Chronic Disease in Ontario and Canada: Determinants, Risk Factors and Prevention Priorities

Summary of Full Report

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1. Introduction

Chronic disease continues to be a critical focus in public health in Canada and worldwide. Recently, the Canadian federal government announced $300 million for chronic disease prevention, with the focus being on improving diet and levels of physical activity in all Canadians. Investing in chronic disease prevention for the population of Canada has the potential to lead to a number of benefits, particularly in the areas of general population health and healthcare expenditures. The direct and indirect costs of chronic disease are substantial, and effective prevention could thus minimize the economic burden, as well as the social and health consequences.

This short report summarizes the work in Haydon, Roerecke, Giesbrecht, Rehm, and Kobus-Matthews (2005) [1] The full report is available to those interested through the Centre for Addiction and Mental Health or the Ontario Public Health Association, however, this short version touches on the main issues explored in the larger report.

The document is divided into several sections. In the first, epidemiologic data on chronic disease is provided, including morbidity and mortality, prevalence and incidence, and economic costs. The second section describes the sociobehavioural risks of chronic disease, emphasizing not only the traditional behavioural factors, but drawing particular attention to the social environmental factors that have been implicated in chronic disease development. Next, we discuss some individual level models and population health models. The fourth section considers "what works" in chronic disease prevention. We describe the Canadian situation regarding programs and evaluation, and then look to tobacco interventions for lessons and best practices. The fifth section presents our recommendations and framework for comprehensive chronic disease prevention in Canada, which we hope will be useful for directing future efforts.

This short report and the larger and more comprehensive document, are intended for a wide variety of audiences, including government, policy makers, industry, program developers and frontline health staff, as well as individuals in the community. All of these groups and individuals are responsible for addressing the chronic disease burden in Canada, and can all contribute to prevention efforts to reduce the burden of disease and improve health for particular risk groups and the population overall.

2. Epidemiology of chronic disease in Canada

Chronic disease results in substantial morbidity and mortality for Canadians. The main non-communicable chronic disease categories that we consider in this report are cardiovascular diseases (CVDs), cancers, respiratory illnesses, diabetes, genitourinary diseases, and mental illnesses. We also examine communicable chronic diseases such as hepatitis C and HIV. Broadly, chronic

[1] The citation of the full report is: E. Haydon, M. Roerecke, N. Giesbrecht, J. Rehm, and M. Kobus-Matthews (2006). *Chronic Disease in Ontario and Canada: Determinants, Risk Factors, and Prevention Priorities*. Prepared for the Ontario Chronic Disease Prevention Alliance and the Ontario Public Health Association. To obtain a copy please call Giselle Sicchia, OPHA, 416 367-3313 ext 254 or via toll free 1-800-267-6817.

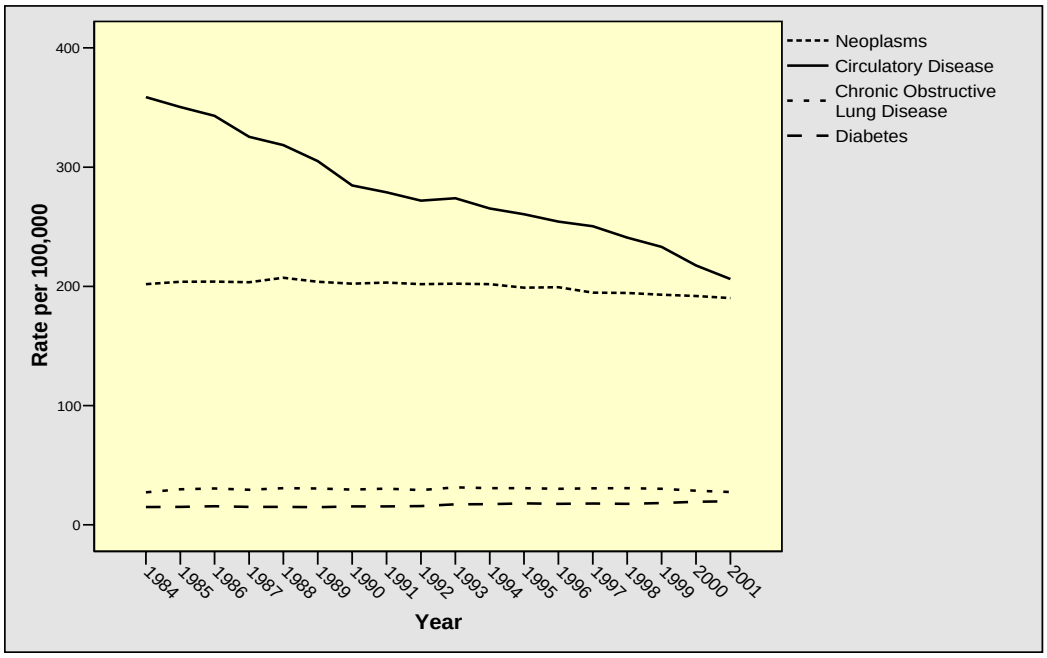
diseases are illnesses that are prolonged, do not resolve spontaneously and are rarely cured completely.

2.1 Morbidity and mortality

The leading causes of death in Canada are, like in most developed countries, chronic diseases such as CVD, cancer, respiratory diseases, cancers, diabetes, and genitourinary diseases. In 2002, there were a total of 223,603 deaths in Canada, of which 113,266 (50.6%) were men and 110,337 (49.4%) were women (Statistics Canada, Mortality Files). According to the Death Database, of the total 223,603 deaths, CVDs account for 33.4% (74,626), 29.1% (65,102) were cancer deaths, 7.9% (17,761) were caused by respiratory diseases, 3.5% (7,868) by diabetes mellitus, and 2.0% (4,529) by genitourinary diseases.

Figure 1 shows the mortality rates for selected chronic diseases that we consider in the report. Note the decline in CVD mortality, and the steadiness of other causes.

Figure 1: Age-Standardized Mortality Rate (Canada 1991) For Selected Causes, Both Sexes, 1984-2001



Sources: Surveillance and Risk Assessment Division, CCDPC, Health Canada; Statistics Canada.

2.2 Prevalence and incidence of chronic disease in Canada

There are a number of data sources that can provide information on the prevalence and incidence of chronic disease in Canada, including self-report surveys and hospital information. This may result, however, in under-reporting of actual disease rates and occurrence, especially since a diagnosis is required by a physician.

2.2.1 Cancer

Estimates from the Canadian Cancer Statistics 2005 report (Canadian Cancer Society, 2005) show that in 2005, approximately 149,000 new cases of cancer will occur, 76,200 of these will be men, while 72,800 will be women. Men will therefore continue to outnumber women in both incidence and deaths from cancer. Men will have a 4.7% higher incidence and an 11.9% higher mortality in 2005. Three types of cancer account for at least half of the new cases in each sex: prostate, lung and colorectal cancers in males, and breast, lung and colorectal cancers in females. It is estimated that between 20-30% of cancers of the breast, colon, esophagus, kidney, and uterus are attributable to excess body weight and physical inactivity (Vainio & Bianchini, 2002). Healthy eating, physical activity and healthy body mass have an estimated potential to decrease cancer incidence by 30-40%.

2.2.2 Cardiovascular disease

CVDs continue to be the leading cause of death, although both the number of deaths due to CVD, after a steady period in the 1990, and the age-standardized mortality rate show a steady decline in mortality over time. Based on estimates from Statistics Canada using current trends in age-standardized mortality, the actual number of deaths due to CVD will increase for women until 2015 and then decrease, and will remain stable for men until 2025 (Heart and Stroke Foundation of Canada, 2003). One-third of all CVD is attributable to one of the following risk factors: tobacco use/exposure, alcohol use, high blood pressure, high cholesterol, or obesity (World Health Organization, 2002). Almost 80% of the Canadian population has at least one of the most common risk factors for CVD, i.e. smoking, being physically inactive, being overweight, having high blood pressure or diabetes (Heart and Stroke Foundation of Canada, 2003).

2.2.3 Respiratory disease

Asthma is a chronic disorder with symptoms of cough, shortness of breath, chest tightness and wheeze. Chronic obstructive pulmonary disease (COPD) is a chronic disease with shortness of breath, cough and sputum production most commonly due to chronic bronchitis (inflammation of the airways causing irritation with increased production of mucous blocking the airways) and emphysema (air sacs are enlarged and damaged, impairing breathing). The age-standardized mortality rate for asthma in Canada shows a steady decline for both sexes from 1984 (2.19 per 100,000 population) to 2001 (0.82 per 100,000 population). Prevalence of asthma is higher among women than men across all age groups. In 2003 in Canada, an estimated total of 2,226,770 Canadians reported being diagnosed with asthma (Statistics Canada, Canadian Community Health Survey data), and approximately 500,000 Canadians were affected by COPD in Canada in 1998/1999 (Health Canada, 2001). Difficulties in diagnosing COPD may account for substantial underreporting of the illness and its costs and consequences.

2.2.4 Diabetes

People with Type 1 diabetes cannot produce any insulin and with type 2 diabetes the production is limited and not effective. Type 2 diabetes usually affects people after the age of 40 and is the preventable form of diabetes, related to physical inactivity, excess food consumption, and obesity (World Health Organization, 2002). Diabetes is a risk factor for other chronic diseases, such as CVD and cerebrovascular disease. Type 2 diabetes, for example, is associated with a 70-80% chance of premature death due to CVD or stroke (Chobanian et al., 2003). Prevalence of diabetes continues to rise dramatically in Canada. The crude prevalence of diabetes in Canada has been estimated to be 4.6% of the population 12 years and over (1,222,882 Canadians). This number is up from 3.0% (722,491) in 1994/95. In 1997, deaths due to diabetes accounted for 2.6% of all deaths; in 2002, this share rose to 3.5%, an increase of 35% in only five years. The age-standardized mortality rate rose steeply since the early 1990s and reached 20 per 100,000 for both sexes in 2001.

2.2.5 Mental health

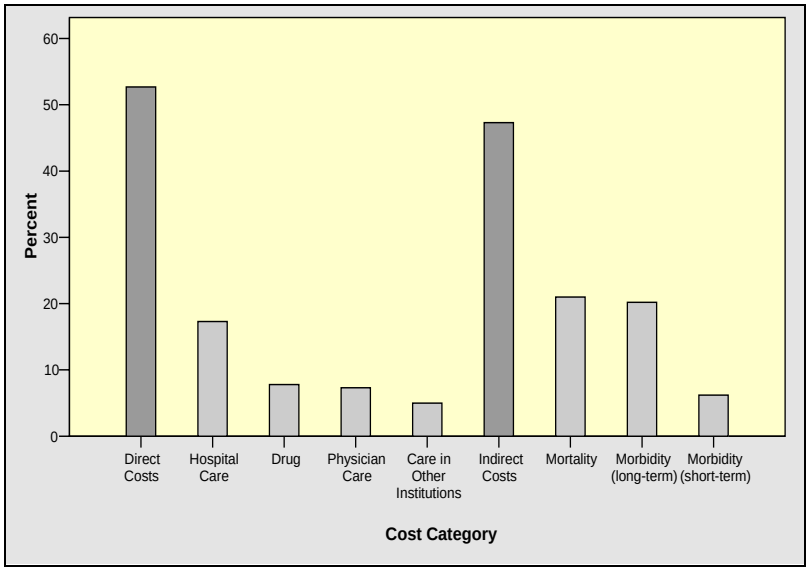
Mental illnesses include mood disorders, such as major depressive episodes, bipolar disorder, dysthymia, schizophrenia, anxiety disorders, personality disorders, eating disorders, and suicidal behaviour. Up to 20% of Canadians will experience a mental illness in their lifetime (Health Canada, 2002b). A report recently published by the Canadian Institute for Health Information (CIHI) showed that in 2002-2003, 6% of all hospitalizations in Canada were attributable to mental illnesses. Taking into account that another 9% involved hospitalizations where mental illness was not the primary diagnosis, mental illnesses accounted for 15% of hospital stays in Canada (Canadian Institute for Health Information, 2005). The age-standardized prevalence rate of depression (with a probability greater then 0.9) declined from 5300 per 100,000 population for both sexes to 4100 per 100,000 population in 1996/1997 and rose to 5000 per 100,000 population in 2000/2001. The prevalence rate for women compared to men was higher at all times (88% in 2000/2001).

2.3 Economic costs

In 2002, Health Canada published a report containing estimates of economic costs of illness using an opportunity approach, estimating the gain for society if the illness or disease would be eliminated in Canada for 1998 (Health Canada, 2002a). The overall costs of illness were estimated to be $159.4 billion in 1998, of which $83.9 billion were in direct costs, and $75.5 billion in indirect costs consisting of productivity losses due to premature mortality and disability (short-term and long-term). Direct costs included payments and resources used for treatment, care, and rehabilitation. Figure 2 provides visual representation of the various costs. CVDs, mental disorders, digestive diseases, respiratory diseases, injuries, and nervous system and sense organ diseases were responsible for more than 50% of the direct costs of illness in Canada.

Musculoskeletal diseases, cancer, CVDs, and injuries contributed over 60% to the indirect costs in 1998 (see Table 1).

Figure 2: Percentage of Total Economic Costs by Category, Canada, 1998 (Total $159.4 billion)



Note: Percentages of hospital care, drugs, physician care, care in other institutions were among all direct costs; mortality and morbidity costs (long and short-term) were among all indirect costs.
Source: Health Canada, *Economic Burden of Illness in Canada*, 1998.

Table 1: Direct and Indirect Costs by Diagnosis Category, 1998

Diagnosis Category	Costs			
	Direct		Indirect	
	% (direct costs)	Costs ($ million)	% (indirect costs)	Costs ($ million)
Cancer	2.9	2,462	15.6	11,758
Cardiovascular Diseases	8.1	6,818	15.4	11,654
Digestive Diseases	4.2	3,540	3.1	2,314
Genitourinary Diseases	3.1	2,597	1.2	916
Injuries	3.8	3,224	12.6	9,512
Mental Disorders	5.6	4,680	4.2	3,190
Musculoskeletal Diseases	3.2	2,648	18.2	13,732
Nervous System/Sense Organ Diseases	3.4	2,822	7.3	5,478
Respiratory Diseases	4.1	3,461	6.7	5,069

Source: Health Canada, *Economic Burden of Illness in Canada*, 1998.

Katzmarzyk and Janssen (2004) estimated the total economic costs attributable to physical inactivity at $5,310 million, of which $1,619 million were for direct costs and $3,690 million for indirect costs. Regarding obesity, total economic costs were estimated to be $4,341 million, of which $2,743 million were indirect costs and $1,598 million were direct costs. Single and colleagues provided estimates for economic costs as a result of alcohol and tobacco consumption for 1992 and reported them to be $7,522 million total costs for alcohol use, $9,559 for tobacco use, and $1,371 million for illicit drug use. The estimates for alcohol and illicit drugs include $1,359 and $400 million, respectively for law enforcement (Single, Robson, Xie, & Rehm, 1998).

3. The sociobehavioural risks of chronic disease

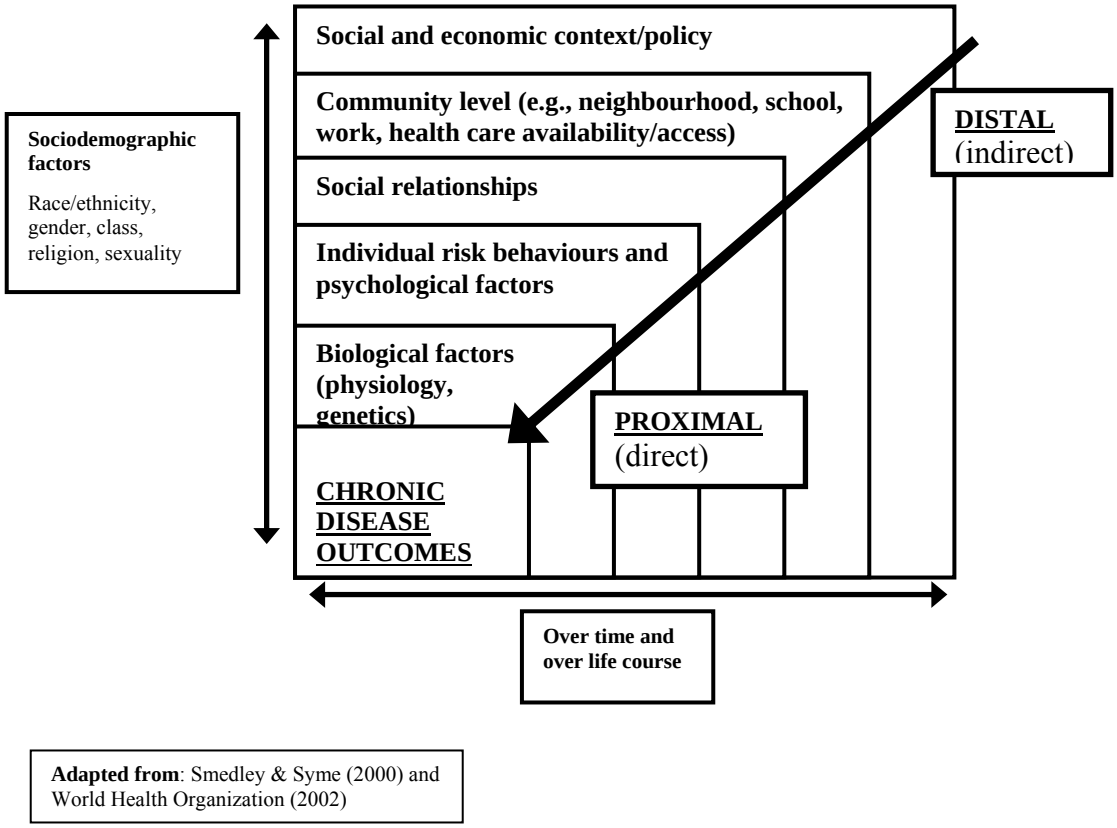
3.1 Defining risk

The WHO defines risk as the probability of an adverse outcome, or a factor that raises this probability (World Health Organization, 2002). Health outcomes have their roots in complex chains of environmental, behavioural, and biological events that have many causes and may have occurred over long periods of time. Proximal factors act directly to cause health outcomes, while distal factors are further back in the causal chain and act mainly via intermediary causes.

Rose (1985; 1992) argues that distal causes have a bigger role to play in the development of disease outcomes than proximal factors, and that these distal factors hold the greater potential for

prevention strategies. However, we have the most information about proximal behavioural factors because these causes are more easily examined by the manipulation of clinical data in a laboratory environment and are more easily identified in within-population comparisons (Schwartz & Diez-Roux, 2001). In Figure 3, our conceptualization of the sociobehavioural risks of chronic disease is represented visually, indicating the relationships between factors.

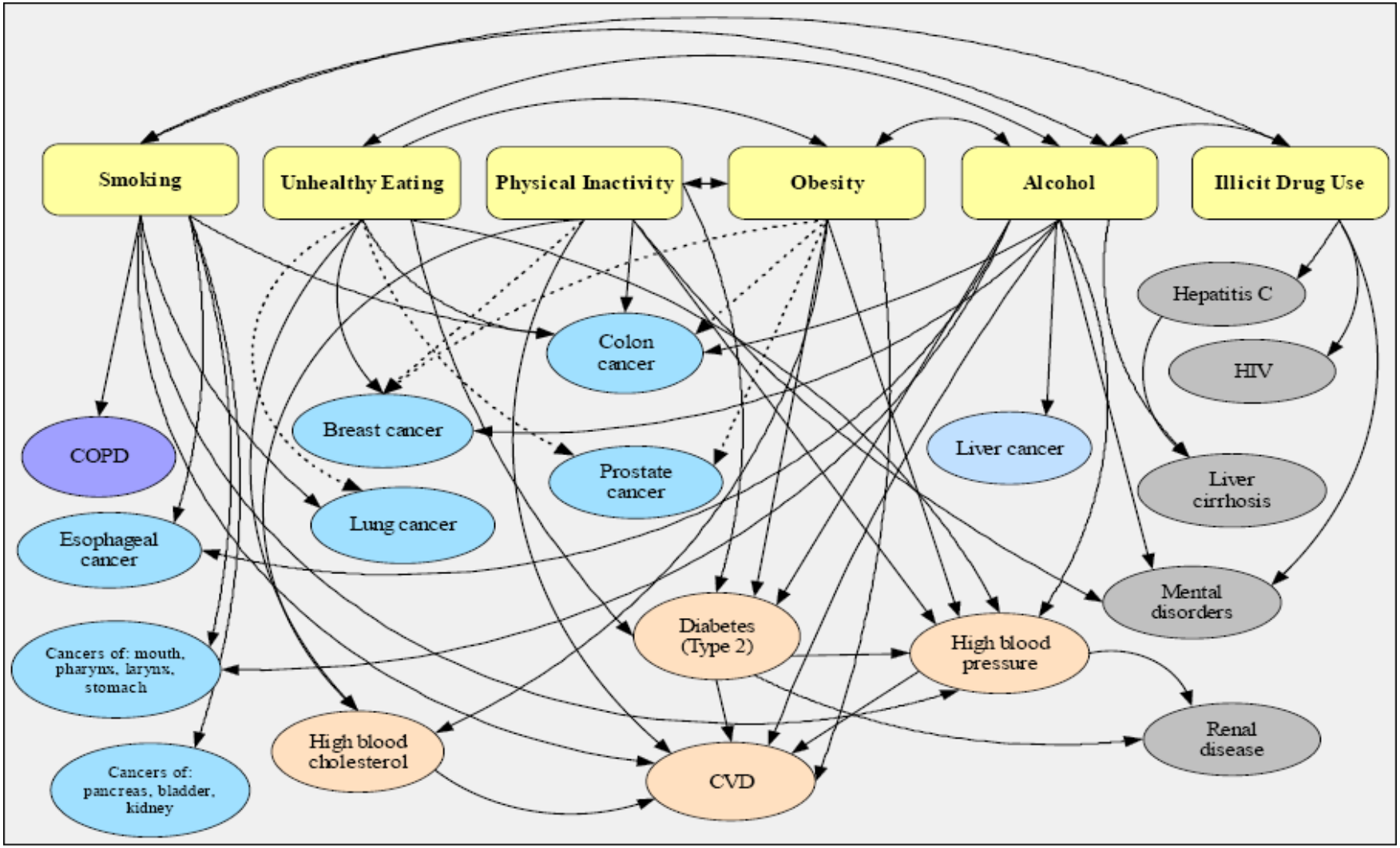
Figure 3: The Sociobehavioural Risks of Chronic Disease (adapted from Smedley & Syme, 2000 and WHO, 2002)



3.2 Proximal risk factors

The proximal factors in chronic disease development have been the main target area of previous and current research and prevention activities, and are thus the factors with the strongest evidence. Physical inactivity and diet are the primary factors in most Canadian chronic disease prevention activities focusing on "healthy living", due to their relationship to overweight and obesity. However, other behavioural factors have come into consideration. Tobacco use, alcohol consumption, and other illicit drug use also play important roles in the development of chronic disease, and thus in prevention efforts. Figure 4 shows the interrelationships between various proximal risk factors and different chronic diseases.

Figure 4: Selected Proximal Behavioural Risk Factors for Selected Chronic Diseases – The Strength of the Evidence



Note: Alcohol has also a protective effect for CVDs among women and men 45 years and older, depending on the pattern of drinking; the link to diabetes also depends on volume and patterns of drinking.

3.2.1 Physical inactivity

Physical inactivity is a major proximal risk factor for CVD (Heart and Stroke Foundation of Canada, 2003) as well as a number of other chronic conditions, including cancers, diabetes, and obesity. A US Surgeon General report (1996) stated that regular physical activity that is performed on most days of the week reduces the risk of dying prematurely in general, or from heart disease, reduces the development of diabetes, high blood pressure, developing colon cancer, reduces feelings of depression, and helps control weight. Duration and level of exercise are important in reducing the risk of negative health effects. Even 60 minutes of vigorous exercise per week – or 150 minutes of moderate physical activity – can reduce the risk of CVD by up to 30% (World Health Organization, 2002).

3.2.2 Unhealthy eating

Nutritional habits in industrialized countries are characterized by high consumption of saturated fat, salt and sugar, and, at the same time, by low consumption of fruits and vegetables (World Health Organization, 2002). From 2000/01 to 2003, the age-standardized prevalence of less than 5 servings of fruits and vegetables dropped from 62,086 per 100,000 to 55,789 per 100,000 for both sexes combined. Nevertheless, the rate remains on a high level and contributes significantly to the burden of disease in Canada. Daily diets high in vegetables and fruits are estimated to reduce cancer incidence by 20% (World Cancer Research Fund and the American Institute for Cancer Research, 1997). However, the extent of the impact of unhealthy eating on chronic disease mortality and morbidity remains difficult to measure.

3.2.3 Overweight and obesity

Although related to nutrition and physical inactivity, obesity poses an independent risk factor for chronic diseases and premature mortality. Based on data from the Canadian Community Health Survey (2003), 3,547,995 people in Canada are obese (BMI $\geq$30) and therefore at greater risk for chronic diseases. Controlling for physical activity level, Katzmarzyk and colleagues reported an elevated relative risk for all-cause mortality of approximately 1.23 for overweight people (BMI $\geq$ 25.0) (Katzmarzyk, Janssen, & Ardern, 2003). Obesity is a risk factor for cardiovascular disease, both directly as a risk factor, and indirectly through its relationship to hypercholesterolemia, hypertension, and diabetes (Heart and Stroke Foundation of Canada, 2003). With increasing obesity, the burden of disease increases as well (Paeratakul, Lovejoy, Ryan, & Bray, 2002). The attributable fraction of obesity for the major comorbidities were: 50.7% for Type 2 diabetes, 31.6% for hypertension, 29.8% for pulmonary embolism, and 26.6% for endometrial cancer.

3.2.4 Tobacco smoking

Smoking is responsible for about 30% of all cancer deaths in Canada (Ontario Tobacco Research Unit., 1995), and accounts for about 85% of all new lung cancer cases (Doll, Peto, Wheatley, Gray, & Sutherland, 1994). Baliunas and colleagues estimated tobacco-attributable deaths in Canada in 2002 at 37,207, of which 23,766 were men and 13,441 women. Smoking-attributable deaths accounted for 16.6% of all Canadian deaths in 2002 (Baliunas et al., manuscript in preparation). Age-standardized prevalence rates of current smokers (daily and occasional) confirm the downward trend among Canadians. For both sexes combined the age-standardized prevalence rate fell from 30,702 per 100,000 population in 1994/95 to 24,268 per 100,000 in 2003. The increase in risk for chronic diseases and premature death due to tobacco smoking are partially reversible (US Department of Health and Human Services, 2004). The elimination of smoking would have a major positive impact on cancer and myocardial infarction mortality rates.

3.2.5 High blood pressure

High blood pressure is a major independent individual risk factor for CVD and is the most important factor in the development of CVD. An increase of only 10 points of diastolic blood pressure, or an increase of 20 points in systolic pressure doubles the risk of CVD (World Health Organization, 2002). The age-standardized prevalence rate increased from 8,856 per 100,000 in 1994/95 to 13,648 per 100,000 in 2003, which corresponds to a 54.1% increase. The average systolic blood pressure of the Canadian population 30 years and over is even higher than in the comparable age group in the US (World Health Organization, 2002). High blood pressure is associated with unhealthy diet, having diabetes, being physically inactive, excessive alcohol consumption, and being overweight or obese. A 5 mm Hg reduction in systolic blood pressure in the population would result in an overall reduction of stroke mortality by 14%, 9% for CVD mortality, and 7% in all cause mortality. Controlling high blood pressure would also reduce the incidence of stroke by 35-40%, and the incidence of heart attack by 20-25% (Chobanian et al., 2003).

3.2.6 Alcohol

Alcohol is related to over 60 medical conditions through various pathways. These include intoxication, resulting mostly in motor vehicle crashes, injuries, and violence, and alcohol dependency, resulting mainly in, but not limited to, liver cirrhosis, and through direct biological effects, such as blood clot dissolution, pancreatic damage and risk for high blood pressure (Apte, Wilson, & Korsten, 1997). A vast majority of Canadians are classified as current drinkers (at least one drink in the past 12 months), and the age-standardized prevalence rate shows that this prevalence has remained relatively stable over the last decade with a slight increase since 1996/97. The age-standardized prevalence rate for heavy drinkers, in this report classified as having had 5 or more drinks on one occasion more than 12 times over the course of the last 12 months prior to the interview, rose from 11,402 per 100,000 in 1996/97 to 17,795 per 100,000 in 2003. The measure of

drinking patterns has been less frequently included in epidemiological studies and there is a clear need for research into the influence of drinking patterns on conditions like cancers, liver cirrhosis, CVD, cerebrovascular diseases, and depression. Low, regular consumption of alcohol has been found to have protective effects for CVD and possibly diabetes (Rehm et al., 2003).

3.2.7 Substance use

According to Health Canada, the number of positive HIV tests has risen in the last five years from 2,111 in 2000 to 2,529 in 2004 (Health Canada, 2005). The percentage of women who have tested positive has increased from less than 10% before 1995 to 26% in 2004. Injection drug use continues to be the primary risk factor in the transmission of HIV. The HIV incidence attributable to injection drug use was highest among the 40-49 age group (27.1%) and second highest among IDUs aged 30-39 years (25.8%) (Health Canada, 2004). Injection drug use is also the major risk factor for infection with the hepatitis C virus (HCV) since transmission through infected blood transfusions has been nearly eliminated since May of 1990 (Zou, Forrester, & Giulivi, 2003). It is estimated that up to 50% of prevalent cases and up to 75% of new infection of HCV are attributable to injection drug use in Canada (Zou et al., 2003).

3.3 Distal risk factors: The social environment

Although the role of the social environment in behaviour and experience has long been established in the sociological and criminological literature, the contribution of environmental factors to health has advanced more slowly. There is recognition now, however, that environmental factors are of critical importance in health and may explain why some populations and individuals are healthier than others. The poor are most likely to live in the polluted parts of cities, be malnourished, live in the poorest quality housing and work in dangerous or stressful jobs (if working at all) (Evans & Kantrowitz, 2002).

3.3.1 Sociodemographics

Sociodemographic factors have been considered mainly in terms of health *inequities*, which are avoidable and unjust differences in health and health access for certain groups (World Health Organization, 2002). Gender, age, culture, sexuality, ethnicity, race, and other social status variables are non-modifiable factors that are critical with regards to the socioeconomic environment. What is modifiable in order to address the inequities in health is the way in which different sociodemographic populations are responded to in policy and other areas.

Women experience not only disparities in health, but also in economic success, and have been culturally, sexually, physically, and historically marginalized (Spitzer, 2005). Women are particularly vulnerable also because of their multiple roles as workers and caregivers participating in both paid and domestic (unpaid) labour. Aboriginal populations are also of concern because of

their disproportionately higher rates of chronic disease related to cultural, social, and economic inequities (Adelson, 2005).

3.3.2 Socioeconomic status

Associations between area or neighbourhood socioeconomic status and a number of health outcomes have been established in the literature, including all-cause mortality, CVD mortality, chronic disease symptoms, smoking, and physical activity (Raphael, 2004). In 2001, 16.2% of the total Canadian population living in private households reported low-income (income level below the low-income cut-off line). The growth of income and wealth in Canada is seen mainly at the top of the ladder and is the driving force for increased income inequalities (Morissette, Zhung, & Drolet, 2002). Only 47% of the Canadians in the lowest income bracket rate their health as very good or excellent, compared with 73% of those in the highest income group (Health Canada, 1999).

Recent evidence in Canada from an analysis of the National Population Health Survey (1994/95 and 2002/2003) indicated that among middle-aged adults aged 45 to 64, socioeconomic characteristics such as the education level and household income were more important determinants of healthy aging than lifestyle behaviours (Statistics Canada, 2005), though these findings require further investigation. In a review of the risks of CVD, Raphael and Farrell (2002) argue that the evidence indicates that CVD results primarily from material deprivation in combination with excessive psychosocial stress and the adoption of unhealthy coping behaviours. Similarly, diabetes in Canada appears to be a disease located within the poor and excluded (Raphael et al., 2003).

Only about 50% of all working Canadians are in a full-time permanent job that they have had for more than 6 months (Tremblay, Ross, & Berthelot, 2002). Thus, half of Canadian workers are 'precarious workers' with limited job security and no employer-financed access to private health insurance. Precarious employment is a source of stress due to lack of income and meaningful work, uncertainty of the future, and its potential to undermine social support networks (World Health Organization, 1999). Working longer hours has been linked to high blood pressure and CVD, and moving to longer working hours can have negative impacts on certain proximal risk behaviours, including smoking, drinking, and poor diet (Statistics Canada, 1999).

Income and employment are also intricately tied to adequate food and housing access, with lower income individuals and populations having poor food security and living in poor housing situations.

3.3.3 Social support networks and social exclusion

Some groups in Canada experience social exclusion – poor social and economic conditions and inequalities in access to resources, support and services, and low civic engagement in mainstream society. These groups include Aboriginal peoples, immigrants and refugees, racialized groups, people with disabilities, single parents, women, the elderly, and lesbian-gay-bisexual-transgendered (LGBT) persons (Galabuzi, 2004). In addition to the negative health effects of relative deprivation, the actual experience of inequality and the stress associated with dealing with

exclusion tend to have psychological effects that impact negatively on health status (Wilkinson, 1996). Having a support network of friends, family and community has been shown to be associated with more positive health outcomes (Galabuzi, 2004).

3.3.4 The physical and built environments

Although the Canadian physical environment is generally healthier than many others within a global perspective, there is increasing concern regarding rising levels of contaminants in the air, water, food, soil, buildings and other structures, as well as the consequences of climate change and exposure to radiation in the environment (Health Canada, 1999). While development and industrialization have been critical in contributing to pollution in air, water and soil and have been instrumental in climate change and ozone depletion, there are certain aspects of the built environment that pose particular risks for the development of chronic disease. Transportation in urban areas is increasingly reliant on vehicles that produce fossil fuel emissions, which have been implicated in the development of chronic diseases such as cardiovascular disease, cancers, asthma, and other respiratory diseases.

3.3.5 The obesogenic environment

The built environment as we experience it today has specific influence in some of our health behaviours, including the consumption of food and engagement in physical activity. The social trends that precipitated the development of the obesogenic environment are many, and include the escalation of reliance on cars, increases in "busy-ness" and lack of time, and the rising use of convenience and prepared foods (Banwell, Hinde, Dixon, & Sibthorpe, 2005). Components of the built environment include urban design factors, land use, available public transportation, and physical activity options for those living in the space (Handy, Boarnet, Ewing, & Killingsworth, 2002). These features of the built environment can facilitate and hinder physical activity and healthy eating (Giles-Corti, Macintyre, Clarkson, Pikora, & Donovan, 2003).

4. Individual and population level models of health

4.1 Individual level models

Individual level intervention strategies use cognitive psychology as their backbone and conceive that thoughts and the way information is processed in an individual can have a great impact on that individual's emotion, motivation, and behaviour. Bandura's Social Cognitive Theory (1989), which includes the important construct of self-efficacy, Ajzen's Theory of Planned Behavior (1991), and Prochaska's (1994) Stages of Change Model are three prevalent models for understanding health-related behavioural changes. These models have received some evidence in

support of their applicability to health behaviours and health promotion, while other evidence has shown that they are not beneficial models for preventing negative health outcomes.

4.2 Comprehensive population level models

Brofenbrenner's (1979) ecological model has provided a strong foundation to population level models in health and health care. According to Bronfenbrenner, each person is significantly affected by interactions among a number of overlapping ecosystems. At the centre is the individual. Microsystems are the systems that directly shape human development. The primary microsystems for individuals include the family, peer group, and neighbourhood. Interactions among the microsystems take place through the mesosystem. Surrounding the microsystems and mesosystem is the exosystem, which includes community structures and local educational, medical, employment, and communications systems that influence the microsystems and their interactions. And influencing all other systems is the macrosystem, which includes cultural values, political philosophies, economic patterns, and social conditions.

Health Canada and the Public Health Agency of Canada have adopted a similar model underpinning their efforts through the funding and support of hundreds of community based projects aimed at enhancing the capacity of individuals to engage in and shape their social environments. The Social Ecological Model of Health Promotion (Hamilton & Tariq, 1996) is a comprehensive health promotion model that is multifaceted, and is concerned with environmental change, behaviour, and policy that help individuals make healthy choices in their daily lives. The ecological model takes into account the physical environment and its relationship to people at individual, interpersonal, organization and community levels. The underlying concept of the model is that behaviour does not occur within a vacuum.

5. Chronic disease prevention: Do we know what works?

Prevention activities on the individual and population level have advantages and disadvantages (Rose 1985; 1992). Rose (1985) draws attention to what he terms the "prevention paradox", which states that, although population health strategies may have the best possibility for benefit for the largest number of people, the benefits on the individual level are small and may take substantial amounts of time to take effect, thus leading to a lack of motivation on the part of the individual. Both individual and population level interventions are considered to have importance in preventing chronic disease.

5.1 The Canadian situation of chronic disease prevention and program evaluation

The current situation of chronic disease prevention in Canada indicates disjuncture in and repetition of activities, with little infrastructure, minimal evaluation, and relatively poor

communication of best practices in place. There are innumerable programs focused on chronic disease prevention, on the national, provincial, municipal, and neighbourhood/community level. Although the main underpinning in Canadian public health and for comprehensive provincial/federal strategies is the population health model, the majority of programs actually implemented tend to focus on individual level interventions, particularly in the areas of healthy eating and physical activity (see Lyons & Kungl (2005) for an environmental scan of Ontario programs).

One of the most detailed and specific plans for addressing chronic disease currently in Canada is the Cancer 2020 plan in Ontario (Canadian Cancer Society & Cancer Care Ontario, 2003). The goals of this program have been consequently implemented into other province-wide frameworks. The guiding principles of the strategy are:

- optimism (through the establishment of deliberately aggressive targets)
- accountability
- population health focus
- evidence-based interventions
- the precautionary principle (i.e., if the consequences of an action are unknown but likely have a high risk of being negative, then it is best not to carry out the action)
- integration and collaboration
- strategic use of resources

The strategy encompasses multiple determinants of cancer: tobacco use, diet and nutrition, healthy body weight, physical activity, alcohol consumption, occupational/environmental carcinogens, UV exposure, viral infections, and screening services for early detection. The Pan-Canadian Healthy Living Strategy (Public Health Agency of Canada, 2003), a federal strategy emphasizing healthy eating and physical activity, has also informed chronic disease prevention efforts in Canada, and has been utilized in the development of provincial frameworks. The national and provincial documents all endorse both individual and population level interventions with regards to chronic disease prevention. There is recognition that the social context shapes the lives of individuals and populations, and that we need to move away from explanations focusing only on individual responsibility.

There are few chronic disease prevention programs that have been evaluated in Canada. The Ontario Tobacco Strategy, Ontario Heart Health Programs, and the Ever Active Adults Program (Alberta) have all been evaluated and have shown positive effects, although there are still major improvements needed, particularly regarding environmental strategies.

5.2 Lessons learned from tobacco prevention

Tobacco prevention is the area in which a comprehensive individual and population level approach was first taken and shown to be successful. Tobacco prevention interventions implement clinical initiatives along with community interventions, regulatory and legislative components. In a recent review, Chopra and Darnton-Hill (2005) examined the strategies that had worked against the tobacco industry in efforts to reduce and prevent tobacco use, and developed similar strategies to

target the food industry in order to help individuals and populations achieve healthier diets. They argued that the attempts by public health agencies and officials to restrict the food industry's efforts to increase demand and sales are being resisted fiercely. They find that the food industry is using some tactics similar to those that were used by the tobacco industry: first, the half true contention that there is no such thing as unhealthy food, only unhealthy diets; second, the contention that the problem is not excessive diet but reduction in physical activity; and third, the smoke screen of conflicting scientific data about sugars and different fats. Yach et al. (2005) also recently pointed to lessons learned from tobacco prevention and how they can apply to interventions for healthy eating and physical activity.

5.3 Current practices in chronic disease prevention

As the research focus has been primarily on proximal behavioural factors, it is those factors for which there is the most evidence of prevention practices. Healthy eating and physical activity are the main areas featured in an overview of practices for chronic disease prevention, while alcohol, tobacco, and other drug use have minimal inclusion in strategic frameworks. There is a plan in place to develop a Canadian best practices system for chronic disease prevention and control (Public Health Agency of Canada, 2005). This process involves understanding the current state of knowledge, making decisions about the information based on priorities, implementing practices that address chronic disease and determinants of health and having a system in place to support and facilitate the decision-making process. Here we detail some of the research evidence – in no order of importance or strength of evidence – for current practices for chronic disease prevention related to the main proximal risk factors (see Table 2; refer to full report for references and further rationale for the practices listed).

Table 2: Recommended Practices for Chronic Disease Prevention

Determinant (target)	Recommended practice
Physical activity **GOAL: Increase physical activity**	School-based multi-component interventions (including physical education programs)
	Exercise referral schemes (interventions providing access to exercise activities/facilities)
	Prompts to increase stair use
	Access to places and opportunities for physical activity
	Comprehensive worksite strategies
	Mass media campaigns
Diet/nutrition	Individual strategies: sessions with nutritionists, educational

GOAL: Improve diet, increase consumption of fruits and vegetables	interventions, behavioural approaches (coupons)
	Family-based interventions
	Point-of-purchase interventions
	School programs: comprehensive school health, school food policies
	Availability of nutritious foods
	Reminders and training to health care providers to give nutritional counselling
	Pricing strategies
	Food security programs and policies
Healthy body weight **GOAL: Reduce body weight, maintain healthy weight**	Low-fat diets
	School-based multi-component interventions
	Dietary education and clinical interventions
	Macro level interventions: community-wide campaigns, school-based campaigns, mass media strategies, laws and regulations, providing reminder systems, reducing costs to patients, home visits
Tobacco use **GOAL: Cessation of tobacco use**	"Quit and Win" contests
	Workplace smoking cessation interventions: bans, social support, environmental support, individual level (therapy, counseling, nicotine replacement)
	Preventing tobacco sales to minors through active enforcement and multi-component education strategies
	Tobacco taxation
	School-based programs: classroom programs (including family/community components)
	Prevention of smoking in public places through comprehensive multi-component approaches

	Assistance to smokers (e.g., telephone helpline)
	Infrastructure development
	Public education and mass media campaigns
Alcohol use **GOAL: Reduce alcohol use and/or damage from alcohol use**	Pricing and taxation increases
	Regulation of the physical availability of alcohol (reductions in hours/days of sale and number of outlets, regulations toward commercial vendors for sales to minors, making low alcohol beverages available) Can be achieved through the establishment of government-owned alcohol outlets
	Modifying the drinking context (Responsible Beverage Service Programs, limiting drinking, community mobilization, general safety measures)
	Drinking-driving countermeasures (punishment and increased visibility of enforcement, laws, treatment programs)
	Regulating alcohol promotion (advertising bans and legislation)
Illicit drug use **GOAL: reduce and prevent illicit drug use and related harms**	Multiple components
	Media
	Psychosocial strategies
	Policy
	School- and family-based programs for children and adolescents

McLaren and colleagues (2004) and Basrur (2004) have written regarding best practices in comprehensive chronic disease prevention, pointing to current shortcomings and the need for environmental interventions to be implemented. In their study of interventions to encourage healthy weight, McLaren et al. (2004) concluded that integration is mainly conceptual or theoretical, as opposed to taking the form of specific action plans. They also found that upstream factors (e.g., social, economic, political and cultural circumstances) are rarely incorporated into intervention strategies and interventions that target these influences are virtually absent in the literature. It is thus difficult to determine the best practices regarding obesity prevention, specifically those that target the environment rather than the individual. Basrur (2004) emphasizes the ecological

approach in addressing healthy weight as well, and emphasizes that the most important task is to address and modify the obesogenic environment. Thus, many are pointing to the importance to build information on best practices where the focus is on population health and environmental factors.

6. Recommendations for chronic disease prevention: A comprehensive framework

"The primary determinants of disease are mainly economic and social, and therefore its remedies must also be economic and social. Medicine and politics cannot and should not be kept apart." (Rose, 1992, p.129)

6.1 Chronic disease prevention: Ecological approach and social justice

The goal of chronic disease prevention is to change behaviours that are related to the development of chronic disease, although it is now recognized that the "point of attack" must change from the individual level to the population level, leaving "victim-blaming" for chronic disease behind.

It has been previously argued that research and intervention efforts to address health and disease should be based on an ecological model, a social environmental approach to health and health interventions (Smedley & Syme, 2000). This population approach has worked before, specifically in the previous movements towards improving hygiene and standards of living, and makes sense in the context of population health (Smedley & Syme, 2000). Through this report we have established the importance of understanding the role of distal social and economic factors in the development of chronic disease, as well as the more proximal behavioural factors that have been the primary focus in existing prevention interventions. Chronic disease prevention has not only the goal of improving outcomes specifically related to chronic disease, but also the hope for progress towards health equity (addressing the inequalities in health through non-health policy to make general life, social, and health improvements). The ecological model includes "downstream" individual-level phenomena, as the majority of chronic disease interventions have, as well as "mainstream" factors such as general population-based strategies focused on education and larger-scale clinical intervention and "upstream" societal-level phenomena, such as public policies, in order to provide a fully comprehensive model of health intervention (Smedley & Syme, 2000).

Chronic disease prevention efforts must thus extend beyond the health care realm, to address the root causes – the social determinants – of health inequalities and inequities. Public health should not only be reactive, but should seek to provide decent minimums of resources and accesses to all in a population. This can be achieved specifically through macro level social and economic policies affecting living and working conditions and leading to empowerment for individuals and populations.

6.2 Recommendations for chronic disease prevention

Based in part on the lessons learned from tobacco and alcohol control, there are recommendations that can be made currently for ways to address and modify the risk factors of chronic disease, including obesity/overweight, physical inactivity, poor diet, and alcohol, tobacco, and illicit drug use. The following 14 recommendations are generic, i.e. they are not specifically oriented to a particular chronic disease or risk factor and they do not specify which group, organization, or government institution should have a lead or supportive role in implementing them (see Table 3). Nevertheless, there are some common experiences, themes and challenges that cut across chronic diseases and their prevention.

Table 3: Recommendations for Comprehensive Chronic Disease Prevention

Recommendation[2]	Explanation/ Rationale
1. Multiple determinants of health should be incorporated into interventions, with the "points of attack" being both individuals and populations.	Chronic disease is not caused by a singular factor (not in a 'vacuum'); rather, there are multiple factors with linkages and interactions between that need to be considered
2. Health inequalities as well as health inequities should be addressed, with an understanding of social and cultural influences on behaviour.	Ensure equitable and equal effects of prevention efforts. Do not 'punish' those individuals or populations who engage in personal cultural or social practices that may 'go against' established policies. Share responsibility.
3. Healthy public policy within health and non-health sectors should be developed.	Policies in other areas (social, economic) have been shown to have effects on health behaviours (e.g. tobacco and alcohol use). Focus on changing environments and institutions as well as behaviours by individuals.
4. Communicable and non-communicable chronic disease, as well as mental illness should be included in prevention initiatives.	Lifestyle factors are related to communicable disease and mental illness as well as to noncommunicable chronic disease. In the vast majority of the literature on chronic disease prevention, mental illness and chronic communicable diseases (e.g., HIV, HCV) have largely been excluded.

[2] These are organized thematically, but the order does not necessarily indicate priority or importance.

5. All relevant risk factors should be included in prevention and management strategies addressing chronic disease (comprehensive strategies).	Risk factors analyses and designation should be based on epidemiology and other research and not be unduly influenced by what is currently popular, topical, or politically "safe". For, example, in a number of Canadian-based prevention initiatives, alcohol, other drugs and mental health issues do not appear to be acknowledged as risk factors for chronic disease; this is in sharp contrast to evidence from WHO as well as research conducted here.
6. Strategies and frameworks should move beyond theoretical and conceptual levels into concrete and explicit initiatives and action steps.	Concrete implementation of evidence-based practices is needed as is promotion of practice-based evidence. This is especially needed to address the environmental determinants of health.
7. Where possible, strategies should rely on evidence-based practices, but can also include promising practices and demonstrated successes.	There needs to be a balance between innovative, but unproven, prevention strategies and those with a proven track record.
8. Support for programs and interventions that have not shown any impact (or may actually increase risky behaviour or worsen living conditions) should be phased out.	Prevention resources – human, financial and institutional -- are limited. For example, if high profile and flashy programs, that are ineffective, continue to attract resources there is less available for those that are effective. Continued support for ineffective initiatives also gives the false impression that something worthwhile is happening.
9. Funding for programming should explicitly require evaluation and monitoring components.	There is typically a disjunction between program funding and evaluation resourcing. Programs with an evaluation component should receive priority in order to increase our knowledge base for best practices and to provide appropriate and timely feedback and support to those carrying out prevention programs at the national, regional or local levels.
10. Strategies should minimize risk factors and maximize protective factors (making healthful choices easy choices).	In addition to the important goals of institutional maintenance, the most important goals of reducing chronic disease might be downplayed or overlooked. Mills (2003) refers to three purpose elements for an integrated chronic disease prevention approach: improve population health, reduce health inequities, and prevent new cases of chronic diseases.

11. Options should be pursued for standardized criteria for chronic disease prevention programs in Canada (for example, for evaluation and comparison).	A number of models might be explored. These criteria should be based on principles of effective interventions. The arrangement would facilitate sharing of best practices and increase the number of effective interventions focusing on a risk factor and across risk factors.
12. Sustainability of prevention programs should be improved over time through the provision of committed, long-term funding.	Yach et al. (2005) indicate that interventions known to be effective should be fully implemented. Those meeting these criteria should receive sustained support.
13. Empowerment and ownership within communities should be a critical component of community-based initiatives.	It is important that locally based interventions address both real and perceived needs (Yach et al. 2005). Addressing both may be essential to developing the social support for population level changes.
14. Capacity should be built through the vertical and horizontal integration and comprehensive institutional organization. Knowledge transfer, linkages, maximization of resources, minimization of duplication of effort, and harmonization of efforts should be central.	This is an ongoing challenge and a cornerstone of sustained and innovative prevention efforts. Mills (2003) describes system capacity along three dimensions: *governance* (linkages, roles and responsibilities, mechanisms for courses correction), *infrastructure* (physical, organizational, financial, human and informational) and *political and institutional commitment*.

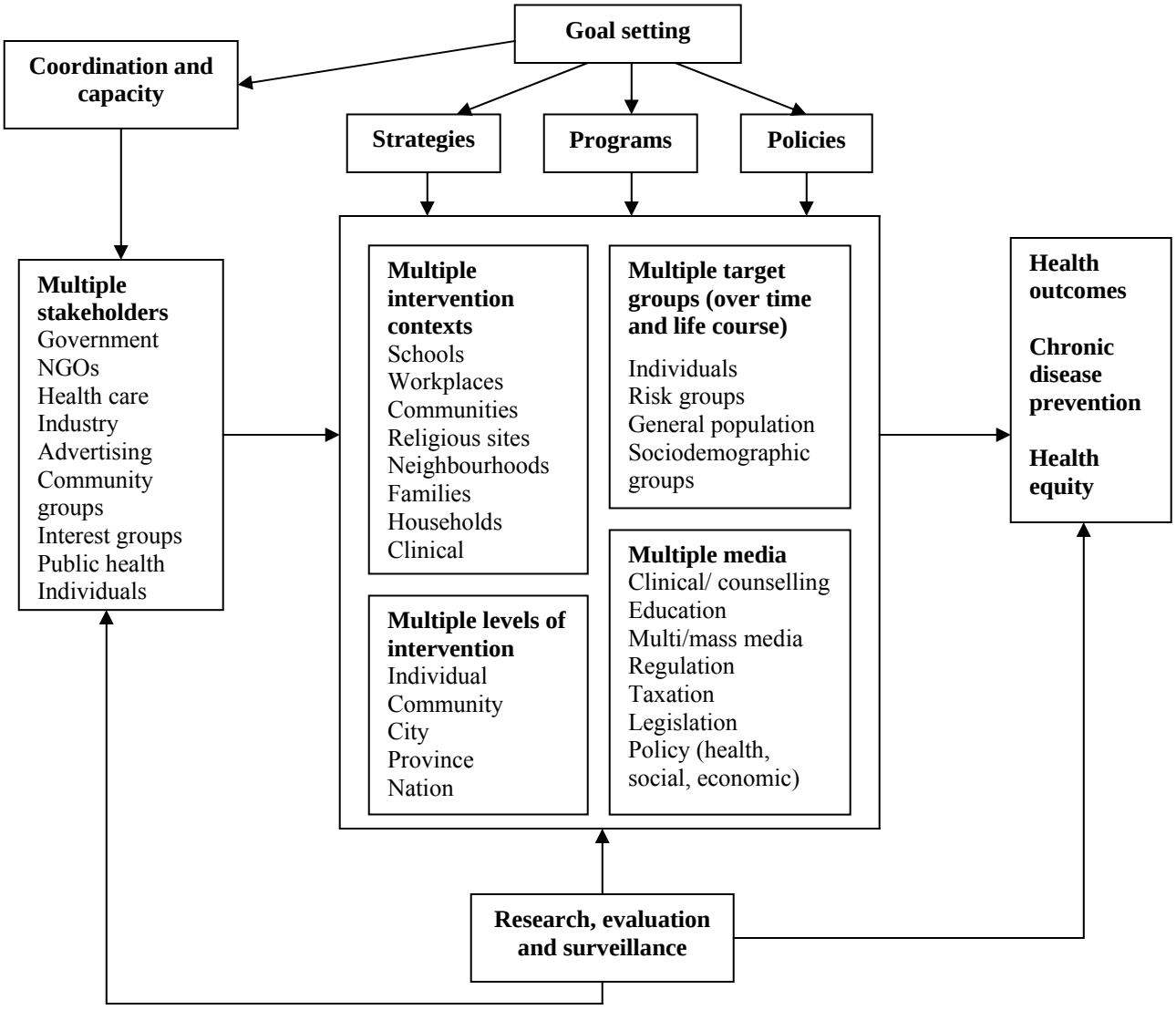
Although initiatives are ongoing with regard a number of these recommendations, further work will require attention to a number of topics, for example: (1) What is the status of current work pertaining to a recommendation? (2) Who should be the lead agency and which partners are essential in moving forward with implementation? (3) What are relevant action steps and messages?

Finally, there are some specific considerations relevant to the implementation of chronic disease prevention that need to be taken into account and that feature prominently in our model (Figure 5):

- *Goal setting*: Are there clear goals and are the resources accessible to achieve them?
- *Policy development*: Are most effective policies in place, implemented and enforced, and at all relevant levels?
- *Programs*: Are most effective best practices the most common? Are there mechanisms in place to facilitate coordination & avoid a duplication of effort?

- *Research*: Is there a good mix of multidisciplinary initiatives to assess causation of chronic diseases, and inform and evaluate interventions?
- *Monitoring and surveillance*: Is it adequate to capture inter-regional differences and sensitive to special populations?
- *Coordination*: Are there adequate resources for infrastructure development, training, dissemination of best practices? Is there a clear understanding of who is responsible for what, how?

Figure 5: Comprehensive Chronic Disease Prevention Framework (this model is a result of multiple resources)



7. Conclusion and future directions

The comprehensive framework for chronic disease prevention thus links multiple levels of risk factors, multiple stakeholders, and multiple strategies. This ensures flexibility for the interventions that can be developed. The inclusion of multiple determinants of health and multiple stakeholders implies the understanding of multiple levels of responsibility for the development and prevention of chronic disease. Ongoing research, surveillance, program and policy development, and coordination and infrastructure are critical to the sustainability of a comprehensive chronic disease prevention strategy. There needs to be ongoing dialogue between all stakeholders involved in chronic disease prevention regarding current best practices and future directions, in order to set realistic goals and to have the resources and knowledge in place to fulfil these goals.

Research and surveillance activities will be able to feed into the process of developing effective programs and policies. We need to look beyond what has been traditionally done and look to the expansion of policy into multiple domains. Policy and programs should be developed in conjunction with and be headed by multiple groups, thus ensuring ownership and empowerment in chronic disease prevention. Our review of the current Canadian situation indicated a disjuncture between the overarching frameworks that emphasize the population health model, and the actuality of program implementation. Program evaluation is also currently not a required component of programming, thus further contributing to the lack of firm knowledge of which programs are presently underway and which are effective.

There are some suggested future directions related to chronic disease prevention in Canada that we foresee. They focus on collecting and organizing background information on risk factors and chronic diseases, evaluations of programs, common policy elements and best practices:

- Establish arrangements to regularly (e.g., every three years) update and disseminate the data-based analysis on risk factors and chronic diseases
- An environmental scan of programs in Canada regarding chronic disease prevention
- A detailed historical progression of policies and programming related to chronic disease in Canada
- Examine and analyze common policy and program elements, opportunities and challenges across risk factors
- Conduct a detailed analysis and review of the available evaluation research
- Conduct an in-depth examination of the impact of environmental and lifestyle factors in relation to chronic disease and assess the quality of the evidence

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