoking could be applied to prevention of e-cigarette use as well. The USPSTF also concludes that the evidence could be applied to prevention of cigar use, which includes cigarillos and little cigars."[70]

In British Columbia

We were unable to find any information about the utilization of primary care-based interventions aimed at reducing smoking/e-cigarette initiation or utilization among non-smoking children and youth in British Columbia.

Best in the World

In Oregon, 87.4% of adolescents ages 10-17 who visited a primary care provider between January 1, 2016 and December 31, 2017 had their smoking status assessed.[71]

In Florida, 92.3% of adolescents ages 11-17 who visited a primary care provider between July 2016 and November 2017 were asked about their current cigarette smoking. Just over half (51.4%) were asked about their current use of smokeless tobacco but none were asked about their use of electronic nicotine delivery systems (ENDS).[72]

In a national US sample of adolescents ages 12 to 17, 45.2% of those who screened positive for current cigarette smoking were advised by their clinician to quit smoking.[73]

In a survey of 1,050 US pediatric care providers conducted in 2021, 69.4% indicated they screen patients for e-cigarette use, 63.8% counsel e-cigarette prevention and 67% counsel e-cigarette cessation.[74]

Matheus and colleagues managed to improve screening rates for e-cigarette use from 23% to 89% of 300 adolescents with a health maintenance or sports physical visit between October 2019 and February 2020 in the US.[75]

For modelling purposes, we have assumed that the best rate in the world for cigarette / e-cigarette screening of children / youth is 92%[76] and 89%[77] of those with a primary health care

[69] US Preventive Service Task Force. Primary care interventions for prevention and cessation of tobacco use in children and adolescents: US Preventive Services Task Force recommendation statement. *JAMA*. 2020; 323(16): 1590-98.
[70] US Preventive Service Task Force. Primary care interventions for prevention and cessation of tobacco use in children and adolescents: US Preventive Services Task Force recommendation statement. *JAMA*. 2020; 323(16): 1590-98.
[71] Bailey S, Fankhosuer K, Marino M et al. Smoking assessment and current smoking status among adolescents in primary care. *Nicotine & Tobacco Research*. 2020; 22(11): 2098-2103.
[72] LeLaurin J, Theis R, Thompson L et al. Tobacco-related counselling and documentation in adolescent primary care practice: Challenges and opportunities. *Nicotine & Tobacco Research*. 2020; 22(6): 1023-9.
[73] Merianos A, Mahabee-Gittens E. Screening, counselling, and health care utilization among a national sample of adolescent smokers. *Clinical Paediatrics*. 2020; 59(4-5): 467-75.
[74] Golden T, VanFrank B, Courtney-Long E. E-cigarette screening and clinical intervention behaviours among pediatric primary care providers, DocStyles 2021. *Paediatrics*. 2022; 149: 740.
[75] Matheus C, Hein N, Narahari P et al. Improving standardized screening for e-cigarette and vaping use among adolescents. *Paediatrics*. 2021; 147 (3-Meeting Abstract): 1002.
[76] LeLaurin J, Theis R, Thompson L et al. Tobacco-related counselling and documentation in adolescent primary care practice: Challenges and opportunities. *Nicotine & Tobacco Research*. 2020; 22(6): 1023-9.
[77] Matheus C, Hein N, Narahari P et al. Improving standardized screening for e-cigarette and vaping use among adolescents. *Paediatrics*. 2021; 147 (3-Meeting Abstract): 1002.

visit in a given year. Furthermore, 45%[78] and 67%[79] of those found positive for cigarette / e-cigarette use receive counselling to quit.

Application of Dental Sealants

Professionally-applied fissure sealants for selective use on permanent molar teeth soon after their eruption.[80,81,82]

In British Columbia

In 2012/13, 91.8% of BC kindergarten children were screened for dental health. Of these, 67.3% were caries free, 18.1% had treated caries and 14.6% had visible decay in one or more teeth. 12.9% were referred for non-urgent treatment and 2.1% for urgent treatment.[83] Despite a decline in the prevalence of visible tooth decay from 17.3% in 2006/07 to 14.6% in 2012/13, we were unable to find any information on the prevalence of dental sealant use in BC.[84]

Best in the World

In the US, the prevalence of dental sealant use in 2011/12 was 43.1% among youth aged 12 to 19, ranging from 30.0% among the non-Hispanic black population to 46.7% among the non-Hispanic white population.[85]

A study in Portugal based on a sample of 447 adolescents aged 12 to 18 found that 58.8% had at least one fissure sealant applied.[86]

For the purposes of this project, we have assumed that the best rate in the world for the application of at least one fissure sealant in children ages 6 to 12 is 59%, based on the results from Portugal.

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[78] Merianos A, Mahabee-Gittens E. Screening, counselling, and health care utilization among a national sample of adolescent smokers. *Clinical Paediatrics*. 2020; 59(4-5): 467-75.

[79] Golden T, VanFrank B, Courtney-Long E. E-cigarette screening and clinical intervention behaviours among pediatric primary care providers, DocStyles 2021. *Paediatrics*. 2022; 149: 740.

[80] Lewis DW and Ismail AI. *Canadian Guide to Clinical Preventive Health Care: Chapter 36: Prevention of Dental Caries*. 1994. Available at http://canadiantaskforce.ca/wp-content/uploads/2013/03/Chapter36_dental_caries94.pdf. Accessed September 2017.

[81] Cochrane Oral Health Group. *Pit and fissure sealants for preventing dental decay in permanent teeth*. The Cochrane Library. July 31, 2017. Available online at http://www.cochrane.org/CD001830/ORAL_sealants-preventing-tooth-decay-permanent-teeth. Accessed September 2017.

[82] Canadian Agency for Drugs and Technologies in Health. *Dental Sealants and Preventive Resins for Caries Prevention: A Review of the Clinical Effectiveness, Cost-effectiveness and Guidelines.* October 31, 2016. Available online at https://www.cadth.ca/sites/default/files/pdf/htis/2016/RC0816%20Dental%20Sealants%20Final.pdf. Accessed September 2017.

[83] Healthy Development and Women's Health Directorate - BC Ministry of Health. *BC Dental Survey of Kindergarten Children 2012-2013: A Provincial and Regional Analysis* 2014. Available at http://www.health.gov.bc.ca/women-and-children/pdf/provincial-kindergarten-dental-survey-2012-13.pdf. Accessed September 2017.

[84] Office of the Provincial Health Officer. *Is "Good", Good Enough? The Health & Well-Being of Children & Youth in BC*. 2016. Available at http://www2.gov.bc.ca/assets/gov/health/about-bc-s-health-care-system/office-of-the-provincial-health-officer/reports-publications/annual-reports/pho-annual-report-2016.pdf. Accessed August 2017.

[85] Dye B, Thornton-Evans G, Li X et al. *Dental Caries and Sealant Prevalence in Children and Adolescents in the United States, 2011-2012*. 2015. U.S. Department of Health and Human Services Available at http://fluoridealert.org/wp-content/uploads/cdc.dye-2015.pdf. Accessed August 2017.

[86] Veiga N, Pereira C, Ferreira P et al. Prevalence of dental caries and fissure sealants in a Portuguese sample of adolescents. *PloS ONE*. 2015; 10(3): 1-12.

Screening for Breast Cancer

Mammography screening between the ages of 50 and 74 every two to three years.[87,88]

In British Columbia

According to the BC Cancer Agency's *Screening Mammography Program 2016 Annual Report*, the following participation rates were observed during the 30-month screening period between July 1, 2013 and December 31, 2015.

Ages 40-49 – 36%

Ages 50-59 – 50%

Ages 60-69 – 55%

Ages 70-79 – 39%

Ages 80-89 – 3%

The average screening rate for 50-69-year-old females was 52.4%.[89]

Best in the World

In Canada in 2014, the highest participation rates for females aged 50 to 69 was in Quebec at 62.3%.[90]

In the U.S., participation rates (mammography within the past two years) in 2014 for the population ages 50-74 were 78.5%, with a high of 88.1% in the state of Massachusetts.[91]

In Finland, a nationwide mammography screening program with a two year interval for women aged 50-59 years was established in 1987. The program allowed optional participation for women aged 60-69 years. The compliance rate for screening in the 50-59 year age group was 89% for the first 10 years of the program.[92] From 1992 to 2003 the compliance rate increased to over 95% in women aged 50-59 but remained at just 20-40% among women aged 60-69.[93] In 2007, all women aged 50-69 were invited for screening.[94] According to the Finnish Cancer Registry, the 2009 rates of breast cancer screening, which included women aged 50 to 69, were 85.5% of invited women.[95] In fact, for women who have

[87] Canadian Task Force on Preventive Health Care. *Screening for Breast Cancer*. 2011. Available at http://canadiantaskforce.ca/guidelines/2011-breast-cancer/. Accessed October 2013.
[88] Siu AL. Screening for breast cancer: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2016; 164(4): 279-96.
[89] BC Cancer Agency. *Screening Mammography Program: 2016 Annual Report*. 2016. Available at http://www.bccancer.bc.ca/screening/Documents/SMP_Report-AnnualReport2016.pdf. Accessed August 2017.
[90] Canadian Partnership against Cancer. *Breast Cancer Screening in Canada: Monitoring and Evaluation of Quality Indicators - Results Report January 2011 to December 2012*. 2017. Available at http://www.cancerview.ca/preventionandscreening/breastcancerscreening/. Accessed August 2017.
[91] National Cancer Institute. *Screening and Risk Factors Table: Had a Mammogram in the Past 2 Years*. 2017. Available at https://statecancerprofiles.cancer.gov/risk/index.php. Accessed July 2017.
[92] Dean PB and Pamilo M. Screening mammography in Finland--1.5 million examinations with 97 percent specificity. Mammography Working Group, Radiological Society of Finland. *Acta Oncologica*. 1999; 38 Suppl 13: 47-54.
[93] Sarkeala T, Heinavaara S and Anttila A. Organised mammography screening reduces breast cancer mortality: a cohort study from Finland. *International Journal of Cancer*. 2008; 122(3): 614-9.
[94] Schopper D and de Wolf C. How effective are breast cancer screening programmes by mammography? Review of the current evidence. *European Journal of Cancer*. 2009; 45(11): 1916-23.
[95] Finnish Cancer Registry. *Organised Breast Cancer Screening Programme in Finland in the Invitation Year 2009*. 2012. Available at http://www.cancer.fi/@Bin/73184124/v2009eng0039r2.html. Accessed October 2013.

been invited to screening, the participation rate since 1992 has remained in the range of 84-89%.[96]

For the purposes of this project, we have assumed that the best rate in the world for screening mammography in women ages 50-74 is 88%, based on results in the state of Massachusetts in 2014.

Screening for Cervical Cancer – Cytology-Based

Routine cytology-based (Pap) screening in females every three years between the ages of 25 and 69.[97,98]

In British Columbia

The average participation rate for women age 25-69 was 68% in 2018, after adjusting for hysterectomy (see following table).[99]

Pap Smear Participation Rates (%) by Age Groups in BC 2018

Age (Years)	Overall	Adjusted for Hysterectomy
25-29	57%	57%
30-39	69%	69%
40-49	65%	69%
50-59	57%	70%
60-69	49%	72%
25-69	60%	68%

Best in the World

In the UK, women are recalled for screening every 3.5 years if they are aged 25 to 49 and every 5.5 years if they are aged 50 to 64. In 2016, 72.7% of women ages 25 to 64 were screened within those time frames.[100] In the U.S., participation rates (Pap test within the past three years) in 2014 for the population ages 21 to 65 were 82.3%, with a high of 88.0% in the state of Massachusetts.[101]

For modelling purposes, we have calculated the CPB and CE based on shifting from no screening to screening 68% of eligible females ages 25 to 69 years of age (the BC screening rate in 2018).

[96] Finnish Cancer Registry. *Breast Cancer Screening Programme in Finland in 1992-2009, Women Aged 50-69 Years*. Available at http://www.cancer.fi/@Bin/73500045/Peitt%C3%A4vyys.pdf. Accessed October 2013.
[97] Canadian Task Force on Preventive Health Care. Recommendations on screening for cervical cancer. *Canadian Medical Association Journal*. 2013; 185(1): 35-45.
[98] US Preventive Services Task Force. Draft Recommendation Statement *Cervical Cancer: Screening.* 2017. Available online at https://www.uspreventiveservicestaskforce.org/Page/Document/draft-recommendation-statement/cervical-cancer-screening2. Accessed December 2017.
[99] BC Cancer Cervix Screening. *BC Cancer Cervix Screening 2018 Program Results*. March 2020. Available online at http://www.bccancer.bc.ca/screening/Documents/Cervix-Program-Results-2018.pdf. Accessed January 2023.
[100] BC Cancer Agency. *Cervical Cancer Screening Program 2015 Annual Report*. 2016. Available at http://www.bccancer.bc.ca/screening/Documents/CCSP_Report-AnnualReport2015.pdf. Accessed August 2017.
[101] National Cancer Institute. *Screening and Risk Factors Table: Pap Test in Past 3 Years, No Hysterectomy*. 2017. Available at https://statecancerprofiles.cancer.gov/risk/index.php. Accessed July 2017.

Screening for Cervical Cancer – HPV-Based

Routine HPV-based screening every five years in females between the ages of 25 and 69.[102]

In British Columbia

Primary screening using HPV testing is not currently available in BC but is in the process of being implemented.[103]

Best in the World

The Netherlands is the first country to implement a national HPV-based screening program, started in January of 2016.[104,105] In 2021, the Netherlands achieved an HPV-based screening rate of 54.8%.[106]

Australia implemented a national HPV-based screening program, started in December of 2017. In 2023, Australia achieved an HPV-based screening rate of 68%.[107]

For modelling purposes, we have calculated the CPB and CE based on shifting from no screening to screening 68% of eligible females ages 25 to 69 years of age (the BC cytology-based screening rate in 2018 and the Australian HPV-based screening rate in 2023).

Screening for Colorectal Cancer

Screening for colorectal cancer every two years using the fecal immunochemical test (FIT) in adults between the ages of 45 and 75.[108]

In British Columbia

The BC Colon Cancer Screening Program started in 2013. In 2019, 34.5% of the BC eligible population (age 50-74) had received a fecal immunochemical test (FIT) within the past 30 months.[109] The 34.5% does not account for those screened outside of the program so the actual rate is likely higher. In 2012, for example, 49.6% of British Columbians ages 50-74 self-reported being up-to-date on their CRC screening.[110]

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[102] US Preventive Services Task Force. Screening for Cervical Cancer: US Preventive Services Task Force Recommendation Statement. *JAMA*. 2018; 320 (7): 674-86

[103] BC Ministry of Health. *Cancer Care You Can Count On: Multi-Year Policy Framework to Deliver Cancer Care in B.C.* February 2023. Available online at https://news.gov.bc.ca/files/CancerPlan2023.pdf. Accessed April 2023.

[104] National Institute for Public Health and the Environment. *Cervical Cancer Screening in the Netherlands*. 2016. Available at http://www.rivm.nl/en/Documents_and_publications/Common_and_Present/Newsmessages/2014/Cervical_cancer_screening_in_the_Netherlands. Accessed August 2017.

[105] Mayer P, Poljak M. Primary HPV-based cervical cancer screening in Europe: Implementation status, challenges, and future plans. *Clinical Microbiology and Infection*. 2020; 26: 579-83.

[106] Netherlands Comprehensive Cancer Organization. *National Monitoring of the Cervical Cancer Screening Programme in the Netherlands 2021*. Available online at https://www.rivm.nl/en/documenten/monitor-national-cervical-cancer-screening-programme-2021. Accessed March 2024.

[107] Australian Institute of Health and Welfare. *National Cervical Screening Program Monitoring Report* 2023. Available online at https://www.aihw.gov.au/reports/cancer-screening/ncsp-monitoring-2023/summary. Accessed March 2024.

[108] US Preventive Services Task Force. Screening for colorectal cancer: US Preventive Services Task Force Recommendation statement. *JAMA*. 2021; 325(19): 1965-1977.

[109] BC Cancer Colon Screening. *2019 Program Results*. March 202. Available online at http://www.bccancer.bc.ca/screening/Documents/Colon-Program-Results-2019.pdf. Accessed November 2021.

[110] Singh H, Bernstein C, Samadder J et al. Screening rates for colorectal cancer in Canada: A cross-sectional study. *CMAJ Open*. 2016; 3(2): E149-E157.

Best in the World

In the US in 2018, 68.8% of adults ages 50-75 were up to date with CRC screening test use, ranging from a low of 57.8% in Wyoming to a high of 76.5% in Massachusetts.[111] Guo et al. report a CRC screening rate of 77.1% in 2008-10 in a German population ages 50 to 75.[112]

For the purposes of this project, we have assumed that the best rate in the world for routine colorectal cancer screening in males and females between the ages of 45 and 75 is 77%.

Screening for Lung Cancer

The CTFPHC recommends screening for lung cancer among adults 55 to 74 years of age with at least a 30 pack-year smoking history, who smoke or quit smoking less than 15 years ago. Screening should take place annually for three consecutive years.[113]

The USPSTF recommends screening asymptomatic adults aged 55 to 80 years, who have a 30 pack-year smoking history and currently smoke or have quit smoking within the past 15 years, annually. Discontinue screening when the patient has not smoked for 15 years.[114]

In British Columbia

BC has announced the implementation of a lung cancer screening program to begin in the spring of 2022.[115] The BC Cancer Agency is currently enrolling patients in the BC Lung Screening Trial who are current or former smokers, are between 55-80 years of age and have smoked for at least 20 years.[116]

Best in the World

Several research projects have asked high-risk smokers whether or not they would be willing to undergo screening with LDCT. In the US, 82% of high-risk smokers said they would participate in screening if their physician recommended it.[117] However, only 32% said they would undergo screening if they had to pay for it. In Ireland, this proportion reached 98%, with 67% willing to pay for the screening.[118] Similarly high 'willingness to screen' rates (96%) have also been noted in Australia.[119]

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[111] Joseph D, King J, Dowling N et al. Vital signs: Colorectal cancer screening test use — United States, 2018. *Morbidity and Mortality Weekly Report*. 2020; 69(10): 253-9.

[112] Guo F, Chen, C, Schottker B et al. Changes in colorectal cancer screening use after introduction of alternative screening offer in Germany: Prospective cohort study. *International Journal of Cancer*. 2020; 146: 2423-32.

[113] Canadian Task Force on Preventive Health Care. Recommendations on screening for lung cancer. *Canadian Medical Association Journal*. 2016: 1-8.

[114] Moyer VA. Screening for lung cancer: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine*. 2014; 160: 330-8.

[115] BC Cancer Agency. *Provincial lung screening program coming in 2022*. Available at http://www.bccancer.bc.ca/screening/lung. Accessed March 2022.

[116] BC Cancer Agency. *The BC Lung Screen Trial.* Available at http://www.bccancer.bc.ca/our-research/participate/lung-health. Accessed March 2022.

[117] Jonnalagadda S, Bergamo C, Lin JJ et al. Beliefs and attitudes about lung cancer screening among smokers. *Lung Cancer*. 2012; 77(3): 526-31.

[118] Pallin M, Walsh S, O'Driscoll MF et al. Overwhelming support among urban Irish COPD patients for lung cancer screening by low-dose CT scan. *Lung*. 2012; 190(6): 621-8.

[119] Flynn AE, Peters MJ, Morgan LC. Attitudes towards lung cancer screening in an Australian high-risk population. *Lung Cancer International*. 2013; doi: 10.1155/2013/789057

Models assessing the cost-effectiveness of lung cancer screening make a variety of assumptions with respect to adherence to lung cancer screening, with adherence estimates ranging from 60% to 100%.[120,121,122]

Despite these optimistic estimates, real world data suggest a much lower uptake.[123,124] Data from the US indicates that the screening rate for the high-risk cohort of 55-74-year-olds has increased from 3.2% in 2010 to 6.0% in 2015.[125]

For the purposes of this project, we have therefore assumed a best in the world rate of 6%. This rate may increase over time and / or in the context of a provincially or nationally organised lung cancer screening program. To take this into account, we have assumed that the rate in BC would eventually approximate rates associated with other cancer screening programs in the province (of approximately 50%-70%). For modelling purposes we chose the midpoint of 60%.

Screening for Hypertension

Blood pressure measurement at least once every two years for adults aged 18 years and older without previously diagnosed hypertension.[126,127]

In British Columbia

We are not aware of any information which indicates the proportion of individuals in BC who routinely have their blood pressure checked.

Best in the World

Canada has become a world leader in the identification and management of hypertension.[128,129] Based on data from the Canadian Primary Care Sentinel Surveillance Network (CPCSSN) for 2011 and 2012, 79% of Canadian adults are screened for blood pressure at least once every two years by their family practitioner.[130]

[120] Goulart BH, Bensink ME, Mummy DG et al. Lung cancer screening with low-dose computed tomography: costs, national expenditures, and cost-effectiveness. *Journal of the National Comprehensive Cancer Network*. 2012; 10(2): 267-75.
[121] McMahon PM, Kong CY, Bouzan C et al. Cost-effectiveness of computed tomography screening for lung cancer in the United States. *Journal of Thoracic Oncology*. 2011; 6(11): 1841-8.
[122] Goffin JR, Flanagan WM, Miller AB et al. Cost-effectiveness of lung cancer screening in Canada. *JAMA Oncology*. 2015; 1(6): 807-13.
[123] Jemal A and Fedewa S. Lung cancer screening with low-dose computed tomography in the United States—2010 to 2015. *Journal of American Medical Association Oncology*. 2017: E1-3.
[124] Soneji S, Yang J, Tanner N et al. Underuse of chest radiography versus computed tomography for lung cancer screening. *American Public Health Association*. 2017; 107(8): 1248-50.
[125] Huo J, Shen C, Volk R et al. Use of CT and chest radiography for lung cancer screening before and after publication of screening guidelines: intended and unintended uptake. *Journal of American Medical Association Internal Medicine*. 2017; 177(3): 439-41.
[126] Lindsay P, Gorber S, Joffres M et al. Recommendations on screening for high blood pressure in Canadian adults. *Canadian Family Physician*. 2013; 59(9): 927-33.
[127] US Preventive Services Task Force. Screening for hypertension in adults: US Preventive Services Task Force Recommendation statement. JAMA. 2021; 325(16): 1650-6.
[128] Schiffrin E, Campbell N, Feldman R et al. Hypertension in Canada: past, present, and future. *Annals of Global Health*. 2016; 82(2): 288-99.
[129] Padwal R and Campbell N. Blood pressure control in Canada: through the looking-glass into a glass half empty? *American Journal of Hypertension*. 2017; 30(3): 223-5.
[130] Godwin M, Williamson T, Khan S et al. Prevalence and management of hypertension in primary care practices with electronic medical records: a report from the Canadian Primary Care Sentinel Surveillance Network. *Canadian Medical Association Journal Open*. 2015; 3(1): E76-E82.

Based on data from the 2015/16 Canadian Community Health Survey, 88.1% of residents of Alberta, Nova Scotia, P.E.I. and Newfoundland & Labrador had their blood pressure checked within the last two years (78.0% within the last year).[131]

For the purposes of this project, we have assumed that the Canadian screening rate of 88.1% is equivalent to the best rate in the world.

Screening for Cardiovascular Disease and Treatment with Statins

Complete a cardiovascular risk assessment every five years for adults aged 40 to 74 years. Initiate the use of low- to moderate-dose statins in adults without a history of cardiovascular disease (CVD) who have one or more CVD risk factors (dyslipidemia, diabetes, hypertension or smoking) and a calculated 10-year CVD event risk of 10% or greater (intermediate risk).[132,133]

In British Columbia

We are not aware of any information which indicates the proportion of adults aged 40 to 74 years in BC who have had a cardiovascular risk assessment within the past five years. Nor are we aware of BC-specific data on the proportion of adults at intermediate or higher risk of CVD who are taking statins over the longer term for primary prevention purposes.

Best in the World

The Health Check program in England has offered a cardiovascular risk assessment every five years to all adults aged 40-74 years with no known cardiovascular diseases since 2009. During the four years between April 1, 2009 and March 31, 2013, 21.4% of eligible patients attended a Health Check.[134,135] The proportion of eligible patients who attend a Health Check has increased year over year, from 5.8% in 2009/10 to 30.1% in 2012/13.[136] More recently (between April 1, 2013 and March 31, 2017), 74.1% of the eligible population were offered a Health Check. Of these 74.1%, 48.9% received a Health Check resulting in 36.2% (.741* .489) of eligible patients attending a Health Check.[137] In the Nottingham region of England, 47.7% of eligible patients ages 40-74 attended a Health Check between April 1, 2013 and March 31, 2017.[138]

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[131] The 2015/16 CCHS is the most recent survey where a significant amount of the represented Canadian population (16%) were asked about their blood pressure. In the 2017/18 survey, by comparison, only 0.1% were asked the question. We took everyone who was included in the blood pressure questions (22,914) in the survey and determined the proportion having had their blood pressure checked within the last year and the last two years, broken down by age and sex. Only four provinces (Alberta, Nova Scotia, P.E.I., and Newfoundland & Labrador) were represented by the data. Residents of other provinces were not asked the question. Therefore BC-specific data is not available.

[132] Bibbins-Domingo K, Grossman D, Curry S et al. Statin use for the primary prevention of cardiovascular disease in adults: US Preventive Services Task Force recommendation statement. *Journal of the American Medical Association*. 2016; 316(19): 1997-2007.

[133] Anderson T, Gregiore J, Pearson G et al. 2016 Canadian Cardiovascular Society guidelines for the management of dyslipidemia for the prevention of cardiovascular disease in the adult. *Canadian Journal of Cardiology.* 2016; 32: 1263-82.

[134] Chang K, Soljak M, Lee J et al. Coverage of a national cardiovascular risk assessment and management programme (NHS Health Check): retrospective database study. *Preventive Medicine*. 2015; 78: 1-8.

[135] Chang K, Lee J, Vamos E et al. Impact of the National Health Service Health Check on cardiovascular disease risk: a difference-in-differences matching analysis. *Canadian Medical Association Journal*. 2016; 188(10): E228-38.

[136] Robson J, Dostal I, Sheikh A et al. The NHS Health Check in England: an evaluation of the first 4 years. *British Medical Journal Open*. 2016; 6(1): 1-10.

[137] England PH. *Public Health Outcomes Framework*. 2017. Available at http://www.phoutcomes.info/search/health%20check#pat/6/ati/102/par/E12000004. Accessed August 2017.

[138] Ibid.

For the purposes of this project, we have assumed that the cardiovascular risk assessment rate observed in the Nottingham region of England (48%) is the best in the world.

Statins were prescribed to 39.9% of Health Check attendees in England between April 1, 2009 and March 31, 2013 with a calculated 10-year CVD event risk of *20% or greater*.[139] During that time, the recommendation from the National Institute for Health and Care Excellence (NICE) was to offer statins for primary prevention only if the 10-year CVD event risk was *20% or greater*. NICE has since modified this to a 10-year CVD event risk of 10% or greater,[140] in line with the Canadian Cardiovascular Society and USPSTF guidelines noted above. While a statin may be prescribed, a challenge is the issue of long-term persistence with statin therapy. Individuals within clinical trials tend to have 90% adherence after one year, 85% after two years and 80% after three years, but real world adherence is much lower at 60%, 45% and 40% after years one, two and three. After three years, rates of adherence tend to stabilize.[141,142,143,144]

For the purposes of this project, after taking into account prescribing rates to high risk individuals in England and long-term persistence, we have assumed that 30% of intermediate and high risk individuals would be willing to take statins over the longer term for primary prevention purposes.

Screening for Prediabetes and Type 2 Diabetes

The USPSTF recommends screening for prediabetes and type 2 diabetes in (nonpregnant) adults aged 35 to 70 years who have overweight or obesity. Clinicians should offer or refer patients with prediabetes to effective preventive interventions. (B Recommendation).[145]

The CTFPHC suggests a two-phase approach to screening.[146] First, it recommends screening all adults ages 18 and older using a validated risk calculator such as Finnish Diabetes Risk Score (FINDRISC) or Canadian Diabetes Risk Assessment Questionnaire (CANRISK). This first level of screening should be completed once every 3-5 years. Those with a FINDRISC score of 15 to 20 are considered to be at high risk of diabetes (an individual's risk of developing type 2 diabetes within 10 years is between 33% and 49%) and those with a score greater than 21 are at very high risk (an individual's risk of developing diabetes within 10 years is 50% or higher). The second phase of screening involves either an A1C, fasting glucose or oral glucose tolerance test. The CTFPHC recommends the use of the A1C test

[139] Chang K, Lee J, Vamos E et al. Impact of the National Health Service Health Check on cardiovascular disease risk: a difference-in-differences matching analysis. *Canadian Medical Association Journal*. 2016; 188(10): E228-38.
[140] National Institute for Health and Care Excellence. *Guide to the methods of technology appraisal 2013*. 2013. Available at https://www.nice.org.uk/process/pmg9. Accessed August 2017.
[141] Avorn J, Monette J, Lacour A. et al. Persistence of use of lipid-lowering medications: a cross-national study. *Journal of the American Medical Association*. 1998; 279(18): 1458-62.
[142] Perreault S, Blais L, Dragomir A. et al. Persistence and determinants of statin therapy among middle-aged patients free of cardiovascular disease. *European Journal of Clinical Pharmacology*. 2005; 61(9): 667-74.
[143] Helin-Salmivaara A, Lavikainen P, Korhonen M et al. Long-term persistence with statin therapy: a nationwide register study in Finland. *Clinical Therapeutics*. 2008; 30(1): 2228-40.
[144] Greving J, Visseren F, De Wit G et al. Statin treatment for primary prevention of vascular disease: whom to treat? Cost-effectiveness analysis. *British Medical Journal*. 2011; 342(1): d1672.
[145] US Preventive Service Task Force. US Preventive Services Task Force Recommendation Statement. Screening for prediabetes and type 2 diabetes: US Preventive Services Task Force recommendation statement. *JAMA*. 2021; 326(8): 736-43.
[146] Canadian Task Force on Preventive Health Care. Recommendations on screening for type 2 diabetes in adults. *Canadian Medical Association Journal*. 2012; 184(15): 1687-96.

given its "convenience for patients." Individuals at high risk are to be screened every 3-5 years while individuals at very high risk are to be screened every year.[147]

In British Columbia

We are not aware of any information which indicates the proportion of nonpregnant adults between the ages of 35 and 70 with overweight or obesity who have been screened for prediabetes or diabetes risk at least once over the past three years.

Best in the World

In Ontario, 74% of the adult population aged 20 years or older were screened with a fasting blood glucose test within a 5 year period after 2000/01.[148]

In the Anglo-Danish-Dutch Study of Intensive Treatment in People with Screen-detected Diabetes in Primary Care (ADDITION-Europe study), 73% of individuals ages 40-69 identified as high risk for diabetes participated in blood glucose testing.[149] The highest rate was observed in Denmark where 95.1% of patients identified as high risk participated in blood glucose testing if the testing occurred immediately following their general practitioner appointment. If the patient was invited to return for a fasting blood glucose test on another occasion, then 80.7% participated. Ongoing attendance for blood glucose testing declines over time.[150]

In Ontario, up-to-date glucose testing (at least 1 glycosylated hemoglobin, plasma or serum glucose or oral glucose tolerance test in the previous 3 years) in 2017 varied by age and sex, as follows:[151]

Age	Males	Females
40-49	57%	70%
50-59	69%	77%
60-69	79%	84%

For the purposes of this project, we have assumed that the best ongoing screening rate in the world for individuals identified as high risk for diabetes would be 80.7%, based on rates observed in Denmark and adjusted this rate by age and sex based on the data from Ontario.

Screening for Depression - Adults

Screen for depression in the general adult population aged 18 and older if adequate systems are in place to ensure accurate diagnosis, effective treatment and appropriate follow-up. This recommendation receives a B grade from the USPSTF.[152] The CTFPHC recommends *against* routine screening for depression in adults at average risk of depression. This is a weak recommendation based on very-low-quality evidence.[153]

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[147] Canadian Task Force on Preventive Health Care. Recommendations on screening for type 2 diabetes in adults. *Canadian Medical Association Journal*. 2012; 184(15): 1687-96.
[148] Wilson SE, Rosella LC, Lipscombe LL et al. The effectiveness and efficiency of diabetes screening in Ontario, Canada: a population-based cohort study. *BMC Public Health*. 2010; 10(1): 506.
[149] Simmons R, Echouffo-Tcheugui J, Sharp S et al. Screening for type 2 diabetes and population mortality over 10 years (ADDITION-Cambridge): a cluster-randomised controlled trial. *The Lancet*. 2012; 380(9855): 1741-8.
[150] Van den Donk M, Sandbaek A, Borch-Johnsen K et al. Screening for Type 2 diabetes. Lessons from the ADDITION-Europe study. *Diabetic Medicine*. 2011; 28(11): 1416-24.
[151] Chu A, Shah B, Rashid M et al. Trends in glucose testing among individuals without diabetes in Ontario between 2010 and 2017: A population-based cohort study. *CMAJ Open*. 2022; 10(3):
[152] Siu AL and the US Preventive Services Task Force (USPSTF). Screening for depression in adults: US Preventive Services Task Force recommendation statement. *JAMA*. 2016; 315(4): 380-7.
[153] Canadian Task Force on Preventive Health Care. Recommendations on screening for depression in adults. *Canadian Medical Association Journal*. 2013; 185(9): 775-82.

The USPSTF found no evidence on ideal screening intervals. In the absence of data, they recommend "screening all adults who have not been screened previously and using clinical judgment in consideration of risk factors, comorbid conditions and life events to determine if additional screening of high-risk patients is warranted."[154]

In British Columbia

We were unable to find any information that specifically identifies what proportion of non-perinatal adults ages 18 and older are being routinely screened for depression in BC.

Best in the World

Based on the National Ambulatory Medical Care Survey in the US, an estimated 885 million physician office visits occurred in 2014.[155] Approximately 36.1 million of these visits included depression screening. That is, depression screening was provided during 4.08% of physician office visits. The 4.08% represents an increase from 1.43% in 2012[156], 1.36% in 2010[157] and 1.07% in 2008.[158]

Of the 885 million visits provided in 2014, 462 million visits were provided by a primary care physician. If we assume that all visits which included depression screening were provided by a primary care physician, then 7.83% of visits to a primary care physician included depression screening. Finally, an average of 1.47 visits per year are made to a primary care physician.[159] If we further assume that patients are only screened once per year, then approximately 11.5% (.0783 * 1.47) of the US population were screened for depression by their primary care physician in 2014.

The US Affordable Care Act, signed into law on March 23, 2010, amends the US Social Security Act to remove "barriers to preventive services in Medicare" (Section 4104-5) and improve "access to preventive services for eligible adults in Medicaid" (Section 4106). A common amendment is the incorporation of "diagnostic, screening, preventive and rehabilitative services including any clinical preventive services that are assigned a grade of A or B by the United States Preventive Services Task Force" [Section 4106 (a)(13)].[160]

The implementation of the Affordable Care Act and the focus on preventive services appears to have resulted in a tripling in screening rates for depression in the US (from screening occurring during 1.36% of physician office visits in 2010 to 4.08% in 2014).

For the purposes of this project, we have assumed that the best screening rate for depression in the world in asymptomatic adults ages 18 and older is 12%, based on the estimated screening rate in the US in 2014 noted above.

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[154] Siu AL and the US Preventive Services Task Force (USPSTF). Screening for depression in adults: US Preventive Services Task Force recommendation statement. *JAMA.* 2016; 315(4): 380-7.
[155] Rui P, Hing E, Okeyode T. *National Ambulatory Medical Care Survey: 2014 State and National Summary Tables*. Available at http://www.cdc.gov/nchs/ahcd/ahcd_products.htm. Accessed August 2017.
[156] National Center for Health Statistics. *National Ambulatory Medical Survey: 2012 Summary Tables*. 2012. Available at http://www.cdc.gov/nchs/data/ahcd/namcs_summary/2012_namcs_web_tables.pdf. Accessed August 2017.
[157] National Center for Health Statistics. *National Ambulatory Medical Care Survey: 2010 Summary Tables*. 2010. Available at http://www.cdc.gov/nchs/data/ahcd/namcs_summary/2010_namcs_web_tables.pdf. Accessed August 2017.
[158] National Center for Health Statistics. *National Ambulatory Medical Care Survey: 2008 Summary Tables*. 2008. Available at http://www.cdc.gov/nchs/data/ahcd/namcs_summary/2008_namcs_web_tables.pdf. Accessed August 2017.
[159] Rui P, Hing E, Okeyode T. *National Ambulatory Medical Care Survey: 2014 State and National Summary Tables*. Available at http://www.cdc.gov/nchs/ahcd/ahcd_products.htm. Accessed August 2017.
[160] U.S. Department of Health & Human Services. *The Affordable Care Act*. 2010. Available at http://www.hhs.gov/healthcare/about-the-law/read-the-law/index.html. Accessed August 2017.

Screening for Depression - Pregnant and Postpartum Females

The USPSTF recommends "screening for depression in the general adult population, *including pregnant and postpartum women* [emphasis added]. Screening should be implemented with adequate systems in place to ensure accurate diagnosis, effective treatment and appropriate follow-up."[161]

The CTFPHC, on the other hand, recommends *against* routinely screening for depression in adults in subgroups of the population who may be at increased risk of depression, including pregnant and postpartum women.[162]

The Lifetime Prevention Schedule Expert Committee acknowledges the conflict between the two recommendations. Upon further examination, the USPSTF review included literature investigating screening and treatment of depression in perinatal and postpartum women. The CTFPHC included literature examining screening only, which was sparse; literature examining screening and treatment was excluded. In BC, the current standard for delivery of public health services is offering the Edinburgh Postnatal Depression Scale (EPDS) by eight weeks postpartum, with education/intervention/referral for treatment as needed. The USPSTF review includes a number of validation studies on perinatal and postpartum depression screening tools (including the Edinburgh Postnatal Depression Scale) in a variety of settings. These do not appear in the CTFPHC review. Finally, there are several studies on perinatal and postpartum depression screening and treatment that were published after the CTFPHC review in 2013, but were included in the more recent USPSTF review. Therefore, the LPS will use the USPSTF recommendation as the most current evidence of clinical effectiveness and proceed with the modeling of population health impact and cost effectiveness of screening and treatment for depression in perinatal and postpartum women.

In British Columbia

The BC Reproductive Mental Health Program recommends screening during pregnancy at 28-32 weeks and again at six to eight weeks postnatally using the EPDS.[163] We were unable to find information on formal screening rates for depression in perinatal and postpartum women in BC.

Best in the World

Eighty percent of mothers are comfortable with the idea of being screened for postpartum depression (PPD).[164,165] Eighty-three percent of family practitioners and 73% of paediatricians are willing to screen for PPD.[166] The theoretical maximum screening rate might therefore be 66% (0.8 * 0.83). In actual practice, however, screening rates using a validated screening tool

[161] Siu AL and the US Preventive Services Task Force (USPSTF). Screening for depression in adults: US Preventive Services Task Force recommendation statement. *JAMA*. 2016; 315(4): 380-7.
[162] Canadian Task Force on Preventive Health Care. Recommendations on screening for depression in adults. *Canadian Medical Association Journal*. 2013; 185(9): 775-82.
[163] BC Reproductive Mental Health Program and Perinatal Services BC. *Best Practice Guidelines for Mental Health Disorders in the Perinatal Period*. 2014. Available at http://www.perinatalservicesbc.ca/Documents/Guidelines-Standards/Maternal/MentalHealthDisordersGuideline.pdf. Accessed August 2017.
[164] Buist A, Condon J, Brooks J et al. Acceptability of routine screening for perinatal depression. *Journal of Affective Disorders*. 2006; 93(1): 233-7.
[165] Gemmill AW, Leigh B, Ericksen J et al. A survey of the clinical acceptability of screening for postnatal depression in depressed and non-depressed women. *BMC Public Health*. 2006; 6: 211.
[166] Glasser S, Levinson D, Bina R et al. Primary care physicians' attitudes toward postpartum depression is it part of their job? *Journal of Primary Care & Community Health*. 2016; 7(1): 24-9.

appear to be closer to 20%.[167,168,169] Even in an outpatient academic medical center, the screening rate only reached 39%.[170]

For the purposes of this project, we have assumed that the best screening rate for postpartum depression in the world is 39%.[171]

Screening for Primary Prevention of Fragility Fractures

The CTFPHC recommends "risk assessment–first" screening for prevention of fragility fractures in females aged 65 years and older, with initial application of the Canadian clinical Fracture Risk Assessment Tool (FRAX) without bone mineral density (BMD). The FRAX result should be used to facilitate shared decision-making about the possible benefits and harms of preventive pharmacotherapy. After this discussion, if preventive pharmacotherapy is being considered, clinicians should request BMD measurement using dual-energy x-ray absorptiometry (DXA) of the femoral neck, and re-estimate fracture risk by adding the BMD T-score into FRAX (conditional recommendation, low-certainty evidence).

These recommendations apply to community-dwelling individuals who are not currently on pharmacotherapy to prevent fragility fractures. [172]

In British Columbia

The rate of screening for the primary prevention of fragility fractures in community-dwelling females 65 years and older in BC is unknown.

Best in the World

Based on a retrospective longitudinal cohort study within 13 primary care clinics in the Sacramento, CA region, 57.8% of 65-74 year old women are referred to and receive a bone density scan within a 7 year period.[173]

We have assumed that the best screening rate for the primary prevention of fragility fractures in women 65 years and older is 57.8%.

Screening for Abdominal Aortic Aneurysm

The USPSTF recommends one-time screening for abdominal aortic aneurysm (AAA) with ultrasonography in men aged 65 to 75 years who have ever smoked.[174]

The CTFPHC recommends one-time screening with ultrasonography for AAA of men aged 65 to 80 years (weak recommendation; moderate quality of evidence).[175]

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[167] Seehusen DA, Baldwin L-M, Runkle GP et al. Are family physicians appropriately screening for postpartum depression? *The Journal of the American Board of Family Practice*. 2005; 18(2): 104-12.
[168] Psaros C, Geller PA, Sciscione AC et al. Screening practices for postpartum depression among various health care providers. *The Journal of Reproductive Medicine*. 2009; 55(11-12): 477-84.
[169] Ford E, Shakespeare J, Elias F et al. Recognition and management of perinatal depression and anxiety by general practitioners: a systematic review. *Family Practice*. 2016; 34(1): 11-9.
[170] Delatte R, Cao H, Meltzer-Brody S et al. Universal screening for postpartum depression: an inquiry into provider attitudes and practice. *American Journal of Obstetrics and Gynecology*. 2009; 200(5): e63-e4.
[171] Ibid.
[172] Theriault G, Limburg H, Klarenbach S et al. Recommendation on screening for primary prevention of fragility fractures. *CMAJ*. 2023; 195: E639-49.
[173] Amarnath A, Franks P, Robbins J et al. Underuse and Overuse of Osteoporosis Screening in a Regional Health System: a Retrospective Cohort Study. *Journal of General Internal Medicine*. 2015; 12(30): 1733-40.
[174] LeFevre ML. Screening for abdominal aortic aneurysm: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine.* 2014; 161(4): 281-90.
[175] Singh H, Dickinson JA, Lewin G et al. Recommendations on screening for abdominal aortic aneurysm in primary care. *Canadian Medical Association Journal*. 2017; 189(36): E1137-E45.

In British Columbia

The rate of one-time screening for abdominal aortic aneurysm (AAA) with ultrasonography in men aged 65 to 75 years who have ever smoked or in all men ages 65 to 80 years in BC is unknown.

Best in the World

Jacomelli and colleagues report that the National Health Service in England's AAA screening programme had mean uptake across the country of 78.1%, but varied regionally between 61.7 – 85.8%.[176]

We have assumed that the best in the world one-time screening rate for AAA in men aged 65 to 75 years who have ever smoked is 85.8%.

Screening for HIV

Screen youth and adults 15 to 65 years of age for HIV infection. Younger adolescents and older adults who are at increased risk should also be screened. Finally, screen all pregnant women for HIV, including those who present in labor who are untested and whose HIV status is unknown.[177]

The CTFPHC has reviewed the USPSTF guideline on screening for HIV infection and conclude that it "is a high-quality guideline, but the CTFPHC does not recommend its use in Canada. In the opinion of the CTFPHC, available evidence does not justify routinely screening all adult Canadians for HIV." Instead, the focus should be on screening high-risk groups and pregnant women.[178]

The USPSTF found insufficient evidence to determine optimum time intervals for HIV screening. They recommend 1-time screening to identify persons who are already HIV-positive, with repeated screening of those who are known to be at risk for HIV infection, those who are actively engaged in risky behaviors, and those who live or receive medical care in a high-prevalence setting (a geographic location or community with an HIV seroprevalence of at least 1%). All pregnant women should be screened. Individuals at increased risk should be screened every 3 to 5 years while those at very high risk should be screened every year.[179]

The 2014 HIV Testing Guidelines for the Province of British Columbia recommend that health care providers offer an HIV test[180]

- Routinely, every five years, to all patients aged 18-70 years
- Routinely, every year, to all patients aged 18-70 years who belong to populations with a higher burden of HIV infection
- Once for patients older than 70 years of age, if HIV status is not known

AND offer an HIV test to patients including adults 18-70, youth and the elderly, whenever

- Ordering diagnostic bloodwork for a new or worsening medical condition
- They present with symptoms of HIV infection or advanced HIV disease

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[176] Jacomelli J, Summers L, Stevenson A et al. Impact of the first 5 years of a national abdominal aortic aneurysm screening programme. *British Journal of Surgery*. 2016; 103(9): 1125-31.
[177] Moyer VA. Screening for HIV: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine*. 2013; 159(1): 51-60.
[178] Canadian Task Force on Preventive Health Care. *HIV 2013 Critical Appraisal Report.* Available online at https://canadiantaskforce.ca/wp-content/uploads/2016/05/2013-hiv-en-ca-final.pdf. Accessed September 2017.
[179] Moyer VA. Screening for HIV: U.S. Preventive Services Task Force Recommendation Statement. *Annals of Internal Medicine*. 2013; 159(1): 51-60.
[180] Office of the Provincial Health Officer. *HIV Testing Guidelines for the Province of British Columbia*. 2014. Available online at http://www2.gov.bc.ca/assets/gov/health/about-bc-s-health-care-system/office-of-the-provincial-health-officer/hiv-testing-guidelines-bc.pdf. Accessed September 2017.

- They or their providers identify a risk for HIV acquisition
- They request an HIV test
- They are pregnant
- They test for or diagnose a sexually transmitted infection, hepatitis C, hepatitis B or tuberculosis

In British Columbia

During the five-year time period from 2009 to 2013, a total of 963,022 HIV tests were provided for 653,417 unique individuals aged 15 to 65 in BC,[181] suggesting a current five-year screening rate in this population of approximately 20% (653,417 divided by the 3,267,099 persons aged 15 to 65 living in British Columbia in 2013).

In 2011, the uptake of prenatal HIV screening in BC reached 95.9%.[182]

Best in the World

In the U.S. in 2013, the proportion of the population ages 18 to 64 who have ever been tested for HIV is approximately 40-45%.[183]

In England in 2016, 63% of adolescents and adults ages 15 to 64 who sought sexual health services were tested for HIV. This cohort is considered to be at increased risk for HIV. For men who have sex with men who also sought sexual health services (a cohort considered to be at very high risk), 83% were tested for HIV.[184]

In the U.K. in 2011, 97% of pregnant women were tested for HIV.[185]

We have assumed that the best HIV screening rates in the world would be 45% for the general population (based on 2013 data from the US), 63% for individuals at increased risk (based on 2016 data from England for adolescents and adults ages 15 to 64 who sought sexual health services), 83% for individuals at very high risk (based on 2016 data from England for men who have sex with men who also sought sexual health services) and 97% for pregnant women (based on 2011 data from the U.K.).

Screening for Hepatitis C Virus Infection

The USPSTF recommends one-time screening for HCV infection to asymptomatic adults born between 1945 and 1965.[186]

The CTFPHC recommends *against* screening for HCV in adults who are not at elevated risk. This is a "strong recommendation" based on "very low-quality evidence".[187]

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[181] Dr. Mark Gilbert, Surveillance & Online Sexual Health Services, Clinical Prevention Services, BC Centre for Disease Control. Personal communication, May, 2014.
[182] Kuo M, Money DM, Alvarez M et al. Test uptake and case detection of syphilis, HIV, and hepatitis C among women undergoing prenatal screening in British Columbia, 2007 to 2011. *Journal of Obstetrics and Gynaecology Canada*. 2014; 36(6): 482-90.
[183] Van Handel M and Branson B. Monitoring HIV testing in the United States: consequences of methodology changes to national surveys. *PloS ONE*. 2015; 10(4): 1-12.
[184] England PH. *Sexually Transmitted Infections (STIs): Annual Data Tables*. 2017. Available at https://www.gov.uk/government/statistics/sexually-transmitted-infections-stis-annual-data-tables. Accessed August 2017.
[185] Health Protection Agency. *HIV in the United Kingdom: 2012 Report*. 2012. Available at http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1317137200016. Accessed August 2017.
[186] Moyer VA. Screening for hepatitis C virus infection in adults: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2013; 159(5): 349-57.
[187] Canadian Task Force on Preventive Health Care. Recommendations on hepatitis C screening for adults. *Canadian Medical Association Journal*. 2017; 189(16): E594-E604.

In British Columbia

Between 1992 and 2013, a total of 443,018 unique individuals between the ages of 48 to 68 years have been tested for HCV,[188] suggesting an overall screening rate in this population in BC of 32.7% (1,354,520 / 443,018).

Best in the World

One-time screening rates for HCV infection in adults born between 1945 and 1965 in the US are up to 76% for high risk patients[189,190] but much lower, at 8 to 10%, for the general population of this cohort.[191,192] In Scotland, an average screening rate of 48% was achieved in eight general practices.[193]

We have assumed that the best one-time screening rate for HCV infection in the general population of adults born between 1945 and 1965 is 48%.

Prevention of Sexually Transmitted Infections

Recommend intensive behavioral counseling ranging in intensity from 30 min to ≥2 hours of contact time for all sexually active youth and for adults who are at increased risk for STIs.[194] Adults at increased risk include those with current STIs or other infections within the past year, adults who have multiple sex partners and adults who do not consistently use condoms.

In British Columbia

We were unable to find data on the use of behavioural counselling interventions in BC to reduce a person's likelihood of acquiring an STI.

Best in the World

Between 2006 and 2010 in the US, 31.2% of sexually experienced females aged 15 to 19 years received STI counseling from a health care provider during the previous 12 months. For sexually experienced males aged 15 to 19 years the rate was 26.1%.[195]

For modelling purposes, we have assumed that the best rate in the world for behavioral counseling in sexually active adolescents is 29%, based on the midpoint for sexually active 15 to 19 year old males and females in the US.

[188] Dr. Mark Gilbert, Surveillance & Online Sexual Health Services, Clinical Prevention Services, BC Centre for Disease Control. Personal communication, May, 2014.
[189] Cartwright E, Rentsch C and Rimland D. Hepatitis C virus screening practices and seropositivity among US veterans born during 1945–1965. *BioMed Central*. 2014; 7(1): 449.
[190] Gemelas J, Locker R, Rudd S et al. Impact of screening implementing HCV screening of persons born 1945-1965: a primary care case study. *Journal of Primary Care & Community Health*. 2016; 7(1): 30-2.
[191] Litwin A, Smith B, Drainoni M et al. Primary care-based interventions are associated with increases in hepatitis C virus testing for patients at risk. *Digestive and Liver Disease*. 2012; 44(6): 497-503.
[192] Cook N, Turse E, Garcia A et al. Hepatitis C virus infection screening within community health centers. *The Journal of the American Osteopathic Association*. 2016; 116(1): 1-11.
[193] Cullen B, Hutchison S, Cameron S, et al. Identifying former injecting drug users infected with hepatitis C: An evaluation of a general practice-based case-finding intervention. *Journal of Public Health*. 2012; 34(1): 14-23.
[194] LeFevre ML. Behavioral counseling interventions to prevent sexually transmitted infections: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2014; 161(12): 894-901.
[195] Tyler C, Warner L, Gavin L et al. Receipt of reproductive health services among sexually experienced persons aged 15–19 years—National Survey of Family Growth, United States, 2006–2010. *Morbidity and Mortality Weekly Report*. 2014; 63(2): 2-5.

Counselling and Interventions to Prevent Tobacco Use

Screen all adults 18 years and older for tobacco use and provide up to 90 minutes of tobacco cessation interventions over multiple contacts for those who use tobacco products.[196]

In British Columbia

The BC Smoking Cessation Program was launched in September of 2011. Between September 30, 2011 and October 31, 2014, this program provided almost 122,000 BC residents with free nicotine gum or patches. There were an estimated 644,600 smokers in BC in 2013, suggesting that at least 19% (122,000 / 644,600) of BC tobacco smokers received a tobacco cessation intervention.[197]

Best in the World

According to results from the 2005 Canadian Tobacco Use Monitoring Survey (CTUMS), 88% of current Canadian smokers reported visiting a health care provider in the preceding 12 months and 54% of those were advised to reduce or quit smoking.[198] Those who reported receiving such advice were asked if they were provided with information on smoking-cessation aids such as nicotine patches and 55% confirmed that they had. Based on this information, for all 2005 Canadian smokers, 47.5% of individuals received advice to quit and 26.1% were also provided with advice on smoking-cessation aids.

In the United States, the Behavioural Risk Factor Surveillance System has tracked the percentage of smokers who received advice to quit smoking from health care providers. The sample size was persons aged 18 and older who are current smokers (ever smoked 100 or more cigarettes and currently smoked every day or some days) who had also seen a health care provider in the past 12 months. Under these conditions, in 2010 it was found that 50.7% of smokers had received advice to quit in the past 12 months. This was down from 53.3% in 2000 and 58.9% in 2005.[199]

We have assumed that the best rate in the world for the provision of tobacco cessation interventions is 51% (based on data from the US in 2010).

Alcohol Misuse Screening and Brief Counselling

Screen and provide behavioral counseling interventions to reduce alcohol misuse by adults 18 years and older, including pregnant women.[200] The 2013 USPSTF review found no evidence to determine the optimal interval for screening but did note that brief multi-contact (each contact is 6 to 15 minutes) interventions are most effective, requiring up to 120 minutes of total counseling contact.[201]

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[196] U.S. Preventive Services Task Force. Counseling and interventions to prevent tobacco use and tobacco-caused disease in adults and pregnant women: U.S. Preventive Services Task Force reaffirmation recommendation statement. *Annals of Internal Medicine*. 2009; 150(8): 551-5.

[197] Province of British Columbia. *BC Smoking Cessation Program: Evaluation of the Nicotine Replacement Therapy Component*. 2015. British Columbia. Available at http://www2.gov.bc.ca/assets/gov/health/health-drug-coverage/pharmacare/smokingcessationevaluationreport.pdf. Accessed August 2017.

[198] Centers for Disease Control and Prevention. Smoking-cessation advice from health-care providers--Canada, 2005. *Morbidity and Mortality Weekly Report*. 2007; 56(28): 708-12.

[199] Kruger J, Shaw L, Kahende J et al. Health care providers' advice to quit smoking, National Health Interview Survey, 2000, 2005, and 2010. *Preventing Chronic Disease*. 2012; 9: E130.

[200] US Preventive Services Task Force. Screening and Behavioral Counseling Interventions to Reduce Unhealthy Alcohol Use in Adolescents and Adults: US Preventive Services Task Force Recommendation Statement. *JAMA*. 2018: 320(18); 1899-1909.

[201] Ibid.

BC guidelines for alcohol misuse screening and brief interventions recommend screening annually,[202] while economic evaluations have assumed that screening would occur at least once a year to at least once every 10 years.[203,204,205]

In British Columbia

We are not aware of any data in BC which indicates the overall proportion of adults who are screened for alcohol misuse or the proportion who misuse alcohol that receive a brief intervention.

Based on a 2008/09 survey, BC health care providers talked to 58% of pregnant women and 10% of non-pregnant women about alcohol and its effects on conception and/or pregnancy.[206]

Best in the World

In integrated health-care systems where screening is mandated and built into the electronic medical record system, screening can be nearly universal. In one study of the US Veterans Health Administration system, 93% of individuals were screened for alcohol misuse in 2004.[207]

A survey of Norwegian midwives (n=103) found that 97% of respondents "mostly" or "always" asked pregnant women about their alcohol use at the first consultation, with 42% using a screening instrument.[208]

In Oregon, 4.6% of individuals are screened in primary care for unhealthy alcohol use[209] but 41% of Medicaid enrollees in the state with an alcohol use disorder receive treatment,[210] suggesting that primary care providers may target at-risk patients for formal screening.

We have assumed that the best alcohol screening rate in the world is 93% for adults 18 years and older and 97% for pregnant women. Furthermore, we assume that the best in the world proportion with a positive screen result that receive a brief intervention is 41%.

Screening and Interventions to Reduce Unhealthy Drug Use

Screen by asking questions about unhealthy drug use in adults age 18 years or older. Screening should be implemented when services for accurate diagnosis, effective treatment, and appropriate care can be offered or referred.[211]

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[202] BC Ministry of Health and British Columbia Medical Association. *BC Guidelines: Problem Drinking* 2013. Available at http://www2.gov.bc.ca/gov/content/health/practitioner-professional-resources/bc-guidelines/problem-drinking. Accessed August 2017.

[203] Purshouse R, Brennan A, Rafia R et al. Modelling the cost-effectiveness of alcohol screening and brief interventions in primary care in England. *Alcohol and Alcoholism*. 2012; 48(2): 180-8.

[204] Angus C, Scafato E, Ghirini S et al. Cost-effectiveness of a programme of screening and brief interventions for alcohol in primary care in Italy. *BioMed Central Family Practice*. 2014; 15(1): 1-26.

[205] Zur R and Zaric G. A microsimulation cost–utility analysis of alcohol screening and brief intervention to reduce heavy alcohol consumption in Canada. *Addiction*. 2016; 111(5): 817-31.

[206] BC Stats, Ministry of Citizens' Services and the Women's Healthy Living Secretariat and Ministry of Healthy Living and Sport. *Healthy Choices in Pregnancy: Results from the Community Health Education and Social Services Omnibus Survey in British Columbia, April 2008 to March 2009*. Available at http://www.health.gov.bc.ca/library/publications/year/2010/bcstats-hcip-report.pdf. Accessed August 2017.

[207] Bradley K, Williams E, Achtmeyer C et al. Implementation of evidence-based alcohol screening in the Veterans Health Administration. *The American Journal of Managed Care*. 2006: 12; 597-606.

[208] Wangberg SC. Norwegian midwives' use of screening for and brief interventions on alcohol use in pregnancy. *Sexual & Reproductive Healthcare*. 2015; 6(3): 186-90.

[209] Rieckmann T, Renfro S, McCarty D et al. Quality metrics and systems transformation: Are we advancing alcohol and drug screening in primary care? *Health Services Research*. 2018: 53(3); 1702-26.

[210] McCarty D, Gu Y, Renfro S et al. Access to treatment for alcohol use disorders following Oregon's health care reforms and Medicaid expansion. *Journal of Substance Abuse Treatment*. 2018: 94; 24-8.

[211] US Preventive Services Task Force. Screening for Unhealthy Drug Use: US Preventive Services Task Force Recommendation Statement. *JAMA*. 2020; 323(22): 2301-2309.

In British Columbia

We are not aware of any data in BC which indicates the overall proportion of adults who are screened for unhealthy drug use or the proportion of individuals with unhealthy drug use who receive a brief intervention.

Best in the World

Based on the US National Survey on Drug Use and Health (noninstitutionalized individuals aged 12 years and older), the percentage of individuals with ≥1 health care visit who reported screening by a health care provider ("During the past 12 months, did any doctor or other health care professional ask, in person or on a form, if you use marijuana or other illegal drugs?") increased from 48.5% in 2013 to 54.3% in 2015.[212]

We have assumed that the assume that the best unhealthy drug use screening rate in the world is 54.3% of those who have had a health care visit in the past year (73.7%) or 40.0% (54.3% * 73.7%).

Of those screened, 15.4% would have a positive screen (both true and false positive) and would thus require a more detailed screen. Of those receiving a positive result on the detailed screen, 33.1% would receive a brief intervention.[213]

Screening For and Management of Obesity in Adults

Screen all adults 18 years and older for obesity and offer or refer patients with a body mass index (BMI) of 30 kg/m^2 or higher to intensive, multicomponent behavioral interventions involving between 12 and 26 sessions in a year.[214,215] Screening should take place on a regular basis to measure weight trajectories over time.

In British Columbia

We were unable to find information for BC regarding the frequency of measuring height and weight in primary care or what proportion of individuals with a BMI of 30 kg/m^2 or higher were being referred to an intensive, multicomponent behavioral intervention.

Best in the World

In the US, the measurement of both height and weight in adults 18+ during a primary care visit increased from 33% in 2005/06 to 54% in 2008/09 and 73% in 2012/13.[216] In 2006/07, 37% of patients with diagnosed obesity in the US received some counselling for diet, exercise or weight reduction in primary care.[217] This proportion has declined to 33% in 2008/09 and 21% in 2012/13. Primary care visits where weight management counseling occurred lasted an average of 22 minutes.[218] In a recent US study of 14 primary care clinics, however, 33% of

[212] Scialli, A & Terplan, M. Rates of and factors associated with patient-reported illicit drug use screening by health care professionals in the United States from 2013 to 2015. *Journal of Addiction Medicine*. 2020; 14(1): 63-68.
[213] Hargraves D, White C, Frederick R et al. Implementing SBIRT (screening, brief intervention and referral to treatment) in primary care: Lessons learned from a multi-practice evaluation portfolio. *Public Health Reviews*. 2017: 38(31).
[214] Canadian Task Force on Preventive Health Care. Recommendations for prevention of weight gain and use of behavioural and pharmacologic interventions to manage overweight and obesity in adults in primary care. *Canadian Medical Association Journal*. 2015; 187(3): 184-95.
[215] Moyer VA. Screening for and management of obesity in adults: US Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2012; 157(5): 373-8.
[216] Fitzpatrick S and Stevens V. Adult obesity management in primary care, 2008–2013. *Preventive Medicine*. 2017; 99: 128-33.
[217] Ma J, Xiao L and Stafford R. Adult obesity and office-based quality of care in the United States. *Obesity*. 2009; 17(5): 1077-85.
[218] Fitzpatrick S and Stevens V. Adult obesity management in primary care, 2008–2013. *Preventive Medicine*. 2017; 99: 128-33.

patients with obesity had documentation of obesity treatment (between January and July of 2015) but only 2.2% of patients had a *referral* to a weight management intervention.[219]

We have assumed that the best rate in the world for obesity screening of adults 18 years and older is 73% (based on evidence from the US in 2012/13) while the best rate in the world for offering or referring patients with a BMI of ≥30 to an intensive, multicomponent behavioral intervention is 33% (based on evidence from the US in 2015).

Preventing Falls in Community-Dwelling Elderly

Exercise or physical therapy and vitamin D supplementation to prevent falls in community-dwelling adults aged 65 years or older who are at increased risk for falls.[220]

The USPSTF suggests annual screening for risk using "a pragmatic, expert-supported approach to identifying high risk persons (based on) a history of falls and mobility problems and the results of a timed Get-Up-and-Go test. The test is performed by observing the time it takes a person to rise from an armchair, walk 3 meters (10 feet), turn, walk back, and sit down again." Exercise should consist of at least 150 minutes of moderate intensity activity per week while Vitamin D supplementation of 800 IU per day should occur for at least one year.[221]

In British Columbia

We are not aware of any information identifying the proportion of community-dwelling elderly in BC who are at risk for falls nor the proportion of those at risk of falls who are engaging in at least 150 minutes of moderate intensity exercise per week or taking 800 IU of vitamin D supplements daily.

Best in the World

We were unable to find any comprehensive data on the proportion of community-dwelling elderly who are screened for fall risk and, when at higher risk, are encouraged to engage in exercise or physical therapy and vitamin D supplementation to reduce that risk.

In a survey of 100 primary care physicians, 63% said they only screened for fall risk if their patients expressed a concern about falling.[222] However, another study found that just 31.2% of elderly females and 24.3% of elderly males talked to their health care provider even after they fell.[223] Based on these two pieces of evidence, and the assumption that 53%[224] of the population age 65 and older are females, 17.6% of the elderly would be screened for fall risk (((0.312 * 0.53) + (0.243 * 0.47)) * 0.63).

[219] Fitzpatrick S, Dickins K, Avery E et al. Effect of an obesity best practice alert on physician documentation and referral practices. *Translational Behavioral Medicine*. 2017: 1-10.
[220] Moyer VA. Prevention of falls in community-dwelling older adults: U.S. Preventive Services Task Force recommendation statement. *Annals of Internal Medicine*. 2012; 157(3): 197-204.
[221] Ibid.
[222] Jones T, Ghosh T, Horn K et al. Primary care physician's perceptions and practices regarding fall prevention in adults 65 years and over. *Accident Analysis & Prevention*. 2011; 43(5): 1605-9.
[223] Stevens J, Ballesteros M, Mack K et al. Gender differences in seeking care for falls in the aged Medicare population. *American Journal of Preventive Medicine*. 2012; 43(1): 59-62.
[224] Based on BC population data for 2017

Adhering to falls prevention interventions by the community-dwelling elderly is another challenge. Even in the context of a research project, a third[225] to half[226] of participants do not adhere to falls prevention interventions.

In 2011/12, 61% of noninstitutionalized adults ≥65 years of age living in the US took a vitamin D supplement, either as part of a multi-vitamin or multi-mineral supplement or as an individual supplement.[227]

Based on this indirect evidence, we have assumed for the purposes of this project that the best screening rate in the world for fall risk is 18% (see calculation of 17.6% above) and that the best rate in the world for vitamin D supplementation is 61% (based on evidence from the US in 2011/12). We were unable to find even indirect evidence indicating the proportion of the elderly at high risk of falling who were encouraged to engage in exercise or physical therapy.

Folic Acid Supplementation for the Prevention of Neural Tube Defects

All women who are planning or capable of pregnancy take a daily supplement containing 0.4 to 0.8 mg (400-800µg) of folic acid.[228]

In British Columbia

In a survey conducted at Children's and Women's Health Center in BC in 1999, 71% of women surveyed knew that vitamins could prevent birth defects, however only 49.4% of all women took vitamins prior to pregnancy.[229]

Based on the Canadian Maternity Experiences Survey conducted between October of 2006 and January of 2007, 61.3% of women who were 5 to 14 months postpartum living in BC reported taking folic acid supplementation three months before pregnancy and 93.9% reported taking it during the first three months of pregnancy.[230]

In a 2003 survey of 148 women aged 18 to 45 years living in Vancouver, 28% used a supplement containing folic acid on a daily basis.[231]

Folic acid supplementation is just one source of folic acid. For example, folic acid is naturally available in some foods and is added to white flour, pasta and cornmeal during manufacturing. Fortification of grains began in 1996 as a response to the growing awareness of the benefits of folic acid. It is therefore important to consider all sources of folic acid.

One way to do this is by measuring the concentration of red blood cell folate. Based on the 2007 – 2009 *Canadian Health Measures Survey*, 22% of women of childbearing age (ages 15 to 45) exhibited a low concentration of red blood cell folate. Specifically, it was below the

[225] Osho O, Owoeye O and Armijo-Olivo S. Adherence and attrition in fall prevention exercise programs for community-dwelling older adults: a systematic review and meta-analysis. *Journal of Aging and Physical Activity*. 2017: 1-41.
[226] Nyman S and Victor C. Older people's participation in and engagement with falls prevention interventions in community settings: an augment to the Cochrane systematic review. *Age and Ageing*. 2011; 41(1): 16-23.
[227] Kantor E, Rehm C, Du M et al. Trends in dietary supplement use among US adults from 1999-2012. *Journal of American Medical Association*. 2016; 316(14): 1464-74.
[228] Bibbins-Domingo K, Grossman D, Curry S et al. Folic acid supplementation for the prevention of neural tube defects: US Preventive Services Task Force recommendation statement. *Journal of American Medical Association*. 2017; 317(2): 183-9.
[229] Morin V, Mondor M and Wilson R. Knowledge on periconceptional use of folic acid in women of British Columbia. *Fetal Diagnosis and Therapy*. 2001; 16(2): 111-5.
[230] Nelson C, Leon J and Evans J. The relationship between awareness and supplementation: which Canadian women know about folic acid and how does that translate into use. *Canadian Journal of Public Health*. 2014; 105(1): e40-6.
[231] French M, Barr S and Levy-Milne R. Folate intakes and awareness of folate to prevent neural tube defects: a survey of women living in Vancouver, Canada. *Journal of the American Dietetic Association*. 2003; 103(2): 181-5.

level considered to be optimal for minimizing the risk of neural tube defects (<906 nmol/L). The inverse argument could also be made, namely that 78% of Canadian women of reproductive age have sufficient folate intake to minimize the risk of neural tube defects.[232]

Best in the World

In 2011/12, 34% of US women between the ages of 20 and 44 used folic acid supplementation, most commonly as part of a multi-vitamin or multi-mineral supplement.[233]

We have assumed a 'best in the world' rate for taking a daily supplement containing folic acid to be 34% (based on the evidence from the US in 2011/12).

Adherence

There are two levels of adherence that need to be taken into account when calculating a rate of coverage for the service in British Columbia or the best rate in the world. The first is clinician adherence with guideline recommendations. For example, guidelines may recommend that 100% of a specific population be offered a particular type of screening. For a variety of reasons, however, not all clinicians offer that screening to the population. The second is patient adherence or compliance. When offered the screening by a clinician, not all patients would agree to have the screening done. Calculating a rate of coverage in the population is based on a combination of these two levels of adherence. For example, if 70% of clinicians offer a service to their patients and 70% of patients accept, then the rate of coverage in the population would be 49% (70% * 70%).

Converting Foreign Currency to Canadian Dollars

Whenever possible, unit costs developed in BC are used in the calculation of cost-effectiveness. Unfortunately, BC-specific unit costs are often not available. In this case, we search for unit cost estimates from other Canadian sources followed by unit cost estimates from international sources. The CCEMG – EPPI-Centre Cost Converter[234,235] is a free web-based tool for adjusting estimates of unit costs expressed in one currency and price year to a specific target currency and price year. In every situation, we want to convert estimated unit costs into 2022 Canadian dollars (CAD).

A challenge specific to converting US health care unit costs to Canadian unit costs is the substantially higher unit costs (or prices) in the US compared to those in Canada for the same output. That is, unit costs are estimated to be 29% higher in the US than in Canada.[236,237,238] To reflect these excess health care prices in the US, we reduce the estimate generated by using the CCEMG – EPPI-Centre Cost Converter by 29%.

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[232] Colapinto C, O'Connor D and Tremblay M. Folate status of the population in the Canadian Health Measures Survey. *Canadian Medical Association Journal*. 2011; 183(2): E100-E6.

[233] Kantor E, Rehm C, Du M et al. Trends in dietary supplement use among US adults from 1999-2012. *Journal of American Medical Association*. 2016; 316(14): 1464-74.

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[237] Anderson GF, Reinhardt UE, Hussey PS et al. It's the prices, stupid: why the United States is so different from other countries. *Health Affairs*. 2003; 22(3): 89-105.

[238] Reinhardt U. *Why Does US Health Care Cost So Much? (Part I)*. 2008. Available at https://economix.blogs.nytimes.com/2008/11/14/why-does-us-health-care-cost-so-much-part-i/. Accessed September 2022.

Note that if the US unit costs included in a given model are not health care-based, then this final step is not taken. Such costs might include, for example, the additional educational costs associated with caring for a child with fetal alcohol spectrum disorder or spina bifida.

To keep relatively current, unit costs should be updated at least once every five years.

Patient Time Costs

Patient time costs resulting from receiving, as well as travelling to and from, a service are valued based on the average hourly wage rate in BC in 2022 ($31.49[239]) plus 18% benefits for an average cost per hour of $37.16. In the absence of specific data on the amount of time required, we assume two hours per service.

Patient time costs are truncated at $278.70 per day (7.5 hours times $37.16). If, for example, we are valuing a patient's time costs while in hospital, each day would be assessed a value of $278.70 (rather than 24 hours times $37.16 or $891.84).

GP Office Visit Cost

The cost of an office visit to a General Practitioner (GP) in BC varies by the age of the patient, as follows:[240]

- Visit in office age 0-1 (MSP fee 12100) - $34.79
- Visit in office age 2-49 (MSP fee 00100) - $31.62
- Visit in office age 50-59 (MSP fee 15300) - $34.79
- Visit in office age 60-69 (MSP fee 16100) - $36.36
- Visit in office age 70-79 (MSP fee 17100) - $41.1
- Visit in office age 80+ (MSP fee 18100) - $47.44

The estimated cost of a visit to a GP of $35.97 is based on the average cost of an office visit between the ages of 2 and 79.

The cost of a follow-up phone call or email correspondence is $20.00 (MSP fee PG14076 - GP Telephone Management Fee).[241]

A key question is whether one or more preventive maneuvers might be completed during an individual office visit. If evidence is available on this question, either research evidence or specific advice from our GP advisors given their knowledge of the BC practice environment, then that evidence is used in the modelling. If no evidence is available, however, then we assume that 50% of an office visit is required per preventive maneuver and modify this from 33% to 66% in the sensitivity analysis.

[239] BC Stats. *Earning & Employment Trends – August 2022*. Available at https://www2.gov.bc.ca/assets/gov/data/statistics/people-population-community/income/earnings_and_employment_trends_data_tables.pdf. Accessed September 2022.
[240] Ministry of Health. *Medical Services Commission Payment Schedule*. 2021. Available at https://www2.gov.bc.ca/assets/gov/health/practitioner-pro/medical-services-plan/msc-payment-schedule-may-2021.pdf. Accessed September 2022.
[241] Ibid.

Life Table

Data on the number and proportion of expected deaths, life-years lived and life expectancy by sex and age group in British Columbia are based on Statistics Canada data for 2018 to 2020 (see following table).[242]

Life Tables, British Columbia, 2018 to 2020

	Females				Males				Both Sexes			
Age	# of Survivors	# of Deaths	Life Years Lived, Age x to x+n	Life Exp.	# of Survivors	# of Deaths	Life Years Lived, Age x to x+n	Life Exp.	# of Survivors	# of Deaths	Life Years Lived, Age x to x+n	Life Exp.
0	100,000	336	99,686	84.9	100,000	393	99,637	79.9	100,000	365	99,661	82.4
1	99,664	19	99,657	84.2	99,607	18	99,599	79.3	99,635	18	99,627	81.7
2	99,645	14	99,634	83.2	99,589	14	99,581	78.3	99,616	14	99,606	80.7
3	99,631	11	99,623	82.2	99,575	11	99,571	77.3	99,602	12	99,596	79.7
4	99,619	9	99,614	81.3	99,564	9	99,559	76.3	99,590	10	99,585	78.7
5	99,610	8	99,606	80.3	99,554	8	99,551	75.3	99,581	8	99,577	77.7
6	99,602	7	99,599	79.3	99,547	7	99,543	74.3	99,573	7	99,569	76.8
7	99,595	6	99,592	78.3	99,540	6	99,537	73.3	99,565	7	99,562	75.8
8	99,589	6	99,586	77.3	99,533	6	99,531	72.3	99,559	6	99,556	74.8
9	99,583	6	99,580	76.3	99,528	6	99,525	71.3	99,552	6	99,549	73.8
10	99,577	6	99,574	75.3	99,522	6	99,519	70.3	99,546	6	99,543	72.8
11	99,571	6	99,568	74.3	99,516	6	99,513	69.3	99,540	7	99,537	71.8
12	99,565	7	99,561	73.3	99,510	8	99,506	68.3	99,534	8	99,530	70.8
13	99,557	9	99,553	72.3	99,502	10	99,497	67.3	99,526	10	99,521	69.8
14	99,548	12	99,542	71.3	99,492	14	99,485	66.3	99,516	13	99,509	68.8
15	99,537	16	99,528	70.3	99,478	21	99,467	65.3	99,503	19	99,493	67.8
16	99,520	22	99,509	69.3	99,456	32	99,440	64.4	99,483	28	99,469	66.8
17	99,498	28	99,484	68.3	99,424	45	99,402	63.4	99,456	37	99,437	65.8
18	99,470	31	99,455	67.4	99,379	57	99,351	62.4	99,419	45	99,397	64.9
19	99,439	33	99,423	66.4	99,322	68	99,288	61.4	99,374	52	99,348	63.9
20	99,406	35	99,389	65.4	99,254	80	99,214	60.5	99,322	59	99,293	62.9
21	99,372	37	99,353	64.4	99,174	91	99,129	59.5	99,264	65	99,231	62.0
22	99,335	38	99,316	63.5	99,084	101	99,033	58.6	99,199	71	99,163	61.0
23	99,296	40	99,276	62.5	98,982	110	98,928	57.7	99,127	77	99,089	60.0
24	99,256	42	99,235	61.5	98,873	116	98,815	56.7	99,051	81	99,010	59.1
25	99,215	43	99,193	60.5	98,756	121	98,696	55.8	98,970	84	98,928	58.1
26	99,171	45	99,149	59.6	98,635	126	98,572	54.8	98,886	87	98,843	57.2
27	99,126	47	99,103	58.6	98,509	130	98,444	53.9	98,799	90	98,754	56.2
28	99,079	49	99,055	57.6	98,379	134	98,312	53.0	98,709	93	98,662	55.3
29	99,030	52	99,004	56.6	98,245	138	98,176	52.1	98,616	96	98,568	54.3
30	98,979	54	98,951	55.7	98,107	141	98,037	51.1	98,520	99	98,470	53.4
31	98,924	57	98,896	54.7	97,966	144	97,894	50.2	98,421	102	98,370	52.4
32	98,867	60	98,837	53.7	97,822	147	97,749	49.3	98,319	104	98,267	51.5
33	98,807	63	98,776	52.8	97,675	151	97,600	48.4	98,215	108	98,161	50.5
34	98,744	66	98,711	51.8	97,525	155	97,447	47.4	98,107	111	98,052	49.6
35	98,679	68	98,645	50.8	97,369	160	97,289	46.5	97,996	115	97,939	48.7
36	98,611	71	98,575	49.9	97,209	165	97,127	45.6	97,882	119	97,822	47.7
37	98,540	74	98,502	48.9	97,044	171	96,959	44.7	97,763	123	97,701	46.8
38	98,465	78	98,426	47.9	96,873	177	96,785	43.7	97,640	128	97,576	45.8
39	98,387	82	98,346	47.0	96,696	184	96,604	42.8	97,512	133	97,445	44.9
40	98,305	88	98,261	46.0	96,513	191	96,417	41.9	97,379	139	97,309	44.0
41	98,217	93	98,171	45.1	96,322	198	96,223	41.0	97,240	146	97,167	43.0
42	98,124	99	98,074	44.1	96,123	207	96,020	40.1	97,094	153	97,018	42.1
43	98,025	106	97,972	43.1	95,916	217	95,808	39.1	96,941	161	96,861	41.1
44	97,919	113	97,862	42.2	95,700	227	95,586	38.2	96,781	169	96,696	40.2
45	97,806	121	97,746	41.2	95,472	239	95,353	37.3	96,611	179	96,522	39.3

[242] Statistics Canada. Table 13-10-0114-01 Life expectancy and other elements of the complete life table, three-year estimates, Canada, all provinces except Prince Edward Island. Available online at http:https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1310011401. Accessed September 2022.

Life Tables, British Columbia, 2018 to 2020 (continued)

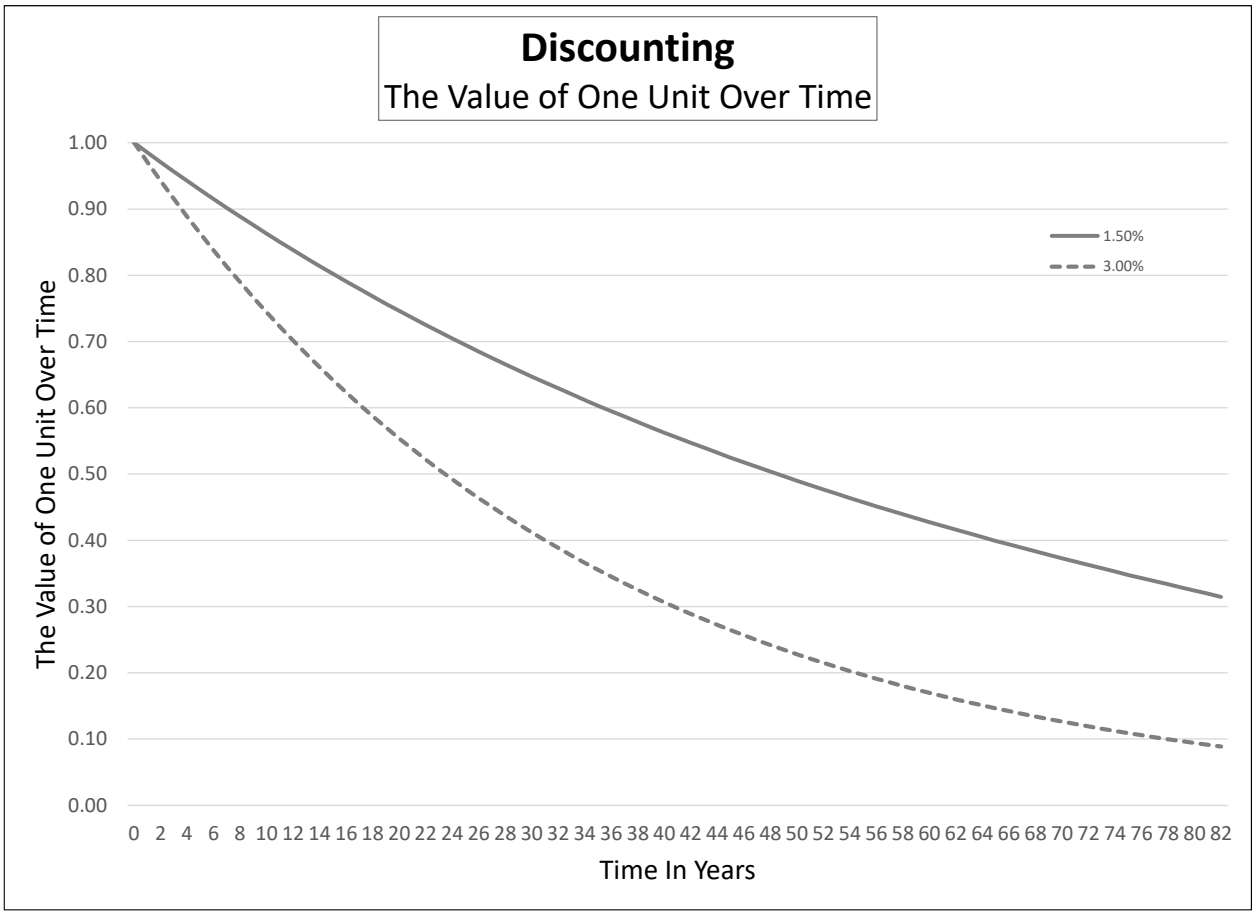
	Females				Males				Both Sexes			
Age	# of Survivors	# of Deaths	Life Years Lived, Age x to x+n	Life Exp.	# of Survivors	# of Deaths	Life Years Lived, Age x to x+n	Life Exp.	# of Survivors	# of Deaths	Life Years Lived, Age x to x+n	Life Exp.
46	97,685	129	97,621	40.3	95,233	252	95,108	36.4	96,432	189	96,338	38.4
47	97,556	138	97,487	39.3	94,982	266	94,848	35.5	96,243	201	96,142	37.4
48	97,418	148	97,344	38.4	94,715	282	94,574	34.6	96,042	214	95,935	36.5
49	97,270	159	97,191	37.4	94,433	300	94,283	33.7	95,828	228	95,714	35.6
50	97,111	170	97,026	36.5	94,134	319	93,974	32.8	95,600	244	95,478	34.7
51	96,941	183	96,849	35.6	93,815	340	93,644	31.9	95,356	261	95,226	33.8
52	96,758	197	96,659	34.6	93,474	363	93,293	31.0	95,095	279	94,956	32.8
53	96,561	212	96,455	33.7	93,111	388	92,917	30.2	94,816	300	94,666	31.9
54	96,348	229	96,234	32.8	92,723	415	92,515	29.3	94,517	322	94,356	31.0
55	96,119	247	95,996	31.9	92,307	445	92,085	28.4	94,195	346	94,022	30.1
56	95,872	268	95,738	30.9	91,862	477	91,624	27.5	93,849	372	93,663	29.3
57	95,605	290	95,460	30.0	91,385	511	91,130	26.7	93,477	401	93,277	28.4
58	95,315	314	95,158	29.1	90,874	549	90,600	25.8	93,077	432	92,861	27.5
59	95,001	341	94,830	28.2	90,325	590	90,030	25.0	92,645	466	92,412	26.6
60	94,660	371	94,474	27.3	89,735	634	89,418	24.1	92,179	503	91,927	25.7
61	94,289	403	94,087	26.4	89,101	682	88,760	23.3	91,676	544	91,404	24.9
62	93,886	439	93,666	25.5	88,419	735	88,051	22.5	91,132	588	90,838	24.0
63	93,446	479	93,207	24.6	87,684	791	87,288	21.7	90,543	637	90,225	23.2
64	92,967	523	92,706	23.8	86,893	853	86,466	20.9	89,906	690	89,561	22.3
65	92,444	571	92,158	22.9	86,040	920	85,580	20.1	89,216	748	88,842	21.5
66	91,873	625	91,560	22.0	85,120	992	84,625	19.3	88,468	812	88,062	20.7
67	91,248	684	90,906	21.2	84,129	1,070	83,594	18.5	87,657	881	87,216	19.9
68	90,564	749	90,189	20.3	83,059	1,155	82,481	17.7	86,776	956	86,298	19.1
69	89,815	821	89,404	19.5	81,904	1,246	81,281	17.0	85,820	1,038	85,301	18.3
70	88,994	901	88,543	18.7	80,658	1,344	79,986	16.2	84,781	1,128	84,217	17.5
71	88,093	988	87,599	17.9	79,314	1,450	78,589	15.5	83,653	1,225	83,041	16.7
72	87,105	1,085	86,563	17.1	77,864	1,564	77,082	14.8	82,428	1,331	81,763	16.0
73	86,020	1,191	85,425	16.3	76,300	1,685	75,458	14.1	81,097	1,445	80,375	15.2
74	84,829	1,308	84,175	15.5	74,615	1,814	73,708	13.4	79,652	1,569	78,867	14.5
75	83,522	1,435	82,804	14.7	72,801	1,951	71,826	12.7	78,083	1,702	77,232	13.8
76	82,086	1,575	81,298	14.0	70,850	2,096	69,802	12.0	76,381	1,845	75,458	13.1
77	80,511	1,728	79,647	13.2	68,754	2,248	67,630	11.4	74,536	1,998	73,537	12.4
78	78,783	1,894	77,836	12.5	66,506	2,406	65,303	10.8	72,538	2,160	71,458	11.7
79	76,889	2,073	75,853	11.8	64,100	2,569	62,816	10.1	70,378	2,331	69,213	11.0
80	74,816	2,265	73,684	11.1	61,531	2,735	60,164	9.5	68,047	2,510	66,792	10.4
81	72,551	2,471	71,315	10.5	58,796	2,903	57,345	9.0	65,537	2,696	64,189	9.8
82	70,080	2,689	68,735	9.8	55,894	3,068	54,360	8.4	62,840	2,887	61,397	9.2
83	67,391	2,917	65,932	9.2	52,826	3,228	51,211	7.9	59,953	3,080	58,413	8.6
84	64,474	3,153	62,897	8.6	49,597	3,379	47,908	7.3	56,873	3,271	55,238	8.0
85	61,321	3,393	59,624	8.0	46,219	3,514	44,462	6.8	53,602	3,456	51,874	7.5
86	57,927	3,632	56,111	7.4	42,705	3,628	40,891	6.4	50,146	3,629	48,332	7.0
87	54,295	3,863	52,363	6.9	39,077	3,714	37,220	5.9	46,517	3,784	44,625	6.5
88	50,432	4,078	48,393	6.4	35,363	3,765	33,481	5.5	42,733	3,912	40,777	6.0
89	46,353	4,266	44,220	5.9	31,598	3,773	29,712	5.1	38,821	4,004	36,819	5.6
90	42,087	4,415	39,880	5.4	27,825	3,731	25,960	4.7	34,817	4,052	32,791	5.2

Source: Statistics Canada. Table 13-10-0114-01 *Life expectancy and other elements of the complete life table, three-year estimates, Canada, all provinces except Prince Edward Island* . Available online at http:https://www150.statcan.gc.ca/t1/tbl1/en/cv.action?pid=1310011401.

Discounting

As noted earlier, we use a 1.5% discount rate in the reference case with a 3% and a 0% discount rate in the sensitivity analysis. A 0% discount rate is equivalent to not discounting. The following chart and table identify the present value of one unit over an 82-year period (the average lifespan of a British Columbian, see above) using a 1.5% and a 3.0% discount rate.[243] The same discount rate is used for both costs and benefits when calculating cost-effectiveness.

In essence, the present value of one unit (either a dollar or a QALY in the current study) is reduced to 31% of its 'full' value if it is incurred 82 years in the future based on a 1.5% discount rate and to 9% of its 'full' value based on a 3.0% discount rate.



[243] The data in the table and chart are derived from Annex 4.2 of Drummond M, Stoddart G and Torrance G. *Methods for the Economic Evaluation of Health Care Programmes.* Oxford: Oxford University Press; 1987.

The Effect of Discounting Over Time		
Time	Discount Rate	
(in years)	1.5%	3.0%
0	1.0000	1.0000
1	0.9853	0.9709
2	0.9708	0.9426
3	0.9565	0.9151
4	0.9424	0.8885
5	0.9286	0.8626
6	0.9150	0.8375
7	0.9017	0.8131
8	0.8885	0.7894
9	0.8756	0.7664
10	0.8628	0.7441
11	0.8503	0.7224
12	0.8380	0.7014
13	0.8259	0.6810
14	0.8140	0.6611
15	0.8022	0.6419
16	0.7906	0.6232
17	0.7793	0.6050
18	0.7681	0.5874
19	0.7571	0.5703
20	0.7463	0.5537
21	0.7356	0.5375
22	0.7251	0.5219
23	0.7148	0.5067
24	0.7047	0.4919
25	0.6947	0.4776
26	0.6848	0.4637
27	0.6752	0.4502
28	0.6656	0.4371
29	0.6562	0.4243
30	0.6470	0.4120
31	0.6382	0.4000
32	0.6294	0.3883
33	0.6206	0.3770
34	0.6118	0.3660
35	0.6030	0.3554
36	0.5948	0.3450
37	0.5867	0.3350
38	0.5786	0.3252
39	0.5704	0.3158
40	0.5623	0.3066
41	0.5548	0.2976
42	0.5472	0.2890
43	0.5397	0.2805
44	0.5322	0.2724
45	0.5247	0.2644
46	0.5177	0.2567
47	0.5107	0.2493
48	0.5037	0.2420
49	0.4967	0.2350
50	0.4898	0.2281
51	0.4833	0.2215
52	0.4768	0.2150
53	0.4703	0.2088
54	0.4638	0.2027
55	0.4574	0.1968
56	0.4513	0.1910
57	0.4453	0.1855
58	0.4393	0.1801
59	0.4332	0.1748
60	0.4272	0.1697
61	0.4216	0.1648
62	0.4159	0.1600
63	0.4103	0.1553
64	0.4047	0.1508
65	0.3991	0.1464
66	0.3938	0.1421
67	0.3885	0.1380
68	0.3832	0.1340
69	0.3779	0.1301
70	0.3727	0.1263
71	0.3677	0.1226
72	0.3627	0.1190
73	0.3577	0.1156
74	0.3527	0.1122
75	0.3478	0.1089
76	0.3430	0.1058
77	0.3383	0.1027
78	0.3336	0.0997
79	0.3288	0.0968
80	0.3241	0.0940
81	0.3194	0.0913
82	0.3146	0.0887

The Disutility Attributable to Taking Preventive Medication

The disutility of taking pills for preventing adverse health outcomes is estimated at 0.24% (95% confidence interval [CI] of 0.17% to 0.33%).[244, 245, 246] The studies by Hutchins and colleagues also found that a significant proportion of respondents (9.5% using the willingness-to-pay approach, 57.5% using the standard gamble approach and 87% using the time trade-off approach) identified no disutility associated with taking one pill daily. In the sensitivity analysis, we therefore ranged the disutility from 0% to 0.33%.

Summary Measures of Population Health

Background

Population health has historically been measured based on mortality indicators, including summary measures such as life expectancy and infant mortality. More recently, summary measures have attempted to take into account both mortality and *morbidity*.

This has led to two types of composite summary measures, health expectancy measures and health gap measures.[247] Health expectancy measures include disability-free life expectancy (DFLE) and health-adjusted life expectancy (HALE). These measures start with a standard theoretical life expectancy (usually based on the best life expectancy observed in the world) and then assess the amount of life lost due to premature death combined with time lost due to morbidity or disability. Health-adjusted life expectancy, for example, estimates the average time in years that a person at a given age can expect to live in the equivalent of full health.[248]

Health gap measures consist primarily of disability-adjusted life years (DALYs) and quality-adjusted life years (QALYs). QALYs were originally developed by economists in the 1960s for use in cost-effectiveness analyses, primarily in higher-income countries. Measures of the effect of morbidity used in calculating QALYs are based on the value or preference that people have for health outcomes or states along a continuum between death (0) and full health (1.0). DALYs, however, have been favoured in measures of global health and have been championed by the Global Burden of Disease (GBD) study since the original publication of results in 1997.[249,250,251] Measures of the effect of morbidity used in calculating DALYs are based on estimates of the impact of a disease or disability on the performance of an individual.

The DALY is essentially the complement to the QALY, with the focus of DALYs being on disability-adjusted life years *averted* and the focus of QALYs on quality-adjusted life years *gained*. The approach to measurement (and corresponding methodological issues) are similar in calculating QALYs and DALYs. Among the key issues in measuring both QALYs and

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[244] Thompson A, Guthrie B and Payne K. Do pills have no ills? capturing the impact of direct treatment disutility. *PharmacoEconomics*. 2016; 34(4): 333-6.
[245] Hutchins R, Pignone M, Sheridan S et al. Quantifying the utility of taking pills for preventing adverse health outcomes: a cross-sectional survey. *British Medical Journal Open*. 2015; 5(e006505): 1-9.
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[247] Hyder A, Puvanachandra P and Morrow R. Measuring the health of populations: explaining composite indicators. *Journal of Public Health Research*. 2012; 1(3): 222-8.
[248] Gold M, Stevenson D and Fryback DG. HALYS and QALYS and DALYS, Oh My: Similarities and differences in summary measures of population health. *Annual Review of Public Health*. 2002; 23(1): 115-34.
[249] Murray CJL and Lopez AD. Regional patterns of disability-free life expectancy and disability-adjusted life expectancy. Global Burden of Disease Study. *The Lancet*. 1997; 349: 1347-52.
[250] Salomon JA, Vos T, Hogan DR et al. Common values in assessing health outcomes from disease and injury: disability weights measurement study for the Global Burden of Disease Study 2010. *The Lancet*. 2012; 380(9859): 2129-43.
[251] Salomon JA, Haagsma JA, Davis A et al. Disability weights for the Global Burden of Diseases 2013 study. *The Lancet Global Health*. 2015; 3: e712-e723.

DALYs are whom to ask (the three choices tend to be clinicians, patients with the disease/injury or the general population), how the impact of the disease/injury is described to the general population if that group is being queried and whether the resulting weights are universally applicable. The GBD study, for example, has developed standardized disability weights by health states based on feedback from 60,890 individuals aged 18-65 in the general population across multiple continents.[252]

The enormous influence of the GBD study has meant that a greater number of cost-effectiveness analyses are now using a cost-per-DALY *averted* as their main outcome measure rather than a cost-per-QALY *gained*.[253]

As noted above, the approach for this project is to use QALYs in assessing both the clinically preventable burden and cost-effectiveness of a CPS.

Sources of Quality of Life Values

Ideal sources of quality of life (QoL) values include large population-based studies assessing a considerable variety of health-related outcomes, such as the studies by Sullivan and colleagues in the US[254] and the UK[255] (see below). Disability weights developed for the GBD study are another useful source as a proxy for QoL.[256] While the disability weights for the 2013 GBD study are the latest available in the academic literature, detailed weights for the 2016 GBD study are publicly accessible online.[257]

If data is not available from such large population-based studies, then larger studies (or meta-analyses, if they are available) assessing the QoL for a specific health-related outcome are used.

Calculating Changes in QoL

Assessing QoL on a 0 – 1 scale assumes that 0 is equivalent to death and 1 is equivalent to full health. A number of publications have assessed the QoL of the general population. The study by Sullivan and colleagues in the US, for example, used a nationally representative survey of 38,678 individuals to estimate a mean population QoL value of 0.867 (0.854 for females and 0.880 for males).[258] Their study in the UK (with a sample size of 79,522) found a mean QoL of 0.828 for the general population (0.815 for females and 0.850 for males).[259] That is, while many individuals within a population may self-identify as a 1.0 (full health), the majority do not.

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[252] Salomon JA, Haagsma JA, Davis A et al. Disability weights for the Global Burden of Diseases 2013 study. *The Lancet Global Health*. 2015; 3: e712-e723.
[253] Neumann PJ, Thorat T, Zhong Y et al. A systematic review of cost-effectiveness studies reporting cost-per-DALY averted. *PLOS ONE*. 2016; 11(12): e0168512.doi:10.1371/journal.
[254] Sullivan P and Ghushchyan V. Preference-based EQ-5D index scores for chronic conditions in the United States. *Medical Decision Making*. 2006; 26(4): 410-20.
[255] Sullivan PW, Slejko JF, Sculpher MJ et al. Catalogue of EQ-5D scores for the United Kingdom. *Medical Decision Making*. 2011; 31(6): 800-4.
[256] Salomon JA, Haagsma JA, Davis A et al. Disability weights for the Global Burden of Diseases 2013 study. *The Lancet Global Health*. 2015; 3: e712-e723.
[257] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[258] Sullivan P and Ghushchyan V. Preference-based EQ-5D index scores for chronic conditions in the United States. *Medical Decision Making*. 2006; 26(4): 410-20.
[259] Sullivan PW, Slejko JF, Sculpher MJ et al. Catalogue of EQ-5D scores for the United Kingdom. *Medical Decision Making*. 2011; 31(6): 800-4.

Mean QoL also decreases with increasing age, as follows:[260,261]

Change in Mean QoL in the General US and UK Populations by Age Group			
Age Group	**United States**	**United Kingdom**	**Average US / UK**
18-29	0.922	0.905	0.914
30-39	0.901	0.879	0.890
40-49	0.871	0.837	0.854
50-59	0.842	0.798	0.820
60-69	0.823	0.774	0.799
70-79	0.790	0.723	0.757
≥80	0.736	0.657	0.697
All Ages 18+	**0.867**	**0.828**	**0.848**

In assessing changes in QoL, we assume that the average QoL value for individuals living in BC is 0.85 (the mean between the US and UK values). A 0.10 reduction in QoL then is equivalent to an 11.8% (0.10 / 0.85) reduction in QoL, if the reduction is applicable to all age groups. If it is only applicable to the 60-69 year age group, then a 0.10 reduction in QoL would be equivalent to a 12.5% (0.10 / 0.80) reduction in QoL.

Utility, Disutility and Disability Weight

Throughout this report, utility, disutility and disability weight will be used to refer to adjustments made to the quality of life. A positive utility is an improvement to the quality of life. A disutility or disability weight is a reduction in the quality of life and is equivalent to a negative utility of the same magnitude. (I.e. a disutility of 0.05, a disability weight of 0.05 and a utility of -0.05 are used interchangeably and all refer to the same thing: a reduction in the quality of life by 0.05 on a scale of 0 to 1.)

[260] Sullivan P and Ghushchyan V. Preference-based EQ-5D index scores for chronic conditions in the United States. *Medical Decision Making*. 2006; 26(4): 410-20.
[261] Sullivan PW, Slejko JF, Sculpher MJ et al. Catalogue of EQ-5D scores for the United Kingdom. *Medical Decision Making*. 2011; 31(6): 800-4.

Major Behavioural Risk Factors

Alcohol Use

- A UK study used a community-based sample ≥ 16 years of age of 14,117 to assess the *effect of alcohol use on QoL*.[262] After adjusting for age, sex, excess weight, physical activity, fruit and vegetable consumption, smoking status, ethnicity, marital status, educational attainment, and income, they found a small but statistically significant positive effect (0.011 to 0.019) on self-reported QoL associated with alcohol consumption when compared with never-drinkers.
- The GBD study found that a very mild alcohol use disorder[263] is associated with a *disutility* of 0.123 (95% CI of 0.082 to 0.177), a mild alcohol use disorder[264] is associated with a *disutility* of 0.235 (95% CI of 0.160 to 0.327), a moderate alcohol use disorder[265] is associated with a disutility of 0.373 (95% CI of 0.248 to 0.508) and a severe alcohol use disorder[266] is associated with a disutility of 0.570 (95% CI of 0.396 to 0.732).[267]
- Consuming more than 4 drinks of alcohol per day *reduces an individual's longevity* by 3.1 (95% CI of 1.9 to 4.0) years.[268]
- In addition to a reduced life expectancy and quality of life, alcohol use is also associated with higher *annual medical care costs* (e.g., hospitalization, physician, drug, etc.) than no alcohol use. In BC, any alcohol use is associated with an annual economic burden of $1,462 million in 2015. Of this amount, $487.4 million is for direct medical care costs (the remaining is for indirect costs associated with premature mortality and short and long-term disability).[269]
- The Canadian Institute for Substance Use Research (CISUR) and the Canadian Centre on Substance Use and Addiction (CCSA) estimated the annual costs of alcohol use in Canada to be $14,641.1 million in 2014. Of this amount, $4,230.2 million (29%) was for healthcare costs, $5,916.4 million (40%) for indirect costs, $3,154.2 million (22%) for criminal justice costs and $1,340.3 million (9%) for 'other' costs (primarily fire and motor vehicle damage).[270]

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[262] Maheswaran H, Petrou S, Rees K et al. Estimating EQ-5D utility values for major health behavioural risk factors in England. *Journal of Epidemiology and Community Health*. 2013; 67(1): 172-80.

[263] **Very mild alcohol use disorder** – "Drinks alcohol daily and has difficulty controlling the urge to drink. When sober, the person functions normally."

[264] **Mild alcohol use disorder** – "Drinks a lot of alcohol and sometimes has difficulty controlling the urge to drink. While intoxicated, the person has difficulty performing daily activities."

[265] **Moderate alcohol use disorder** – "Drinks a lot, gets drunk almost every week and has great difficulty controlling the urge to drink. Drinking and recovering cause great difficulty in daily activities, sleep loss and fatigue."

[266] **Severe alcohol use disorder** – "Gets drunk almost every day and is unable to control the urge to drink. Drinking and recovering replace most daily activities. The person has difficulty thinking, remembering and communicating, and feels constant pain and fatigue."

[267] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[268] Li K, Hüsing A and Kaaks R. Lifestyle risk factors and residual life expectancy at age 40: a German cohort study. *BioMed Central Medicine*. 2014; 12(1): 59-69.

[269] H. Krueger & Associates Inc. *The Economic Burden of Risk Factors in British Columbia: Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption.* 2018. Vancouver, B.C.: Provincial Health Services Authority, Population and Public Health Program.

[270] Canadian Substance Use Costs and Harms Scientific Working Group. *Canadian substance use costs and harms (2007 – 2014)*. 2018. Prepared by the Canadian Institute for Substance Use Research and the Canadian Centre on Substance Use and Addiction. Ottawa, Ontario.

- The CISUR and CCSUA analysis also estimated the annual costs of alcohol use in BC to be $1,936 million in 2014. Of this amount, $673 million (35%) was for healthcare costs, $744 million (38%) for indirect costs, $349 million (18%) for criminal justice costs and $169 million (9%) for 'other' costs.[271]
- The economic burden attributable to alcohol use increases with the amount consumed. Low alcohol use (less than 3 drinks per day for males and less than 1.5 drinks per day for females) is associated with excess annual medical care costs per female of $36 and per male of $77 in 2013. Hazardous alcohol use (3 to 4.5 drinks per day for males and 1.5 to 3 drinks per day for females) is associated with excess annual medical care costs per female of $279 and per male of $488. Harmful alcohol use (>4.5 drinks per day for males and >3 drinks per day for females) is associated with excess annual medical care costs per female of $1,153 and per male of $1,235.[272]
- We increased the above annual economic burden attributable to alcohol use by sex and consumption level by 38% to take into account higher estimates of healthcare costs for BC in the CISUR / CCSUA analysis ($673 million) compared with the previous BC analysis ($487.4 million).
- In addition to direct medical care costs, alcohol use is associated with criminal justice costs and 'other' costs, primarily fire and motor vehicle damage. In BC, the CISUR / CCSUA analysis indicates that the criminal justice costs are equivalent to 51% of the direct medical care costs while other costs are equivalent to 25% of the direct medical care costs.[273]
- The adjusted excess annual medical care costs (direct costs), criminal justice costs and other costs (both calculated as a proportion of direct medical care costs) are shown in the table below, inflated to 2022 CAD.

Summary of Annual Cost of Unhealthy Alcohol Use
British Columbia, 2022 CAD

	Direct Healthcare Costs		Criminal Justice Costs		'Other' Costs		**Total Costs**	
	Female	Male	Female	Male	Female	Male	**Female**	**Male**
Low Alcohol Use	$57	$122	$29	$62	$14	$31	**$101**	**$215**
Hazardous Alcohol Use	$443	$774	$226	$395	$111	$194	**$779**	**$1,362**
Harmful Alcohol Use	$1,829	$1,959	$933	$999	$457	$490	**$3,219**	**$3,448**

Sources: Canadian Substance Use Costs and Harms Scientific Working Group (2018) and Krueger et al. (2017)

- For the purposes of this project, we have assumed that excess annual medical and other direct costs associated with low, hazardous and harmful alcohol use are $101 / $779 / $3,219, respectively for females and $215 / $1,362 / $3,448, respectively for males. Harmful alcohol use is associated with 3.1 life years lost. Furthermore, hazardous alcohol use is equivalent to a very mild alcohol use disorder with a

[271] Canadian Substance Use Costs and Harms Scientific Working Group. *Canadian substance use costs and harms in the provinces and territories (2007 – 2014).* 2018. Prepared by the Canadian Institute for Substance Use Research and the Canadian Centre on Substance Use and Addiction. Ottawa, Ontario.
[272] Krueger H, Koot J, Andres E. The economic benefits of fruit and vegetable consumption in Canada. *Canadian Journal of Public Health*. 2017; 108(2): e152-61.
[273] Canadian Substance Use Costs and Harms Scientific Working Group. *Canadian substance use costs and harms in the provinces and territories (2007 – 2014).* 2018. Prepared by the Canadian Institute for Substance Use Research and the Canadian Centre on Substance Use and Addiction. Ottawa, Ontario.

disutility of 0.123 and harmful alcohol use is equivalent to a mild alcohol use disorder with a disutility of 0.235.

Unhealthy Drug Use

- Disability weights assigned by the Global Burden of Diseases (GBD) study for unhealthy drug use are as follows:[274]
    - **Mild opioid dependence** ("uses heroin or methadone daily and has difficulty controlling the habit. When not using, the person functions normally") – **0.335** with a 95% CI of 0.221 to 0.473.
    - **Severe opioid dependence** ("uses heroin daily and has difficulty controlling the habit. When the effects wear off, the person feels severe nausea, agitation, vomiting and fever. The person has a lot of difficulty in daily activities") – **0.697** with a 95% CI of 0.510 to 0.843.
    - **Mild cocaine dependence** ("uses cocaine at least once a week and has some difficulty controlling the habit. When not using, the person functions normally") – **0.116** with a 95% CI of 0.074 to 0.165.
    - **Severe cocaine dependence** ("uses cocaine and has difficulty controlling the habit. The person sometimes has mood swings, anxiety, paranoia, hallucinations and sleep problems, and has some difficulty in daily activities") – **0.479** with a 95% CI of 0.324 to 0.634.
    - **Mild amphetamine dependence** ("uses stimulants at least once a week and has some difficulty controlling the habit. When not using, the person functions normally") – **0.079** with a 95% CI of 0.051 to 0.114.
    - **Severe amphetamine dependence** ("uses stimulants and has difficulty controlling the habit. The person sometimes has depression, hallucinations and mood swings, and has difficulty in daily activities") – **0.486** with a 95% CI of 0.329 to 0.637.
    - **Mild cannabis dependence** ("uses marijuana at least once a week and has some difficulty controlling the habit. When not using, the person functions normally") – **0.039** with a 95% CI of 0.024 to 0.060.
    - **Severe cannabis dependence** ("uses marijuana daily and has difficulty controlling the habit. The person sometimes has mood swings, anxiety and hallucinations, and has some difficulty in daily activities") – **0.266** with a 95% CI of 0.178 to 0.364.
- In France, Kopp & Ogrodnik estimated the annual health care, law enforcement and prevention costs associated with unhealthy drug use to be €7,903 per user (in 2010 Euros or $13,879 in 2022 C$).[275] Of the total, €4,860 (61% or $8,535 in 2022 C$) was for excess healthcare costs and €3,043 (39% or $5,344 in 2022 C$) for law enforcement and prevention.
- The Canadian Institute for Substance Use Research (CISUR) estimated the annual costs of unhealthy drug use in BC to be $1,671 million in 2014. Of this amount, $227 million (14%) was for healthcare costs, $718 million (43%) for criminal justice

[274] Institute for Health Metrics and Evaluation. GBD 2016 sequelae, health states, health state lay descriptions, and disability weights. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed August 2021.
[275] Kopp P & Ogrodnik M. The social cost of drugs in France in 2010. *The European Journal of Health Economics*. 2017; 18: 883-92.

costs, $147 million (8.8%) for motor vehicle damage and $580 million (35%) for indirect costs.[276]

- In our detailed analysis, we estimated that 5.28% of the BC adult population had unhealthy drug use (excluding cannabis) and a further 4.07% had cannabis use disorder, or 9.35% of BC adults ages 18 and older. If this proportion holds for 2014, then we would expect approximately 361,000 BC adults with unhealthy drug use in BC in 2014. The direct cost estimate from the CISUR analysis for BC in 2014 is $1,092 million or $3,022 per unhealthy drug user ($3,405 in 2022 C$). This $3,405 annual excess cost consists of $715 (21%) for healthcare costs, $2,247 (66%) for criminal justice costs and $443 (13%) for motor vehicle damage costs.
- We assume that a year without unhealthy drug use is associated with $8,642 (($3,405 + $13,879)/2) in direct costs avoided, including healthcare and criminal justice costs.

Tobacco Smoking

- A UK study used a community-based sample ≥ 16 years of age of 14,117 to assess the effect of tobacco smoking on QoL.[277] After adjusting for age, sex, alcohol use, physical activity, fruit and vegetable consumption, excess weight, ethnicity, marital status, educational attainment, and income, they found a utility of -0.031 (95%CI of -0.018 to -0.045) associated with light tobacco smoking (less than 10 cigarettes per day), -0.033 (95% CI of -0.019 to -0.047) for moderate tobacco smoking (10 to 19 cigarettes per day) and -0.062 (95% CI of -0.042 to -0.082) for heavy tobacco smoking (20 or more cigarettes per day).
- Tobacco smoking also *reduces an individual's longevity.* In the United States, an average of 11.5 life years are lost per tobacco smoker. An average of 10.5 of these life-years can be regained by stopping smoking at age 30, 9.5 by stopping smoking at age 40 and 6.5 by stopping smoking at age 50.[278] In Australia, an average of 10 life years are lost per tobacco smoker. Mortality for former smokers who quit prior to age 45 did not differ significantly from never-smokers.[279] Mortality increases with the duration and intensity of smoking.[280,281,282] In the US, for example, light tobacco smoking is associated with a relative risk (RR) of premature mortality of 1.98 (compared to never smokers). This RR increases to 2.7 for moderate tobacco smoking and to 3.74 for heavy tobacco smoking.[283]

[276] Canadian Substance Use Costs and Harms Scientific Working Group. *Canadian substance use costs and harms in the provinces and territories (2007 – 2014)*. 2018. Prepared by the Canadian Institute for Substance Use Research and the Canadian Centre on Substance Use and Addiction. Ottawa, Ontario.
[277] Maheswaran H, Petrou S, Rees K et al. Estimating EQ-5D utility values for major health behavioural risk factors in England. *Journal of Epidemiology and Community Health*. 2013; 67(1): 172-80.
[278] Jha P, Ramasundarahettige C, Landsman V et al. 21st-century hazards of smoking and benefits of cessation in the United States. *New England Journal of Medicine*. 2013; 368(4): 341-50.
[279] Banks E, Joshy G, Weber M et al. Tobacco smoking and all-cause mortality in a large Australian cohort study: findings from a mature epidemic with current low smoking prevalence. *BioMed Central Medicine*. 2015; 13(1): 38-48.
[280] Pirie K, Peto R, Reeves G et al. The 21st century hazards of smoking and benefits of stopping: a prospective study of one million women in the UK. *The Lancet*. 2013; 381(9861): 133-41.
[281] Banks E, Joshy G, Weber M et al. Tobacco smoking and all-cause mortality in a large Australian cohort study: findings from a mature epidemic with current low smoking prevalence. *BioMed Central Medicine*. 2015; 13(1): 38-48.
[282] Inoue-Choi M, Liao L, Reyes-Guzman C et al. Association of long-term, low-intensity smoking with all-cause and cause-specific mortality in the National Institutes of Health–AARP diet and health study. *Journal of American Medical Association Internal Medicine*. 2017; 177(1): 87-95.
[283] Pirie K, Peto R, Reeves G et al. The 21st century hazards of smoking and benefits of stopping: a prospective study of one million women in the UK. *The Lancet*. 2013; 381(9861): 133-41.

- Tobacco smoking is associated with excess *annual medical care costs* (e.g., hospitalization, physician, drug, etc.). Research in BC identified these costs average $1,358 per year: $893 per year for light tobacco smoking (less than 10 cigarettes per day), $1,576 per year for moderate tobacco smoking (10 to 19 cigarettes per day) and $2,332 per year for heavy tobacco smoking (20 or more cigarettes per day). The equivalent costs for females are $1,199 / $803 / $1,367 / $2,359 and for males are $1,466 / $956 / $1,752 / $2,321. [284]

- For the purposes of this project, we have assumed light, moderate and heavy smoking are associated with utilities of -0.031, -0.033 and -0.062, respectively. On average, tobacco smoking is associated with 10 life years lost,[285] with 6.6, 11.9 and 18.1 life years lost associated with light, moderate and heavy smoking.[286] Finally, the annual medical care costs associated with light, moderate and heavy smoking are $893, $1,576 and $2,332, respectively.

E-Cigarette Use

- Only a minority of adolescents (7.8%)[287] or young adults (12.8%)[288] who use e-cigarettes report using them for the purpose of smoking cessation.

- Among baseline adolescent never smokers, e-cigarette users have a much higher odds of subsequent **infrequent** (OR=4.27, 95% CI 2.75 – 6.62) or **frequent** (OR=3.51, 95% CI 1.97 – 6.24) cigarette use than never smokers who do not use e-cigarettes.[289]

- The probability of cigarette smoking initiation by an adolescent **ever** e-cigarette user is 30.4% vs. 7.9% by an adolescent **never** e-cigarette user, an odds ratio of 3.62 (95% CI of 2.42 to 5.41).[290]

- In a longitudinal study of 17,073 children with an average initial age of 9.9 years, ever-use of tobacco products, including e-cigarettes, was associated with inferior

[284] H. Krueger & Associates Inc. *The Economic Burden of Risk Factors in British Columbia: Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption.* 2017. Vancouver, B.C.: Provincial Health Services Authority, Population and Public Health Program.

[285] Banks E, Joshy G, Weber M et al. Tobacco smoking and all-cause mortality in a large Australian cohort study: findings from a mature epidemic with current low smoking prevalence. *BioMed Central Medicine*. 2015; 13(1): 38-48.

[286] In BC in 2015, 56% of tobacco smokers were light smokers, 28% were moderate smokers and 17% were heavy smokers. The estimated annual economic burden attributable to premature mortality in 2015 is $1,346 ($891 for light, $1,607 for moderate and $2,439 for heavy smokers). H. Krueger & Associates Inc. *The Economic Burden of Risk Factors in British Columbia: Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption.* 2017. Vancouver, B.C.: Provincial Health Services Authority, Population and Public Health Program. We used this data to estimate life years lost by smoking intensity as follows: $891 / $1,346 * 10 life years lost = 6.6 life years lost for light smokers; $1,607 / $1,346 * 10 life years lost = 11.9 life years lost for moderate smokers; $2,439 / $1,346 * 10 life years lost = 18.1 life years lost for heavy smokers.

[287] Tsai J, Walton K, Coleman B et al. Reasons for electronic cigarette use among middle and high school students – National Youth Tobacco Survey, United States, 2016. *Morbidity and Mortality Weekly Report*. 2018; 67(6): 196-200.

[288] Hong H, Liu F, Urman R et al. Reasons for electronic cigarette use among South California young adults. In: *Proceedings of the American Thoracic Society International Conference*; May 19-24, 2017; Washington DC.

[289] Barrington-Trimis J, Komg G, Leventhal A et al. E-cigarette use and subsequent smoking frequency among adolescents. *Paediatrics*. 2018; 142(6): e20180486.

[290] Soneji S, Barrington-Trimis J, Wills T et al. Association between initial use of e-cigarettes and subsequent cigarette smoking among adolescents and young adults: A systematic review and meta-analysis. *JAMA Paediatrics*. 2017; 171(8):788-97.

cognitive performance and reduced brain structure with sustained effects for at least two years.[291]

- Based on data from the 2016/17 US Behavioral Risk Factor Surveillance System, Obisesan and colleagues found that former e-cigarette users had a 1.60-fold (95% CI, 1.54-1.67) higher odds of reporting a history of clinical diagnosis of depression than never users, whereas current e-cigarette users had 2.10 (95% CI, 1.98-2.23) times higher odds. Additionally, higher odds of reporting depression were observed with increased frequency of use among current e-cigarette users compared with never users (**daily use**: OR, 2.39; 95% CI, 2.19-2.61; **occasional use**: OR, 1.96; 95% CI, 1.82-2.10).[292]
- Based on a study of 2,299 high school seniors, McCabe et al found that among users of e-cigarettes, lifetime cigarette smoking, alcohol use, marijuana use, nonmedical prescription drug use and illicit drug use (e.g. cocaine, LSD, heroin) are much higher compared with non-users of e-cigarettes. In particular, early onset of e-cigarette use (by grade 9 or earlier) was associated with an increased odds ratio of 14.2 for lifetime cigarette smoking, 70.6 for lifetime alcohol use, 16.4 for lifetime marijuana use, 9.5 for lifetime nonmedical prescription drug use and 19.2 for lifetime illicit drug use.[293]
- In their 2020 review of the available literature on the cardiovascular risk of e-cigarettes, Buchman and colleagues conclude that "there is growing evidence that e-cigarettes and their aerosol constituents, nicotine, carbonyl compounds, particulate matter, metals, and flavourings, can have adverse effects on the cardiovascular system" and furthermore "while there is a paucity of data, recent studies have also suggested that e-cigarette use is associated with inflammation, oxidative stress, and haemodynamic imbalance leading to increased cardiovascular diseases risk."[294]
- Dual use (combining the use of conventional cigarettes and e-cigarettes) may increase cardiovascular disease risk when compared with those who use only conventional cigarettes.[295]
- Based on a review of current evidence on the respiratory effects of e-cigarettes, Miyashita and Foley conclude that "e-cigarette exposure can disrupt pulmonary homeostasis, with reports of gas exchange disturbance, reduced lung function, increased airway inflammation and oxidative stress, downregulation of immunity, and increased risk of respiratory infection."[296]
- Based on a systematic review of the available literature on e-cigarette use and oral health, Yang and colleagues found that "the majority of mouth and throat symptoms experienced by e-cigarette users were relatively minor and temporary, with some evidence that conventional smokers who switched to e-cigarettes experienced mitigation of these symptoms. E-cigarette exposure increased the risk for

[291] Dai H, Doucet G, Wang Y et al. Longitudinal assessments of neurocognitive performance and brain structure associated with initiation of tobacco use in children, 2016 to 2021. *JAMA Network Open*. 2022; 5(8): e2225991.
[292] Obisesan O, Mirbolouk M, Osei A et al. Association between e-cigarette use and depression in the Behavioral Risk Factor Surveillance System, 2016-2017. *JAMA: Public Health*. 2019; 2(12): e1916800. doi:10.1001/jamanetworkopen.2019.16800.
[293] McCabe S, West B, McCabe V. Associations between early onset of e-cigarette use and cigarette smoking and other substance use among US adolescents: A national study. *Nicotine & Tobacco Research*. 2018; 923-30.
[294] Buchanan N, Grimmer J, Tanwar V et al. Cardiovascular risk of electronic cigarettes: A review of preclinical and clinical studies. *Cardiovascular Research*. 2020; 116: 40-50.
[295] Kim C, Paek Y, Seo H et al. Dual use of electronic and conventional cigarettes is associated with higher cardiovascular risk factors in Korean men. *Scientific Reports*. 2020; 10: 5612.
[296] Miyashital, Foley G. E-cigarettes and respiratory health: the latest evidence. *British Medical Journal*. 2019; 366: 5027-38.

deteriorating periodontal, dental and gingival health as well as changes to the oral microbiome. Extensive dental damage as a result of e-cigarette explosions were described in case reports."[297]

- Based on a systematic review of the available literature, Bjurlina et al found that "biomarkers of carcinogens, several with a strong link to bladder cancer, are present in the urine of e-cigarette users. Long-term implications of urothelial exposure to these toxicants are unknown but concerning, given the similarities to tobacco smoke and its established relationship with bladder cancer."[298]
- Other potential harms include unintentional injuries due to device malfunctions, ingesting e-liquids by young children, nicotine toxicity and withdrawal symptoms.[299]
- Despite the evolving evidence linking e-cigarette use to a variety of harms, as noted above, little evidence currently exists quantifying the harms of e-cigarettes in terms of quality-adjusted life expectancy.
- To begin to address the gap in evidence quantifying the harms of e-cigarettes in terms of quality-adjusted life expectancy, Nutt and colleagues gathered a group of experts in 2013 and used a multi-criteria decision analysis approach in a 2-day facilitated workshop to estimate the harms of a variety of nicotine-containing products, including e-cigarettes. While not explicitly stated, it appears that the group of experts consisted of 11 authors of the subsequent publication.[300] Using this process, they determined that e-cigarettes were just 5% as harmful as smoking conventional cigarettes.[301]
- In 2020, Allcot and Rafkin surveyed 137 public health experts whose responses indicated that e-cigarettes where 37% as harmful as smoking conventional cigarettes, when considered in terms of quality-adjusted life expectancy.[302] There was substantial disagreement between experts, with the interquartile range of beliefs about relative harms ranging from 10% to 60%. When the experts were asked why they disagreed with the prior assessment by Nutt et al they gave three main explanations: "they disagree with how researchers interpreted the evidence available at the time, new research evidence is becoming available, and e-cigarette products have changed."[303] In addition, three of the authors of the Nutt et al study had financial ties with e-cigarette producers.[304] In particular, the consultant who facilitated the group process for the Nutt et al paper had financial ties with British American Tobacco and a number of other companies that produce smoking cessation products.[305] Indeed, the editors of the publishing journal took the extraordinary step

[297] Yang I, Sandeep S, Rodriguez J. The oral health impact of electronic cigarette use: a systematic review. *Critical Reviews in Toxicology*. 2020; 50(2): 97-127.
[298] Bjurlina M, Matulewicz R, Roberts T et al. Carcinogen biomarkers in the urine of electronic cigarette users and implications for the development of bladder cancer: A systematic review. *European Urology Oncology*. 2021; 5(4): 766-783.
[299] Chadi N, Vyver E, Belanger R. Protecting children and adolescents against the risks of vaping. *Paediatrics and Child Health*. 2021; 351-65.
[300] Nutt D, Phillips L, Balfour D et al. Estimating the harms of nicotine-containing products using the MCDA approach. *European Addiction Research*. 2014; 20: 218-25.
[301] Ibid.
[302] Allcott H, Rafkin C. *Optimal Regulation of e-Cigarettes: Theory and Evidence*. National Bureau of Economic Research Working Paper Series, August 2021. Available online at https://www.nber.org/system/files/working_papers/w27000/w27000.pdf. Accessed November 2022.
[303] Ibid.
[304] Nutt D, Phillips L, Balfour D et al. Estimating the harms of nicotine-containing products using the MCDA approach. *European Addiction Research*. 2014; 20: 218-25.
[305] Ibid.

of justifying why they accepted the paper for publication despite the consultant's financial ties.[306] By comparison, the research by Allcot and Rafkin explicitly excluded "people with tobacco industry affiliations."[307]

- Based on the available evidence, we have assumed that e-cigarettes use is 37% as harmful as smoking conventional cigarettes, when considered in terms of quality-adjusted life expectancy. This estimate was varied from 10% to 60% in the sensitivity analysis.
- Wang and colleagues have estimated the annual excess medical care costs of exclusive e-cigarette use in adults ages 18 and older in the US to be $1,796 (in 2018 USD). They compare this with the estimated annual excess medical care costs of $5,602 (in 2018 USD) attributed to conventional cigarette smoking in the US.[308] That is, in the US, annual medical care costs associated with exclusive e-cigarette use are approximately one-third (32.1%) that associated with conventional cigarette use. For modelling purposes, we have assumed that annual medical care costs associated with exclusive e-cigarette use in BC would be 32.1% of the $1,358 (see first bullet point above) attributable to conventional cigarette smoking, or $436. These costs would begin at age 19.

Excess Weight

- Obesity *reduces an individual's longevity*.[309,310]
- Di Angelantonio and colleagues published a study assessing the relationship between excess weight and all-cause mortality based on a meta-analysis of 239 prospective studies from four continents.[311] Based on strict inclusion criteria (the study analyses excluded the first 5 years of follow-up and was restricted to never-smokers without pre-existing chronic disease), males who are overweight (BMI of 25 to <30), obese class I (BMI of 30 to <35), obese class II (BMI of 35 to < 40) or obese class III (BMI of ≥40) have a 12%, 70%, 168% and 324%, respectively, increased risk of premature mortality, compared with males of a healthy weight. Females who are overweight, obese class I, obese class II or obese class III have an 8%, 37%, 86% and 173%, respectively, increased risk of premature mortality, compared with females of a healthy weight.
- Research by Fontaine and colleagues suggests that the number of life years lost by the US white population ages 20-29 increases with increasing levels of excess weight, from 0.6 (0.8 for males and 0.4 for females) years for overweight, 1.9 years (2.2 for males and 1.6 for females) for obese class I and 3.8 years (4.2 for males and 3.4 for females) for obese class II.[312]

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[306] Ibid.
[307] Allcott H, Rafkin C. *Optimal Regulation of e-Cigarettes: Theory and Evidence*. National Bureau of Economic Research Working Paper Series, August 2021. Available online at https://www.nber.org/system/files/working_papers/w27000/w27000.pdf. Accessed November 2022.
[308] Wang Y, Sung H, Lightwood J et al. Healthcare utilization and expenditures attributable to current e-cigarette use among US adults. *Tobacco Control*. 2022; doi:10.1136/tobaccocontrol-2021-057058.
[309] Peeters A, Barendregt JJ, Willekens F et al. Obesity in adulthood and its consequences for life expectancy: a life-table analysis. *Annals of Internal Medicine*. 2003; 138(1): 24-32.
[310] Finkelstein EA, Brown DS, Wrage LA et al. Individual and aggregate years-of-life-lost associated with overweight and obesity. *Obesity*. 2010; 18(2): 333-9.
[311] Di Angelantonio E, Bhupathiraju SN, Wormser D et al. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *The Lancet*. 2016; 388(10046): 776-86. See etable 7 in the Supplementary Material.
[312] Fontaine K, Redden D, Wang C et al. Years of life lost due to obesity. *JAMA*. 2003; 289(2): 187-93.

- In Australia, compared with normal weight females age 20-29, females age 20-29 who are overweight would live 3.6 fewer years, females with class I obesity would live 6.1 fewer years and females with class II/III obesity would live 7.7 fewer years. Compared with normal weight males age 20-29, males age 20-29 who are overweight would live 4.2 fewer years, males with class I obesity would live 8.3 fewer years and males with class II/III obesity would live 10.5 fewer years.[313]
- Not all research studies have found this association. Research by Steensma et al in Canada found that life expectancy was *significantly longer* for both males and females with overweight compared with their normal weight colleagues.[314] This so-called "obesity paradox" found in a number of studies may be at least partially due to using self-reported height and weight in calculating BMI, the imperfect nature of BMI as a predictor of metabolic risk, confounding due to pre-existing diseases at baseline and inadequately controlling for tobacco use.[315,316]
- For modelling purposes we have assumed a mid-point in life years lost (LYL) between the US[317] and Australian estimates.[318]

  Obese class I males – 5.25 LYL (2.2 to 8.3)

  Obese class II/III males – 7.35 LYL (4.2 to 10.5)

  Obese class I females – 3.85 LYL (1.6 to 6.1)

  Obese class II/III females – 5.55 LYL (3.4 to 7.7)
- Based on 2011 data, Twells and colleagues found that 11.7% / 9.7% of males/females ages 18 and older in BC would be in obese class I, 2.7% / 2.5% in class II and 0.6% / 1.7% in class III.[319]
- We combine the sex-specific proportion of BC individuals in each weight class with the life years lost estimates from the US and Australia to determine a weighted average life years lost for an individual with obesity in BC (see following Table). Males with obesity lose an average of 5.7 (2.6 to 8.8) years of life while females lose an average of 4.4 (2.1 to 6.6) years of life.

[313] Lung T, Jan S, Tan E et al. Impact of overweight, obesity and severe obesity on life expectancy of Australian adults. *Epidemiology and Population Health*. 2019; 43: 782-9.
[314] Steensma C, Loukine L, Orpana H et al. Comparing life expectancy and health-adjusted life expectancy by body mass index category in adult Canadians: a descriptive study. *Population health metrics*. 2013; 11(1): 21.
[315] Di Angelantonio E, Bhupathiraju SN, Wormser D et al. Body-mass index and all-cause mortality: individual-participant-data meta-analysis of 239 prospective studies in four continents. *The Lancet*. 2016; 388(10046): 776-86. See etable 7 in the Supplementary Material.
[316] Chrysant S and Chrysant G. The single use of body mass index for the obesity paradox is misleading and should be used in conjunction with other obesity indices. *Postgraduate Medicine*. 2019; 131(2): 96–102.
[317] Fontaine K, Redden D, Wang C et al. Years of life lost due to obesity. *JAMA*. 2003; 289(2): 187-93.
[318] Lung T, Jan S, Tan E et al. Impact of overweight, obesity and severe obesity on life expectancy of Australian adults. *Epidemiology and Population Health*. 2019; 43: 782-9.
[319] Twells LK, Gregory DM, Reddigan J et al. Current and predicted prevalence of obesity in Canada: a trend analysis. *CMAJ Open.* 2014; 2(1): E18.

Weighted Average Life Years Lost Due to Obesity

		Obesity Distribution in BC Population in 2011[1]	Proportion of Individuals with Obesity in each Class	Life Years Lost[2,3]			Weighted Average Life Years Lost for Individual with Obesity		
				Base	Low	High	Base	Low	High
Male	Class I	11.7%	78.0%	5.25	2.2	8.3	***5.7***	2.6	8.8
	Class II	2.7%	18.0%	7.35	4.2	10.5			
	Class III	0.6%	4.0%	7.35	4.2	10.5			
Female	Class I	9.7%	69.8%	3.85	1.6	6.1	***4.4***	2.1	6.6
	Class II	2.5%	18.0%	5.55	3.4	7.7			
	Class III	1.7%	12.2%	5.55	3.4	7.7			

[1] Twells et al. [2] Fontaine et al. [3] Lung et al.

- Obesity *reduces an individual's quality of life*.

In Children / Youth

- An Australian study used a community-based sample of 1,569 children (mean age of 10.4 years) to assess the effect of excess weight on QoL.[320] They found that QoL as identified by parents was reduced by 3.7% for overweight and 9.7% for obesity whereas QoL as identified by children was reduced by 1.5% for overweight and 8.1% for obesity.
- A further Australian study of 2,890 adolescents also assessed the effect of excess weight on QoL.[321] They found that overweight is associated with a disutility of 0.018 while obesity is associated with a disutility of 0.059. The disutility associated with overweight was only significant in girls (0.039) while the disutility associated with obesity was significant in both girls (0.084) and boys (0.041).
- Based on a meta-analysis of 11 studies with 13,210 study participants using the PedsQL index to assess QoL in children and youth, Ul-Haq and colleagues found a clear dose relationship between excess weight and QoL.[322] Overweight was associated with a reduction in the total PedsQL score of 1.43 (95% CI of 0.32 to 2.55) while obesity was associated with a reduction of 10.63 (95% CI of 7.24 to 14.03). This is based on the assessment being completed by the child/adolescent. If the parent completes the assessment, overweight was associated with a reduction in the total PedsQL score of 2.60 (95% CI of 1.19 to 4.00) while obesity was associated with a reduction of 18.87 (95% CI of 11.14 to 26.60).
- The relationship between excess weight and poor QoL is strengthened with increasing age through childhood and adolescence.[323]

[320] Williams J, Wake M, Hesketh K et al. Health-related quality of life of overweight and obese children. *JAMA*. 2005; 293(1): 70-6.
[321] Keating CL, Moodie ML, Richardson J et al. Utility-based quality of life of overweight and obese adolescents. *Value in Health*. 2011; 14(5): 752-8.
[322] Ul-Haq Z, Mackay D, Fenwick E et al. Meta-analysis of the association between Body Mass Index and Health-related Quality of Life among children and adolescents, assessed using the Pediatric Quality of Life Inventory Index. *The Journal of Pediatrics*. 2013; 162(2): 280-6.
[323] Killedar A, Lung T, Petrou S et al. Weight status and health-related quality of life during childhood and adolescence: Effects of age and socioeconomic position. *Pediatrics*. 2020; 44: 637-45.

- For the purposes of this project, we adjusted the PedsQL overall scores as identified by children/youth in the Ul-Haq et al study[324] to reflect Child Health Utility-9 Dimension (CHU-9D) scores.[325] The CHU-9D has been specifically developed for economic evaluations in children 5 years of age and older. The results suggest a change in utility associated with overweight and obesity of 0.003 (95% CI of 0.0 to 0.006) and 0.026 (95% CI of 0.017 to 0.036), respectively. We apply the QoL disutility of 0.026 (or 2.6%) associated with ***obesity***, but not overweight, to children and youth between the ages of 6 – 17.

In Adults

- A UK study used a community-based sample ≥ 16 years of age of 14,117 to assess the effect of excess weight on QoL.[326] They found a utility of -0.019 (95% CI of -0.026 to -0.011) associated with overweight (BMI of 25 to <30) compared to normal weight (BMI of 18.5 to <25) in their unadjusted model. After adjusting for age, sex, alcohol use, physical activity, fruit and vegetable consumption, smoking status, ethnicity, marital status, educational attainment, and income, however, this utility was no longer statistically significant (-0.005 with a 95% CI of -0.029 to 0.019). The utility associated with obesity class I & II (BMI of 30 to <40) and class III (BMI ≥40) remained significant after adjustment at -0.031 (95% CI of -0.020 to -0.041) and -0.105 (95% CI of -0.072 to -0.137) respectively.
- The table below shows the weighted disutility results based on the distribution of obesity classes in BC.[327] Based on this data, we assume a QoL disutility of 0.034 (0.022 to 0.045) in males ages 18 and older with obesity and of 0.040 (0.026 to 0.053) in females ages 18 and older with obesity.

Weighted Average Disutility in Adults (16+) Due to Obesity

		Obesity Distribution in BC Population in 2011[1]	Proportion of Individuals with Obesity in each Class	Disutility[2]			Weighted Average Disutility for Individual with Obesity		
				Base	Low	High	Base	Low	High
Male	Class I	11.7%	78.0%	0.031	0.020	0.041	**0.034**	0.022	0.045
	Class II	2.7%	18.0%	0.031	0.020	0.041			
	Class III	0.6%	4.0%	0.105	0.070	0.137			
Female	Class I	9.7%	69.8%	0.031	0.020	0.041	**0.040**	0.026	0.053
	Class II	2.5%	18.0%	0.031	0.020	0.041			
	Class III	1.7%	12.2%	0.105	0.070	0.137			

[1] Twells et al. [2] Maheswaran et al.

- Overweight and obesity are associated with higher *annual medical care costs* (e.g., hospitalization, physician, drug, etc.).

[324] Ul-Haq Z, Mackay D, Fenwick E et al. Meta-analysis of the association between Body Mass Index and Health-related Quality of Life among children and adolescents, assessed using the Pediatric Quality of Life Inventory Index. *The Journal of Pediatrics*. 2013; 162(2): 280-6.
[325] Lamb T, Frew E, Ives N et al. Mapping the Paediatric Quality of Life Inventory (PedQL™) generic core scales onto the Child Health Utility Index-9 Dimension (CHU-9D) score for economic evaluation in children. *PharmacoEconomics*. 2018; 36: 451-65.
[326] Maheswaran H, Petrou S, Rees K et al. Estimating EQ-5D utility values for major health behavioural risk factors in England. *Journal of Epidemiology and Community Health*. 2013; 67(1): 172-80.
[327] Twells LK, Gregory DM, Reddigan J et al. Current and predicted prevalence of obesity in Canada: a trend analysis. *CMAJ Open.* 2014; 2(1): E18.

- Research in BC identified these costs as $227 (in 2015 CAD) per year for overweight (BMI of 25 to <30) ($191 in males and $284 in females) and $805 (in 2015 CAD) per year for obesity (BMI of ≥30) ($698 in males and $952 in females).[328] Converted to 2022 CAD, the equivalent costs for total/male/female are $258/$217/$333 for overweight and $915/$794/$1,083 for obesity.

Estimates for Specific Disease/Treatment/Injury States

Amblyopia

- Considerable debate exists about whether or not **living with amblyopia** reduces QoL.
- In a 2002 study assessing the cost-effectiveness of *treatment* for amblyopia, Membrano and colleagues assumed a reduction in QoL of 3.5% associated with living with amblyopia, based on their own assessment of 75 patients.[329]
- In 2004, Konig and Barry published the results of the long-term cost-effectiveness of a hypothetical screening program for untreated amblyopia in 3-year-old children in German kindergartens.[330] They assumed a reduction in QoL of 4.0% associated with living with amblyopia and then used a range of 0% to 8.0% in their univariate sensitivity analysis.
- In 2008, Carlton and colleagues published an extensive systematic review and economic evaluation of the clinical effectiveness and cost-effectiveness of screening programmes for amblyopia and strabismus in children up to the age of 4-5 years.[331] Based on their review, they then developed their own model in which the base case included the assumption of no change in QoL associated with living with amblyopia due to the lack of "direct evidence of a utility effect". In their sensitivity analysis they included a 2.0% reduction in QoL associated with living with amblyopia.
- In 2011, Carlton and Kaltenthaler published a systematic review to identify the health-related quality of life (HRQoL) implications of amblyopia and/or its treatment.[332] Based on a review of 35 publications, they conclude that the HRQoL implications of amblyopia are "related specifically to amblyopia treatment, rather than to the condition itself. These included impact on family life, social interactions, difficulties in undertaking daily activities, as well as feelings and behaviour." They recommend that "further research is required to assess the immediate and long-term effects of amblyopia and/or its treatment on HRQoL".

[328] H. Krueger & Associates Inc. *The Economic Burden of Risk Factors in British Columbia: Excess Weight, Tobacco Smoking, Alcohol Use, Physical Inactivity and Low Fruit and Vegetable Consumption.* 2017. Vancouver, B.C.: Provincial Health Services Authority, Population and Public Health Program.
[329] Membreno JH, Brown MM, Brown GC et al. A cost-utility analysis of therapy for amblyopia. *Ophthalmology*. 2002; 109(12): 2265-71.
[330] König H-H and Barry J-C. Cost-utility analysis of orthoptic screening in kindergarten: a Markov model based on data from Germany. *Pediatrics*. 2004; 113(2): e95-e108.
[331] Carlton J, Karnon J, Czoski-Murray C et al. The clinical effectiveness and cost-effectiveness of screening programmes for amblyopia and strabismus in children up to the age of 4-5 years: a systematic review and economic evaluation. *Health Technology Assessment*. 2008; 12(25): xi-194.
[332] Carlton J and Kaltenthaler E. Amblyopia and quality of life: a systematic review. *Eye*. 2011; 25(4): 403.

- Research on the QoL implications of amblyopia and/or its treatment continues, with the focus seemingly remaining on the QoL implications associated with treatment rather than living with amblyopia.[333,334,335]
- Sufficient evidence exists to suggest a *disutility* associated with **treatment for amblyopia.** We model a 3.6% disutility (based on the midpoint of the reduction in QoL observed by Membrano et al[336] (3.5%) and van de Graaf et al[337] (3.7%)) for a period of six months for children receiving treatment.
- We have found no convincing evidence of significant QoL reductions associated with **living with amblyopia** and therefore do not include these impacts in the base model. In our sensitivity analysis, we include a QoL reduction of 0.003 (ranging from 0.001 to 0.007), based on disability weights calculated by the Global Burden of Disease study for mild vision impairment.[338]

Abdominal Aortic Aneurysm

- The incidence of acute AAA events is 55 / 100,000 per year in 65-74 year old males and 112 / 100,000 per year in 75-84 year old males. Of these acute AAA events, 59.2% were fatal within 30 days.[339]
- AAA is usually asymptomatic prior to rupture,[340] therefore reduced quality of life in those living with AAA is not considered in our modelling.
- The cost of an abdominal ultrasound scan is $110.36.[341]
- 58% of elective AAA-repair in BC is carried out by endovascular aneurysm repair (EVAR) surgery, with the balance being open surgery.[342]

[333] Chen Y, Chen X, Chen J et al. Longitudinal impact on quality of life for school-aged children with amblyopia treatment: perspective from children. *Current Eye Research*. 2016; 41(2): 208-14.
[334] Bokhary K. Impact of amblyopia treatment on vision-related quality of life. *Optometry: Open Access*. 2016; 1(2):
[335] Buckley CY, Whittle JC, Verity L et al. The effect of childhood eye disorders on social relationships during school years and psychological functioning as young adults. *British and Irish Orthoptic Journal*. 2018; 14(1): 35-44.
[336] Membreno JH, Brown MM, Brown GC et al. A cost-utility analysis of therapy for amblyopia. *Ophthalmology*. 2002; 109(12): 2265-71.
[337] van de Graaf ES, van Kempen-du Saar H, Looman CW et al. Utility analysis of disability caused by amblyopia and/or strabismus in a population-based, historic cohort. *Graefe's Archive for Clinical and Experimental Ophthalmology*. 2010; 248(12): 1803-7.
[338] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed December 2019.
[339] Howard D, Banerjee A, Fairhead J et al. Age-specific incidence, risk factors and outcome of acute abdominal aortic aneurysms in a defined population. *British Journal of Surgery*. 2015; 102(8): 907-15.
[340] Kapila V, Jetty P, Doug Wooster M et al. 2018 Screening for abdominal aortic aneurysms in Canada: review and position statement from the Canadian Society of Vascular Surgery. Available at https://canadianvascular.ca/resources/Documents/Clinical-Guidelines/FINAL-2018-CSVS-Screening-Recommendations.pdf. Accessed January 2019.
[341] B.C. Ministry of Health, Health Sector Information, Analysis & Reporting Division. *MSP Fee-For-Service Payment Analysis 2016/2017 - 2020/2021*. 2021. Available at https://www2.gov.bc.ca/assets/gov/health/practitioner-pro/medical-services-plan/msp_ffs_payment_analysis_20162017_to_20202021.pdf. Accessed September 2023.
[342] Aciemme (Sam) Ospan, Senior Manager, Lifetime Prevention Schedule, Healthy Living and Health Promotion Branch, BC Ministry of Health. June 3, 2019. Personal communication.

- Emergency AAA-repair surgery costs an estimated $52,395.[343,344]
- Elective open surgery costs an estimated $50,178.[345,346]
- Elective EVAR surgery costs an estimated $39,891 (2022 CAD).[347, 348]

Angina

- Moderate **angina** ("has chest pain that occurs with moderate physical activity, such as walking uphill or more than half a kilometer on level ground. After a brief rest, the pain goes away") reduces a person's quality of life by 8% (95% CI of 5.2% to 11.3%).[349]
- The typical event cost for **angina** is $3,183 with annual costs thereafter of $1,485 (in 2000 CAD)[350] or $5,328 and $2,486 respectively in 2022 CAD.

Anxiety

- Based on a community sample of 1,719 Norwegian adolescents aged 12–17, 17.0% had a medium or high level of anxiety (as measured by the Spence Children's Anxiety Scale), 8.9% in males and 24.2% in females.[351]
- Disability weights developed for the Global Burden of Disease (GBD) study are a useful source as a proxy for QoL.[352] While not specifically for children and/or adolescents, the disability weights for anxiety identified by the GBD are as follows:[353]

  Mild anxiety disorders - 0.03 (95% CI of 0.018 to 0.046) "Feels mildly anxious and worried, which makes it slightly difficult to concentrate, remember things, and sleep. The person tires easily but is able to perform daily activities."

[343] Giardina S, Pane B, Spinella G et al. An economic evaluation of an abdominal aortic aneurysm screening program in Italy. *Journal of Vascular Surgery.* 2011; 54(4): 938-46.
[344] Silverstein MD, Pitts SR, Chaikof EL et al. Abdominal aortic aneurysm (AAA): cost-effectiveness of screening, surveillance of intermediate-sized AAA, and management of symptomatic AAA. *Baylor University Medical Center Proceedings*. 2005; 18(4): 345-67.
[345] Burgers L, Vahl A, Severens J et al. Cost-effectiveness of elective endovascular aneurysm repair versus open surgical repair of abdominal aortic aneurysms. *European Journal of Vascular and Endovascular Surgery*. 2016; 52(1): 29-40.
[346] Visser JJ, van Sambeek MR, Hunink MM et al. Acute abdominal aortic aneurysms: cost analysis of endovascular repair and open surgery in hemodynamically stable patients with 1-year follow-up. *Radiology*. 2006; 240(3): 681-9.
[347] Burgers L, Vahl A, Severens J et al. Cost-effectiveness of elective endovascular aneurysm repair versus open surgical repair of abdominal aortic aneurysms. *European Journal of Vascular and Endovascular Surgery*. 2016; 52(1): 29-40.
[348] Svensjö S, Mani K, Björck M et al. Screening for abdominal aortic aneurysm in 65-year-old men remains cost-effective with contemporary epidemiology and management. *European Journal of Vascular and Endovascular Surgery*. 2014; 47(4): 357-65.
[349] GBD 2016
[350] O'Brien JA, Patrick AR and Caro JJ. Cost of managing complications resulting from type 2 diabetes mellitus in Canada. *BMC Health Services Research*. 2003; 3(1): 7.
[351] Raknes S, Pallesen S, Himle J et al. Quality of life in anxious adolescents. *Child and Adolescent Psychiatry and Mental Health*. 2017; 11(33)
[352] Salomon JA, Haagsma JA, Davis A et al. Disability weights for the Global Burden of Diseases 2013 study. *The Lancet Global Health*. 2015; 3: e712-e723.
[353] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed August 2023.

Moderate anxiety disorders - 0.133 (95% CI of 0.091 to 0.186) "Feels anxious and worried, which makes it difficult to concentrate, remember things, and sleep. The person tires easily and finds it difficult to perform daily activities."

Severe anxiety disorders - 0.523 (95% CI of 0.362 to 0.677) "Constantly feels very anxious and worried, which makes it difficult to concentrate, remember things and sleep. The person has lost pleasure in life and thinks about suicide."

Atopic Dermatitis / Eczema

- The mean duration of atopic dermatitis is 10 years with 45% of cases being mild in severity, 45% moderate and 10% severe. Barbeau and Lalonde describe mild atopic dermatitis as "occasional, slight itching/scratching", moderate as "constant or intermittent itching/scratching which does not disturb sleep" and severe as "bothersome itching/scratching which disturbs sleep".[354]
- The GBD study found that mild atopic dermatitis was associated with a disability weight of 0.027 (95% CI of 0.015 to 0.042).[355] Mild atopic dermatitis in the GBD study is described as follows: "has a slight, visible physical deformity that is sometimes sore and itchy. Others note the deformity, which causes some worry and discomfort". Moderate atopic dermatitis was associated with a disability weight of 0.188 (95% CI of 0.125 to 0.267) and is described as "has a visible physical deformity that is sore and itchy. Other people stare and comment, which causes the person to worry. The person has trouble sleeping and concentrating". We have assumed that mild atopic dermatitis in the GBD study is roughly equivalent to mild and moderate atopic dermatitis in the Barbeau and Lalonde study and that moderate atopic dermatitis in the GBD study is roughly equivalent to severe atopic dermatitis in the Barbeau and Lalonde study. Based on this assumption, we calculated an average utility of -0.043 ((0.90 * -0.027) + (0.10 * -0.188)).
- The direct annual costs per mild, moderate and severe case are $175, $300, and $405, respectively. The average weighted cost totalled $254 (in 2001 CAD) or $382 in 2022 CAD.[356] Lifetime costs were estimated at $3,820 (10 years * $382).

Blindness / Vision Deficits

- A community-based analysis of 38,678 individuals in the US found a utility associated with blindness and low vision (ICD-9 369) of -0.05, after adjusting for age, comorbidity, gender, race, ethnicity, income and education.[357]
- The GBD study found that mild vision impairment was associated with a disability weight of 0.003 (95% CI of 0.001 to 0.007), moderate vision impairment with 0.031 (95% CI of 0.019 to 0.049), severe vision impairment with 0.184 (95% CI of 0.125 to 0.258) and blindness with 0.187 (95% CI of 0.124 to 0.260).[358]

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[354] Barbeau M and Lalonde HL. Burden of atopic dermatitis in Canada. *International Journal of Dermatology*. 2006; 45(1): 31-6.
[355] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
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- In the US, blindness is associated with an annual increase in medical costs of $2,157 (in 2004 USD) or $2,606 in 2022 CAD, after adjusting for age, sex, marital status, education, income, self-reported health status, type of health insurance and family size.[359]
- A 2003 US study estimated the direct lifetime costs per individual associated with vision impairment to be $129,476.[360] The costs included physician visits, prescription medications, hospital inpatient stays, assistive devices, therapy and rehabilitation, long-term care, home and vehicle modifications and special education. We converted these costs to equivalent 2022 Canadian health care costs for a lifetime cost per individual of $160,605 with vision impairment.

Cancer - Breast

- Based on data from BC between 2000 and 2007, female breast cancers occur at the mean age of 62.2 years.[361]
- In BC, the *life expectancy* of a 62.2-year-old female is 24.9 years. The average survival of a female breast cancer patient, however, is approximately 12 years.[362] The average breast cancer survivor thus losses 12.9 years of life (24.9 – 12.0). International research indicates that breast cancer is associated with approximately 4 years of life lost (YLL) in Australia,[363] 6 YLL in the US,[364] 13 YLL in the UK[365] and 17 YLL in Norway.[366]
- The diagnosis and treatment phase for breast cancer lasts an average of 3 months[367] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[368]

[359] Frick K, Gower E, Kempen J et al. Economic impact of visual impairment and blindness in the United States. *Archives of Ophthalmology*. 2007; 125(4): 544-50.
[360] Economic costs associated with mental retardation, cerebral palsy, hearing loss, and vision impairment – United States, 2003. *MMWR Weekly*. 2003; 53(03): 57-9.
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[363] Baade P, Youlden D, Andersson T et al. Estimating the change in life expectancy after a diagnosis of cancer among the Australian population. *British Medical Journal Open*. 2015; 5(4): e006740-6.
[364] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.
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- The metastatic phase for breast cancer lasts an average of 17.7 months[369] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[370]
- The ongoing, controlled phase (remission) for breast cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[371]
- A *false-positive* mammography result is associated with a one-time QALY loss of -0.013 (4.7 days).[372]
- Information from the BC Cancer Agency Screening Mammography Program indicates a cost of $79.35 per screen in 2015/16[373] or $90.23 in 2022 CAD.
- The cost of an unnecessary biopsy associated with a false-positive result is estimated to be $396 (in 2008 USD)[374] or $430 in 2022 CAD.
- The cost of radiotherapy, breast conserving surgery and a mastectomy are $5,014, $4,937 and $6,956, respectively (in 2012 CAD)[375] or $5,860, $5,770 and $8,130 in 2022 CAD.
- Based on data from Ontario, the cost estimates for the *acute phase of a fatal breast cancer* are $35,600 (95% CI of $34,208 to $39,162) (in 2009 CAD).[376] We converted this to $44,711 in 2022 CAD. In British Columbia, the health system costs during the interval from diagnosis of first breast cancer recurrence or metastasis until death has been estimated at $36,474 (95% CI of $29,752 to $43,196) in 1995 CAD.[377] This includes all hospital costs ($19,496), BC Cancer Agency costs ($7,769), MSP costs ($3,294), home care costs ($4,661) and Pharmacare costs ($1,254). We converted this to $60,930 (95% CI $49,701 - $72,160) in 2022 CAD. For the purposes of this project, we used the midpoint between these two estimates ($52,821) in the reference case and the range in the sensitivity analysis.

[369] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[370] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[371] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

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[374] Schousboe JT, Kerlikowske K, Loh A, et al. Personalizing mammography by breast density and other risk factors for breast cancer: analysis of health benefits and cost-effectiveness. *Annals of Internal Medicine*. 2011; 155(1): 10-20.

[375] Gocgun Y, Banjevic D, Taghipour S et al. Cost-effectiveness of breast cancer screening policies using simulation. *The Breast*. 2015; 24(4): 440-8.

[376] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[377] Wai ES, Trevisan CH, Taylor SCM et al. Health system costs of metastatic breast cancer. *Breast Cancer Research and Treatment*. 2001; 65(3): 233-40.

- Based on data from Ontario, the estimated *first year costs* associated with a breast cancer survivor are $20,227 (95% CI of $19,951 to $20,503) (in 2009 CAD).[378] We converted this to $25,404 in 2022 CAD. A further Ontario-based study estimated the costs for the *two years* following diagnosis in breast cancer survivors to be $40,426 (in 2008 CAD).[379]
- Evidence from Belgium indicates that the direct medical costs attributable to breast cancer between years 2 and 5 following diagnosis/treatment were €3,496 (in 1998 Euros) and that they decreased from €1,424 in year 2 to €164 in year 5, at which point costs were not significantly different than matched controls.[380] For the purposes of this project, we assumed excess annual ongoing costs of €874 (€3,496 / 4) or $1,931 in 2022 CAD for years 2 through 5 following diagnosis/treatment.

Cancer - Cervical

- A false-positive Pap smear result is associated with a disutility of 0.046 for a period of approximately 10 months.[381]
- Diagnosis and treatment for cervical intraepithelial neoplasia (CIN) 1-3 is associated with a disutility of 0.066 for a period of approximately 20 months.[382]
- The diagnosis and treatment phase for cervical cancer lasts an average of 4.8 months[383] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[384]
- The metastatic phase for cervical cancer lasts an average of 9.2 months[385] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[386]
- The ongoing, controlled phase (remission) for cervical cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[387]

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[378] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

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[384] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[385] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[386] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

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- Three Canadian studies estimated the *cost of a conventional cytology screen* to be $28[388], $57[389] and $92[390] in 2005 or 2006 CAD. We updated these estimates to 2022 CAD and then used the average for the base case estimate and the extremes in the sensitivity analysis ($79 with a range from $37 to $124, in 2022 CAD).
- Cost estimates for HPV testing are based on Popadiuk et al. who estimated costs (in 2008 CAD) to be $87.70 per test, which included consultation, tray, and kit with lab interpretation fees costing $33.70, $10.99, and $43.10 respectively. [391] We updated this estimate to $108 in 2022 CAD.
- Three Canadian studies estimated the *cost of a colposcopy with biopsy* to be $148[392], $151[393] and $337[394] in 2005 or 2006 CAD. We updated these estimates to 2022 CAD and then used the average for the base case estimate and the extremes in the sensitivity analysis ($283 with a range from $200 to $444, in 2022 CAD).
- Three Canadian studies estimated the *cost per treatment for a precancerous lesion* to be $965[395], $1,032[396] and $1,071[397] in 2005 or 2006 CAD. We updated these estimates to 2022 CAD and then used the average for the base case estimate and the extremes in the sensitivity analysis ($1,371 with a range from $1,271 to $1,447, in 2022 CAD).
- Based on data from Ontario, the cost estimates for the *acute phase* of a fatal cervical cancer are $41,536 (95% CI of $38,642 to $44,429) in 2009 CAD.[398] We converted this to $50,961 (95% CI of $47,410 to $54,510) in 2022 CAD.
- In BC the initial hospital costs by stage were as follows:[399]
    - Stage I - $16,241 (in 2014 $, $18,301 in 2022$)
    - Stage II - $22,072 ($24,872)

[388] Kulasingam S, Rajan R, St Pierre Y et al. Human papillomavirus testing with Pap triage for cervical cancer prevention in Canada: a cost-effectiveness analysis. *BioMed Central Medicine*. 2009; 7(1): 69.
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[390] Krahn M, McLauchlin M, Pham B et al. *Liquid-Based Techniques for Cervical Cancer Screening: Systematic Review and Cost-Effectiveness Analysis*. 2008. Available at https://www.cadth.ca/sites/default/files/pdf/333_LBC-Cervical-Cancer-Screenin_tr_e.pdf. Accessed August 2017.
[391] Popadiuk C, Gauvreau C, Bhavsar M et al. Using the Cancer Risk Management Model to evaluate the health and economic impacts of cytology compared with human papillomavirus DNA testing for primary cervical cancer screening in Canada. *Current Oncology*. 2016; 23(Supp.1): S56-S63.
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[395] Ibid.
[396] Krahn M, McLauchlin M, Pham B et al. *Liquid-Based Techniques for Cervical Cancer Screening: Systematic Review and Cost-Effectiveness Analysis*. 2008. Available at https://www.cadth.ca/sites/default/files/pdf/333_LBC-Cervical-Cancer-Screenin_tr_e.pdf. Accessed August 2017.
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[398] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.
[399] Cromwell I, Ferreira Z, Smith L et al. Cost and resource utilization in cervical cancer management: A real-world retrospective cost analysis. *Current Oncology*. 2016: 23(S1): S14-22.

- Stage III - $24,043 ($27,093)
- Stage IV - $41,022 ($46,225)

- Based on data from Ontario, the estimated *first year costs* associated with a cervical cancer survivor are $18,055 (95% CI of $17,305 to $18,804) in 2009 CAD.[400] We converted this to $22,676 (95% CI of $21,734 to $23,617) in 2022 CAD.
- Based on data from Ontario, the *ongoing annual costs* associated with a cervical cancer survivor after the first year are estimated at between $633 and $1,174 in 2022 CAD.[401] We used the midpoint of this range ($904) in our base case estimate and the extremes in the sensitivity analysis.
- Cervical cancers in BC occur at the mean age of 49.1 years (see above). A BC women 49.1 years of age has a life expectancy of 36.5 years. Cervical cancer is associated with 17.3 years of life lost (see above). Therefore, the average women in BC with cervical cancer would survive for 19.2 years (36.5 – 17.3).

Cancer - Colorectal

- The diagnosis and treatment phase for colorectal cancer lasts an average of 4 months[402] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[403]
- The metastatic phase for colorectal cancer lasts an average of 2.5 years (30 months)[404] and is associated with a utility loss of -0.451 (95% CI of -0.307 to -0.600).[405]
- The ongoing, controlled phase (remission) for colorectal cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[406]
- A colonoscopy results in a utility loss equivalent to 2 days per colonoscopy performed (0.0055 QALYs per colonoscopy).[407]
- A minor bleeding event results in a utility loss equivalent to 2 days per minor bleeding event (0.0055 per bleeding event).[408]

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[400] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[401] Sander B, Wong W, Yeung M et al. The cost-utility of integrated cervical cancer prevention strategies in the Ontario setting–Can we do better? *Vaccine*. 2016; 34(16): 1936-44.

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[403] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[404] Dr. Jonathan Loree, Medical Oncologist at BC Cancer. Personal Communication. February 2022.

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[407] Goede S, Rabeneck L, van Ballegooijen M et al. Harms, benefits and costs of fecal immunochemical testing versus guaiac fecal occult blood testing for colorectal cancer screening. *PLOS One.* 2017; 12(3): e0172864.

[408] Knudsen A, Rutter C, Peterse E et al. *Colorectal Cancer Screening: An Updated Decision Analysis for the U.S. Preventive Services Task Force*. Agency for Healthcare Research and Quality. May, 2021.

- A non-lethal major complications (i.e., major bleed requiring hospitalization or perforation) results in a utility loss equivalent to 2 weeks (0.0384 QALYs per major complication).[409]
- Based on data from Ontario, the cost of a colonoscopy (no polypectomy) is $872 (in 2013$ or $1,096 in 2022$).[410]
- Based on data from Ontario, the cost of a colonoscopy (with polypectomy) is $1,097 (in 2013$ or $1,379 in 2022$).[411]
- Based on data from Ontario, the estimated net healthcare costs associated with a CRC by sex and phase are as follows:[412]
    - Females
        - Initial 6 months - $24,765 (in 2009$, $34,039 in 2022$)
        - Continuing care (annual) - $5,349 ($7,352)
        - Terminal care (12 months) - $31,120 ($42,774)
    - Males
        - Initial 6 months - $25,138 ($34,552)
        - Continuing care (annual) - $5,446 ($7,486)
        - Terminal care (12 months) - $32,408 ($44,545)
- Based on data from Ontario, *first year* healthcare costs associated with a CRC survivor are $47,823 (in 2017$ or $65,733 in 2022$). The mean costs for females / males in 2022$ are $62,177 and $68,220, respectively. The costs by stage in 2022$ are $34,562 for Stage I, $56,956 for Stage II, $87,106 for Stage III and $114,276 for Stage IV.[413]
- Based on the data in the two previous bullet points, we assumed no difference in treatment costs between males and females.
- Based on data from Ontario, the estimated *first year* healthcare costs associated with a CRC survivor by stage was as follows:[414]
    - Stage I - $28,981 (in 2013 $, $36,434 in 2022$)
    - Stage II - $43,348 ($54,495)
    - Stage III - $62,259 ($78,270)
    - Stage IV – $83,440 ($104,897)

[409] Goede S, Rabeneck L, van Ballegooijen M et al. Harms, benefits and costs of fecal immunochemical testing versus guaiac fecal occult blood testing for colorectal cancer screening. *PLOS One.* 2017; 12(3): e0172864.
[410] Goede S, Rabeneck L, van Ballegooijen M et al. Harms, benefits and costs of fecal immunochemical testing versus guaiac fecal occult blood testing for colorectal cancer screening. *PLOS One.* 2017; 12(3): e0172864.
[411] Ibid.
[412] de Oliveira C, Pataky R, Bremner K et al. Phase-specific and lifetime costs of cáncer care in Ontario, Canada. *BMC Cancer*. 2016; 16: 809.
[413] Paszat L, Sutradhar R, Luo J et al. Overall health care cost during the year following diagnosis of colorectal cancer stratified by history of colorectal evaluative procedures. *Journal of the Canadian Association of Gastroenterology*. 2021. 4(6): 274-83.
[414] Goede S, Rabeneck L, van Ballegooijen M et al. Harms, benefits and costs of fecal immunochemical testing versus guaiac fecal occult blood testing for colorectal cancer screening. *PLOS One.* 2017; 12(3): e0172864.

- Based on data from Ontario, the *ongoing annual* healthcare costs associated with a CRC survivor by stage was as follows:[415]
    - Stage I - $7,442 (in 2013 $, $9,356 in 2022$)
    - Stage II - $10,435 ($13,118)
    - Stage III - $13,344 ($16,776)
    - Stage IV – $42,551 ($53,493)

- Based on data from Ontario, the *final year* healthcare costs associated with a death due to CRC by stage was as follows:[416]
    - Stage I - $302,484 (in 2013 $, $380,271 in 2022$)
    - Stage II - $202,540 ($254,625)
    - Stage III - $134,354 ($168,905)
    - Stage IV - $117,128 ($147,249)
- Complication rates following screening colonoscopy occur at a rate of 0.84 minor bleeds, 1.08 major bleeds (requiring hospitalization), 0.53 perforations and 0.02 deaths per 1,000 colonoscopies.[417]
- Based on data from Ontario, the cost of a bleeding complication following a colonoscopy is $3,521 (in 2013$ or $4,426 in 2022$).[418]
- Based on data from Ontario, the cost of a perforation complication following a colonoscopy is $34,412 (in 2013$ or $43,261 in 2022$).[419]

[415] Goede S, Rabeneck L, van Ballegooijen M et al. Harms, benefits and costs of fecal immunochemical testing versus guaiac fecal occult blood testing for colorectal cancer screening. *PLOS One.* 2017; 12(3): e0172864.
[416] Goede S, Rabeneck L, van Ballegooijen M et al. Harms, benefits and costs of fecal immunochemical testing versus guaiac fecal occult blood testing for colorectal cancer screening. *PLOS One.* 2017; 12(3): e0172864.
[417] Fitzpatrick-Lewis D. Usman A, Ciliska D et al. *Screening for Colorectal Cancer*. Ottawa: Canadian Task Force on Preventive Health Care. 2015. Available online at https://canadiantaskforce.ca/wp-content/uploads/2016/03/crc-screeningfinal031216.pdf. Accessed November 2021.
[418] Goede S, Rabeneck L, van Ballegooijen M et al. Harms, benefits and costs of fecal immunochemical testing versus guaiac fecal occult blood testing for colorectal cancer screening. *PLOS One.* 2017; 12(3): e0172864.
[419] Ibid.

Cancer - Liver

- The diagnosis and treatment phase for liver cancer lasts an average of 4 months[420] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[421]
- The metastatic phase for liver cancer lasts an average of 2.5 months[422] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[423]
- The ongoing, controlled phase (remission) for liver cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[424]
- Based on data from Ontario, the cost estimates for the *acute phase of a fatal liver cancer* are $27,560 (95% CI of $25,747 to $29,373) (in 2009 CAD).[425] We converted this to $37,881 in 2022 CDN.
- Based on data from Ontario, the estimated *first year costs* associated with a liver cancer survivor are $32,717 (95% CI of $30,591 to $34,844) (in 2009 CAD).[426] We converted this to $44,969 in 2022 CAD.
- Based on data from the US, the *ongoing annual costs* associated with a liver cancer survivor after the first year are estimated at $6,611 (in 2010 USD) or $7,495 in 2022 CAD.[427]
- In BC, the *life expectancy* of a 64.3-year-old is 22.4 years. Based on data from the US, liver cancers are associated with 16.7 YLL.[428] In BC then, the average 64.3-year-old liver cancer survivor would have a life expectancy of 5.7 years (22.4 – 16.7).

[420] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[421] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[422] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[423] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[424] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[425] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[426] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[427] Mariotto A, Robin Y, Shao Y et al. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011; 103(2): 117-28. This study included the costs of care for 14 major cancers which did not include liver cancer. We used the 'other' cancer category to estimate ongoing annual costs for liver cancer.

[428] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.

Cancer - Lung

- The diagnosis and treatment phase for lung cancer lasts an average of 3.3 months[429] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[430]
- The metastatic phase for lung cancer lasts an average of 4.5 months[431] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[432]
- The ongoing, controlled phase (remission) for lung cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[433]
- Based on data from BC between 2000 and 2007, lung cancers occur at the mean age of 69.8 years.[434]
- In BC, the *life expectancy* of a 69.8-year-old is 17.7 years. International research indicates that lung cancer is associated with approximately 12 years of life lost (YLL) in the UK,[435] 13 YLL in Australia,[436] 14 YLL in the US,[437] and 15 YLL in Norway.[438] We used the average of this range (13.5 YLL) in our base case estimate and the extremes in the sensitivity analysis. Therefore, the average British Columbian with lung cancer would survive for 4.2 years (17.7 – 13.5).
- Based on data from Ontario, the cost estimates for the *acute phase of a fatal lung cancer* are $33,018 (95% CI of $32,660 to $33,376) (in 2009 CAD).[439] We converted this to $41,468 in 2022 CAD.

[429] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[430] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[431] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[432] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[433] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[434] Coleman MP, Forman D, Bryant, H et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden and the UK, 1995-2007 (the International Benchmarking Partnership): an analysis of population-based cancer registry data. *The Lancet*. 2011; 377: 127-38.

[435] Burnet N, Jefferies S, Benson R et al. Years of life lost (YLL) from cancer is an important measure of population burden–and should be considered when allocating research funds. *British Journal of Cancer*. 2005; 92(2): 241-5.

[436] Baade P, Youlden D, Andersson T et al. Estimating the change in life expectancy after a diagnosis of cancer among the Australian population. *British Medical Journal Open*. 2015; 5(4): e006740-6.

[437] Liu P, Wang J and Keating N. Expected years of life lost for six potentially preventable cancers in the United States. *Preventive Medicine*. 2013; 56(5): 309-13.

[438] Brustugun O, Møller B and Helland Å. Years of life lost as a measure of cancer burden on a national level. *British Journal of Cancer*. 2014; 111(5): 1014-20.

[439] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

- Based on data from Ontario, the estimated *first year costs* associated with a LC survivor are $29,878 (95% CI of $29,386 to $30,371) (in 2009 CAD).[440] We converted this to $37,526 in 2022 CAD.
- Based on data from the US, the *ongoing annual costs* associated with a lung cancer survivor after the first year are estimated at $7,861 (in 2010 USD) or $8,376 in 2022 CAD.[441]

Cancer - Ovarian

- The diagnosis and treatment phase for ovarian cancer lasts an average of 3.2 months[442] and is associated with a utility of -0.288 (95% CI of -0.193 to -0.399).[443]
- The metastatic phase for ovarian cancer lasts an average of 25.6 months[444] and is associated with a utility of -0.451 (95% CI of -0.307 to -0.600).[445]
- The ongoing, controlled phase (remission) for ovarian cancer is associated with a utility of -0.049 (95% CI of -0.031 to -0.072).[446]
- Based on data from BC between 2000 and 2007, ovarian cancers occur at the mean age of 63.9 years.[447]
- In BC, the *life expectancy* of a 63.9-year-old female is 23.7 years. International research indicates that ovarian cancer is associated with approximately 16 YLL in the UK[448] and 17 YLL in Norway.[449] We used the average of this range (16.5 YLL) in our base case estimate. Therefore, the average British Columbian with ovarian cancer would survive for 7.2 years (23.7 – 16.5).

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[440] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.

[441] Mariotto A, Robin Y, Shao Y et al. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011; 103(2): 117-28.

[442] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[443] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[444] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[445] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

[446] Fitzmaurice C, Allen C, Barber R et al. Global, regional, and national cancer incidence, mortality, years of life lost, years lived with disability, and disability-adjusted life-years for 32 cancer groups, 1990 to 2015: a systematic analysis for the global burden of disease study. *Journal of American Medical Association Oncology*. 2017; 3(4): 524-48.

[447] Coleman MP, Forman D, Bryant, H et al. Cancer survival in Australia, Canada, Denmark, Norway, Sweden and the UK, 1995-2007 (the International Benchmarking Partnership): an analysis of population-based cancer registry data. *The Lancet*. 2011; 377: 127-38.

[448] Burnet N, Jefferies S, Benson R et al. Years of life lost (YLL) from cancer is an important measure of population burden–and should be considered when allocating research funds. *British Journal of Cancer*. 2005; 92(2): 241-5.

[449] Brustugun O, Møller B and Helland Å. Years of life lost as a measure of cancer burden on a national level. *British Journal of Cancer*. 2014; 111(5): 1014-20.

- Based on data from Ontario, the cost estimates for the *acute phase of a fatal ovarian cancer* are $46,270 (95% CI of $44,452 to $48,088) (in 2009 CAD).[450] We converted this to $56,905 in 2022 CAD.
- Based on data from Ontario, the estimated *first year costs* associated with an ovarian cancer survivor are $29,640 (95% CI of $28,538 to $30,743) (in 2009 CAD).[451] We converted this to $36,453 in 2022 CAD.
- Based on data from the US, the *ongoing annual costs* associated with an ovarian cancer survivor after the first year are estimated at $8,296 (in 2010 USD) or $8,840 in 2022 CAD.[452]

Cardiovascular Disease - Myocardial Infarction

- The GBD study estimated a utility of -0.432 (95% CI of -0.288 to -0.579) during days 1 and 2 following an AMI and a disutility of -0.074 (95% CI of -0.049 to -0.105) during days 3 to 28.[453] This results in a combined disutility of -0.098 (95% CI of -0.065 to -0.137) for a period of one month or a total disutility of -0.008 (95% CI of -0.005 to -0.011) over a year.
- Anis et al estimated the cost of the *acute phase of a fatal MI* at St. Paul's Hospital in BC to be $6,289 (in 2002 CAD).[454] We converted this to $9,346 in 2022 CAD.
- Cohen and colleagues estimated the *first year costs* associated with an MI in Ontario to be $20,794 (in 2008 CAD).[455] We converted this to $25,500 in 2022 CAD.
- Cohen and colleagues estimated the *ongoing annual costs* following a myocardial infarct to be $1,325 (in 2008 CAD).[456] We converted this to $1,626 in 2022 CAD.

Cerebrovascular Disease - Stroke

- The GBD study groups the long term consequences following a stroke into five levels of severity.[457] Level 1 ("has some difficulty in moving around and some weakness in one hand, but is able to walk without help") is associated with a utility of -0.019 (95% CI of -0.010 to -0.032). Level 2 ("has some difficulty in moving around, and in using the hands for lifting and holding things, dressing and grooming") is associated with a utility of -0.070 (95% CI of -0.046 to -0.099). Level 3 ("has some difficulty in moving around, in using the hands for lifting and holding things, dressing and

[450] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.
[451] de Oliveira C, Bremner K, Pataky R et al. Understanding the costs of cancer care before and after diagnosis for the 21 most common cancers in Ontario: a population-based descriptive study. *Canadian Medical Association Journal Open*. 2013; 1(1): E1-E8.
[452] Mariotto A, Robin Y, Shao Y et al. Projections of the cost of cancer care in the United States: 2010–2020. *Journal of the National Cancer Institute*. 2011; 103(2): 117-28.
[453] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed February 2022.
[454] Anis A, Sun H, Singh S et al. A cost-utility analysis of losartan versus atenolol in the treatment of hypertension with left ventricular hypertrophy. *Pharmacoeconomics*. 2006; 24: 387-400.
[455] Cohen D, Manuel D, Tugwell P et al. Direct healthcare costs of acute myocardial infarction in Canada's elderly across the continuum of care. *The Journal of Economics of Ageing*. 2014; 3: 44-49.
[456] Cohen D, Manuel D, Tugwell P et al. Direct healthcare costs of acute myocardial infarction in Canada's elderly across the continuum of care. *The Journal of Economics of Ageing*. 2014; 3: 44-49
[457] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

grooming, and in speaking. The person is often forgetful and confused") is associated with a utility of -0.316 (95% CI of -0.206 to -0.437). Level 4 ("is confined to a bed or a wheelchair, has difficulty speaking and depends on others for feeding, toileting and dressing") is associated with a utility of -0.552 (95% CI of -0.377 to -0.707). Level 5 ("is confined to a bed or a wheelchair, depends on others for feeding, toileting and dressing, and has difficulty speaking, thinking clearly and remembering things") is associated with a utility of -0.588 (95% CI of -0.411 to -0.744).

- We have assumed that the five severity levels identified by the GBD are approximately comparable to Modified Rankin scale scores of 1 through 5. Furthermore, an estimated 25.5% of stroke survivors have a Rankin score of 0, 21.5% a 1, 11.3% a 2, 18.5% a 3, 18.6% a 4 and 4.6% a 5.[458] The average utility associated with a stroke would therefore be -0.200 (95% CI of -0.134 to -0.265) ((0.255*0) + (0.215*-0.019) + (0.113*-0.070) + (0.185*-0.316) + (0.186*-0.552) + (0.046*-0.588)).
- Goeree et al estimated the costs associated with the *acute phase of a fatal stroke* in Canada to be $9,364 (in 2004 CAD).[459] We converted this to $13,501 in 2022 CAD.
- Goeree et al estimated the *first year costs* associated with a stroke in Canada by age as follows:[460]
    - <55 years of age - $15,926 in 2004 CAD (converted to $22,196 in 2022 CAD)
    - 55-64 - $12,955 ($18,056)
    - 65-74 - $24,593 ($34,276)
    - 75-84 - $28,608 ($39,872)
    - ≥85 - $29,210 ($40,711)
- Gloede and coauthors in Australia estimated the *ongoing annual costs* (including informal care and out-of-pocket costs) associated with an ischemic stroke to be $7,996 (in 2010 AUD) while costs associated with a haemorrhagic stroke were $10,251.[461] Based on a mix of 85% ischemic strokes in Canada,[462] the weighted cost would be $8,335. We converted this to $8,524 in 2022 CAD.

Childhood Asthma

- The Global Burden of Disease Study found that controlled asthma is associated with a utility weight of -0.015 (95% CI of -0.007 to -0.026) while partially controlled asthma is associated with a utility weight of -0.036 (95% CI of -0.022 to -0.055) and uncontrolled asthma is associated with a utility weight of -0.133 (95% CI of -0.086 to -0.192).[463] We assumed that asthma is controlled in 24% of children, partially

[458] Krueger H, Lindsay P, Cote R et al. Cost avoidance associated with optimal stroke care in Canada. *Stroke.* 2012; 43(8): 2198-206.
[459] Goeree R, Blackhouse G, Petrovic R et al. Cost of stroke in Canada: A 1-year prospective study. *Journal of Medical Economics*. 2005; 8: 147-67.
[460] Ibid.
[461] Gloede T, Halbach S, Thrift A et al. Long-term costs of stroke using 10-year longitudinal data from the North East Melbourne Stroke Incidence Study. *Stroke*. 2014: 1-8.
[462] Krueger H, Lindsay P, Cote R et al. Cost avoidance associated with optimal stroke care in Canada. *Stroke.* 2012; 43(8): 2198-206.
[463] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.

controlled in 67% of children and uncontrolled in 9% of children[464] and estimated a weighted utility of -0.040 ((0.24 * -0.015) + (0.67 * -0.036) + (0.09 * -0.133)).

- A BC study estimated the annual direct costs attributable to asthma at $444 per person year (in 2006 CAD)[465] or $585 in 2022 CAD. Based on an average treatment duration of 10 years,[466] the total costs attributable to childhood asthma would be $5,850 per case.

Childhood Leukemia

- The lifetime cost per case in the US has been estimated at $136,444 (in 2007 USD)[467] or $151,078 in 2022 CAD.

Chronic Kidney Disease

- The GBD study found that being on dialysis because of end-stage renal disease caused by diabetes is associated with a disability weight of 0.571 (95% CI of 0.398 to 0.725).[468]
- The annual costs of caring for patients with chronic kidney disease (CKD) who are not on dialysis or had a transplant at baseline is estimated at $14,634 (in 2017 CAD) or $16,104 in 2022 CAD.[469]
- The annual costs for end-stage renal disease are $63,045 (in 2000 CAD)[470] or $96,428 in 2022 CAD.

Chronic Pelvic Pain

- The GBD study found that moderate pelvic pain is associated a disability weight of 0.114 (95% CI of 0.078 to 0.159).[471] We have assumed that this pain would last for a period of five years.[472]

Dental Caries

- The Global Burden of Disease Study found that symptomatic dental caries ("has a toothache, which causes some difficulty in eating") is associated with a disability weight of 0.01 (95% CI of 0.005 to 0.019). Severe tooth loss ("has lost more than 20 teeth including front and back, and has great difficulty eating meat, fruits and

[464] Chapman K, Ernst P, Grenville A et al. Control of asthma in Canada: failure to achieve guideline targets. *Canadian Respiratory Journal*. 2001; 8(Suppl A): 35A-40A.
[465] Sadatsafavi M, Lynd L, Marra C et al. Direct health care costs associated with asthma in British Columbia. *Canadian Respiratory Journal*. 2010; 17(2): 74-80.
[466] Bartick M and Reinhold A. The burden of suboptimal breastfeeding in the United States: a pediatric cost analysis. *Pediatrics*. 2010; 125(5): e1048-e56.
[467] Bartick M and Reinhold A. The burden of suboptimal breastfeeding in the United States: a pediatric cost analysis. *Pediatrics*. 2010; 125(5): e1048-e56.
[468] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[469] Manns B, Hemmelgarn B, Tonelli M et al. The cost of care for people with chronic kidney disease. *Canadian Journal of Kidney Health and Disease*. 2019; 6: 1-11.
[470] O'Brien JA, Patrick AR and Caro JJ. Cost of managing complications resulting from type 2 diabetes mellitus in Canada. *BMC Health Services Research*. 2003; 3(1): 7.
[471] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[472] Hu D, Hook EW and Goldie SJ. Screening for Chlamydia trachomatis in women 15 to 29 years of age: a cost-effectiveness analysis. *Annals of Internal Medicine*. 2004; 141(7): 501-13.

vegetables") is associated with a disability weight of 0.067 (95% CI of 0.045 to 0.095).[473]

- A pit and fissure sealant application costs $19.74 for the first tooth in a quadrant and $10.83 for each additional tooth in the quadrant.[474]
- An amalgam restoration costs between $83.10 and $102.40 depending on whether or not the restoration is bonded and to which teeth the restoration is applied.[475] We used the mid-point ($92.75) for the base case and the extremes in the sensitivity analysis.
- The cost per day surgery for dental cavities in BC is estimated at $1,782 which includes $1,515 for hospital and $267 for anaesthesia costs in 2011[476] or $2,108 in 2022 dollars.

Depression

- Depression has an important influence on a person's QoL. Studies have shown that individuals with current or treated depression report lower preference scores for depression health states than the general population.[477,478] Pyne and colleagues suggest that "public stigma may result in the general population being less sympathetic to the suffering of individuals with depression and less willing to validate the impact of depression symptoms."[479] Revicki and Wood, based on input from patients with depression who had completed at least eight weeks of antidepressant medication (ADM), identified the following health state utilities (or quality of life): severe depression = 0.30, moderate depression = 0.55 to 0.63, mild depression = 0.64 to 0.73 and antidepressant maintenance therapy = 0.72 to 0.83.[480] Whiteford and colleagues[481] suggest the following health utilities:
    - Severe depression, QoL = 0.35 (95% CI of 0.18 to 0.53)
    - Moderate depression, QoL = 0.59 (95% CI of 0.45 to 0.72)
    - Mild depression, QoL = 0.84 (95% CI of 0.78 to 0.89)

    For modelling purposes we assumed an equal proportion of individuals with mild, moderate and severe depression and used the average quality of life provided by Whiteford and colleagues of 0.59 (95% CI of 0.47 to 0.72).

[473] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed October 2017.
[474] BC Ministry of Social Development and Poverty Reduction. *Dental Supplement*. 2020. Available online at https://www2.gov.bc.ca/assets/gov/family-and-social-supports/income-assistance/on-assistance/schedule-dentist.pdf. Accessed September 2023.
[475] Ibid.
[476] Canadian Institute for Health Information. *Treatment of Preventable Dental Cavities in Preschoolers: A Focus on Day Surgery Under General Anesthesia*. 2013. Available at https://secure.cihi.ca/free_products/Dental_Caries_Report_en_web.pdf. Accessed January 2018.
[477] Pyne JM, Fortney JC, Tripathi S et al. How bad is depression? Preference score estimates from depressed patients and the general population. *Health Services Research*. 2009; 44(4): 1406-23.
[478] Gerhards SA, Evers SM, Sabel PW et al. Discrepancy in rating health-related quality of life of depression between patient and general population. *Quality of Life Research*. 2011; 20(2): 273-9.
[479] Pyne JM, Fortney JC, Tripathi S et al. How bad is depression? Preference score estimates from depressed patients and the general population. *Health Services Research*. 2009; 44(4): 1406-23.
[480] Revicki DA and Wood M. Patient-assigned health state utilities for depression-related outcomes: differences by depression severity and antidepressant medications. *Journal of Affective Disorders*. 1998; 48(1): 25-36.
[481] Whiteford HA, Degenhardt L, Rehm J et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*. 2013; 382(9904): 1575-86.

- The GBD study found that mild depression was associated with a disability weight of 0.145 (95% CI of 0.099 to 0.209), moderate depression was associated with a disability weight of 0.396 (95% CI of 0.267 to 0.531) and severe depression was associated with a disability weight of 0.658 (95% CI of 0.477 to 0.807).[482] The results by Whiteford et al. were generated for the GBD.[483]
- In a US study by Wright and colleagues, adolescents ages 13-17 who screened negative for depression utilized $2,357 (in 2013 USD) in health care services in the 12-month period following the screening. By comparison, adolescents who screened positive for moderate to severe depression utilized $8,173 in health care services in the 12-month period following the screening.[484] We assumed that the difference of $5,816 ($8,173 - $2,357) would be avoided in those adolescents for whom treatment for MDD was effective. This comes to $5,853 (2022 CAD).

Diabetes – Type 1

- The lifetime cost per case in the US has been estimated at $77,463 (in 2007 USD)[485] or $85,771 in 2022 CAD.

Diabetes – Type 2

- The GBD study found that diabetic neuropathy ("person has pain, tingling and numbness in the arms, legs, hands and feet. The person sometimes gets cramps and muscle weakness") is associated with a disability weight of 0.133 (95% CI of 0.089 to 0.187).[486]
- Uncomplicated diabetes mellitus is associated with a disability weight of 0.049 (95% CI of 0.031 to 0.072).[487] In this situation, the person has "a chronic disease that requires medication every day and causes some worry but minimal interference with daily activities".

Ectopic Pregnancy

- The GBD study found that an ectopic pregnancy is associated a disability weight of 0.114 (95% CI of 0.078 to 0.159).[488] We have assumed that the disability would last for a period of four weeks.[489]

[482] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[483] Whiteford HA, Degenhardt L, Rehm J et al. Global burden of disease attributable to mental and substance use disorders: findings from the Global Burden of Disease Study 2010. *The Lancet*. 2013; 382(9904): 1575-86.
[484] Wright DR, Katon WJ, Ludman E et al. Association of adolescent depressive symptoms with health care utilization and payer-incurred expenditures. *Academic Pediatrics.* 2016; 16(1): 82-9.
[485] Bartick M and Reinhold A. The burden of suboptimal breastfeeding in the United States: a pediatric cost analysis. *Pediatrics*. 2010; 125(5): e1048-e56.
[486] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[487] Ibid.
[488] Ibid.
[489] Hu D, Hook EW and Goldie SJ. Screening for Chlamydia trachomatis in women 15 to 29 years of age: a cost-effectiveness analysis. *Annals of Internal Medicine*. 2004; 141(7): 501-13.

Falls

- Individuals who survive a fall-related hospitalization have a 0.20 reduction in quality of life in year 1 following the hospitalization and 0.06 reduction per year thereafter.[490]
- Falls-related hospitalization – The cost of a falls-related hospitalization is taken from the Canadian Institute of Health Information Patient Cost Estimator.[491] We used the average cost in British Columbia in 2021/22 associated with a hospitalization for a primary procedure of case-mix group 727 *Fixation/repair hip/femur* of $15,029.

Fetal Alcohol Spectrum Disorder

- The estimated average annual direct costs per individual with FASD is detailed in the following table. From a societal perspective, annual costs total $18,780 in 2007. Of this amount, $4,785 (25%) are patient out-of-pocket costs.[492] Inflated to 2022, the equivalent costs are $23,959 and $7,077.

[490] Ibid.
[491] Canadian Institute for Health Information. *Patient Cost Estimator*. 2023. Available at https://apps.cihi.ca/mstrapp/asp/Main.aspx. Accessed December 2023.
[492] Stade B, Ali A, Bennett D et al. The burden of prenatal exposure to alcohol: revised measurement of cost. *Canadian Journal of Clinical Pharmacology*. 2009; 16(1): e91-e102.

Estimated Average Annual Cost of FASD per Case

Canada, 2007

Component	Societal Cost ($)	Ministry of Health/Social Services Cost ($)	Patient Cost ($)
Direct Costs: Medical			
Hospitalization	$1,445	$1,445	N/A
Emergency Room/Clinic Visits	$661	$661	N/A
	$2,106	**$2,106**	
Visits to Health Professionals			
Family Doctor	$301	$301	N/A
Orthopedic Surgery	$68	$68	N/A
Urologist	$46	$46	N/A
Allergist	$6	$6	N/A
Pediatrician	$242	$242	N/A
Psychiatrist	$892	$892	N/A
Occupational Therapist	$444	$352	$92
Physiotherapist	$91	$91	$0
Speech Therapist	$59	$28	$30
Psychologist	$737	$122	$615
	$2,886	**$2,148**	**$738**
Medical Devices	$416	$282	$134
Medication Dispensing Fees	$56	$48	$9
Prescription Medications	$800	$592	$208
Non-Prescription Medication	$218	N/A	$218
Diagnostic Tests	$148	$148	N/A
	$1,638	**$1,070**	**$569**
Total	**$6,630**	**$5,324**	**$1,306**
Direct Costs: Education			
Home Schooling	$199	$199	N/A
Special Schooling	$3,238	$3,238	N/A
Residential Program	$1,600	$1,000	$600
Post-Secondary Education - Tutor	$64	N/A	$64
Job Education	$160	$160	N/A
Total	**$5,260**	**$4,596**	**$664**
Direct Costs: Social Services			
Respite Care	$152	$152	N/A
Foster Care	$2,000	$2,000	N/A
Institutionalization	$1,655	$1,655	N/A
ODSP	$143	$143	N/A
Legal Aid	$125	$125	N/A
Total	**$4,076**	**$4,076**	
Out-of-Pocket			
Transportation Per Visit	$152	N/A	$152
Parking	$162	N/A	$162
Externalizing Behaviours	$2,500	N/A	$2,500
Total	**$2,814**	**N/A**	**$2,814**
Total Direct Costs	**$18,780**	**$13,995**	**$4,785**

Source: Stade B, Ali A, Bennett D et al. The burden of prenatal exposure to alcohol: revised measurement of cost. Canadian Journal of Clinical Pharmacology. 2009; 16(1): e91-102

- Stade and colleagues provide additional information on costs by severity of FASD, with adjusted annual costs of $10,009 for mild (n = 122), $17,345 for moderate (n = 84) and $31,235 for severe (n = 44) FASD.[493] Stade and colleagues included individuals up to age 53 in their study and presented adjusted annual costs by age group.
- To calculate the lifetime costs of an individual living with FASD (see following table), we took the age-specific breakdown from Stade et al. and made the following adjustments:
    - assumed that "severe FASD" was equivalent to FAS and that mild and moderate FASD cases would be proportionally distributed in our FASD without FAS population
    - calculated that the annual cost of FAS ("severe FASD") would be 1.93 times the average annual cost of FASD and that the combination of mild and moderate FASD would be 0.80 times the average annual cost of FASD
    - assumed that the annual cost from 54 - 65 years of age was equivalent to the average of the 36 – 45 and 46 – 53 year age groups reported by Stade et al.
    - inflated the 2007 CAD costs to 2022 CAD costs

Lifetime Cost of FAS / FASD
Canada, 2022

	Annual Cost (2007 CAD)				Severity Adjustment		Annual Cost (2022 CAD)		Years	Lifetime Cost per Individual	
Age Range	Mean	95% CI		Inflation	FASD	FAS	FASD	FAS	#	FASD[1]	FAS[2]
0 - 2	$30,222	$26,302	$38,222	1.28	0.80	1.93	$30,924	$74,296	3	$92,771	$222,887
3 - 6	$26,544	$23,666	$30,328	1.28	0.80	1.93	$27,160	$65,254	4	$108,641	$261,016
7 - 12	$28,666	$25,446	$32,832	1.28	0.80	1.93	$29,332	$70,471	6	$175,990	$422,823
13 - 17	$20,201	$16,997	$24,885	1.28	0.80	1.93	$20,670	$49,661	5	$103,350	$248,304
18 - 21	$16,544	$14,888	$18,234	1.28	0.80	1.93	$16,928	$40,671	4	$67,713	$162,683
22 - 25	$16,232	$14,666	$18,002	1.28	0.80	1.93	$16,609	$39,904	4	$66,436	$159,615
26 - 35	$15,998	$14,021	$18,112	1.28	0.80	1.93	$16,369	$39,328	10	$163,695	$353,956
36 - 45	$14,689	$12,888	$16,681	1.28	0.80	1.93	$15,030	$36,110	10	$150,301	
46 - 53	$14,810	$12,664	$16,988	1.28	0.80	1.93	$15,154	$36,408	8	$121,231	
54 - 65	$14,750	n/a	n/a	1.28	0.80	1.93	$15,092	$36,259	12	$181,104	
										$1,231,232	**$1,831,283**

Source: Stade et al. (2009). Adjustments by H. Krueger & Associates Inc.
[1] From birth to 65 years old.
[2] From birth to 34 years old.

[493] Stade B, Ali A, Bennett D et al. The burden of prenatal exposure to alcohol: revised measurement of cost. *Canadian Journal of Clinical Pharmacology*. 2009; 16(1): e91-e102.

Fragility Fractures

- The decrement in QoL by fracture type and time since the fracture are indicated in the following table, based primarily on research from Australia[494] and Canada.[495,496]

QoL Decrement Following a Fragility Fracture
By Fracture Type and Years Since the Incident Fracture

Fracture Type	Number of Years Since the Fracture				
	1	2	3	4	≥ 5
Hip	26.0%	19.4%	19.4%	19.4%	19.4%
Vertebral	20.0%	11.0%	10.0%	9.0%	8.5%
Wrist	11.0%				
Humerus	17.0%				
Multiple	21.0%				
Other	21.0%				

- According to the BC Medical Services Plan Fee-For-Service Payment Analysis for 2016/17 – 2020/21, a single area bone density scan (fee item 8688) averaged $69.28 per scan in 2020/21. Adding a second area (fee item 8689) costs an additional $47.48 per scan. A second area scan occurred at a rate of approximately 99.4% of single area scans.[497] The average cost of a bone scan is therefore $116.47 ($69.28 + (0.994 * $47.48).
- Based on data from Pacific Blue Cross,[498] the generic equivalent to alendronate 70 mg weekly costs between $1.92 and $2.73 per pill (in Vancouver), with a mid-point of $2.33. The dispensing fee ranges from $4.49 - $13.99, with only a single dispensing fee below $10.00. We assume a dispensing fee at the midpoint of $10.00 - $13.99 (or $12.00) and assume a 3-month dose is dispensed each time. Annual costs would therefore be $169.16 ($2.33 * 52 + $12.00 * 4).
- Based on data from Pacific Blue Cross,[499] the generic equivalent to risedronate 35 mg weekly costs between $1.81 and $3.18 per pill (in Vancouver), with a mid-point of $2.50. The dispensing fee ranges from $4.49 - $11.60, with only a single dispensing fee below $9.99. We assume a dispensing fee at the midpoint of $9.99 - $11.60 (or $10.80) and assume a 3-month dose is dispensed each time. Annual costs would therefore be $173.20 ($2.50 * 52 + $10.80 * 4).

[494] Abimanyi-Ochom J, Watts J, Borgstrom F et al. Changes in quality of life associated with fragility fractures: Australian arm of the International Cost and Utility Related to Osteoporotic Fractures Study (AusICUROS). *Osteoporosis International*. 2015; 26: 1781-90.
[495] Papaioannou A, Kennedy C, Ioannidis G et al. The impact of incident fractures on health-related quality of life: 5 years of data from the Canadian Multicentre Osteoporosis Study. *Osteoporosis International*. 2009; 20: 703-14.
[496] Borhan S, Papaioannou A, Gaji-Veljanoski O et al. Incident fragility fractures have a long-term negative impact on health-related quality of life of older people: The Canadian Multicentre Osteoporosis Study. *Journal of Bone and Mineral Health.* 2019; 34(5): 838-48.
[497] B.C. Ministry of Health, Health Sector Information, Analysis & Reporting Division. *MSP Fee-For-Service Payment Analysis 2016/2017 - 2020/2021*. 2021. Available at https://www2.gov.bc.ca/assets/gov/health/practitioner-pro/medical-services-plan/msp_ffs_payment_analysis_20162017_to_20202021.pdf. Accessed January 2024.
[498] Pacific Blue Cross. *Pharmacy Compass*. 2023. Available online at https://www.pac.bluecross.ca/pharmacycompass. Accessed January 2024.
[499] Ibid.

- The cost for an annual 5mg IV infusion of zoledronic acid is estimated at $447.[500] The cost of administering zoledronic acid intravenously has been estimated at $187 (2013 USD) per infusion,[501] or $200 in 2022 CAD. The total annual cost of zoledronic acid would thus be $647 ($447 + $200).
- A 2016 Canadian study by Hopkins et al. estimated the annual direct medical costs of a fragility fracture to be $24,789 (in 2014 CAD or $33,128 in 2022 CAD).[502] Costs included acute care, rehabilitation care, long term care, home care, outpatient physician services and mobility devices. The direct medical costs by fragility fracture type are as follows:
    - Hip - $61,540 in 2014 CAD / $75,890 in 2022 CAD
    - Wrist - $8,117 / $10,010
    - Vertebral - $25,965 / $32,020
    - Humerus - $14,937 / $18,420
    - Multiple - $51,312 / $63,277
    - All Other - $13,579 / $16,745
- Nikotovic and colleagues calculated that direct health care costs utilized in the process of dying following a hip fracture were $34,873 (in 2010 CAD or $46,605 in 2022 CAD).[503]

Gastrointestinal Bleeding

- In a Canadian study of 124 patients (mean age of 58.8 years) with acute lower gastrointestinal hemorrhage, the mean hospital stay was 7.5 days at a cost of $4,832 per stay (in 2002 CAD) or $7,859 (in 2022 CAD).
- In a study of 936 patients with acute upper gastrointestinal bleeding (AUGIB) in the UK (mean age of 59.4 years), 42 (4.5%) had died by day 28 following the bleeding episode. The mean QoL score at 28 days for surviving patients was 0.735 compared to 0.86 for the general UK population, a disutility of 0.125 (or 14.5%). We have assumed that this disutility lasts for a one-year period.[504]
- In the same UK study, the mean hospital stay was 5.34 days with total hospital costs of £2,458 (in 2012/13 £). Mean post hospital discharge costs to day 28 were £391.[505] We converted the total cost of £2,849 to $6,204 2022 CAD.

[500] Coyle D. Cost-effectiveness of pharmaceutical treatments for osteoporosis consistent with the revised economic evaluation guidelines for Canada. *MDM Policy & Practice*. 2019; 4(1). doi:10.1177/2381468318818843.
[501] Insinga R. Administration costs of denosumab and zoledronic acid for postmenopausal osteoporosis. *The American Journal of Pharmacy Benefits*. 2016; 8(3): e42-7.
[502] Hopkins R, Burke N, Von Keyserlingk C et al. The current economic burden of illness of osteoporosis in Canada. *Osteoporosis International*. 2016; 27(10): 3023-32.
[503] Nikitovic M, Wodchis W, Krahn M et al. Direct health-care costs attributable to hip fractures among seniors: A matched cohort study.
[504] Campbell H, Stokes E, Bargo D et al. Costs and quality of life associated with acute upper gastrointestinal bleeding in the UK: cohort analysis of patients in a cluster randomised trial. *British Medical Journal Open*. 2015; 5(4): e007230.
[505] Ibid.

Gastrointestinal Infection

- A US study suggests the direct costs for gastrointestinal infections and lower respiratory tract infections are $331 per case (in 1995 USD)[506] or $472 in 2022 CAD.

Hearing Deficits

- The GBD study found that a mild hearing loss was associated with a utility of -0.01 (95% CI of -0.004 to -0.019), a moderate hearing loss with -0.027 (95% CI of -0.015 to -0.042), a severe hearing loss with -0.158 (95% CI of -0.105 to -0.227), a profound hearing loss with -0.204 (95% CI of -0.134 to -0.288) and a complete hearing loss with -0.215 (95% CI of -0.144 to -0.307).[507]

- A 2003 US study estimated the direct lifetime costs per individual associated with hearing loss to be $153,151 USD.[508] The costs included physician visits, prescription medications, hospital inpatient stays, assistive devices, therapy and rehabilitation, long-term care, home and vehicle modifications and special education. We converted these costs to equivalent 2022 Canadian health care costs for a lifetime cost per individual of $202,089 CAD associated with hearing loss.

Heart Failure

- Moderate heart failure ("is short of breath and easily tires with minimal physical activity, such as walking only a short distance. The person feels comfortable at rest but avoids moderate activity") reduces a person's quality of life by 7.2% (95% CI of 4.7% to 10.3%).[509] Individuals with heart failure have a life expectancy of approximately 2.5 years.[510]

- Heart failure is associated with annual costs of $7,100[511] (in 2020 CDN or $8,231 in 2022 CDN). Individuals with heart failure have a life expectancy of approximately 2.5 years.[512]

HIV/AIDS

- The GBD study found that symptomatic HIV without anemia is associated with a disability weight of 0.274 (95% CI of 0.184 to 0.377), symptomatic HIV with mild anemia is associated with a disability weight of 0.277 (95% CI of 0.189 to 0.379), symptomatic HIV with moderate anemia is associated with a disability weight of

[506] Ball TM and Wright AL. Health care costs of formula-feeding in the first year of life. *Pediatrics*. 1999; 103(Suppl. 1): 870-6.
[507] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[508] Economic costs associated with mental retardation, cerebral palsy, hearing loss, and vision impairment – United States, 2003. *MMWR Weekly*. 2003; 53(03): 57-9.
[509] GBD 2016
[510] Limpens M, Asllanaj E, Dommershuijsen L et al. Healthy lifestyle in older adults and life expectancy with and without heart failure. *European Journal of Epidemiology*. 2022; 37: 205-14.
[511] Levy A, Johnston K, Daoust A et al. Health expenditures after first hospital admission for heart failure in Nova Scotia, Canada: A retrospective cohort study. *CMAJ Open*. 2021; 9(3):
[512] Limpens M, Asllanaj E, Dommershuijsen L et al. Healthy lifestyle in older adults and life expectancy with and without heart failure. *European Journal of Epidemiology*. 2022; 37: 205-14.

0.312 (95% CI of 0.217 to 0.418) and symptomatic HIV without severe anemia is associated with a disability weight of 0.381 (95% CI of 0.269 to 0.505).[513]

- The GBD study found that AIDS with antiretroviral treatment (ART) without anemia is associated with a disability weight of 0.078 (95% CI of 0.052 to 0.111), AIDS with antiretroviral treatment with mild anemia is associated with a disability weight of 0.081 (95% CI of 0.054 to 0.116), AIDS with antiretroviral treatment with moderate anemia is associated with a disability weight of 0.125 (95% CI of 0.085 to 0.176) and AIDS with antiretroviral treatment with severe anemia is associated with a disability weight of 0.215 (95% CI of 0.148 to 0.295).[514]

- Long and colleagues estimated the gain in quality of life associated with early detection and treatment of an HIV infection to be is 0.11 and the difference in quality of life between avoided infection and symptomatic HIV treated with ART to be 0.17.[515]

- The annual direct medical costs (excluding medications) associated with HIV/AIDS in Canada have been estimated by stage of infection at $1,684 for asymptomatic HIV, $2,534 for symptomatic HIV and $9,715 for AIDS (in 2009 CAD)[516] or $2,115, $3,183 and $12,201 respectively in 2022 CAD.

Hypertension

- Pharmaceutical treatment for hypertension is associated with an increased rate of hypotension, syncope, electrolyte abnormalities, and acute kidney injury.[517]
- Bress and co-authors calculated the cost per serious adverse event (SAE) to be as follows:[518]
    - Hypotension - $7,314 in 2017 USD ($7,401 in 2022 CAD)
    - Syncope - $6,697 in 2017 USD ($6,776 in 2022 CAD)
    - Electrolyte abnormality - $7,142 in 2017 USD ($7,226 in 2022 CAD)
    - Acute kidney injury - $10,041 in 2017 USD ($10,160 in 2022 CAD)

  If one of the above SAE occurs, the probability of that occurrence is 20.4% / 24.8% / 28.4% / 26.4%, respectively.[519] The weighted cost per SAE would therefore be $7,925 in 2022 CAD.

[513] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[514] Ibid.
[515] Long EF, Brandeau ML and Owens DK. The cost-effectiveness and population outcomes of expanded HIV screening and antiretroviral treatment in the United States. *Annals of Internal Medicine*. 2010; 153(12): 778-89.
[516] Kingston-Riechers, J. *The Economic Cost of HIV/AIDS in Canada*. Canadian AIDS Society, 2011. Available online at http://www.cdnaids.ca/files.nsf/pages/economiccostofhiv-aidsincanada/$file/Economic%20Cost%20of%20HIV-AIDS%20in%20Canada.pdf. Accessed July, 2014.
[517] Sheppard J, Stevens S, Stevens R et al. Benefits and harms of antihypertensive treatment in low-risk patients with mild hypertension. *JAMA Internal Medicine*. 2018; 178(12): 1626-34.
[518] Bress A, Bellows B, King J et al. Cost-effectiveness of intensive versus standard blood-pressure control. *New England Journal of Medicine*. 2017; 377(8): 745-55.
[519] Bress A, Bellows B, King J et al. Cost-effectiveness of intensive versus standard blood-pressure control. *New England Journal of Medicine*. 2017; 377(8): 745-55.

- Richman et al assumed a 4 day hospital stay associated with each SAE with an estimated cost of $7,151 (in 2016 USD) per event.[520] We converted this to $7,373 in 2022 CAD.
- Tran et al estimated the cost of a hospitalization with a primary diagnosis of syncope (ICD-10 code R55) to be $4,481 in 2018 CAD (or $5,309 in 2022 CAD).[521]
- For modelling purposes, we took the difference for the cost of treating syncope in the Bress study ($6,776) and the Tran study ($5,309), or -$1,467 (-21.7%) and reduced the weighted cost per SAE from the Bress study ($7,925) by this 21.7% ($6,209).

Infertility

- The GBD study found that primary infertility ("wants to have a child and has a fertile partner but the couple cannot conceive") is associated with a disability weight of -0.008 (95% CI of -0.003 to -0.015) while secondary infertility ("has at least one child, and wants to have more children. The person has a fertile partner but the couple cannot conceive") is associated with a disability weight of 0.005 (95% CI of 0.002 to 0.011).[522]

Intellectual Disability

- The GBD study found that borderline intellectual functioning is associated with a utility of -0.011 (95% CI of -0.005 to -0.02), mild intellectual disability is associated with a utility of -0.043 (95% CI of -0.026 to -0.064), moderate intellectual disability is associated with a utility of -0.1 (95% CI of -0.066 to -0.142) and profound intellectual disability is associated with a utility of -0.2 (95% CI of -0.133 to -0.283).[523]
- A 2003 US study estimated the direct lifetime costs per individual associated with intellectual disability to be $243,620 USD.[524] The costs included physician visits, prescription medications, hospital inpatient stays, assistive devices, therapy and rehabilitation, long-term care, home and vehicle modifications and special education. We converted these costs to equivalent 2022 Canadian health care costs for a lifetime cost per individual of $321,466 CAD associated with intellectual disability.

Lower Extremity Amputation

- The GBD study found that diabetic foot due to neuropathy due to diabetes mellitus type 2 is associated with a utility of -0.150 (95% CI of -0.103 to -0.208) and diabetic neuropathy and amputation with treatment due to diabetes mellitus type 2 is associated with a utility of -0.167 (95% CI of -0.114 to -0.229).[525]

[520] Richman I, Fairley M, Jorgensen M et al. Cost-effectiveness of intensive blood pressure management. *JAMA Cardiology*. 2016; 8: 872-9.
[521] Tran D, Sheldon R, Kaul P et al. The current and future hospitalization cost burden of syncope in Canada. *Canadian Journal of Cardiology Open*. 2020; 2(4): 222-8.
[522] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.
[523] Ibid.
[524] Economic costs associated with mental retardation, cerebral palsy, hearing loss, and vision impairment – United States, 2003. *MMWR Weekly*. 2003; 53(03): 57-9.
[525] Ibid.

- The typical event cost for a lower extremity amputation is $24,583 with annual costs thereafter of $1,020 (in 2000 CAD)[526] or $37,600 and $1,560 respectively in 2022 CAD.

Lower Respiratory Tract Infections

- A US study suggests the direct costs for gastrointestinal infections and lower respiratory tract infections are $331 per case (in 1995 USD)[527] or $462 in 2022 CAD.

Nephropathy

- Nephropathy (chronic kidney disease) ("tires easily, has nausea, reduced appetite and difficulty sleeping") is associated with a reduction in quality of life of 10.4% (95% CI of 7.0% to 14.7%).[528]
- Nephropathy (microalbuminuria) is associated with annual costs of $3,936[529] (in 2012 USD or $4,291 in 2022 CDN).

Otitis Media

- Two estimates from the US suggest a direct cost (ambulatory care and antibiotics) per case of $156 (2007 USD)[530] and $106 (2004 USD).[531] A Canadian study suggested additional hospital costs over and above physician and drug costs of 15.6%.[532] We have converted the $156 to 2022 CAD and then added 15.6% to account for hospital costs for a total cost per case of $200 CAD.

Pre-Term Birth

- Very low birth weight survivors experience a 0.06 (95% CI of 0.04 to 0.08) decrement in QoL when compared with normal birth weight peers.[533]
- Johnston and colleagues estimated the economic burden attributable to prematurity during the first 10 years of life to be $67,467 for early preterm infants (<28 weeks gestational age), $52,796 for moderate preterm infants (28-32 weeks) and $10,010 for late preterm infants (33-36 weeks), in 2012 CAD.[534] In our modelling we have assumed a distribution of 12.0% early, 12.3% moderate and 75.7% late preterm births. The weighted cost per pre-term birth would thus be $22,188 in 2012 CAD

[526] O'Brien JA, Patrick AR and Caro JJ. Cost of managing complications resulting from type 2 diabetes mellitus in Canada. *BMC Health Services Research*. 2003; 3(1): 7.
[527] Ball TM and Wright AL. Health care costs of formula-feeding in the first year of life. *Pediatrics*. 1999; 103(Suppl. 1): 870-6.
[528] GBD 2016
[529] Zhuo X, Zhang P, Hoerger T. Lifetime direct medical costs of treating type 2 diabetes and diabetic complications. *American Journal of Preventive Medicine*. 2013; 45(3): 253-61.
[530] Bartick M and Reinhold A. The burden of suboptimal breastfeeding in the United States: a pediatric cost analysis. *Pediatrics*. 2010; 125(5): e1048-e56.
[531] Zhou F, Shefer A, Kong Y et al. Trends in acute otitis media-related health care utilization by privately insured young children in the United States, 1997–2004. *Pediatrics*. 2008; 121(2): 253-60.
[532] Coyte PC, Asche CV and Elden LM. The economic cost of otitis media in Canada. *International Journal of Pediatric Otorhinolaryngology*. 1999; 49(1): 27-36.
[533] Bolbocean C, van der Pal S, van Buuren S et al. Health-related quality-of-life outcomes of very preterm or very low birth weight adults: Evidence from an individual participant meta-analysis. *Pharmacoeconomics*. 2023; 41: 93-105.
[534] Johnston K, Gooch K, Korol E et al. The economic burden of prematurity in Canada. *BMC Pediatrics*. 2014; 14(93):

(12.0% * $67,467 + 12.3% * $52,796 + 75.7% * $10,010), adjusted to $25,931 in 2022 CAD.

Sexually Transmitted Infection

- The GBD study found that a mild chlamydial or gonococcal infection is associated with a utility of -0.006 (95% CI of -0.002 to -0.012).[535]

Spina Bifida

- Based on a consecutive cohort of 117 children with spina bifida in the UK, 33.9% presented with a sacral lesion, 28.6% with a lower lumbar lesion and 37.5% with an upper lumbar lesion.[536]

- Based on a study of 98 children with spina bifida in Arkansas, the average loss in QoL associated with spina bifida was 41%, ranging from 34% (6% to 62%) for the sacral lesion, 42% (22% to 62%) for the lower lumbar lesion and 52% (25% to 78%) for the upper lumbar lesion.

- The GBD study found the following utilities associated with spina bifida.

Health State	Utility Weight	95% CI	
Mild motor impairment due to spina bifida	-0.010	-0.005	-0.019
Mild motor impairment and mild intellectual disability due to spina bifida	-0.031	-0.018	-0.050
Moderate motor impairment due to spina bifida	-0.061	-0.040	-0.089
Moderate motor impairment and borderline intellectual disability due to spina bifida	-0.071	-0.045	-0.106
Moderate motor impairment and mild intellectual disability due to spina bifida	-0.101	-0.066	-0.146
Moderate motor impairment and incontinence due to spina bifida	-0.191	-0.132	-0.263
Moderate motor impairment, borderline intellectual disability and incontinence due to spina bifida	-0.200	-0.139	-0.273
Moderate motor impairment and moderate intellectual disability due to spina bifida	-0.203	-0.134	-0.290
Moderate motor impairment and severe intellectual disability due to spina bifida	-0.211	-0.145	-0.293
Moderate motor impairment and profound intellectual disability due to spina bifida	-0.249	-0.174	-0.338
Moderate motor impairment, mild intellectual disability and incontinence due to spina bifida	-0.272	-0.191	-0.364
Moderate motor impairment, moderate intellectual disability and incontinence due to spina bifida	-0.272	-0.191	-0.364
Moderate motor impairment, severe intellectual disability and incontinence due to spina bifida	-0.320	-0.228	-0.429
Moderate motor impairment, profound intellectual disability and incontinence due to spina bifida	-0.352	-0.254	-0.465
Severe motor impairment due to spina bifida	-0.402	-0.268	-0.545

- Grosse and co-authors estimated the lifetime costs associated with spina bifida to be $791,900 (in 2014 USD). This includes $513,500 in medical costs, $63,500 in special education and developmental service costs and $214,900 in parental time costs.[537] We converted these costs to $540,119 in medical costs, $94,073 in special education and developmental service costs and $318,366 in parental time costs in 2022 CAD.

[535] Institute for Health Metrics and Evaluation. *GBD 2016 sequelae, health states, health state lay descriptions, and disability weights*. Available online at http://ghdx.healthdata.org/record/global-burden-disease-study-2016-gbd-2016-disability-weights. Accessed January 2018.

[536] Oakeshott P, Hunt G, Poulton A et al. Expectation of life and unexpected death in open spina bifida: a 40-year complete, non-selective, longitudinal cohort study. *Developmental Medicine & Child Neurology*. 2009; 52(8): 749-53.

[537] Grosse S, Berry R, Tilford J et al. Retrospective assessment of cost savings from prevention: folic acid fortification and spina bifida in the US. *American Journal of Preventive Medicine*. 2016; 50(5S1): S74-S80.

Suicide

- Clayton and Barcelo estimated the direct costs associated with death by suicide in the province of New Brunswick to be $5,693 (in 1996 CAD) or $9,153 in 2022 CAD, including ambulance, hospital, physician, autopsy, and funeral services plus the cost of police investigations.[538]
- Kinchin and Doran estimated the direct costs per youth suicide in Australia to be $9,721 (in 2014 AUD) or $9,356 in 2022 CAD.[539]
- Shepard et al estimated that the direct costs per nonfatal suicide attempt are 10% higher than the direct costs per death by suicide in the US.[540]
- For modelling purposes, we have assumed the direct costs per death by suicide in BC to be $9,255 ($9,153 + $9,356 / 2) and the direct cost per suicide attempt to be $10,180 ($9,255 * 1.1).

[538] Clayton D and Barcel A. The cost of suicide mortality in New Brunswick, 1996. *Chronic Diseases in Canada.* 1999; 20(2): 89-95.
[539] Kinchin I and Doran CM. The cost of youth suicide in Australia. *International Journal of Environmental Research and Public Health.* 2018; 15(4): 672-82.
[540] Shepard DS, Gurewich D, Lwin AK et al. Suicide and suicidal attempts in the United States: costs and policy implications. *Suicide and Life-Threatening Behavior*. 2016; 46(3): 352-62.