INVESTING IN PREVENTION
THE ECONOMIC PERSPECTIVE

Key Findings from a Survey of the Recent Evidence

Public Health Agency of Canada

MAY 2009

Public Health Agency of Canada
Agence de la santé publique du Canada

Canada

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Également disponible en français sous le titre : INVESTIR EN PRÉVENTION – Principales conclusions d'un examen des données récentes.

Cat.: HP5-88/2009E-PDF
ISBN: 978-1-100-14013-1

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Acknowledgements

Sincere thanks are extended to the Public Health Agency of Canada colleagues, in particular Sylvie Desjardins, Alan Diener, Nabanita Giri, Doug Hopkins, and Howard Morrison, for providing expert advice and feedback. We would also like to thanks Trevor Hancock (BC Ministry of Healthy Living and Sport) and Alan Shiell (University of Calgary) for their insightful and constructive comments as external reviewers.

Contents

1. Overview

Understanding the economic benefits and costs of preventive health interventions enables policymakers and program managers to make better-informed decisions about where and how best to invest to order to improve the health of the population. While the economic dimension is only one of many inputs to consider when considering the merit of an intervention, having such knowledge on hand allows for a more rigorous, systematic, and transparent decision-making process in a world of limited resources.

Supporting this knowledge is an extensive body of evidence on the economics of prevention. This literature is vast, encompassing research on the economic costs of illness and injury, economic evaluations of specific clinical and health promotion interventions, and the potential micro- and macro-economic benefits of improved health and well-being. It is also evolving and expanding rapidly, mirroring the growing interest among researchers and practitioners alike in applying economic analyses to the realm of public health.

In 2004, Goldsmith and colleagues (2004) undertook a broad review of this field from a Canadian perspective. Since then, new data have emerged and further inquiries have been advanced. To capture this latest knowledge in a way that supports the needs of decision-makers, a further summative review is in order.

This synthesis paper summarizes the current state of knowledge and debate about the economic benefits of prevention. It highlights the economic potential of preventive health, draws on examples of recent economic evaluations in key intervention areas to illustrate general research trends, discusses current gaps in evaluation knowledge, and outlines some of the critical methodological considerations when using economic evaluation evidence to inform policy and program decisions. Importantly, while it strives to be comprehensive in scope, the analysis contained herein neither purports to be nor constitutes a systematic review of the literature.

The remainder of this paper is organized as follows. Section 2 examines the economic case for investing in prevention, focusing on the economic costs of ill health (or conversely, the potential economic benefits of avoided illness and improved health) for the health care system and society more broadly. Section 3 offers a brief overview of the research methodology, and presents the organizational framework for the results. Section 4 discusses key findings and messages, based on our survey of the evidence, that together illustrate the state of knowledge about the economic benefits of prevention, and in particular the application of economic evaluations in preventive health interventions. Section 5 provides a brief summary and concluding remarks.

2. The economic rationale for investing in prevention

2.1. The economic burden of illness in Canada

Ill health imposes significant economic costs on both the Canadian health care system and society more broadly. The extent of this burden can be understood as comprising three components: direct costs, indirect costs, and the value of morbidity and mortality.

- *Direct costs* refer to "the value of goods and services for which payment was made and resources used in treatment, care, and rehabilitation related to illness or injury" (Health Canada, 2002:1).

- *Indirect costs* represent "the value of economic output lost because of illness, injury-related work disability, or premature death" (Health Canada, 2002:1). They are often measured in terms of lost potential earnings resulting from illness-related absence from work or early mortality. Other indirect costs include underperformance at work due to sickness ("presenteeism"), the value of lost non-market production (e.g., care-giving, unpaid work) due to illness or disability, and the value of time lost from work and leisure activities by family members or friends providing care to ill persons.

- The *value of morbidity and mortality* (sometimes referred to as "intangible costs") reflects the intrinsic worth attributed to better health, and includes "the personal and/or subjective consequences associated with illness such as physical pain, mental anguish, anxiety, fear, loss of good health, stress in personal relations, and family life" (Hankivsky et al., 2004:268). While this final category of costs is the broadest in scope and the most difficult to assess, methods have been developed to value them in either utility terms, such as a quality-adjusted life-year (QALY) or disability-adjusted life-year (DALY), or in monetary terms (e.g., through "willingness-to-pay" surveys).

The total economic burden of disease and injury in Canada is substantial. In 2000, the direct and indirect costs alone were estimated at $188 billion (internal PHAC data). Figure 1 illustrates these costs for seven major disease and injury categories. Notably, the indirect costs accrued by society are as great as or greater than the direct costs associated with the provision of health services.

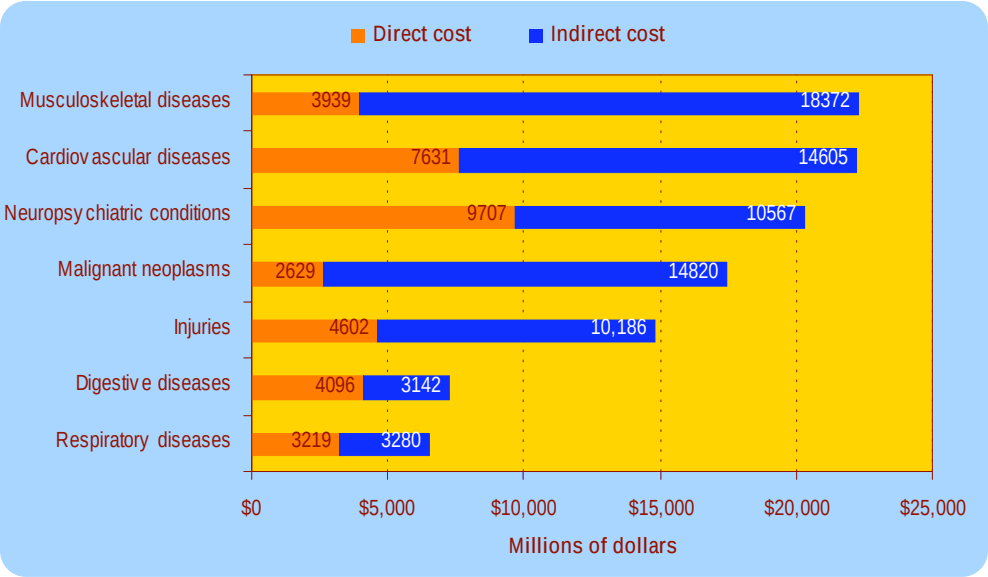

Figure 1: The economic burden for major diseases/injury categories in Canada, 2000.
Note: Direct costs are expenditures for health services. Indirect costs include the value of years of life lost due to premature death and the value of activity days lost due to short-term and long-term disability.
(Source: Adapted from IHE, 2008; based on data from the Public Health Agency of Canada)

2.2. Understanding the economic potential of prevention

In the context of rising health care costs and growing emphases on budgetary containment and evidence-based decision-making, recognition of the substantial economic burdens imposed by largely avoidable diseases and injuries has led to a resurgence of interest in preventive public health measures as a means to control health care spending. Prevention is thought in many instances to be cost-effective, such that a given amount of money could "buy" more health through preventive health measures than through clinical treatment. In some cases, prevention might even be "cost-saving" to the health care system, such that investing in prevention now will avoid having to pay for more costly treatment later on. As well, good health in itself may generate economic growth, such that, in avoiding illness and injury, people have more opportunities in life to maximize their educational, labour, and human potentials (Suhrcke et al., 2008).

Accepting the general economic case for investing in prevention, however, does not by itself provide decision-makers with clear direction on the specific types of public health intervention to prioritize for investment. To meet this need, economic evaluations—the comparative analysis of alternate interventions in terms of their costs and consequences (Drummond et al., 2005)—across the spectrum of preventive health are needed.

Such analyses are indeed on the rise (e.g., Rush et al., 2004). Economic evaluation offers a systematic framework for measuring and comparing the economics of policy alternatives (Box 1) (Mudarri, 1993). This potential can be harnessed to support evidence-based policy-making, improve spending efficiency, and ultimately enhance the sustainability of the health care system. Saha and colleagues (2001) note six contributions that such analyses can make towards informing decision-making around preventive services:

- quantifying the differences between two or more effective services for the same condition;
- illustrating the impact of delivering a given intervention at different time intervals, at different ages, or to different risk groups;
- evaluating the potential role of new technologies for prevention;
- identifying key "real-life" conditions that must be met to achieve the intended benefit of an intervention;
- incorporating the target population's preferences for intervention outcomes (e.g., balancing quantity and quality of life) (specific to CUAs); and
- developing a ranking of services in order of their costs and expected benefits (though only if economic analyses are standardized with common units for measuring outcomes).

At the same time, economic evaluations are only one of many factors to be weighed in determining the allocation of scarce health system resources. The first priority of public health—as with clinical medicine and allied health professions—is to protect and improve health. Achieving this objective efficiently is of course important, particularly where public funds are involved. However, as Stein (2001:68) notes, "efficiency is about how we should allocate our resources to achieve our goals, not what our goals should be. What our goals are, and how much we value them, is properly outside the language of efficiency."

BOX 1: COMMON TYPES OF ECONOMIC EVALUATIONS IN HEALTH RESEARCH

Cost analysis (CA) computes the net cost of an intervention by subtracting the cost of treating an illness from the cost of preventing it. An intervention is said to be cost-saving when its *net cost* is negative. CAs do not assess the benefits of the intervention, however, and therefore are not strictly economic evaluations.

Cost-benefit analysis (CBA) typically compares the cost of an intervention to the expected or actual improvements in health as valued in dollars. CBAs can also adopt a broader societal perspective to capture benefits beyond health. Results are often presented in terms of a *benefit-to-cost ratio* (i.e., dollar value of health and/or social improvement divided by cost of prevention). Benefit-to-cost ratios greater than one suggest that the intervention of interest offers value-for-money. In practice, however, the assignment of dollar values to various health and social gains, including the value of life itself, presents a number of challenges (including that of public acceptability).

Cost-effectiveness analysis (CEA) compares interventions in terms of the net cost required to achieve a natural unit of health improvement, such as life-year gained or case of illness avoided. CEA calculations are typically expressed in terms of an *incremental cost-effectiveness ratio (ICER)* (e.g., cost/death averted), which compares the net costs and net health outcomes of two or more alternate interventions. To be informative, ICERs are compared either against the ratio of another intervention option (e.g., the next best alternative, standard practice, no intervention, etc.) or an arbitrary threshold below which interventions are considered reasonably cost-effective. A common rule of thumb in North American research practice is to set this latter benchmark at US$50,000-$100,000/QALY.

Cost-utility analysis (CUA) is a sub-type of CEA for which the unit of health improvement achieved is a utility-weighted health metric, such as a quality-adjusted life year (QALY). The primary benefit of CUAs is that they facilitate the direct comparison of two or more interventions, even across disparate issues whose natural units of health differ from one another.

(Adapted from Partnership for Prevention, 2001)

Public policy-making is both an evidence-driven and a value-based enterprise. While its development should not turn on common-sense assumptions or advocacy pressures, neither should it be determined solely through a mechanical accountancy of costs and benefits. Economic evaluations of existing and new health interventions can help to address important public sector considerations of accountability, fiscal responsibility, and value-for-money in times of budgetary constraint. However, determining which programs to support requires the thoughtful deliberation and balancing of factors beyond those captured through summary measures of economic efficiency. These include, among others, public perceptions of safety and acceptability; societal values of equal access, fairness, solidarity, and distributive justice; and less tangible preferences placed on the avoidance of discomfort, pain, and suffering in oneself and in others.

3. A brief summary of the methodology

The academic and grey literatures were surveyed with the intention of capturing and synthesizing the latest knowledge drawn from economic evaluations of preventive health interventions as well as ongoing research questions and methodological considerations that offer context and guidance on the use of the evidence.

In order to maintain a manageable scope of work, literature searches were concentrated on review articles published in peer-reviewed academic journals and grey literature reports between January 2004 and February 2009. The Medline/PUBMED database was searched using combinations of the following keywords: (i) “clinical prevention,”

"primary prevention," "health promotion," "health protection," or "population health" and (ii) "cost-saving," "cost-benefit," "cost-effectiveness," "cost-utility," or "economic evaluation." Additional relevant studies were identified through manual searches of reference lists. Relevant publications in the grey literature were identified through a combination of web searches, reference lists of peer-reviewed papers, and consultations with colleagues with expertise in specific public health areas.

Source authors were relied upon to ensure that the cost-effectiveness studies reviewed met minimum standards of scholarly rigour for the conduct of health economic evaluation (e.g., Chiou et al., 2003; Drummond et al., 2005). While sufficient for present purposes, it is recognized that this approach is less than optimal; any future systematic review of the literature is encouraged to independently appraise the quality of the research studies consulted. A number of tools and guidelines are available for this purpose (see, e.g., Carande-Kulis et al., 2000; Centre for Reviews and Dissemination (CRD), 2008; Chiou et al., 2003; Drummond et al., 2005).

The four "faces" of the prevention spectrum employed by Goldsmith et al. (2004) were utilized as an organizational framework:

- *Clinical prevention* – includes one-on-one activities involving a health care provider and a recipient of care (patient or client), who may accept or decline the service or recommended health action.
- *Health promotion* – includes interventions delivered at a group- or population-level that encourage individual behaviours believed to produce positive health effects and discourage behaviours that produce negative health effects.
- *Health protection* – includes interventions delivered at the organizational (e.g., hospital policy), local, provincial, national or international level that reduce health risks by changing the physical or social environment in which people live, such that the role of individual beneficiaries of health protection interventions is either passive or limited to compliance with laws or regulations.
- *Healthy public policy* – includes social or economic interventions that act on the determinants of health, and thereby affect health but do not have health as the main policy objective.

Where available, Canadian evidence was prioritized, but as this represented a relatively small proportion of the total literature, evidence from comparable Western developed nations, primarily the US, the UK, Australia, and New Zealand was also drawn upon.

The methodology adopted for this paper was designed to capture in broad strokes the current state of the field. However, given the richness of the relevant literature as well as the summative and non-systematic nature of the chosen research approach, the findings discussed herein should be viewed as tentative. Moreover, the threat of replicating reporting biases—that is, the widespread tendency for positive or statistically significant research results to be published and cited more frequently than unfavourable findings—cannot be ruled out (Sassi et al., 2002; Suhrcke et al., 2007).

4. Key findings and messages

4.1. Summarizing the evidence: economic evaluations of preventive health interventions

4.1.1. Many preventive health interventions are cost-effective

Where they are known to be effective, many of the public health interventions reviewed across the spectrum of prevention were found to be cost-effective (relative either to treatment, the next best prevention alternative, or conventional protocols, depending on the study in question), particularly when a long-term horizon and societal perspective are adopted. This suggests the possibility of enhancing the fiscal sustainability of the health care system by identifying areas where the health objectives can be achieved more efficiently through investment in more cost-effective intervention approaches.

The following sections illustrate the economic evaluation evidence for preventive health interventions by highlighting examples drawn from four "faces" along the prevention spectrum (Goldsmith et al., 2004). The selection of intervention areas is based on the availability of economic evaluation data as well as their potential relevance for Canadian public health policy-makers, and should not be construed as an endorsement of their worthiness as preventive interventions relative to other interventions.

A. Examples from clinical prevention

Diabetes prevention. As of 2005-2006, approximately 1.9 million Canadians, or about one in 17, had been diagnosed with diabetes, including 5.5% of females and 6.2% of males (PHAC, 2008). Clinical trials have shown that diabetes can be prevented through clinically-based lifestyle modification programs, with some studies reporting a reduced cumulative incidence of as much as 58% compared to placebo (Delahanty and Nathan, 2008).

Moreover, these health gains appear to be achievable at costs generally considered acceptable to society. One review study found that, compared to placebo, a lifestyle intervention involving a healthy diet and moderate physical activity generated a cost per QALY gained of US$1,100 (2000 dollars) when only direct intervention costs were considered. When a societal perspective was adopted, which included costs of participant time, exercise classes, exercise equipment, food and food preparation items, and transportation, the cost per QALY

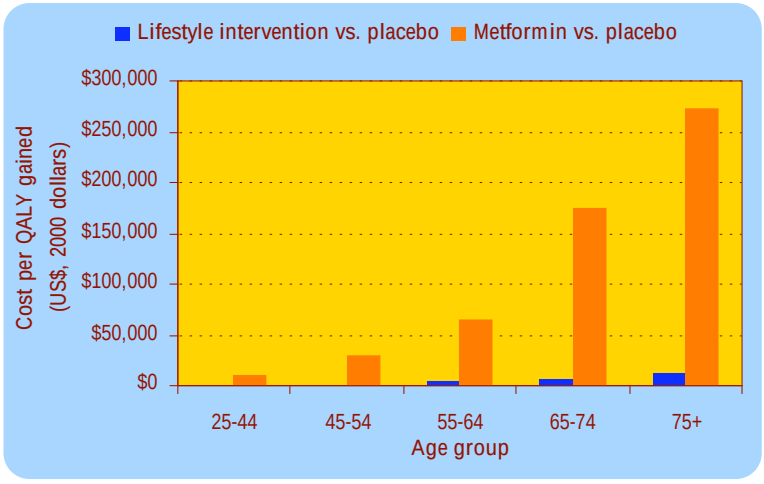

Figure 2: Cost-effectiveness ratios of lifestyle and Metformin intervention to prevent type 2 diabetes in adults with impaired glucose tolerance, by age (Source: Herman et al., 2005)

increased to $8,800. These cost-effectiveness ratios were found to be substantially lower than those of a popular pharmaceutical intervention (vs. placebo) (Figure 2) (Burnet, 2006).

Colorectal cancer screening. Colorectal cancer (CRC) remains a major health concern in Canada. Recent surveillance data have reported CRC as the third most commonly diagnosed cancer overall and the third and second most common cause of cancer death in women and men, respectively (CSS/NCIC, 2008; Marrett, 2008).

CRC screening with faecal occult blood test (FOBt) has been shown to be both effective in reducing mortality in large randomised trials and cost-effective based on economic analyses that compare intervention cost against commonly used benchmark standards (e.g., $50,000/QALY). In one Canadian study, the potential impact of population-based screening with FOBt followed by colonoscopy on CRC mortality was estimated through microsimulation modelling (Flanagan et al., 2003). Biennial screening of 67% of individuals aged 50 to 74 in the year 2000 resulted in a 15% rise in demand for colonoscopy in the first year, a 17% reduction in 10-year CRC mortality, and an average 15-day increase in life expectancy. The estimated cost of screening was $112 million per year or $11,907 per life-year gained (discounted at 5%). Similarly, another modelling study utilizing a hypothetical birth cohort of 40,000 adults 50 and older in British Columbia found CRC screening to have a cost-effectiveness ratio of $11,100 per QALY gained (H. Krueger and Associates, 2008a).

The cost-effectiveness of screening to prevent CRC is further supported by international data. For example, CRC screening with FOBt was estimated by a recent UK study to cost £2,600-£6,000 (approximately CA$4,500-$10,500) per QALY gained (Hayee, 2006).

B. Examples from health promotion

HIV/AIDS prevention. HIV prevention programs include mass media and community-based awareness campaigns; school-based sex education; peer- and community opinion leader-led skills workshops; condom distribution and social marketing; promotion of voluntary testing, counselling, and treatment; blood safety practices and universal precautions; and harm reduction programs for injection drug users (IDUs), such as needle exchange and safe-injection site programs. Often, effectiveness is enhanced by combining programs within a comprehensive strategy aimed at multiple target groups.

A recent review that modelled the relative cost-effectiveness of 26 HIV prevention interventions commonly used in North America concluded that two factors were particularly important in determining the likely cost-effectiveness of a program: the prevalence of HIV infection in the target population, and the cost per person reached by the intervention. In relatively low-prevalence populations (e.g., heterosexuals), mass media campaigns and condom availability programs with low per-person costs were the most cost-effective approaches. In high-prevalence populations (e.g., men who have sex with men), opinion leader programs and community mobilization initiatives achieved the most favourable cost-effectiveness ratios. Other targeted interventions may be cost-effective only if local prevalence is very high (i.e., approaching 0.2). School-based HIV prevention and other youth-focused programs were found to be unlikely to be cost-effective, primarily due to the very low prevalence of HIV in these particular populations (Cohen et al., 2004).

Promotion of healthy eating and physical activity. Lifestyle-related factors such as diet, exercise, smoking, and alcohol consumption are key drivers of much of the chronic disease burden in Canada as elsewhere. For example, the World Cancer Research Fund, in collaboration with the American Institute for Cancer Research, has conservatively estimated that 25% of all cancers could be prevented solely through healthier diets and more physical activity (Figure 3) (WCRF/AICR, 2009).

Type of Cancer	USA	UK
Mouth, pharynx, larynx	63	67
Oesophagus	69	75
Lung	36	33
Stomach	47	45
Pancreas	39	41
Gallbladder	21	16
Liver	15	17
Colorectum	45	43
Breast	38	42
Endometrium	70	56
Prostate	11	20
Kidney	24	19
Total for these cancers combined	34	39
Total for all cancers	24	26

N.B. These values are percentages rounded to the nearest whole number and are based on several assumptions. There is a range of likely plausible figures around these point estimates, but they represent the most likely estimates. See source for details.

Figure 3: Estimates of cancer preventability by appropriate food, nutrition, physical activity, and body fatness in two countries (Source: WCRF/AICR, 2009)

Given the potentially sizeable benefits of healthier lifestyles for improved population health, understanding the costs and impacts of lifestyle-focused health promotion interventions is an important research and policy priority. While the economic evaluation evidence in this area remains relatively sparse overall, several recent studies have reviewed the cost-effectiveness of interventions to promote healthy eating and physical activity.

In one such study, Dalziel and Segal (2007) modeled the economic performance of 8 nutritional interventions in Australia, ranging from physician-delivered nutritional counselling to population-wide social marketing campaigns. All were found to be economically efficient, with cost-effectiveness ratios ranging from US$46 to $14,800 (per various health outcomes, e.g., percentage point increase in those eating more than five servings of fruit and vegetable per day, kilogram weight lost, etc.). These results compared favourably to other options commonly used to manage the risk factors associated with obesity, including hypertension- and cholesterol-reducing prescription medications.

Roux et al. (2008) conducted a lifetime cost-effectiveness analysis from a societal perspective of seven public health interventions aimed at decreasing the relative risk of chronic diseases by improving physical activity status. The interventions included community-wide campaigns, individually-adapted health behavioural change programs, and enhanced access to physical activity information and opportunities. All of the physical activity interventions were found to contribute to reductions in disease incidence and contribute to both survival and health-related quality of life. Moreover, these improved health outcomes were generally achieved cost-effectively, ranging from US$14,000 to US$69,000/QALY.

C. Examples from health protection

Vaccination programs. Universally recommended vaccination has been hailed as one of the "ten great public health achievements of the 20th century," and is credited with saving more lives than any other health intervention (CDC, 1999; PHAC, n.d.). Many established vaccination programs, particularly standardized immunization schedules delivered in childhood, are highly cost-effective and, in some cases, cost-saving for the health sector.

For example, in an unpublished study prepared for the British Columbia Clinical Prevention Policy Review Committee, Canadian researchers assessed the health

burden and cost-effectiveness of seasonal influenza vaccination for adults aged 50 and older in a hypothetical cohort of BC residents. They calculated that such an intervention would result in 3,300 QALYs gained at a favourable per-QALY cost of $11,900, placing it among the top clinical preventive services in terms of effectiveness and cost-effectiveness (H. Krueger and Associates, 2008a).

These findings were consistent with those of a larger US study on which it modelled its methodology (Maciosek et al., 2006b). In this latter study, which involved a birth cohort of 4 million US residents, influenza immunizations for individuals aged 50+ would prevent 2.64 million cases of influenza-like illness, 180,000 hospitalizations, and 40,500 deaths over the lifetime of the cohort. This would result in 275,000 QALYs saved at the average annual net cost of US$1.5 billion (2000 dollars), yielding an incremental cost-effectiveness ratio of $5,800/QALY ($28,000/QALY among those aged 50 to 64 and $980/QALY among those aged 65+).

Another area of significant interest among public health practitioners and policy-makers is human papillomavirus (HPV) vaccination. HPV is among the most common sexually transmitted infections in Canada, with approximately 75% of sexually active Canadians likely to contract at least one type of HPV infection in their lifetime. HPV has been implicated in almost all cases of cervical cancer, and is linked to other medical conditions such as ano-genital warts. The introduction of the Pap screening test has led to a reduction in the incidence and mortality of cervical cancer in developed countries. Nevertheless, cervical cancer remains the third most common cancer among Canadian women aged 20-49, with approximately 1,400 new diagnoses and 400 attributable deaths annually (CSS/NCIC, 2006).

In Canada, vaccination against the two leading types of cancer-causing HPV as well as the two leading types of HPV that cause ano-genital warts is recommended for females between the ages of 9 and 26 (National Advisory Committee on Immunization, 2007). HPV vaccination is currently not recommended for females under 9 years, males, and pregnant women, due to insufficient evidence of efficacy.

Owing to the relative novelty of population-level HPV vaccination programs in Canada, as well as ongoing uncertainties about the vaccine's efficacy and duration of conferred immunity, studies have yet to assess the intervention's long-range cost-effectiveness (Morris and Nguyen, 2008). Instead, most research to date has employed modelling techniques to simulate the economic impact of HPV vaccination. These studies have generally found HPV vaccination to be cost-effective relative to current practice (e.g., H. Krueger and Associates, 2008b; Newall and colleagues, 2007). One Canadian study, considering economic costs from the health system perspective, calculated a cost-utility ratio of $20,500/QALY when assuming a lifelong duration of vaccine protection and $64,500/QALY when assuming a protective duration of 30 years (Brisson et al., 2007). Another study, also Canadian in origin, assessed the cost-effectiveness of three school-based HPV vaccine schedules: (1) vaccination for females at age 14; (2) vaccination for females at age 11; and (3) a combined program of vaccination of females aged 11 and 14 for 3 years followed by vaccination at age 11 only. Relative to screening, all three strategies were similarly cost-effective, at CA$24,530/QALY for vaccination of 14-year-old girls, $24,945/QALY for vaccination of 11-year old girls, and $25,417/QALY for the combined program (Marra et al., 2007; cited in Canadian Immunization Committee, 2008).

Tobacco control. The restriction of tobacco sales and prohibition of smoking in designated areas are two of the most well-established regulatory public health initiatives in Canada, and have helped to establish the country's reputation as a global leader in tobacco control. Overall, the cost-effectiveness of these types of preventive health interventions has also been encouraging.

For example, in their review of the cost-effectiveness of various youth-focused smoking prevention measures, Rasch and Greiner (2008) described a simulation study that modelled the cost-effectiveness of enhanced enforcement of the prohibition of tobacco sales among under-age US adolescents. Even the most pessimistic scenario, involving the highest estimates of additional enforcement and related costs and the lowest reasonable expectations of impact on teenage smoking rates, produced a cost-effectiveness ratio of US$3,100 per life-year saved. Mid-range assumptions resulted in cost-effectiveness ratios ranging from US$260 to $1,100 per life year saved.

Smoke-free workplaces are another common tobacco control intervention. These policies can be doubly beneficial from a health protection perspective, by protecting non-smoker employees from environmental tobacco smoke as well as creating an environment that encourages smokers to reduce or quit (Moher et al., 2005). In a systematic review of 26 studies in Canada, the US, Australia, and Germany, Fichtenberg and Glantz (2002) found that complete workplace smoking bans resulted in a 3.8% reduction in prevalence of smoking and an absolute reduction of 3.1 cigarettes smoked per day per continuing smoker. On a per employee basis (smokers and non-smokers combined), these findings translated to a 29% relative reduction in total employee cigarette use, an effect roughly equivalent to a 73% increase in cigarette pricing.

Other research suggests that even small reductions in smoking attributable to workplace smoking bans are economically efficient, particularly given the relatively low costs associated with implementing such policies (e.g., Lightwood and Glantz, 1997; Lightwood et al., 1999). For instance, smoke-free workplaces appear to be cost-effective relative even to free nicotine replacement therapy (NRT) programs, which themselves are known to be very cost-effective. According to one US study, a free state-wide NRT program was estimated to generate a cost-effectiveness ratio of $4,440/QALY, nearly 9 times higher than the $506/QALY ratio associated with the implementation of a state-wide smoke-free workplace policy (Ong and Glantz, 2005).

4.1.2. A subset of preventive health interventions are "cost-saving" from the health system perspective

A number of preventive health interventions offer particularly high economic value when seen from the health service payers' perspective (in the Canadian context, primarily the public-funded health system, defined here as the health care and public health sectors together), in that the value of health system resources avoided through prevented illness or injury (and thus freed up for other use) exceeds the value of resources required to implement the intervention.[1] It is important to note that this limited perspective considers

[1] While the public health literature typically describes such interventions as "cost-saving," the term carries a more precise meaning in the management and accounting fields, where it refers specifically to a tangible reduction in the financial bottom-line that results in saved money that can be removed from a budget or reinvested elsewhere. In contrast, a second and less tangible type of cost containment, known as "cost avoidance," refers to acts that do not appear on, but materially impact, the immediate bottom-line by reducing or preventing future costs. Cost avoidance often becomes cost-savings over time (Ashenbaum,

only those direct costs associated with the delivery of health-related services in relation to the prevention, diagnosis, and treatment of disease (e.g., community preventive health services, medications, ambulances, inpatient or outpatient care, rehabilitation, etc.). Excluded from consideration are the often substantial public and private costs borne by individuals and institutions outside of the formal health sector.

The following is a sample of interventions that have consistently demonstrated the potential to generate cost-savings for the health system:

- Repeated *clinical smoking-cessation counselling* is considered among the most clinically important and highest value-for-money preventive services available in medical practice (Maciosek et al., 2006a), and was ranked by a recent Canadian analysis as the highest priority among effective clinical preventive services based on its associated clinically preventable burden (H. Krueger and Associates, 2008a). A US-based modelling study concluded that delivery of this intervention nation-wide could save 2.5 million QALYs annually at a cost-savings of US$500 per smoker who receives the service, largely due to the financial savings accrued from the prevention of smoking-attributable diseases (Solberg et al., 2006).
- Herbst and colleagues (2007) summarized economic evaluations of various *group- and community-level HIV behavioural risk-reduction interventions* for US adult men who have sex with men. Overall, both group-level interventions involving small-group cognitive-behavioural and skills training workshops and community-level interventions involving peer opinion leadership programs were found to generate significant net cost-savings for the health system, primarily because the costs of treating HIV or AIDS far overshadow the program-related costs of preventing infection.
- Drawing on Canadian case study data, a recent review of the economic impact of *needle exchange programs* aimed at reducing HIV infection risk among injection drug users found that such interventions could prevent approximately 24 cases of HIV over a 5-year period, generating a total health care savings-to-cost ratio of 4-to-1 (Delgado, 2004). International data corroborate the cost-saving potential of these and other needle syringe programs (Wodak and Cooney, 2006).
- The Department of Human Services (2006) in Victoria, Australia, reviewed the cost-effectiveness of 13 *obesity interventions for children and adolescents*, and identified six as “extremely good” value-for-money (i.e., cost-saving). These included school-based programs to reduce television viewing and soda consumption, family-based programs targeting obese children, and partial bans on advertisements of unhealthy foods during children’s television programming. This last intervention was determined to have a 100% chance of being cost-saving, by as much as AU$300 million.
- *Regulations mandating the installation and use of vehicular safety-belts* for front-seat drivers and passengers has consistently been found to be cost-saving, even when occupant compliance rates are modestly assumed (e.g., 50%; Graham et al., 1997), due to the high health protection efficacy and relatively low costs of implementing such policies (Grosse et al., 2007).

Overall, however, cost-saving interventions constituted only a small minority of the total,

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2006). As existing economic evaluation studies of preventive health interventions generally do not distinguish between “cost-saving” and “cost avoidance,” the term “cost-saving” will be used in its general meaning for the purposes of this paper.

indicating that preventive health interventions are generally not cost-saving for the payer. This finding is consistent with that of previous research (e.g., Coffield et al., 2001; Cohen et al., 2008; Doubilet et al., 1986; Grosse, 2005; Russell, 1986, 2007).

Several views have been put forward to explain this general result. First, because it is impossible to know with certainty which individuals within a population will actually develop a health condition of interest, population-level prevention programs are invariably delivered to more people than those who would actually benefit from them (Woolf, 2008). Second, compared to the immediate benefit of treating an illness (i.e., the reduction if not elimination of current and tangible suffering), the benefit of preventing that illness (i.e., the potential avoidance or mitigation of imagined, if probable, future suffering) often lacks sufficient urgency to induce a sustained commitment to a preventive intervention regimen, particularly where personal behaviour change is involved (Hagberg and Lingstrom, 2005). Consequently, most preventive health programs are ever only partially effective, necessitating intensified and repeated efforts to achieve the same health gains. Finally, some successful preventive health interventions may lead counter-intuitively to higher lifetime health system expenditures, if the savings accrued through the prevention of a potentially fatal illness in the short-term are offset by the need to treat more, and more costly, diseases that are allowed to develop over the extended lifespan (van Baal et al., 2008).

It is important to recognize that these arguments are intended not to undermine current public health efforts, but rather to underscore the view that preventing and mitigating illness and injury and promoting good health are legitimate social objectives that, in and of themselves, justify public health actions. All else being equal, health interventions that are cost-saving are clearly preferable, but the ability to produce net cost-savings cannot be held as a prerequisite for support, as this would exclude the vast majority of currently available medical treatments and preventive health measures. To take but one example, many newborn screening programs for metabolic and other disorders are not cost-saving for the health system but are nevertheless seen by society as providing a net good, and thus are supported on these grounds (Grosse, 2005).

Moreover, it would be misguided to interpret the specific failure of preventive health interventions to demonstrate a universal—or even general—capacity to produce net cost-savings for the health system as a general inability to contribute to the long-term sustainability of the health care system. Their potential to do so is in fact great, when seen from the perspective of economic efficiency. Health interventions need not reduce the bottom-line in order to generate value.

To the extent that improving health is “too expensive” under the current health system—as suggested by ever-mounting health care expenditures and growing concerns about the sustainability of the system—it reflects a problem of inefficiency that calls for a more judicious allocation of investments in order to reduce overall spending per health unit gained (Woolf, 2008). As Woolf and colleagues (2009: 4) note, “through sheer volume, much more can be accomplished by limiting spending on expensive, relatively low-value services and shifting these dollars to high-value services that can generate greater or comparable health improvements at less cost.” In other words, a promising contribution to the long-term sustainability of the health system lies not in the pursuit of absolute cost-savings, but rather in the pursuit of incrementally improving the relative cost-effectiveness of its cumulative performance.

The economic evaluation evidence discussed above strongly suggests that a strategic shift in spending towards preventive health efforts may help to achieve this. Many treatment interventions delivered in clinical care settings have poor cost-effectiveness ratios (Figure 4). In many—though far from all—cases, the same health outcome gains achieved through treatment interventions could be attained more efficiently through disease prevention and health promotion strategies. In other cases, treatment trumps prevention as the more effective and cost-effective option. The point is not to pit one against the other, but rather to recognize that both share the common objective of improving health. Consequently, to the extent that economic perspectives are considered in the allocation of health sector resources, health interventions that offer higher value-for-money could be expected to be favoured. This provides further impetus for applying a consistent and thorough economic evaluation lens across all health sector interventions, both preventive and curative.

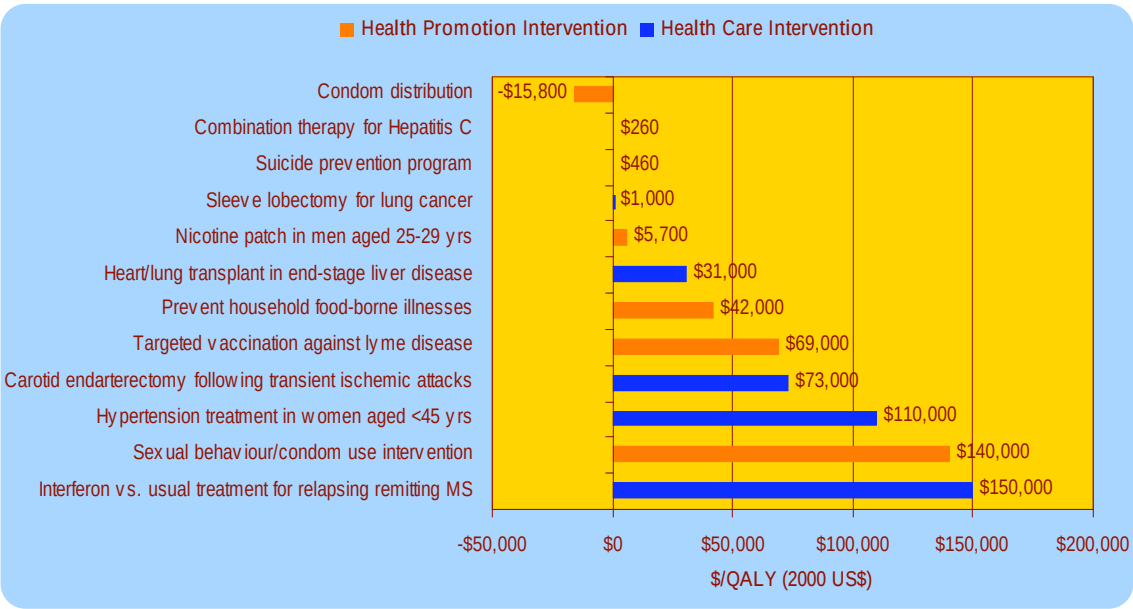

Figure 4: Cost per QALY gained for selected health promotion and health care interventions
(Source: Adapted from Shiell and MacIntosh, 2006:25)

4.1.3. The cost-effectiveness of an intervention is highly sensitive to context

Whether a particular intervention is cost-effective and/or cost-saving depends on key contextual variables involving place and time. Sculpher and colleagues (2004:10) identified 26 such factors that may cause variability in cost-effectiveness across locations, including case mix, culture/attitudes, demography, and health professional's skill-sets and experience. Welte and colleagues (2004) offer a similar list of 14 "transferability factors" to be considered when transferring economic evaluation results across country contexts.

In some instances, interventions that are found to be presently cost-effective or cost-saving in a particular setting may not remain so if expanded or delivered under different circumstances. For example, economic analyses to date have generally provided strong empirical support for the net cost-savings of universally recommended immunization programs, particularly when administered at an early age (Ortega-Sanchez et al., 2008; Zhou et al., 2005). However, even vaccines that are highly cost-saving on average may

not be so as higher rates of population coverage are achieved and additional efforts are needed to reach the most marginalized recipients. Similarly, in one study that examined the literature to determine the economics of HPV vaccine provision across different age groups of young women, it was found that cost-effectiveness declined dramatically as the scope of the intervention increased by age group: $43,600/QALY gained for the vaccination of 12-year-old girls; $97,300/QALY for expansion to 18-year-olds; $120,400/QALY for expansion to 21-year-olds; and $152,700/QALY for expansion to 26-year-olds (Kim and Goldie, 2008).

Conversely, some interventions that are not cost-effective in one context may become so in another. In certain cases, this may involve targeting the intervention at specific groups, such as high-risk populations (Dalziel and Segal, 2007; Woolf et al., 2009). In others, the time horizon with which to observe the fruition of the intervention's benefits and consequences may need to be extended. For example, in one simulation study of community-based interventions to promote physical activity, reducing the analytic time-horizon from 40 years to 10 years led to a more than five-fold increase in the cost-to-QALY ratio, from US$27,000 per QALY to $147,000 per QALY (2003 dollars) (Roux et al., 2008). In other words, the intervention in question would generally be considered cost-effective given a 40-year time-horizon for health improvements to be observed, but not cost-effective if a 10-year window were chosen instead.

In general, whether a particular preventive health intervention saves money for the payer or is otherwise a reasonable investment from either the health system or societal perspective will depend both on the nature of the intervention of interest and the characteristics of the target population for which it is intended. Just as it would be inappropriate to generalize beyond specific findings for one intervention to all forms of prevention, it is inadvisable to infer the cost-effectiveness or cost-savings of a specific intervention in a local context based on the implementation and evaluation of a similar program in a different setting (Anderson, 2009). Determining the value-for-money of any given intervention in a particular place and time is best done on a case-by-case basis.

4.2. *Building the evidence: critical knowledge gaps in preventive health intervention evaluation*

4.2.1. Economic evaluations are inconsistently applied across the prevention spectrum

To date, economic evaluations have been inconsistently applied in the area of prevention in at least two ways: they are unequally distributed across the prevention spectrum, and they vary in the quality of their research designs and output.

First, economic evaluations of public health interventions are unequally distributed across the prevention spectrum, with the majority concentrated in the areas of clinical prevention. Some additional work is found in selected health protection domains. By contrast, health promotion interventions have been the subject of relatively few economic evaluations; fewer still have assessed interventions that address the "upstream" determinants of health in terms of the potential for cost-savings or cost-effectiveness.

The lop-sidedness of the current economic evaluation literature is consistent with the findings of previous reviews of the evidence (Carande-Kulis et al., 2000; Goldsmith et al., 2004; Ramsey, 2000; Rush et al., 2004). For example, in their 2002 census of economic evaluations of primary prevention interventions in population health, University of Calgary researchers found that of 414 evaluations identified, nearly 90 percent focused on "downstream" biological or behavioural risk factors and only 10 percent on "upstream" environmental, social, and economic determinants. In terms of health promotion activity area, nearly three-quarters of economic evaluation citations related to clinical preventive efforts or personal skill development, while only one-fifth targeted the creation of supportive environments. No economic evaluations of interventions to build healthy public policy were identified (Rush et al., 2004).

The relatively sporadic use of economic evaluation analyses in "upstream" preventive health interventions is linked in part to the myriad conceptual and methodological issues associated with performing economic evaluations on these relatively complex initiatives. Key challenges include:

- identifying, isolating, and quantifying the economic costs and benefits of complicated and often multi-faceted interventions whose effects are frequently spread across multiple social domains;
- maintaining a sufficiently long-term view to capture or infer the full scope of benefits, including those that may take upwards of a generation to materialize;
- teasing apart causality and confounding generated by interactions between relevant genetic, biological, and behavioural risk factors and social, economic, and environmental risk conditions; and
- navigating the above challenges in situations where the intervention of interest is delivered within, and may even explicitly seek to change, a setting or system that is itself characterized by complexity (Shiell et al., 2008).

In addition to their sporadic application, the evidence that is available is characterized by a diversity of study designs and outcome measures as well as significant variability in research quality. This reduces both confidence in the validity of economic evaluation findings as well as the comparability across different interventions and contexts, ultimately limiting the usefulness of the evidence for decision-makers and practitioners.

Recognizing this gap, researchers have called for more coordinated and rigorous economic evaluation efforts in many preventive health intervention areas (e.g., Hawthorne et al., 2008; Pomerleau et al., 2005; Priest et al., 2008; Vijgen et al., 2006; Waddell et al., 2007; Wall et al., 2006). Greater investment in economic evaluations is needed in order to better identify those preventive health interventions that can most successfully achieve their program goals in a cost-effective manner.

4.2.2. Many preventive health interventions have not been evaluated for their program effectiveness

If many "upstream" preventive health interventions lack rigorous and systematic data on their cost-effectiveness, then many others lack sufficient evidence on even their basic program or policy effectiveness (Task Force on Community Preventive Services, 2009; Wanless, 2004). This more foundational knowledge gap is also due to some extent to the methodological challenges inherent in attempting to isolate and quantify the various cause-and-effect pathways within a community-level intervention (Dooris et al., 2007;

Rychetnik et al., 2002), particularly as many such interventions that target mid- and upstream risk factors often produce additional health and non-health benefits beyond their primary focus of attention. Ensuring that the full spectrum of value is captured in program evaluations is important if the effectiveness—and cost-effectiveness—of these types of interventions are to be accurately assessed.

The Walking School Bus (WSB), a safe and active transportation model for schoolchildren that has been adapted in neighbourhoods across the UK, Australia, New Zealand, Europe, and North America, is a case in point. In an evaluation of a local WSB program as part of a review of 13 obesity-related interventions, the Department of Human Services in Victoria, Australia, concluded that the initiative was limited in its effectiveness and thus "not cost-effective under current assumptions" (Department of Human Services, 2006). Shiell (2007) observes, however, that many potential benefits of the program other than obesity reduction were acknowledged but otherwise ignored in the evaluation, including reduced traffic congestion and pollution; more opportunities to meet friends and neighbours; greater awareness of local neighbourhoods and sense of community; enhanced pedestrian skills and fewer road accidents; and increased physical activity and exercise habits. As a result, the broader social value of the initiative remains largely unknown, rendering any conclusions about its effectiveness and cost-effectiveness premature.

Demonstrating the cost-effectiveness of a preventive health intervention is unlikely to convince decision-makers of its value unless its effectiveness in achieving its intended health outcomes can first be shown. This evidence of effectiveness must be determined empirically rather than merely assumed, particularly given that some may not only be ineffective but may even harm health (Adams and White, 2005; Shiell and McIntosh, 2006). Indeed, the protocol adopted by the US Taskforce on Community Preventive Services for its systematic reviews of population-based prevention programs requires that interventions first demonstrate effectiveness before their economic dimensions are considered. Therefore, a principal challenge for improving knowledge about the economics of preventive health is to first improve knowledge on the effectiveness of complex interventions that currently lack such data (Zechmeister et al., 2008).

At the same time, there are also risks associated with making the implementation of preventive health interventions, especially those within the health promotion and healthy public policy domains, contingent on the availability of complete evidence demonstrating cost-effectiveness, particularly as action in these relatively neglected areas is a necessary precondition for generating that evidence (Goldsmith et al., 2004). There is an urgent need to invest in these types of interventions, and to build rigorous evaluation mechanisms into their programming, in order to identify the most promising initiatives. Evaluation of demonstration projects and serendipitous policy or program "interventions" are two possible mechanisms for facilitating this iterative action-knowledge cycle.

4.3. Expanding the evidence: the broad economic benefits of good health beyond the health sector

Much of the available economic evaluation research and analytical work has adopted a health system perspective, focusing on whether prevention is cost-saving for the health system, in the ideal case, or else allows for a more cost-effective distribution of

resources such that more health can be "bought" with current levels of funding.

Increasingly, researchers have sought to broaden the scope of inquiry by considering more explicitly the potential economic benefits of good health in general for society, over and above their impacts on health expenditures. Indeed, current good practice in economic evaluation calls for the adoption of this societal perspective, which includes the economic benefits associated with the avoidance of indirect costs (or conversely, the accrual of indirect gains) (Weinstein et al., 1996). Bloom and Canning (2000) identified four avenues through which a healthier population can contribute to microeconomic growth (that is, economic gains at the individual and household levels):

- labour productivity (i.e., a more efficient workforce, leading to increased wages and earnings);
- labour supply (i.e., longer participation in the workforce due to extended good health at all stages of life as well as reduced need to exit the labour force to provide care for ill dependents);
- education (i.e., enhanced cognitive development, reduced school absenteeism, and reduced early drop-out rates, all contributing to higher educational attainment and improved life chances); and
- savings and investment (i.e., increased savings for retirement or investment in physical capital as a result of an anticipated longer lifespan).

Others have argued even further, noting that community development programmes, as a key component of health promotion activity (WHO, 1986), are capable of producing a number of important social benefits with potential economic implications—e.g., capacity-building, community cohesion and empowerment, etc.—that should also be taken up for consideration (Shiell and Hawe, 1996).

Furthermore, the possibility has been raised that, through the aggregation of these microeconomic contributions, a healthier population may generate greater rates of macroeconomic growth than would a relatively less healthy population (Suhrcke et al., 2006; Suhrcke et al., 2007). Much of this research is still in its infancy and has focused on developing nations as part of broader efforts to situate health at the centre of development agendas. In the context of high-income countries, what little work has been undertaken to date has produced plausible but mixed results. More research is needed to clarify these initial findings.

Nevertheless, to the extent that good health confers microeconomic (and potentially macroeconomic) benefits beyond those immediately relevant to the health care sector, it raises a number of implications for the scope of the economic case for prevention. First, it implies that investing in actions that target the broader determinants of health, which lie largely outside the formal health sector, can generate significant health-related economic returns. Second, it implies that investing in actions that aim to reduce health inequalities may also be economically justifiable, insofar as improving the health status of currently disadvantaged individuals and groups would enable them to pursue more fully their human, economic, and social potentials, and in doing so mitigate (in part or in full) the initial costs of those investments.

4.3.1. Healthy public policies as preventive health interventions

Recent reports by Canada's Chief Public Health Officer (Butler-Jones, 2008) and the

WHO's Commission on Social Determinants of Health (2008) demonstrate that the social determinants of health—the conditions under which we live and work—can exert a greater impact on population health outcomes than factors such as genetics, lifestyles, or health care services. These conditions are largely shaped by social and economic policies, lying outside the formal health sector, that influence quality-of-life and the resources available to individuals and families (Williams et al., 2008). In response, researchers and policy-makers are increasingly recommending that investments to improve population health focus not only on relatively "downstream" interventions that strive to change adverse health behaviours, but also on cross-sectoral "upstream" interventions that attempt to change the conditions and circumstances that encourage adverse health behaviours (e.g., Kelly et al., 2005; Wanless, 2004).

If policies and program interventions outside of the health sector can generate health benefits, a question arises as to whether they can do so in a cost-effective manner. If so, then a strong economic case could be made for investing in "upstream" actions that could improve health—for example, so-called "healthy public policies." Unfortunately, economic evaluation data is lacking for most of these initiatives, many of which do not focus on health as an explicit objective (Rush et al., 2004). One exception to this general case is early childhood development.

Early childhood development. Adverse socioeconomic circumstances in infancy and childhood lead to poor mental and physical development trajectories. In turn, ill health in these early years impacts future well-being, as these and other health and social disadvantages tend to accumulate throughout one's life-course and over generations (Robert Woods Johnson Foundation, 2008).

Just as circumstances in early life have a powerful impact on future health, social, and economic outcomes, much evidence points to the powerful impact of policies that encourage healthy child development on improving life chances. The individual and societal benefits of early childhood development (ECD) initiatives have been well-documented, particularly in the US, thanks in large part to rigorous evaluations and long-term follow-up studies of a number of model ECD programs.

These analyses have consistently reported that each dollar invested in a strong start to the early years generates positive returns for both program participants and the broader public in the form of reduced health care costs for paediatric health problems; increased educational attainment, income earnings, and adult productivity; and reduced rates of welfare dependency and crime, all of which lead in turn to better health outcomes (Karoly et al., 2005). Investments in ECD programs therefore easily pay for themselves over time, particularly when investments are targeted at children living in high-risk situations. Benefit-to-cost ratios of 3:1 or more are typically reported (Lynch, 2004). For example, the Perry Preschool Project, which recently completed a 40-year evaluation of participant outcomes, has produced a discounted benefit-to-cost ratio of more than 16:1, indicating a return of US$16.14 (2000 dollars) per dollar invested (Schweinhart, 2005). Notably, more than three-quarters of these economic benefits ($12.90 per dollar invested) were spillovers accrued to non-participants, indicating that society at large has potentially even more to gain from ECD investments than program participants themselves (Figure 5).

One important limitation of the existing economic evaluation evidence is that it relates to targeted ECD programs aimed at a highly disadvantaged population. Extrapolating

findings from these small-scale interventions to broader contexts must be undertaken with caution and confirmed through additional analysis. Nevertheless, with these caveats in mind, some researchers have begun to examine whether more comprehensive or universal ECD programs may also be highly cost-saving for society.

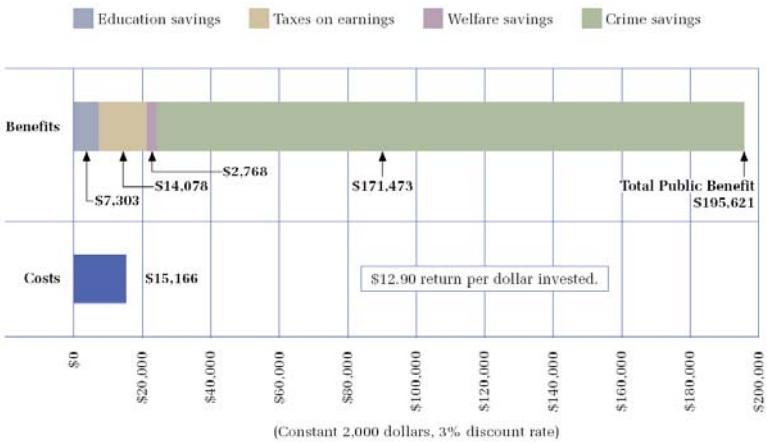

Figure 5: High/Scope Perry Preschool Program public costs and benefits (Source: Schweinhart, 2005)

According to one estimate, a publicly financed ECD program for all US children in low-income families would generate substantial budgetary savings over time. Although program costs would be necessarily high given its national scope, the net budgetary effect for all levels of government combined would become positive over time, as initial investments in the early life development of program participants begin to manifest in terms of higher educational attainment, improved labour productivity, and reduced delinquency. Within 25 years, net savings would reach US$31 billion (2004 dollars); within 45 years, $61 billion. Increase in individual earnings would boost GDP by 0.43% ($107 billion), and the benefits of averted criminal activity would amount to approximately $155 billion (Lynch, 2004). Along a similar vein, a recent comparative analysis of preschool education and traditional economic development levers as means of increasing employment rates and annual earnings per person found that the magnitude of the potential economic benefits of universal, high-quality preschool education compared favourably even with the benefits of equivalent subsidies to business, generating more jobs and earnings over the long-term (Bartik, 2006).

4.3.2. The potential economic impact of reduced health inequalities

The case for addressing health inequalities involves recognizing their substantial social, economic, and political costs as well as the benefit of improved overall health for individuals, communities, and society.

In one sense, heath inequalities themselves can be seen as health system cost drivers, in that people of relatively lower social status tend to consume more health care services than those of relatively higher status. According to one estimate, approximately 20% of total health care spending in Canada can be attributed to income disparities alone (Health Disparities Task Group, 2005). Similarly, Lemstra and colleagues (2008) found that low-income residents in Saskatoon were 27-33% more likely to be hospitalized and 36-45% more likely to be receiving medication compared to higher-income groups. Increased health care utilization by low income residents was due mainly to increased disease prevalence rather than differences in utilization behaviour. The researchers concluded that low income residents in Saskatchewan consume $179 million more in health care costs than is anticipated in comparison to middle and high income residents, implying that some if not all of these costs can be avoided through effective interventions that aim to improve health outcomes and socioeconomic status concurrently.

At an aggregate level, Mackenbach et al. (2007) developed a conceptual model to illustrate in quantitative terms the impact of health inequalities on individual (microeconomic) and national (macroeconomic) economic outcomes in the European Union (EU). The economic costs of the unequal distribution of the burden of ill health, based on educational attainment (above versus below high-school level) as a crude measure of socioeconomic status, were found to be substantial. Inequalities-related losses related to health as a ”capital good” (i.e., reduced labour productivity) amounted to 1.4% of GDP annually (€141 billion). Losses to health as a ”consumption good” (i.e., the value placed on the personal well-being that health provides) were estimated at 9.5% of GDP annually (approximately €1 trillion). If all persons had the health corresponding to those with the highest educational levels, costs for the EU social security (i.e., unemployment and disability benefits) and health care systems would be reduced by 15% (€60 billion) and 20% (€177 billion), respectively. Likewise, reducing all health inequalities in the EU by 10% would generate annual economic benefits of €14 billion through gains in health as a ”capital good,” €70 billion through gains in health as a “consumption good,” €18 billion through reduced health care costs, and €6 billion through reduced social security costs. However, as the approximate costs of the policies and programs needed to reduce these health inequalities were not reported, the cost-effectiveness or cost-savings of such interventions remains unknown.

Dow and Shoeni (2008) produced similar estimates of forgone economic value associated with health inequalities in the US, focusing on the monetary benefits of improving the health of less-educated Americans. Without claiming that education in itself causes improved health or longer life-spans, they calculated that if all US adults with less than a college education experienced the health status and death rates of college-educated Americans, the total economic value gained would be more than US$1 trillion annually (2006 dollars). Moreover, this value is an underestimate of the total potential economic benefits, since it represents only the economic gains accrued to the less-educated adults themselves and not those accrued to their families and society, and reflects only the health-related economic gains associated with improved social conditions. As with the EU example above, Dow and Shoeni did not report on the public costs associated with the interventions, making cost-effectiveness determinations impossible at this time. Nevertheless, given the magnitude of the potential economic benefits associated with reduced health inequalities in both case studies, favourable returns on investment can reasonably be expected.

4.4. Using the evidence: key methodological considerations

Although economic evaluations can be a useful tool for informing policy decisions, they are also subject to several important shortcomings. The judicious use of economic evaluation evidence requires that these limitations be respected so as to minimize any negative unintended consequences that may arise from its application. Chief among these considerations is understanding how costs and benefits are defined when carrying out economic evaluation analyses, and the implications of these definitions for issues such as health equity and bias.

As noted earlier, the costs and benefits of a given intervention can be understood along several dimensions (Figure 6). To reiterate, the narrower health payer perspective limits the costs and benefits to those that are directly related to health system performance. A

broader societal perspective expands the scope towards incrementally more inclusive accounts of individual and societal costs and consequences, such as the direct personal costs of lost wages or transportation expenses needed to access the intervention as well as indirect societal costs (e.g., lost labour force productivity) associated with illness, disability, or premature death. Finally, the broadest and most inclusive perspective, that of social welfare, attempts to capture the intrinsic value that people place on better health (Suhrcke et al., 2008). Additionally, costs and benefits can also be viewed in terms of whether they accrue within the public or private domains (Hankivsky et al., 2004).

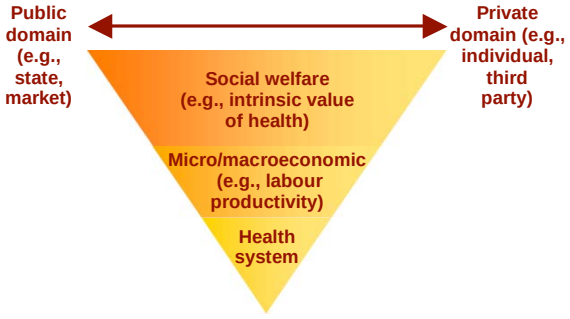

Figure 6: Conceptual levels and domains of economic costs and benefits of prevention

Despite the recommendation from the US Panel on Cost-Effectiveness in Health and Medicine that analyses intended to inform public policy should adopt a societal perspective when considering costs and benefits (Weinstein et al., 1996), typically only those costs and benefits that are relatively easy to measure are included in practice (Grosse et al., 2007). In turn, this often translates to fulsome attention being paid to health system costs, somewhat intermittent attention to individual health benefits, sporadic attention to societal and microeconomic costs and benefits, and little if any attention to social welfare considerations.

This common omission is problematic from the perspectives of both equity and implementation efficiency. For example, relatively few economic evaluations of preventive interventions include participants' and/or their caregivers' unpaid time as a cost parameter, yet both the perceived and actual amount of time required to be invested are key determinants of program adherence, which in turn can significantly influence program effectiveness and cost-effectiveness (Dishman et al., 1985; Hagberg and Lindholm, 2005). Consequently, the exclusion of time costs can yield misleading results for interventions that require substantial effort from participants or care-givers, particularly those targeting marginalized people for whom time is already a scarce resource. Likewise, Reid (1999) has argued from the perspective of adolescent tobacco prevention that complex school-based interventions often place unrealistic time demands on the teachers who typically deliver them, and hence may prove less cost-effective than community-based interventions over the long term as competing pressures compel staff to deviate from the intervention's protocol.

Similarly, relatively few economic evaluation studies break down intervention effectiveness, costs, and benefits by specific sub-populations, with the majority relying instead on average values for the entire population (Roux et al., 2008). Yet, research has demonstrated that an individual's or group's exposure to and uptake of preventive health advice and services is typically moderated by age, ethnicity/race, sexual orientation, socioeconomic status, and life circumstances, such that some consistently and more readily benefit from population-wide preventive interventions than others (e.g., Diamant et al., 2000; Lorant et al., 2002; Lynch et al., 1997; Meltzer et al., 2002; Tjepkema, 2008). Failure to account for this may lead to resources being directed at interventions that are effective and economically efficient for the average recipient but less so for those who are marginalized or disadvantaged. Ultimately, this would have

the undesired effect of increasing health inequalities (Hagberg and Lindholm, 2005).

Even when differential effects by subpopulations are included in analyses, a number of important equity considerations may be overlooked due to systematic biases in economic evaluation instruments. Jones and Frick (2008; Frick and Jones, 2008) identify three areas of potential gender bias in economic evaluation methods:

- the consistent under-valuation, in monetary terms, of women's time spent in paid and unpaid work when estimating productivity losses associated with illness;
- quality-of-life valuations generally and as applied to types of conditions more likely to be (or only) experienced by women; and
- the ways in which gender role differences may interact with the health and well-being of family members to produce secondary effects that may be large in magnitude, but are overlooked by economic evaluators.

Likewise, Hankivsky and others (2004) note that conceptual flaws in conventional economic evaluation approaches to measuring lost productivity due to illness and premature death can occasionally lead to superficially absurd results, such as cost-of-illness findings implying that the mortality costs associated with the total burden of illness are nearly twice as high for men as they are for women. Clearly, acting upon these findings uncritically could lead to highly inequitable consequences.

Acknowledgement of these and other methodological considerations does not invalidate existing economic evaluation efforts. Instead, making these assumptions explicit allows them to be incorporated more consciously and conscientiously within existing research and knowledge translation projects, and encourages a more thorough assessment of the evidence base. This has the dual benefit of stimulating the development of more sophisticated research methodologies that address these limitations as well as helping to mitigate the risk of inadvertently perpetuating health and social inequities in the course of policy analysis and decision-making.

SUMMARY POINTS AND CONSIDERATIONS

1. Overall, the evidence suggests that many preventive health interventions can be cost-effective both from the health service payers' and the societal perspectives, although most are unlikely to generate net cost-savings for the payer.

2. Many preventive health interventions generate a wide range of indirect individual and societal benefits, including those that can potentially contribute to improved overall economic well-being for society. As much as possible, efforts should be made to account for these benefits in economic evaluations so as to reflect the full scope of the intervention's potential.

3. The cost-effectiveness of a preventive health intervention is highly sensitive to context. To determine whether a given intervention is likely to offer good value-for-money, the available economic evidence should be translated and adapted to local conditions and circumstances.

4. High-quality data on effectiveness and cost-effectiveness are lacking for many preventive health interventions, particularly those health promotion, health protection, and healthy public policy interventions that target the "upstream" determinants of health. Substantial efforts are needed to fill these critical knowledge gaps.

5. Reducing social inequalities in health may directly and indirectly produce significant economic benefits for both the health system and society more broadly.

6. Economic evaluation evidence can play an important role as one of several key inputs within a broader rationale for investing in preventive health interventions.

5. Concluding considerations

Consistent with other assessments of the economics of preventive health interventions, our brief survey of the recent evidence found that some interventions are cost-saving for the health system, and many others are cost-effective. Adopting a broader societal perspective increases the cost-effectiveness of many prevention initiatives, and increases the likelihood for overall favourable cost-savings.

However, as Russell (1986) pointed out more than two decades ago, one cannot make generalizations about preventive interventions as though they are all alike, nor can one take for granted the cost-effectiveness or cost-saving potential of even the most well-established and highly regarded program. The context-sensitive nature of public health action means that the economic benefits of the range of preventive interventions must first be assessed individually, across diverse settings and longer timeframes, before more general conclusions can be attempted.

Moreover, the inconsistent utilization of economic evaluations across the spectrum of preventive health interventions, as well as the variable quality of the available evidence, have given rise to a number of critical knowledge gaps. Addressing these gaps should be made a research priority if economic evaluation evidence is to be included consistently as an input into the decision-making process.

Of particular concern from a Canadian perspective is the under-representation of economic evaluations of Canadian interventions within the broader literature. Although there are sufficient commonalities between Canada and other key jurisdictions (i.e., the US, the UK, Australia, New Zealand) exist allow for a cautious transfer of knowledge across national settings, more Canadian-specific evaluations is needed to confirm the relevance of, and/or adapt where applicable, the international evidence to local contexts (Drummond et al., 2005).

At the same time, the systematic use of economic evaluations for policy-making purposes should in itself be assessed in terms of relative merits and drawbacks, given the limits of existing methodological tools in capturing the full scope of costs and benefits for many preventive health interventions, particularly those that target more complex "upstream" health determinants. As Goldsmith and colleagues conclude in their review of the economic evaluation of prevention literature,

> requiring economic evidence as a mandatory input to decision making would, in the short term, delay the implementation of preventive programs with demonstrated large population health effects that had not yet been subjected to economic evaluation. Perhaps more importantly, in the long term such a requirement would discriminate against health promotion, health protection and healthy public policy interventions whose costs and consequences are often difficult to measure credibly because they are spread across multiple health and social domains. (Goldsmith et al., 2004:33-34)

Lastly, it is emphasized that while economic evaluations can offer a systematic framework for assessing the relative cost-effectiveness of different health interventions, both preventive or curative, delineating the economic impacts of these options will not obviate the need for policy-makers to make difficult choices about the allocation of finite

and perpetually inadequate health sector funds (Russell, 2007). Where a particular intervention is determined to be cost-saving, the economic argument for investment is readily apparent. Unfortunately, the number of instances in which this is the case are frustratingly few. More often, some interventions are relatively cost-effective in most but not all contexts, while others may be so when delivered to a specific target population or in a particular setting. Others still may never offer favourable economic benefits, yet nevertheless warrant support on non-economic grounds. Ultimately, public investments to prevent illness and injury and improve individual and population health are driven by societal values. Economic evaluation can inform, but cannot in itself deliver, the final determination of these priorities.

6. References

Adams J, White M. "When the population approach to prevention puts the health of individuals at risk." *International Journal of Epidemiology* 2005;34:40-43.

Anderson R. "Systematic reviews of economic evaluations: utility or futility?" *Health Economics* 2009;DOI 10.1002/hec.1486 (published online 20 April 2009 in advance of print).

Ashenbaum B. "Defining cost reduction and cost avoidance." *CAPS Research Critical Issues Report*, March 2006.

Bartik, TJ. "The economic development benefits of universal preschool education compared to traditional economic development programs." (Report to the Committee for Economic Development), 2006. Available at http://www.upjohninst.org/preschool/short_report.pdf, accessed 27 February 2009.

Bloom DE, Canning D. "The health and wealth of nations." *Science* 2000;287(5456):1207-1209.

Brisson M, Van de Velde N, De Wals P, Boily MC. "The potential cost-effectiveness of prophylactic human papillomavirus vaccines in Canada." *Vaccine* 2007;25:5399-5408.

Burnet DL, Elliott LD, Quinn MT, Plaut AJ, Schwartz MA, Chin MH. "Preventing diabetes in the clinical setting." *Journal of General Internal Medicine* 2006;21:84-93.

Butler-Jones D. *The Chief Public Health Officer's Report on the State of Public Health in Canada, 2008*. Ottawa: Her Majesty the Queen in Right of Canada, 2008.

CCS/NCIC (Canadian Cancer Society/National Cancer Institute of Canada). *Canadian Cancer Statistics 2008*. Toronto: CCS/NCIC, 2008.

CCS/NCIC (Canadian Cancer Society/National Cancer Institute of Canada). *Canadian Cancer Statistics 2006*. Toronto: CCS/NCIC, 2006.

CDC (Centers for Disease Control and Prevention). "Achievements in public health, 1900-1999 impact of vaccines universally recommended for children—United States, 1990-1998." *Mortality and Morbidity Weekly Report* 1999;48(12):243-248.

CIC (Canadian Immunization Committee). *Recommendations on a Human Papillomavirus Vaccination Program*. Ottawa: Her Majesty the Queen in Right of Canada, 2008.

Carande-Kulis VG, Maciosek MV, Briss PA, Teutsch SM, Zaza S, Truman BI, Messonnier ML, Pappaioanou M, Harris JR, Fielding J; Task Force on Community Preventive Services. "Methods for systematic reviews of economic evaluations for the Guide to Community Preventive Services." *American Journal of Preventive Medicine* 2000;18(S1):75-91.

CRD (Centre for Reviews and Dissemination). *Systematic Reviews: CRD's Guidance for Undertaking Reviews in Health Care*. York, UK: CRD, 2008.

Chiou CF, Hay JW, Wallace JF, Bloom BS, Neumann PJ, Sullivan SD, Yu HT, Keeler EB, Henning JM, Ofman JJ. "Development and validation of a grading system for the quality of cost-effectiveness studies." *Medical Care* 2003;41(1):32-44.

Coffield AB, Maciosek MV, McGinnis JM, Harris JR, Caldwell MB, Teutsch SM, Atkins D, Richland JH, Haddix A. "Priorities among recommended clinical preventive services." *American Journal of Preventive Medicine* 2001;21:1-9.

Cohen DA, Wu SY, and Farley TA. "Comparing the cost-effectiveness of HIV prevention interventions." *Journal of Acquired Immune Deficiency Syndromes* 2004;37(3):1404-1414.

Cohen JT, Neumann PT, and Weinstein MC. "Does preventive care save money? Health economics and the presidential candidates." *New England Journal of Medicine* 2008;358(7):661-663

Commission on Social Determinants of Health. C*losing the Gap in a Generation: Health Equity Through Action on the Social Determinants of Health. Final Report of the Commission on Social Determinants of Health.* Geneva: World Health Organization, 2008.

Dalziel K, Segal L. "Time to give nutrition interventions a higher profile: cost-effectiveness of 10 nutrition

interventions." *Health Promotion International* 2007;22(4):271-283.
Delahanty LM, Nathan DM. "Implications of the Diabetes Prevention Program and Look AHEAD Clinical Trials for Lifestyle Interventions." *Journal of the American Dietetic Association* 2008;108(4Suppl1):S66-S72.
Delgado C. "Evaluation of needle exchange programs." *Public Health Nursing* 2004;21(2):171-178.
Department of Human Services (State Government of Victoria, Australia). *ACE-Obesity: Assessing Cost-Effectiveness of Obesity Interventions in Children and Adolescents—Summary of Results.* Melbourne: State of Victoria, 2006.
Diamant AL, Schuster MA, Lever J. "Receipt of preventive health care services by lesbians." *American Journal of Preventive Medicine* 2000;19(3):141-148.
Dishman RK, Sallis JF, Orenstein DR. "The determinants of physical activity and exercise." *Public Health Reports* 1985;100(2):158–171.
Dooris M, Poland B, Kolbe L, de Leeuw E, McCall D, Wharf-Higgins J. "Healthy settings: building evidence for the effectiveness of whole system health promotion—challenges and future directions." In McQueen D, Jones C (Eds), *Global Perspectives on Health Promotion Effectiveness*. NY: Springer.
Doubilet P, Weinstein MC, McNeil BJ. "Use and misuse of the term 'cost effective' in medicine." *New England Journal of Medicine* 1986;314:253-256.
Dow W, Schoeni RF. *Economic Value of Improving the Health of Disadvantaged Americans* [technical report for *Overcoming Obstacles to Health, Report from the Robert Wood Johnson Foundation to the Commission to Build a Healthier America*], 2008. Available at http://www.commissiononhealth.org/Publications.aspx, accessed 2 March 2009.
Drummond MF, Sculper MJ, Torrance GW, O'Brien BJ, Stoddart GL. *Methods for the Economic Evaluation of Health Care Programmes* (3rd ed.). Oxford: Oxford University Press, 2005.
Fichtenberg CM, Glantz SA. "Effect of smoke-free workplaces on smoking behaviour: systematic review." *British Medical Journal* 2002;325:188-194
Flanagan WM, LePetit CL, Berthelot JM, White KJ, Coombs BA, Jones-McLean E. "Potential impact of population-based colorectal cancer screening in Canada." *Chronic Disease in Canada* 2003:24(4);81-88.
Frick KD, Jones AS. "Gender bias in economic evaluation methods: quality of life and family role effects." *Women's Health Issues* 2008;18:4-6.
Goldsmith LJ, Hutchinson B, Hurley J. *Economic Evaluation Across the Four Faces of Prevention: A Canadian Perspective*. Centre for Health Economics and Policy Analysis, Working Paper 06-01, 2004.
Graham JD, Thompson KM, Goldie SJ, Segui-Gomez M, and Weinstein MC. "The cost-effectiveness of air bags by seating position." *Journal of the American Medical Association* 1997;278(17):1418-1425.
Grosse SD. "Does newborn screening save money? The difference between cost-effective and cost-saving interventions." *Journal of Pediatrics* 2005;146:168-170.
Grosse SD, Teutsch SM, Haddix AC. "Lessons from cost-effectiveness research for United States public health policy." *Annual Review of Public Health* 2007;28:365-391.
H. Krueger and Associates. "Establishing priorities among effective clinical prevention services in British Columbia: summary and technical report" (unpublished report prepared for the BC Clinical Prevention Policy Review Committee), 2008a.
H. Krueger and Associates. "Implementing a human papillomavirus vaccination program: evidence on cost-effectiveness," 2008b. Available at http://www.krueger.ca, accessed 18 March 2009.
Hagberg LA, Lindholm L. "Is promotion of physical activity a wise use of societal resources? Issues of cost-effectiveness and equity in health." *Scandinavian Journal of Medicine and Science in Sports* 2005;15:304-312.
Hankivsky O, Friesen J, Varcoe C, MacPhail F, Greaves L, Spencer C. "Expanding economic costing in health care: values, gender and diversity." *Canadian Public Policy* 2004;30(3):257-282.
Hawthorne K, Robles Y, Cannings-John R, Edwards AGK. "Culturally appropriate health education for type 2 diabetes mellitus in ethnic minority groups." *Cochrane Database of Systematic Reviews* 2008;Issue 3.
Hayee BH, Chung-Faye G. "Colorectal cancer screening." *Clinical Medicine* 2006;6(5):453-456.
Health Canada. *Economic Burden of Illness in Canada 1998*. Ottawa: Minister of Public Works and Government Services Canada, 2002.
Health Disparities Task Group, Federal/Provincial/Territorial Advisory Committee on Population Health and Health Security. *Reducing Health Disparities—Roles of the Health Sector: Discussion Paper (December 2004)*, 2005. Available at http://www.phac-aspc.gc.ca/ph-sp/disparities/pdf06/disparities_discussion_paper_e.pdf, accessed 29 April 2009.
Herbst JH, Beeker C, Mathew A, McNally T, Passin W, Kay L, Crepaz N, Lyles C, Briss P, Chattopadhyay S, Johnson RL; Task Force on Community Preventive Services. "The effectiveness of individual-, group-, and community-level HIV behavioral risk-reduction interventions for adult men who have sex with men: a systematic review." *American Journal of Preventive Medicine* 2007;32(4):38-67.
Herman WH, Hoerger TJ, Brandle M, Hicks K, Sorensen S, Zhang P, Hamman RF, Ackermann RT,

Engelgau MM, Ratner RE; Diabetes Prevention Program Research Group. “The cost-effectiveness of lifestyle modification or Metformin in preventing Type 2 diabetes in adults with impaired glucose tolerance.” *Annals of Internal Medicine* 2005;142:323-332.
IHE (Institute of Health Economics). *IHE in your Pocket 2008: A Handbook of Health Economic Statistics*. Edmonton: IHE, 2008.
Jones AS, Frick KD. “Gender bias in economic evaluation methods: time costs and productivity loss.” *Women’s Health Issues* 2008;18:1-3.
Karoly L, Kilburn MR, Cannon J. *Early Childhood Interventions: Proven Results, Future Promise*. Santa Monica: RAND Corporation, 2005.
Kelly MP, McDaid D, Ludbrook A, Powell J. “Economic appraisal of public health interventions” [NHS briefing paper]. Available at www.nice.org.uk/page.aspx?o=513210, accessed 17 March 2009.
Kim JJ, Goldie SJ. “Health and economic implications of HPV vaccination in the United States.” *New England Journal of Medicine* 2008;359(8):821-832.
Lemstra M, Neudorf C, Mackenbach J, Nannapaneni U. “High healthcare utilization and costs associated with lower socioeconomic status: results from a linked dataset.” In Lemstra M, Neudorf C (eds.), *Health Disparity in Saskatoon: Analysis to Intervention*, pp. 214-224. Saskatoon: Saskatoon Health Region, 2008.
Lightwood JM, Glantz SA. “Short-term economic and health benefits of smoking cessation: myocardial infarction and stroke.” *Circulation* 1997;96:1089-1096.
Lightwood JM, Phibbs CS, Glantz SA. “Short-term health and economic benefits of smoking cessation: low birth weight.” *Pediatrics* 1999;104(6):1312-1320.
Lorant V, Boland B, Humblet P, Deliège D. “Equity in prevention and health care.” *Journal of Epidemiology and Community Health* 2002;56:510-516.
Lynch JW, Kaplan GA, Salonen JT. “Why do poor people behave poorly? Variation in adult health behaviours and psychosocial characteristics by stages of the socioeconomic lifecourse.” *Social Science and Medicine* 1997;44(6):809-819.
Lynch RG. *Exceptional Returns: Economic, Fiscal, and Social Benefits of Investment in Early Childhood Development*. Washington DC: Economic Policy Institute, 2004.
Maciosek MV, Coffield AB, Edwards NM, Flottemesch TJ, Goodman MJ, Solberg LI. “Priorities among effective clinical preventive services: results of a systematic review and analysis.” *American Journal of Preventive Medicine* 2006a;31(1):52-61.
Maciosek MV, Solberg LI, Coffield AB, Edwards NM, Goodman MJ. “Influenza vaccination: health impact and cost effectiveness among adults aged 50 to 64 and 65 and older.” *American Journal of Preventive Medicine* 2006b;31(1):72-79.
Mackenbach JP, Meerding WJ, Kunst AE. *Economic Implications of Socio-economic Inequalities in Health in the European Union*. European Commission Health and Consumer Protection Directorate-General, 2007.
Marra F, Gunther O, Ogilvie G, Marra CA, Pourbohloul B, Ehlen T, Miller D, Naus M, Patrick DM, Brunham RC. *A dynamic model to determine cost effectiveness of HPV vaccine in girls and boys in Canada.* ISSTDR, Seattle, Washington, July 29th – August 1st, 2007.
Marrett LD, De P, Airia P, Dryer D; Steering Committee of Canadian Cancer Statistics 2008. “Cancer in Canada in 2008.” *Canadian Medical Association Journal* 2008;179(11):1163-1170.
Meltzer DO, Huang ES, Zhang Q, Brown S. “Effects of patient self-selection on cost-effectiveness of diabetes therapy by age.” iHEA 2007 6th World Congress: Explorations in Health Economics Paper, 2002.
Moher M, Hey K, Lancaster T. “Workplace interventions for smoking cessation.” *Cochrane Database of Systematic Reviews* 2005;Issue 2.
Morris SK, Nguyen CK. “The human papillomavirus vaccine in Canada.” *Canadian Journal of Public Health* 2008;99(2):114-116.
Mudarri DH. “The costs and benefits of smoking restrictions: an assessment of the Smoke-Free Environment Act of 1993” (H.R. 3434). Government Document 1994; H.R. 3434, April 1994.
NACI (National Advisory Committee on Immunization). “Statement on human papillomavirus vaccine.” *Canada Communication Disease Report* 2007;33(ACS-2):1-32.
Ong MK, Glantz SA. “Free nicotine replacement therapy programs vs implementing smoke-free workplaces: a cost-effectiveness comparison.” *American Journal of Public Health* 2005;95(6):969-975.
Ortega-Sanchez IR, Lee GM, Jacobs RJ, Prosser LA, Molinari NA, Zhang X, Baine WB, McCauley MM, Miller T; Working Group on Leading Economic Issues for New Vaccine for Adolescents. *Pediatrics* 2008;121(S1):S63-S78.
Newall AT, Beutels P, Wood JG, Edmunds WJ, MacIntyre CR. “Cost-effectiveness analyses of human papillomavirus vaccination.” *Lancet Infectious Disease* 2007;7:289-296.Neumann PJ. *Using Cost-Effectiveness Analysis to Improve Health Care*. New York: Oxford University Press, 2005.
Partnership for Prevention. *What Policymakers Need to Know About Cost Effectiveness*. Washington DC:

Partnership for Prevention, 2001.
PHAC (Public Health Agency of Canada). “Immunization: the most successful public health measure” [website], n.d. Available at http://www.phac-aspc.gc.ca/im/measure-intervention-eng.php, accessed 28 February 2009.
PHAC (Public Health Agency of Canada). *Report from the National Diabetes Surveillance System: Diabetes in Canada, 2008*. Ottawa: Her Majesty the Queen in Right Canada, 2008.
PHAC (Public Health Agency of Canada). *Economic Burden of Illness in Canada, 2000* [internal data].
Pomerleau J, Lock K, Knai C, McKee M. “Interventions designed to increase adult fruit and vegetable intake can be effective: a systematic review of the literature.” *Journal of Nutrition* 2005;135(10):2486-2495.
Priest N, Armstrong R, Doyle J, Waters E. “Interventions implemented through sporting organisations for increasing participation in sport.” *Cochrane Database of Systematic Reviews* 2008;Issue 3.
RWJF (Robert Woods Johnson Foundation). *Overcoming Obstacles to Health: Report from the Robert Wood Johnson Foundation to the Commission to Build a Healthier America*. Washington DC: RWJF, 2008.
Ramsey SD. “Methods for reviewing economic evaluations of community preventive services: a cart without a horse?” *American Journal of Preventive Medicine* 2000;18(S1):15-17.
Rasch A, Greiner W. “Cost-effectiveness of smoking prevention measures in adolescents.” *Journal of Public Health* 2008;16:3-11.
Reid D. “Failure of an intervention to stop teenagers smoking: not such a disappointment as it appears.” *British Medical Journal* 1999;319:934–935.
Roux L, Pratt M, Tengs TO, Yore MM, Yanagawa TL, Van Den Bos J, Rutt C, Brownson RC, Powell KE, Heath G, Kohl HW III, Teutsch S, Cawley J, Lee IM, West L, Buchner DM. “Cost effectiveness of community-based physical activity interventions.” *American Journal of Preventive Medicine* 2008;35(6):578-588.
Rush B, Shiell A, and Hawe P. “A census of economic evaluations in health promotion.” *Health Education Research* 2004;19(6):707-719.
Russell LB. *Prevention’s Potential for Slowing the Growth of Medical Spending*. Washington DC: National Coalition on Health Care, 2007.
Russell LB. *Is Prevention Better Than Cure?* Washington DC: Brookings, 1986.
Rychetnik L, Frommer M, Hawe P, Shiell A. ”Criteria for evaluating evidence on public health interventions.” *Journal of Epidemiology and Community Health* 2002;56:119-127.
Saha S, Hoerger TJ, Pignone MP, Teutsch SM, Helfand M, Mandelblatt JS; Cost Work Group of the Third US Preventive Services Task Force. “The art and science of incorporating cost effectiveness into evidence-based recommendations for clinical preventive services.” *American Journal of Preventive Medicine* 2001;20(3S):36-43.
Sassi F, Archard L, McDaid D. “Searching literature databases for health care economic evaluations: how systematic can we afford to be?” *Medical Care* 2002;40(5):387-394.
Schweinhart LJ. *The High/Scope Perry Preschool Study Through Age 40: Summary, Conclusions, and Frequently Asked Questions*. Ypsilanti, MI: High/Scope Educational Research Foundation, 2005.
Sculpher M, Pang F, Manca A, Drummond M, Golder S, Urdahl H, Davies L, Eastwood A. “Generalisability in economic evaluation studies in healthcare: a review and case studies.” *Health Technology Assessment* 2004;8(49).
Shiell A. “In search of social value.” *International Journal of Public Health* 2007;52:333-334.
Shiell A, Hawe P. “Health promotion community development and the tyranny of individualism.” *Health Economics* 1996;5:241-247.
Shiell A, Hawe P, Gold L. “Complex interventions or complex systems? Implications for health economic evaluation.” *British Medical Journal* 2008;336:1281-1283.
Shiell A, McIntosh K. “Some economics of health promotion: what we know, don’t know and need to know before spending to promote public health.” *Harvard Health Policy Review* 2006;7(2):21-31.
Solberg LI, Maciosek MV, Edwards NM, Khanchandani HS, Goodman MJ. “Repeated tobacco-use screening and intervention in clinical practice: health impact and cost effectiveness.” *American Journal of Preventive Medicine* 2006;31(1): 62-71.
Stein, JG. *The Cult of Efficiency*. Toronto: House of Anansi, 2001.
Suhrcke M, Sauto Arce R, McKee M, Rocco L. *Economic Costs of Ill Health in the European Region*. Geneva: World Health Organization, 2008.
Suhrcke M, Urban D, Iburg KM, Schwappach D, Boluarte T, McKee M. *The economic benefits of health and prevention in a high-income country: the example of Germany*. Berlin: Veröffentlichungsreihe der Forschungsgruppe Public Health, 2007.
Suhrcke M, McKee M, Stuckler D, Sauto Arce R, Tsolova S, Mortensen J. “The contribution of health to the economy in the European Union.” *Public Health* 2006;120(11):994-1001.
Task Force on Community Preventive Services. “The Guide to Community Preventive Services: Task Force Findings” [website]. Available at http://www.thecommunityguide.org, accessed 28 April 2009.

Tjepkema M. “Health care use among gay, lesbian, and bisexual Canadians.” *Health Reports* 2008;19(1):53-64.
van Baal PHM, Polder JJ, de Wit GA, Hoogenveen RT, Feenstra TL, Boshuizen HC, Engelfriet PM, Brouwer WBF. “Lifetime medical costs of obesity: prevention no cure for increasing health expenditure.” *PLoS Medicine* 2008;5(2):e29.
Vijgen SM, Hoogendoorn M, Baan CA, de Wit GA, Limburg W, Feenstra TL. “Cost effectiveness of preventive interventions in type 2 diabetes mellitus: a systematic literature review.” *Pharmaeconomics* 2006;24(5):425-441.
Waddell C, Hua JM, Garland OM, Peters RD, McEwan K. “Preventing mental disorders in children: a systematic review to inform policy-making.” *Canadian Journal of Public Health* 2007;98(3):166-173.
Wall J, Mhurchu CN, Blakely T, Rodgers A, Wilton J. “Effectiveness of monetary incentives in modifying dietary behavior: a review of randomized, controlled trials.” *Nutrition Reviews* 2006;64(12):518-531.
Wanless D. *Securing Good Health for the Whole Population: Final Report*. London: HM Treasury, 2004.
Weinstein MC, Siegel JE, Gold MR, Kamlet MS, and Russell LB. “Recommendations of the Panel on Cost-Effectiveness in Health and Medicine.” *Journal of the American Medical Association* 1996;276(15):1253-1258.
Welte R, Feenstra T, Jager H, Leidl R. “A decision chart for assessing and improving the transferability of economic evaluation results between countries.” *Pharmacoeconomics* 2004;22(13):857-876.
Williams DR, Costa MV, Odunlami AO, Mohammed SA. “Moving upstream: how interventions that address the social determinants of health can improve health and reduce disparities.” *Journal of Public Health Management and Practice* 2008;14(Suppl.):S8-S17.
Wodak A, Cooney A. “Do needle syringe programs reduce HIV infection among injecting drug users: a comprehensive review of the international evidence.” *Substance Use and Misuse* 2006;41:777-813.
Woolf SH, Husten CG, Lewin LS, Marks JE, Fielding JE, Sanchez EJ. “The economic argument for disease prevention: distinguishing between value and savings.” [Policy paper prepared for the National Commission on Prevention Priorities, Partnership for Prevention], 2009.
Woolf SH. “The power of prevention and what it requires.” *Journal of the American Medical Association* 2008;299(20):2437-2439.
WCRF/AICR (World Cancer Research Fund/American Institute for Cancer Research). *Policy and Action for Cancer Prevention. Food, Nutrition, and Physical Activity: a Global Perspective*. Washington DC: AICR, 2009.
WHO (World Health Organization). *Ottawa Charter for Health Promotion* [WHO document no. WHO/HPR/HEP/95.1]. WHO: Geneva, 1986.
Zechmeister I, Kilian R, McDaid M, the MHEEN group. “Is it worth investing in mental health promotion and prevention of mental illness? A systematic review of the evidence from economic evaluations.” *BMC Public Health* 2008;8:20.
Zhou F, Santoni F, Messonnier ML, Yusuf HR, Shefer A, Chu SY, Rodewald L, Harpaz R. “Economic evaluation of the 7-vaccine routine childhood immunization schedule in the United States, 2001.” *Archives of Pediatrics and Adolescent Medicine* 2005;159:1136–1144.