BUILDING THE CASE FOR THE PREVENTION OF CHRONIC DISEASE

MARCH 31, 2002

DIR - 31

215 150 - 02901 - 20 KA – 252193

DR. GREGORY TAYLOR, MD, DIRECTOR

DISEASE INTERVENTION DIVISION

CENTRE FOR CHRONIC DISEASE PREVENTION AND CONTROL

HEALTH CANADA

PREPARED BY THE:

ALLIANCE FOR THE PREVENTION OF CHRONIC DISEASE

ROOM 421, EDUCATION BUILDING

UNIVERSITY OF MANITOBA

WINNIPEG, MANITOBA, R3J 3N9

BUILDING THE CASE FOR THE PREVENTION OF CHRONIC DISEASE

ALLIANCE FOR THE PREVENTION OF CHRONIC DISEASE

DEXTER HARVEY

ETHEL HOOK

JENNIFER KOZYNIAK

MORGAN SELVANATHAN

TABLE OF CONTENTS

A CASE FOR THE PREVENTION OF CHRONIC DISEASE

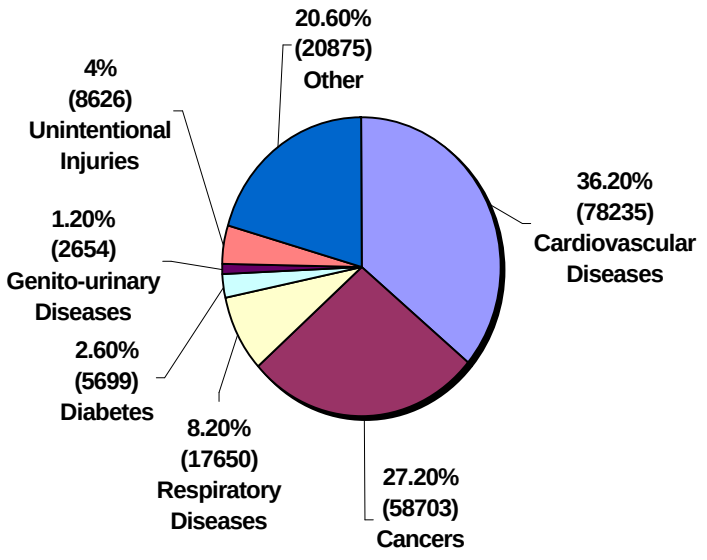
SECTION 1:

Burden of Illness

Leading causes of death in Canada

The Centers for Disease Control (CDC) defines chronic disease broadly as "Illnesses that are prolonged, do not resolve spontaneously and are rarely cured completely"[1]. Chronic diseases are the leading causes of death in Canada (Figure 1). In 1997, there were a total of 215,669 deaths in Canada, with more than 75% of the deaths attributable to one of the following five chronic diseases: cancer, cardiovascular disease, diabetes, kidney disease, and respiratory diseases[2]. Unintentional injuries accounted for 4% of total deaths, and deaths attributed to other reasons were equivalent to 24.2% (52,134) of the total deaths.

Figure 1. Leading Causes of Death, number & percentage of deaths, Canada, 1997



Source: Statistics Canada, Health Statistics Division

Cardiovascular disease (CVD) is the greatest single cause of death, disability, and illness in Canada and has accounted for 78,235 deaths, or 36.2% of all deaths[2]. The break-down of the cardiovascular disease (CVD) category for both sexes combined for all ages for 1997 shows acute myocardial infarction (AMI) and ischemic heart disease (IHD) accounted for 54.7% of all deaths attributed to CVD, followed by 20.2% for cerebrovascular diseases, heart failure (5.7%), and aortic aneurysm (2.7%)[2].

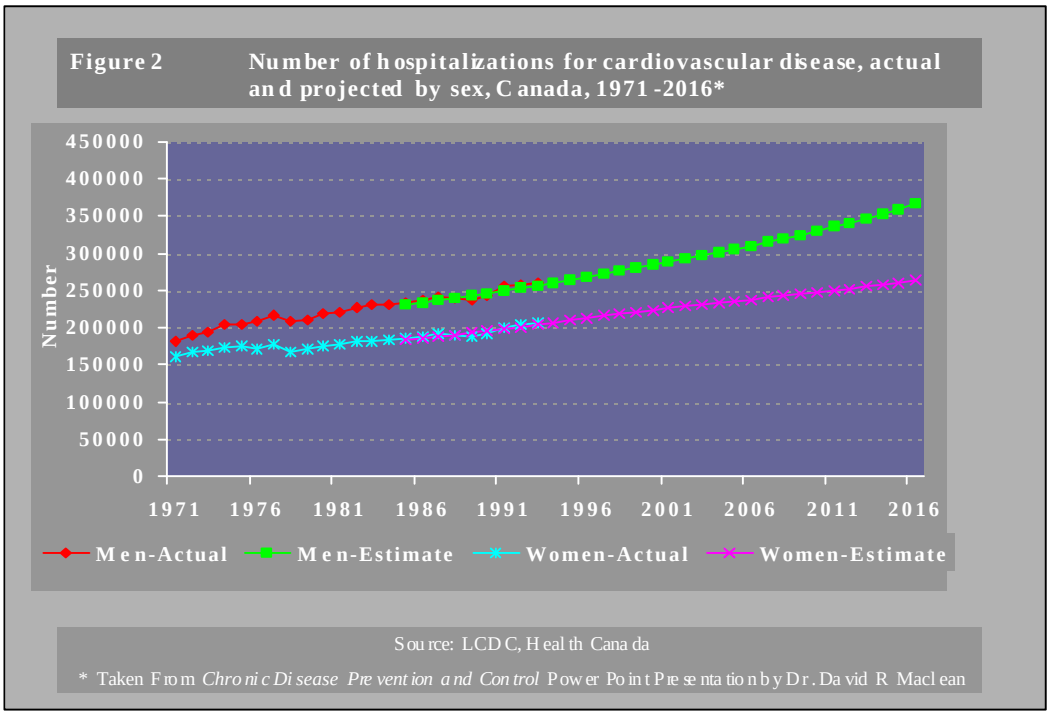
Cancer-related deaths were 27.2% of the total deaths in Canada in 1997. Over 60% of the 58,703 cancer deaths were due to the following cancers: lung (26%), colorectal (10%), breast (8%), prostate (6%), pancreas (5%) and urinary tract (5%)[3]. Non-lung cancer-related respiratory diseases accounted for 8.2% of the total deaths in 1997. Of these, more than half (4.5%) were related to chronic obstructive pulmonary disease (COPD). The other respiratory-related deaths were due to pneumonia, influenza and allied conditions[4].

Diabetes accounted for 2.6% of the total deaths in 1997[5]. Genito-urinary diseases accounted for 1.2% of the deaths[6].

Incidence and Prevalence of Chronic Diseases

Incidence and prevalence rates for cardiovascular disease, diabetes and respiratory diseases come from national hospitalization reports and the National Population Health Survey (NPHS). Caution must be exercised when looking at NPHS data, as they are based on self-reported information. There are limitations also to information from national hospitalization reports, as the data reflect the number of episodes, (event-based), rather than the number of patients (person-based)[7].

Cardiovascular disease is the leading cause of death in the overall population, as well as in the 65 and older age group. Figure 2 shows that both actual and estimated hospitalizations for CVD for both genders in Canada are expected to rise between 1971 (with 12% population aged 65 and older) and 2016 (with predicted 16% population aged 65 years and older)[8]. Hospitalization rates for cardiovascular diseases have been increasing since 1986, and are projected to increase further over time, as the population ages[9].



Cancer is one of the leading causes of death in Canada, and estimates indicate that one-third of Canadians will be affected by the disease at least once in their lifetime. Statistics Canada data[3] show an increase in the number of new cases in the last decade with an increase in the aging population, as half of all new cases of cancer occur after the age of sixty-five[6]. Age-standardized incidence rates have remained relatively stable.

The Canadian Cancer Statistics 2001[3] report shows that an estimated 134,100 new cases of cancer and 65,300 deaths from cancer will occur in Canada in 2001. It is estimated that men will outnumber women for both new cancer cases and deaths, by 4.8% for incidence and 12.7% for mortality respectively. Three types of cancer account for at least half of the new cases in each gender: prostate, lung and colorectal cancers in males; and breast, lung and colorectal cancers in females. The incidence of these gender-related cancers among women continues to rise. Estimates for 2001 show breast cancer incidence at 19,500 new cases, lung cancer at 9,200 new cases, and 7,400 new cases for colorectal cancer. The 2001 estimates for Canadian men indicate that prostate cancer will continue as the leading form of cancer incidence, with an estimated 17,800 newly diagnosed prostate cases as compared with 12,100 lung cancer cases. Deaths from lung cancer however, are predicted to exceed the deaths due to prostate cancer in men in 2001 (10,700 to 4,300 respectively)[3].

The 2001 report "Respiratory Disease in Canada"[4] used self-reported data from the 1998/99 National Population Health Survey to determine the prevalence of respiratory diseases other than lung cancer. The data show a prevalence rate of 3.2% of the adult population aged 34 years and above (men, 2.8% or 211,900; and women, 3.6% or 286,600) claiming a formal diagnosis of chronic bronchitis or emphysema. These rates may be under-represented, since many people do not recognize the early symptoms of the disease and hence do not seek treatment.

Based on the 1996/97 National Population Health Survey (NPHS) data,[10] it is estimated that there will be 60,000 new cases of diagnosed diabetes every year in Canada, for an incidence rate of 2.6 new cases per 1000 people aged 12 and older. Although Types 1 and 2 diabetes are not differentiated in the NPHS results, it is recognized that up to 90% of new cases are Type 2 diabetes[10]. Type 2 diabetes is one of the most rapidly increasing chronic diseases in the world. The prevalence of diabetes was estimated to be 3.2% of the population (779,000 Canadians) aged 12 and over have a diagnosis of diabetes[5]. Diabetes prevalence increases with age, with the prevalence rate for people 65 years and older three times (10.4%) that of those aged 35-64 years (3.2%). In relation to gender, the prevalence rate for men is significantly higher (3.5%) than for women (2.9%), again due to the higher prevalence in the 35-64 and 65^{+} age groups[5].

The incidence and prevalence of end-stage renal disease (ESRD) have increased significantly in Canada over the last two decades. ESRD has shown a 6.2% mean annual increase – an increase from 49.5 new cases per 100,000 population in 1981 to an incidence rate of 111.2 per 100,000 population in 1996[11].

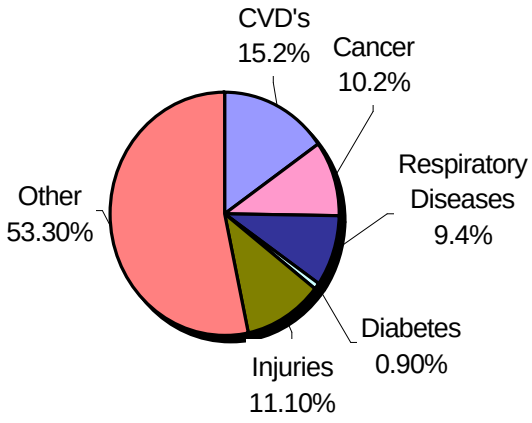
Economic Burden of Chronic Diseases

The following information is based on a Summary Report of the Economic Burden of Illness in Canada 1993, which reports that the total cost of illness in Canada for 1993 was $129.2 billion[12]. This amount included direct costs such as hospital, diagnostic, physician/other health professionals and drug costs; and indirect costs being lost productivity due to short and long-term disability and premature death.

Thirty-six percent of the total health care costs in 1993 were attributable to cardiovascular disease, cancer, diabetes and respiratory diseases, for a total cost of $47 billion (Figure 3). The 1993 health care costs attributable to cardiovascular disease were 15.2% of the total, or $19.8 billion; and cancer costs were 10.1% ($13 billion). Respiratory diseases accounted for 9.4% of the total costs ($12.1 billion); and diabetes accounted for 0.9% of the total ($1.1 billion).

The direct and indirect costs of cardiovascular diseases were $7.4 billion and $12.4 billion respectively, for a total cost of $19.8 billion. Cancer costs were $3.2 billion for direct costs and $9.8 billion for indirect costs, for a total cost of $13 billion. These two disease categories ranked among the top four diagnoses that incurred the highest indirect costs[12]. It is suggested that 90.1% of the indirect costs of cancer and 60.2% of the indirect costs for cardiovascular disease were due to lost productivity through premature mortality[12].

Figure 3. Economic Burden of Illness, Percentage of Total Cost (Direct & Indirect) by Category: Canada 1993



Total Direct and Indirect Estimated Cost for 1993: $129.2 billion
Laboratory Centre for Disease Control, 1996

The direct costs of respiratory diseases in 1993 were $3.79 billion, and the indirect costs were

$8.39 billion. One third of both the direct costs ($1.33 billion) and indirect costs ($2.99 billion) were spent on chronic bronchitis, emphysema and asthma[4].

The 1993 economic burden of diabetes was estimated at $1.1 billion annually[13]. This amount does not reflect the costs of complications of diabetes such as cardiovascular disease and renal failure.

Some factors that contribute to rising health care costs include Canada's aging population, inflation, rising drug and treatment costs, and new technology. Over the next decade, such spending is projected to grow by 58%, although the Canadian population is expected to increase by only 8%. Average spending on health is projected to rise to over $5000 per capita in 2026/27, as compared to $1759 per capita in 1999/00[14]. It is quite clear that the burden of chronic diseases on Canadians is extensive, and will continue to be so as the population ages.

SECTION 2:

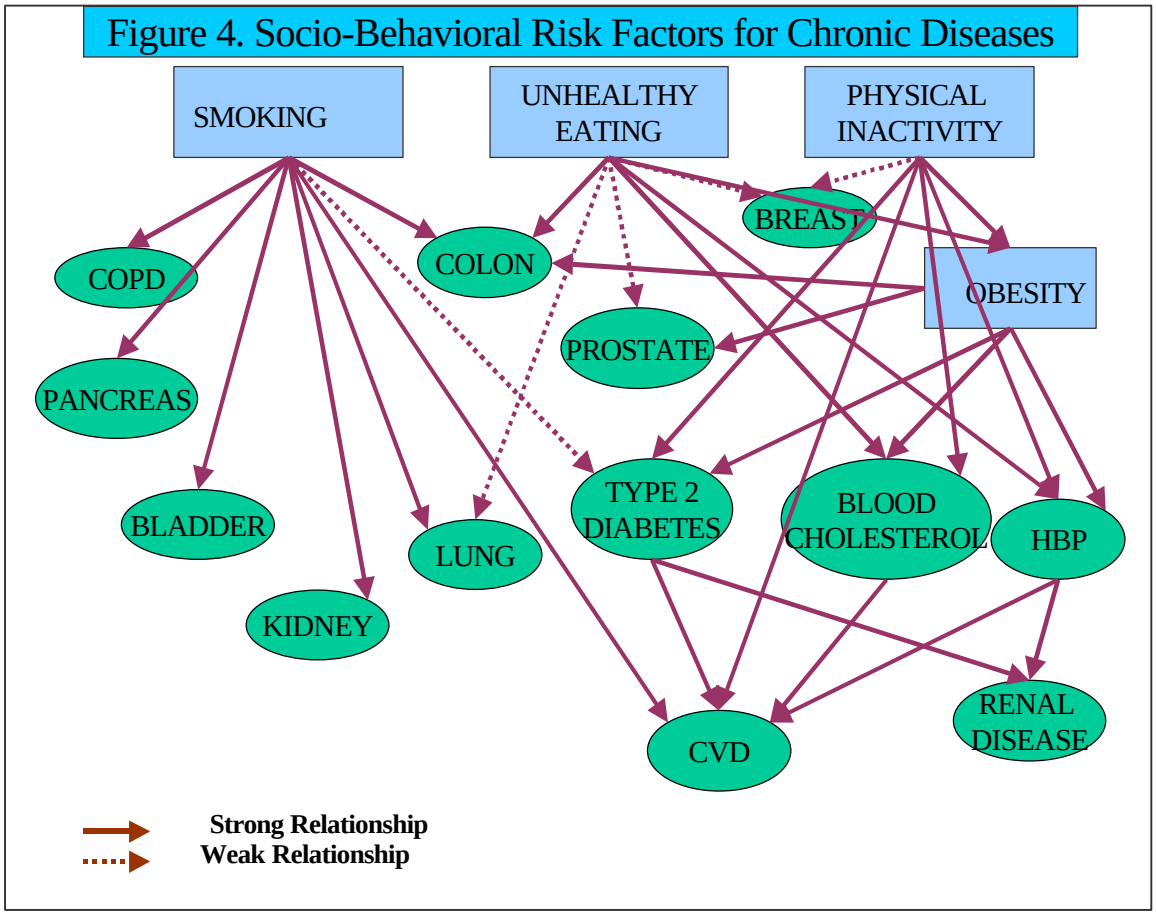
Chronic Disease: Behavioural Risk Factors

Chronic diseases are the result of a complex web of causation. While the "causes" of chronic diseases are not totally known, research has identified an ever-increasing number of factors statistically associated with the development of a disease[15]. These include a range of personal, social, economic and environmental factors that are important in their own right, but at the same time are interrelated[16]. It is believed that the removal of one or more of these factors will reduce the incidence of chronic diseases.

This section will summarize the relationship between the risk behaviours of smoking, physical inactivity and unhealthy eating, with their corollary physiological consequences of obesity, hypertension, hypercholesterolemia and impaired glucose tolerance, and cardiovascular disease, cancer and diabetes.

Figure 4 depicts the association between the risk behaviours and the respective chronic diseases. The solid lines reflect a strong association, while the dotted lines show a weaker association.

What Figure 4 portrays is the commonality of the risk behaviours across the diseases, and in some cases the interrelationships of the diseases themselves.



Smoking

Smoking is responsible for about 30% of all cancer deaths,[17] and accounts for about 85% of all new lung cancer cases[18]. Tobacco consumption is related causally to cancers of the lung, mouth, larynx, esophagus, bladder, kidney and pancreas. Studies documenting these relationships go back more than 40 years. The most convincing evidence comes from prospective follow-up studies, such as the original British Doctors Study conducted by Doll et al[18], and an American Cancer Society study of one million men and women[19]. In addition to the above cancers, about 25% of colon cancer can be attributed to smoking for 30 or more years[20]. Besides causing lung cancer, smoking and the exposure to environmental tobacco smoke causes more than 80% of all chronic obstructive pulmonary disease (COPD)[21].

Smokers' risk of heart attack and stroke is more than twice that of nonsmokers[22]. Smoking acts with other risk factors to greatly increase the risk for cardiovascular disease; and influences several factors that may increase insulin resistance and interfere with insulin action[23]. Smoking therefore may be associated with the development of Type 2 diabetes, although the evidence is preliminary[23]. Smoking is also related to the premature development of multiple complications of diabetes, such as neuropathy and nephropathy. Data suggest that smoking is related to the development of retinopathy in persons with diabetes, although the evidence is less conclusive[24].

There is sufficient evidence, based on studies in humans to show that environmental tobacco smoke (ETS) is a human carcinogen, with a causal relationship between passive exposure to tobacco smoke and lung cancer in non-smokers[25]. Regular ETS exposure increases the risk of heart attack[26] and stroke[27] in non-smokers. Results from epidemiological studies provide strong evidence that exposure of children to second-hand smoke is associated with increased rates of lower respiratory illness, and increased rates of middle ear effusion, asthma, and sudden infant death syndrome[28].

Smokeless tobacco (chewing tobacco and snuff) is also listed as a human carcinogen, based on similar evidence from studies in humans that indicate a causal relationship between smokeless tobacco and oral cancer[29, 30].

Physical Inactivity

Physical inactivity is a major risk factor for cardiovascular disease[9]. Physical inactivity increases risk of heart attack and of death following a heart attack[31]. It is associated with high blood pressure[32, 33]; abnormal plasma lipid profile (reduced HDL)[34]; decreased clotting time[35]; obesity[36, 37]; and Type 2 diabetes[38]. Physical inactivity is also associated with breast and colon cancers[39, 40] and osteoporosis[36].

Studies have shown that increasing regular physical activity is a preventive action for cardiovascular disease[31], blood pressure[33] and cholesterol control[34]; certain cancers[39, 40] and Type 2 diabetes[38]. Health benefits for the elderly include improved physical functioning and independent living, and greater longevity[41]. Dr. Robert Butler M.D. a former Director for the National Institute for Aging stated: "If exercise could be packaged into a pill, it would be the single most widely prescribed and beneficial medicine in the nation."

Obesity

Almost one-third of adult Canadians are at increased risk of disability, disease and premature death because of being obese[42]. The relationship between obesity and cancer is complex and not yet clearly understood. Obesity in women is related to cancers of the gallbladder, breast, cervix, endometrium, uterus and ovary. Women who are above 35% of their ideal body weight have a 55% higher chance of developing these cancers than do leaner women. In men, obesity is most closely related to cancer of the colon and prostate. Men who are above 35% of their ideal body weight have a 40% greater chance of developing these cancers than do leaner men[43].

Obesity is a risk factor for cardiovascular disease, both directly as a risk factor, and indirectly through its relationship to hypercholesterolemia and hypertension[44, 45]. The prevalence of obesity, both generally and abdomen-specific (waist-hip ratio) increases with age, and is accompanied by an increased prevalence of high blood pressure, elevated levels of low-density lipoproteins (LDL cholesterol) and triglycerides, and Type 2 diabetes[46].

Although Type 2 diabetes has a genetic predisposition, three major modifiable risk factors: smoking[23], obesity and physical inactivity are important because of their involvement in the development of insulin resistance[47]. Eriksson et al[47] note that the disease process leading to Type 2 diabetes is probably in existence for a decade prior to diagnosis, because of the up to 50% loss in pancreatic beta cell capacity that is usually evident on first diagnosis. They suggest that the "optimal (and probably the only effective) strategy to reduce the increased burden of Type 2 diabetes is primary prevention".

Unhealthy Eating

Although healthy weight is primarily related to healthy eating, the issue of nutrition by itself is a significant factor for chronic disease prevention. Excessive saturated fat and salt intake increase the risk for high blood pressure, which is a major factor in cardiovascular and renal diseases[48]. Hypercholesterolemia, dyslipidemia and elevated triglycerides factor in both heart disease and stroke incidence: Prevention strategies include a reduced intake of total fat and salt, and an increase in consumption of fibre[48].

The role of diet in cancer causation is complex and difficult to unravel, but ample evidence exists to support the recommendations for healthy eating. Reducing meat and animal fat intake, increasing consumption of vegetables and fruits, and reducing alcohol intake has been shown to reduce the risk of cancer overall and more specifically breast and colorectal cancers[49].

The 1996/97 National Population Health Survey data for Canada provide an interesting challenge for prevention: 24% of all adults were smokers; 57% were physically inactive; and 48% were either overweight or obese[14]. Obesity among Canadian children and youth is increasing: The data show that since 1981, for both genders, ages 7-13 years, body mass index increased almost 0.1 kg/m^2 per year, indicating that Canadian children are becoming progressively more overweight and obese[50].

Smoking is responsible for about 30% of all cancer deaths, and accounts for about 85% of all new cases of lung cancer.[19] Smoking also is responsible for 25% and 20% of male and female deaths due to myocardial infarction[51]. The elimination of smoking would have a major impact on cancer and myocardial infarction mortality rates. Healthy eating, physical activity and healthy body mass have an estimated potential to decrease cancer incidence by 30-40%. Daily diets high in vegetables and fruits are estimated to reduce cancer incidence by 20%[52].

The evidence points to the importance of healthy eating, healthy weights, physical activity, not smoking and not being exposed to tobacco smoke in the prevention of cardiovascular disease, cancer, diabetes, and COPD.

SECTION 3:

Chronic Disease Prevention Framework

In Section 2, the connections of the three risk behaviours smoking, physical inactivity and unhealthy eating/weights with the major chronic disease were established. This section will add the impact of some of the socio-economic determinants of health.

Health and well-being are complex and multi-faceted concepts and conditions. Socio-economic conditions and environments are key contributing factors in people's health[53]. Choices regarding health practices and beliefs are constrained by their physical, social and cultural environments. Factors that are external to the individual and community determine the health of both individuals and populations. These health determinants include income and social status, social support networks, education, employment and working conditions, social and physical environments, personal health practices and coping skills, biology and genetic endowment, healthy child development, health services, gender and culture[54].

The most firmly established associations between chronic diseases and factors in the life span are those between disease and the major known 'adult' risk factors namely tobacco use, physical inactivity and unhealthy eating/obesity[55]. They are shown to be significant at both individual and population levels[56].

The unhealthy behaviours do not just emerge in adulthood. They are already taken up in childhood and adolescence as shown by the Bogalusa Heart Study[57, 58, 59]. Parental physical inactivity has been linked to childhood physical inactivity and consequent obesity[60], and unhealthy parental diets have been linked to unhealthy dietary intake and overweight children[61]. Children and adolescents also take up unhealthy behaviours through mass marketing and media pressure, which are reinforced through peer pressures Parental tobacco smoking and quitting have been found to be important influences on the uptake of smoking especially by younger children[62].

Aboderin et al[56] report solid evidence that risk behaviour development is the result of numerous factors over the life span. It is clear that the risks for chronic disease accumulate with age and are influenced by factors acting at all stages of the life span, with increasing indications that the interactions of the early and later factors may lead to very high risks for chronic disease.

Unhealthy behaviours are directly and indirectly shaped by family, friends, peer groups, schools, and the broader social and physical environments. The prevalence of unhealthy behaviours shows clear variations between race, gender and socio-economic groups, indicating the importance that social or economic determinants have on individuals' choice of diet, smoking and the extent of physical activity[56].

Studies from various countries show that physical inactivity among adults and youth is highest in low income and occupational strata groups[63, 64, 65]. Similarly, smoking and unhealthy diets were found to be associated with lower occupational or income levels[66]. Lynch et al[64] reported that in Finland people in the lower socio-economic strata had the highest rates of total calorie and saturated fat intakes and lowest levels of fresh vegetables and fruit intake. They conclude that the clustering of unhealthy behaviours in the lower socioeconomic groups is consistent but do not fully explain the observed inequalities in health and disease rates.

While the above evidence shows that unhealthy diet, smoking and physical inactivity in adults are related to current socio-economic status, these same health behaviours are often also related to their earlier socio-economic position such as lower levels of education and poorer background in childhood[63, 64]. This early influence of socio-economic position may increase the risk of later disease as a result of children and youth adopting unhealthy behaviours and attitudes.

Lantz et al[67] investigated the degree to which four behavioural risks (cigarette smoking, alcohol drinking, sedentary lifestyle and relative body weight) explain the observed association between education and income and all-cause mortality. Using the data from the Americans' Changing Lives longitudinal study, they examined the impact of income, education and the four health behaviours on the risk of dying within the next 7.5 years. Subjects were 25 years or older. The

results showed quite clearly that lower levels of income are associated with significantly higher levels of risk behaviours and significantly higher rates of mortality, but health risk behaviours account for only a modest proportion of deaths in the low income and middle-income sectors. They conclude that both risk behaviours and socioeconomic status are important determinants in mortality.

The literature related to health behaviours and socio-economic status clearly suggests that prevention initiatives must address both behaviours and the structural elements of inequality in society. This can only be accomplished through multiple component strategies that address policy, information and prevention, through initiatives that reach people in all their domains of life and extend clear across the lifespan. These strategies require a social ecological perspective framework for prevention.

Social Ecological Model

Bronfenbrenner's ecological model[68] states that people exist within a system of relationships within complex layers of environments that impact on their lives. Changes or impacts in one layer tend to ripple throughout other layers. Bronfenbrenner views behaviour as influencing, and being influenced by these complex layers of environment, dividing the environmental influences on individual behaviours into micro-, meso-, exo- and macro-systems. The microsystem is the layer closest to the individual and contains the structures with which one has direct contact: family, school, neighbourhood and work environments. The mesosystem is the layer where connections are made between structures within the microsystem. Beyond this layer is the exosystem that consists of the larger social system, in which the individual does not function directly. The structures within this layer impact the individual by interacting with one or more structures of the mesosystem. Finally, the macrosystem is the outermost layer, comprised of cultural values, customs and laws that indirectly impact the individual. The effect of the larger principles defined by the macrosystem have a cascading influence throughout the interactions of all other layers.[68]

McLeroy et al[69] provide a social ecological model for health promotion based on Bronfenbrenner's conceptual framework. In this model, behaviour is influenced by five major

categories of factors: Intrapersonal Factors (individual characteristics such as knowledge, skills, behaviour, self-referent beliefs, individual developmental history); Interpersonal Processes and Primary Group (social networks and social supports including the family, work group and friendship networks); Institutional Factors (rules and regulations for operation of social institutions and organizations); Community Factors (relationships among the various organizations, institutions and informal groups); and Public Policy (all levels of government). This model can be utilized to inform and guide interventions and evaluation planning across each level. Research has shown that efforts to target the full range of levels within the social ecological model may be important in improving the effectiveness of interventions[70].

Stokols[70] offers some practical planning guidelines from the core principles of the ecological perspective: (1) Prevention initiatives need to enhance the fit between people and their surroundings; (2) Consider joint influences of intrapersonal and environmental conditions. Personal as well as physical and social environmental factors must be taken into account in the design and implementation of prevention programs. This implies that prevention must focus on multiple components or means to influence behaviour that address individual needs as well as the environmental determinants of health; (3) Prevention initiatives need to focus on high-impact behavioural and organizational 'leverage points'. This means that places and environments in which a behaviour is most likely to occur can play a significant role in influencing that behaviour, if it is an environment supportive of that behaviour; and (4) Prevention initiatives need to address the interdependence between the physical and social environments and encompass multiple settings and life domains. People's activity patterns are organized in relation to their major life domains – residential, educational, religion. Planning needs to consider multiple opportunities in multiple settings. Consistent with the social ecological perspective is that strategies must focus on places where people live, work and play.

Stages of Change

Chronic disease primary prevention interventions must address both individual behaviour and inequities in the environment. The social ecological model provides an overarching conceptual framework for prevention. However, populations involve individuals with different interests or motivations with respect to behaviour change. Behaviour change is seldom a single event: The

individual moves slowly, from being uninterested to considering a change, to deciding and preparing to change. Prochaska's change theory[71] or Stages of Change model recognizes that behaviour is too complex to systematically and consistently respond to just one form of intervention. Behaviour change is a process, and certain processes facilitate progressive movement through the various stages of pre-contemplation, contemplation, preparation, action and maintenance. Individuals are seen to progress consistently through five stages in order to create a change in behaviour. 'Pre-contemplation' is the stage where people are not interested in change: They may actually deny that there is a need to change. 'Contemplation' is the stage when people begin to recognize the need to change, to consider altering a behavior. Planning and small changes begin at the 'Preparation' stage. When people approach the 'Action' stage, they begin to make a commitment to undertake action. The fifth and final stage is 'Maintenance', when true alterations and stability in behaviours are seen: Behaviour change can become ingrained or relapse (a sixth stage) can occur.

The Stages of Change model can guide thinking in the selection of approaches whether they are informational, behavioural or policy oriented to match the varying stages of change that will be found in all communities. The Stages of Change model was developed using factor and cluster analytical methods in retrospective, prospective and cross-sectional studies. The model has been applied extensively[72], and has been validated for smoking cessation[73], exercise behaviour[72,74] and dietary behaviour[75,76]. Prochaska's change theory encompasses many change models[71] And complements the social ecological model.

SECTION 4:

Chronic Disease Prevention through Population Strategies

A case has been presented in Sections 1 and 2 regarding the burden of chronic disease, and the association of these diseases with three risk behaviours: smoking, unhealthy eating and physical inactivity. In Section 3, a social ecological framework was presented, as a guide to address behaviour change and the social and physical environments. This Section will present examples of where risk factors in the population, or in groups, have been changed; and in some instances where the risk factor changes have resulted in the actual reduction of disease incidence and mortality.

There have been more than three decades of community prevention trials focused on reducing risk factors for cardiovascular disease. Most of the trials were primary prevention initiatives designed to reduce the population prevalence of multiple cardiovascular disease risk factors in intact communities. A limitation of most of the studies is that they were not true experimental designs. However, the evidence is consistent enough to warrant attention to their results, which can guide policy and program decisions. Since one or more of the cardiovascular risk factors are also risk factors for cancer, diabetes and chronic obstructive pulmonary disease, the cardiovascular primary prevention research initiatives have relevance for chronic disease prevention.

There is strong evidence indicating that communities can make major gains once becoming involved in reducing health risk behaviors associated with many chronic diseases[77]. Much of the evidence in heart health intervention indicates that these programs are cost-effective, easily transferable and have dramatic impacts on health policy development[78]. Researchers have found that community-based prevention programs also can substantially promote a positive shift in health status in high-risk populations[79].

The most notable cardiovascular disease prevention trials are the Stanford Three-Community Project, North Karelia Project, Stanford Five-City Project, Minnesota Heart Health Program and the Pawtucket Heart Health Program. These five projects identify that cardiovascular diseases are preventable through modifications of established risk factors such as cigarette smoking, elevated blood lipids, elevated blood pressure and sedentary lifestyle. The basic premise for this work is that community-wide strategies lead to a reduction in disease rates through changes in individual and community risk factors. Each provides valuable models, methodologies and strategies for planning and implementing community-based/led programs.

Stanford Three-Community Project (1972-75)

The Stanford Three-Community Project was conducted in three non-randomized matched towns in California. Intervention activities included media and direct education. One town received the media intervention only, the second media and direct education and the third was a comparison town. This study provided support for the effectiveness of mass media and interpersonal

instruction for high-risk groups in producing favorable changes in heart disease risk factors. The results showed that from 1972-75 there were significant reductions in smoking, blood pressure, cholesterol, body weight, and composite coronary heart disease risk. This composite risk reduction was 23%.[80, 81, 82]

North Karelia Project (1972-95)

The North Karelia Project in Finland is often cited as the model for other national and international prevention trials. It was launched in response to local concerns about the need for urgent and effective help to reduce the burden of exceptionally high coronary heart disease mortality rates in the region. The province of North Karelia received the intervention while a second province served as a reference. The North Karelia Project, a population-based approach, built an education and advocacy organization of over a thousand lay leaders[83]. These lay opinion leaders took the lead in promoting the diffusion of health innovations in the community programs[83]. The project used a combined approach of education (including risk factor screening programs and skill building courses) and policy initiative to achieve a healthier environment. There were strong partnerships with residents and their organizations. Within five years there were favorable reductions in cardiovascular disease events for men aged 35-64 years in North Karelia. By year ten, for men 35-64 years, there were significant reductions in smoking, blood pressure, cholesterol and coronary heart disease risk; along with a 24% reduction in cardiovascular disease mortality in the intervention province compared with a 12% reduction for Finland as a whole[84, 85, 86]. From 1969 to 1995, the age adjusted coronary heart disease mortality rate for men 35-64 years in North Karelia dropped 72% compared to a 64% drop in all of Finland[87]. While coronary heart disease mortality was decreasing, so were cancer mortality rates in 35-64 year-old males: More than 45% in North Karelia and approximately 35% in the rest of Finland[88].

Stanford Five-City Project (1980-86)

The Stanford Five-City Project built on the work of the Three-Community Study. It was conducted in five northern California cities. The intervention consisted of a five-year education program consisting of TV, radio, newspaper and other print materials, community events and

direct education in two cities. Members of the communities were involved in establishing local health education programs; and providing opportunities for intensive, interpersonal education and locally produced media programs. The three remaining cities served as references. The project was successful at decreasing blood pressure, smoking, cholesterol and coronary heart disease risk in the two intervention cities[89, 90].

Minnesota Heart Health Project (1981-88)

The Minnesota Heart Health Project was designed to provide community education for the prevention of cardiovascular disease. The study involved three pairs of non-randomized communities in the Midwestern United States matched by size and type. Each pair had one education and one comparison site. Most of the community-based programs centered on non-smoking; healthy eating patterns to lower blood cholesterol; hypertension prevention, detection and control; and regular physical activity. All of the interventions operated at the individual, group and community levels. Community organization methods were used to engage community leaders and their organizations as active participants in the education programs. Advisory boards based within the community were organized, representing medical, political, business, labour, religious, educational and other elements of the community. The direct education program provided classes at local schools and other sites on individual approaches to reduce cardiovascular risks. School programs advocated healthy eating patterns, regular physical activity and non-smoking among youth[91].

It was found that a 5-6 year educational program could (1) improve population health behaviors, (2) lower population levels of blood cholesterol, blood pressure and cigarette smoking, and (3) increase physical activity levels. Evaluations of the project showed that it was much easier to change the risk profiles of people who participate directly in these programs than it was to engage a large enough fraction of a community to change risk profiles for that community[92]. Total population cross-sectional surveys revealed significant reductions in female smoking and increased physical activity in both men and women[93].

Pawtucket Heart Health Project (1984-91)

The Pawtucket Heart Health Program involved one intervention and one matched reference city in New England. It was a demonstration project based within the community. The primary focus of the seven-year campaign was on modifying risk factors for cardiovascular disease among residents. The goal was to reduce cardiovascular morbidity and mortality using strategies that relied on community volunteers, and to develop a framework of community organization capable of sustaining health enhancement programs. People learned skills, built support systems and developed strategies for initiating and maintaining healthy behaviors through the collaborative efforts of individuals, groups, organizations and the entire community.

The risk factors targeted included high blood cholesterol levels, high blood pressure, smoking, sedentary lifestyle, and obesity. Volunteers were recruited and trained to develop, deliver, evaluate and eventually manage the programs to change risk behaviors associated with cardiovascular disease. Evaluations were put in place whereby random cross-sectional household surveys monitored relevant changes in Pawtucket and the reference city. The surveys showed significant treatment effects for obesity and reduced coronary heart disease risk. A marketing strategy was developed to promote intervention programs and education programs. Based on social learning theory, materials were designed for people with low literacy levels. Interventions on weight control, reducing blood cholesterol levels, and smoking cessation were part of the design[94].

The program could not have worked without its volunteers. More than 3,600 people in the community and surrounding areas gave their time and energy to the project. The most notable effects were seen in individuals with lower levels of education. It was found that certain subgroups, specifically those of low socioeconomic status, appeared to benefit from the interventions[95].

Discussion of the Five Community Studies in Cardiovascular Disease Prevention

The five prevention trials were quite diverse in their methodological perspectives, addressing awareness and education, skill-building and advocacy. Three were successful in reducing smoking rates, two reported reductions in obesity/body weight, four reported a coronary heart

disease risk reduction, three reported a reduction in cholesterol, and three reported a reduction in blood pressure. The North Karelia Project was the only one of the five trials that demonstrated a reduction in coronary heart disease reduction. In the three studies in the 1980s, the decrease of the risk factors were often small but even a reduction of a few percentage points in a primary cardiovascular disease risk factor has considerable significance at a population level[96].

The Stanford Five-City, Minnesota Heart Health Project, and the Pawtucket Heart Health Project combined produced fifty sub-studies that evaluated a variety of program components separate from their population wide effects. These program components include mass media campaigns, events and contests, group and individual (direct) education, school programs, worksite programs, grocery store and restaurant programs, physician and health care settings screenings and policies. Schooler et al[97] reviewed the (fifty) sub-studies, and concluded that the component studies generally show greater risk factor changes than seen in their population-wide samples. The (separate) sub-component studies demonstrate that it is easier to change program participant risk profiles than it is to engage sufficient community participation to result in a change in a community's risk profile.

The five prevention trials all reflect a similar set of three primary categories of components in their interventions. These components are mass media; program-specific prevention initiatives that provide education and/or skill building for health behaviour development in multiple settings; and environmental support actions through policy development and site program development resulting in the support of health enhancing behaviours.

Diabetes Prevention Studies

Three studies in diabetes prevention demonstrate the effectiveness of lifestyle changes in the prevention of Type 2 diabetes. The first study took place in Finland and involved the random assignment of 522 middle-aged overweight subjects (172 males and 350 females, mean age 55 and mean body-mass index of 31) with impaired glucose tolerance to either an intervention or control group. Intervention group subjects received individualized counseling for weight reduction, fat intake reduction, fiber intake increase and increased physical activity. The mean duration of follow-up was 3.2 years. The mean amount of weight lost between base line and the

end of year one was 4.2 kilograms in the intervention group and 0.8 kilograms in the control group. By the end of year two, the net loss was 3.5 and 0.8 kilograms respectively in the intervention and control groups. The cumulative incidence of diabetes after four years was 11% in the intervention group and 23% in the control group. The intervention group risk for diabetes during the trial was reduced by 58%. The study concluded that Type 2 diabetes could be prevented among high-risk subjects through changes in lifestyle[98].

The second diabetes study[99] involved 41 male subjects with early stage Type 2 diabetes and 181 male subjects with impaired glucose tolerance, selected to determine the effect of a long-term life style change program. All subjects were 47-49 years of age. A five-year protocol consisting of dietary treatment and/or increase in physical activity were completed by 90% of all the subjects. Body weight was reduced by 2.3 –3.7 % among the participants in the study compared with a 0.5-1.7% weight increase in the non-intervention subjects with impaired glucose tolerance and in normal control subjects. Glucose tolerance was normalized in more than 50% of subjects with impaired glucose tolerance. The accumulated incidence of diabetes was 10.6%, with more than 50% of the diabetic patients in remission after a mean follow-up of 6 years. The study found that the improvement of glucose tolerance was correlated to weight reduction and increased physical fitness[99].

In 1986, 577 subjects with impaired glucose tolerance attending health care clinics in Da Qing, China[100] were randomized by the clinic to either a control group or to one of three active treatment groups. One of the treatment groups received a diet-only program; a second group received an exercise-only program; and the third group received both a diet and exercise program. Follow-up evaluation examinations occurred at 2-year intervals over a 6-year period to identify subjects who had developed Type 2 diabetes. Over the six years, the accumulated incidence of diabetes in the control group was 67.7% compared with 43.8% in the diet group, 41.1% in the exercise group and 46% in the diet and exercise group. The study concluded that diet and exercise interventions led to significant decreases in Type 2 diabetes over a six-year period among subjects with impaired glucose tolerance.

Discussion of Type 2 Diabetes Prevention Studies

These three studies show the benefit of healthy weights, healthy eating and physical activity in preventing Type 2 diabetes. Community prevention initiatives addressing obesity, healthy eating and physical activity may have important implications in the prevention of Type 2 diabetes in high-risk populations, which supports the notion of integrated prevention initiatives.

The CVD prevention trials and the diabetes studies provide solid evidence that physical inactivity, smoking and unhealthy eating/obesity rates can be influenced by community-based initiatives. Further, the Schooler et al[97] review of the fifty sub-studies from the Stanford Five-City, Minnesota Heart Health and Pawtucket Heart Health projects found extensive evidence for the effectiveness of programs in changing participant risk behaviours.

SECTION 5:

Potential Health Benefit of Risk Behaviour Reduction

Section 1 presented evidence on the burden of chronic disease on Canadians, while Section 2 presented evidence on the relationship between physical inactivity, active and passive smoking, obesity and healthy eating; and cancer, cardiovascular disease, chronic lung disease, diabetes and kidney disease. This Section will link the extent to which the risk behaviours cause disease and cost, and where possible, how much can be saved through a reduction of risk factors.

Smoking

More than 45,000 Canadians deaths each year are attributable to smoking. Smoking is responsible for 30% of all cancer deaths,[17] 85% of new lung cancer cases[18, 19] and 25% (male) and 20% (female) deaths due to myocardial infarction[101]. It has also been reported that Canadian regular smokers lose about 15 years of their life expectancy[102].

Smoking costs the Canadian economy roughly $336 for each Canadian.[103] In 1991, lost productivity due to smoking deaths in Canada was estimated to be $10.6 billion, while more than 38,000 Canadians were residing in long-term care facilities because of smoking-related

diseases[104]. Ontario research found that in 1994 the average per capita cost of physicians' services increased by $1.75 for every year of daily smoking.[105] Other research has found that current smoking status and a history of tobacco use increase annual per patient charges by 18% and 25.8% respectively[106].

Physical Inactivity and Obesity

Katzmarzyk and colleagues[107] report that, in 1999 about 2.5%, or $2.1 billion of direct health care costs in Canada were attributable to physical inactivity. They estimate that 10% reduction in the prevalence of physical inactivity could result in a saving of $150 million per year. Using 1995 data, they also found that if physical inactivity in Canada were totally eliminated it would increase life expectancy and save 21,340 lives lost prematurely each year, or 10.3% of total deaths among adults. The Conference Board of Canada, using 1993 data, calculated that a 1% increase in the number of Canadians who were physically active would result in an annual saving of $877,000[108].

Stephenson et al[109] report that every 1% gain in the proportion of the Australian population that is physically active will reduce coronary heart disease deaths by 100 per year; 112 hospital admissions for acute myocardial infarctions per year; and have a potential saving in health care costs of $2.6 million for coronary heart disease, $2 million for stroke 0.6 million for Type 2 diabetes, $0.3 million saving for colon cancer, $0.3 million for breast cancer and $88 million for all cause mortality.

Obesity in Canada had an estimated cost of $1.8 billion in 1997[42]. Pronk et al[106] report that after adjusting for basic demographic characteristics and chronic disease status, there is a 1.9% increase in health care costs per body mass unit for each individual. Finkelstein[105] reported that for Ontario in 1994, physician service per capita cost increased by $8.90 for every unit increase of body mass index beyond the optimal range of 20-25.

The Victorian Burden of Disease Study[110] published in 2000 by the Public Health and Development Division of the Department of Human Services in the state of Victoria, Australia

determined the contribution of risk factors to the burden of total mortality for the state of Victoria for the year 1996. The study reported that smoking was responsible for 16.7% and 9.3% of deaths in men and women respectively; obesity was responsible for 8.4% and 9.5% of deaths in men and women respectively; and physical inactivity was responsible for 7.3% and 9.3% of deaths in men and women respectively[110]. Mathers et al[111] reported that for 1996, considerable proportions of the overall burden of disease in Australia were attributable to a number of risk factors. Tobacco smoking was the leading risk factor responsible for 10% of the total burden of disease, followed by physical inactivity at 7% and obesity at 4%. Insufficient intake of fruits and vegetables (fewer that five servings a day) caused an estimated 3% of the total burden of disease and 11% of the cancer burden.

It is difficult to pin point exact cost savings that might be gained from specific percent reductions in smoking, physical inactivity or body mass index units. The evidence presented however, clearly indicates that there could be significant reductions in the burden of morbidity, mortality, and/or economic costs, as a result of changes in one or more of the risk behaviours. The benefit of risk behaviour improvement economic dividends does not take into consideration the cost of delivering the primary prevention intervention. Even a modest $5 per capita cost for comprehensive community-led primary prevention programs addressing all three risk behaviours would have a total cost of about $150 million per year. This total expenditure would be paid back with a 10% reduction of physical inactivity. Additional savings would come from smoking reduction, increased healthy eating and a reduction in unhealthy weights

SECTION 6:

Recommendations for Prevention

A case has been made for chronic disease prevention: The escalating prevalence and cost of chronic disease, of which a considerable proportion could be prevented or delayed by reducing modifiable risk factor levels and providing supportive environments through population and high risk strategies. The literature describing research trials and demonstration projects identifies population strategies that have shown success in reducing (socio) behavioural risk factors and building supportive environments. In some of the prevention trials, the decrease in risk factor levels was small. However, at a population level even a small decrease may have a large effect

in preventing the move of low-risk persons to a high-risk level[96]. The challenge is to be able to deliver an adequate dose to the respective priority populations to bring about a population effect.

The fifty sub-studies reviewed by Schooler et al[97] were component studies from the three major US demonstration trials (Stanford, Minnesota and Pawtucket). The authors suggest that such an assessment of the separate components of large studies may obscure the synergy that occurred overall, as well as the interactions that occurred between the components. They note that the interactions between interventions did result in a more widespread impact. The authors present some 'practice principles', which are instructive and relevant as recommendations for prevention.

Comprehensive Interventions

The primary prevention of chronic disease will require multiple strategies that focus on both behaviour change and social and physical environment changes supportive of healthy behaviours and health. To accomplish this will require multiple approaches for communication/information, public policy and prevention initiatives that reach people in multiple settings (workplace, community, home, schools, restaurants, grocery stores) across the age span, as well as priority populations. The behaviour and policy approaches must address multiple risk behaviours and inequalities. Comprehensive interventions require the collaboration of individuals, communities, community organizations and governments.

Integration

A successful comprehensive intervention needs to be carefully integrated so that the information, policy and prevention initiatives reaching the total population in multiple settings are mutually reinforcing. This will require an integration of information, public policy and prevention initiatives to enhance synergy. Integration also means that primary prevention approaches need to encompass both the total population and those at high-risk. While the low-income sectors of the population have a disproportionate amount of the burden of chronic disease, the vast majority of the total burden rests with those who are outside the low-income strata. Therefore, it is not an "either or" approach, but a comprehensive integrated approach that addresses high, medium and low-income populations.

Sustainability

Sustainability in this document refers to the ability and capability to sustain the process and the initiatives. Comprehensive interventions need to be developed within the capacity of their settings. This means the ability to maintain the programs with respect to knowledge and technical skills, and capability in terms of resources (monetary and human).

Community-Led

Community involvement and ownership are crucial to the implementation of comprehensive interventions. Communities need to be a part of the decision-making, and in fact should have a lead role. Communities themselves know how to attain a social ecological perspective that will lead to comprehensive interventions that are integrated, sustainable and fit the social and physical environments.

Disseminate Research Results and Lessons Learned

Despite the fact that there is strong evidence of the success of population-based chronic disease prevention strategies, prevention is a low priority among governments and organizations. Farquhar[112] states that there is a need to raise the priority of chronic disease prevention, especially community-based chronic disease prevention. Widespread sharing of the findings, challenges and successes of prevention studies and programs allows countries and communities to learn from others, reduces cost and time delays of duplication, and allows for adaptation to different environments. Blending education with advocacy, and building health professionals' commitment, skills and freedom to modify the health system's traditional 'top-down' approach with 'bottom-up' community activation for health incorporates the practicalities of 'how-to,' through using real-life examples from research.

The Need to Study Deployment of Community-Based Prevention Interventions Developed from Research

This document has presented a body of evidence concerning the effectiveness of community–based chronic disease prevention. However, the transfer of this new knowledge from the research to practice is far from optimal[112]. While the importance of the transfer of this community-based prevention research to practice is recognized, there has been relatively little

done to develop successful approaches for such transfer[113]. It was further noted that without some form of translation of prevention research into practice, accomplishments will remain "on the shelf"[113].

It would be naïve to think that research on community-based prevention can be directly applied to communities in a routine way. Research evidence will always need to be adapted to fit local contexts in order to respond to the complexity of factors influencing behaviours, exposure to risk and the capacity of individuals and communities to change their circumstances. However, in order to ensure that decision-making is based on the best available evidence concerning effectiveness and application to "real life" settings, there is need to study research-based interventions in contexts outside of the research settings. Further, it is necessary to determine whether the research based interventions can be deployed or widely implemented across a number of communities and still maintain the effectiveness and resource and capacity management found in the research. Farquhar[112] states, "There is nothing so useless as a theory untested in the real world of the community itself"

Nutbeam[114] offers a model to guide approaches to address the translation of research into practice. He offers a four-stage model that describes the stages and corresponding research which link fundamental research with practice. Stage 1 is Problem Definition and Prioritization, and includes epidemiological and demographic research to investigate the causal health problems, the scope of needed interventions and the priority populations. Stage 2 is Solution Generating, and it includes research that assesses the scope for change in behavioural and environmental determinants; identifies priority populations and potential intervention settings; and completes a systematic review of research to determine effective interventions. Stage 3 is Solution Testing, and it includes research of interventions in "ideal" conditions and demonstration evaluations of interventions under "normal" conditions, to better ascertain conditions for success. Stage 4 is Solution Maintenance, and it is focused on studying how programs can be widely implemented or deployed on a large scale. The research includes monitoring and resource management and ways to disseminate or diffuse programs. Nutbeam also provides outcomes of importance for each stage.

In Stage 1, the outcome is the definition of priorities relating to health, in Stage 2, the outcomes are a definition of priorities stated in health targets and the definition of program objectives, in Stage 3 the outcome is the achievement of program objectives from Stage 2 and a clarification of conditions for successful implementation. Stage 4 outcomes are the development of "practice guidelines" for the deployment of the intervention on a large scale and the replication of the intervention effects in diverse settings.

Most of the published research in prevention is descriptive and falls into Nutbeam's Stages 1 and 2. In the case of Stage 3, most of the evaluative research publications are those with maximum internal validity, and are of the least use to practitioners. Very little prevention research has been published that addresses Stage 4**.** While all four stages proposed by Nutbeam are important in moving research to practice, it is really the Stage 4 research that provides the information of greatest interest to program managers, practitioners, and policy makers, because it defines what needs to be done, by whom, to what standard, and at what cost. It is the most important research, because it provides information on the effectiveness of the application of the prevention intervention to the general population and to specific subgroups[115].

Brownson and Simoes[116] provide a framework to evaluate research advances in practice settings. While the framework has not been tested prospectively, it is a complement to Nutbeam's[114] Stage 4: Combined, they provide the bases for developing evidence informed practice guidelines.

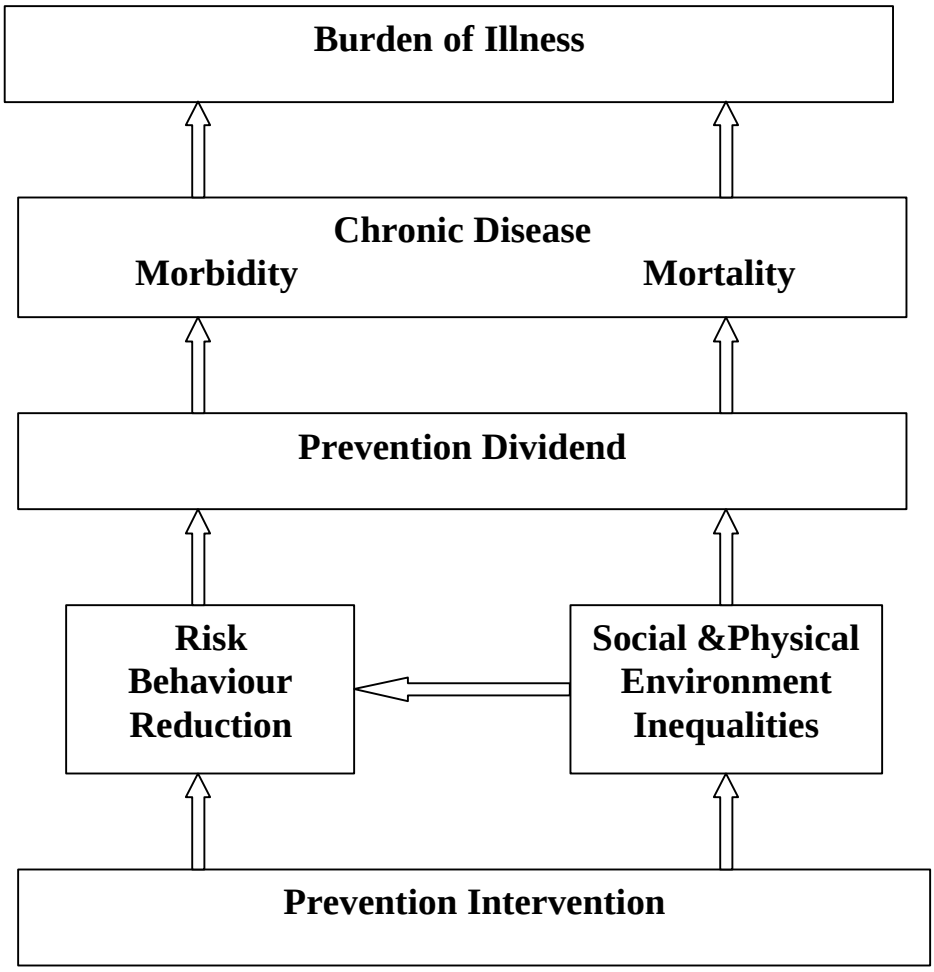
The foregoing addresses the framework or model that can guide the study of the deployment or dissemination of community-based prevention on a large scale. But the framework itself is not sufficient in the translation of the research to practice. This translation or transfer is greatly enhanced if it is done in partnership involving program managers, practitioners, policy-makers, communities and researchers/evaluators[117, 118, 119]. This working together of practitioners and researchers is crucial in developing the science to effectively disseminate prevention programs[120].

Conclusion

Figure 5 depicts the case for prevention. Starting at the top, evidence was presented on the increasing disease and economic burden of chronic disease, if present rates are maintained. Estimates of morbidity, mortality and economic savings were presented if the risk behaviours of smoking, physical inactivity, unhealthy eating and unhealthy weights that were shown to be linked to chronic diseases were reduced. Social inequalities were shown to be linked to both risk behaviours and chronic diseases. Finally, evidence was presented on the success of community-based prevention projects in reducing risk behaviours and building supportive environments.

If we start at the bottom of the Figure, we have a framework for achieving chronic disease primary prevention.

Figure 5. Prevention Case



References

[1] National Center for Chronic Disease Prevention and Health Promotion – http://www.cdc.gov/nccdphp/about.htm
[2] Leading Causes of Death, Cardiovascular Disease Surveillance On-Line, Population and Public Health Branch, Health Canada, 1997
[3] National Cancer Institute of Canada: Canadian Cancer Statistics 2001, Toronto, Canada, 2001
[4] Canadian Institute for Health Information, Canadian Lung Association, Health Canada, Statistics Canada. Respiratory disease in Canada, Sept 2001: http://www.lung.ca/statistics/booksummary.html
[5] Diabetes in Canada, Health Protection Branch – Laboratory Centers for Disease Control, Health Canada, 1996/97
[6] Leading Causes of Deaths, Laboratory Centre for Disease Control, Statistics Canada, 1999
[7] Population and Public Health Branch, Health Canada, Cardiovascular Disease Surveillance On-Line: http://www.cythera.ic.gc.ca/dsol/cvd/glossa_e.html#hosp_sep
[8] Langille DB, Joffres MR, MacPherson KM et al. Prevalence of risk factors for cardiovascular disease in Canadians 55 to 74 years of age: results from the Canadian Heart Health Surveys, 1986-1992. Canadian Medical Association Journal, 1999; 161(8 Suppl):S1-2
[9] Heart and Stroke Foundation of Canada: The Changing Face of Heart Disease and Stroke in Canada 2000; Ottawa, Canada, 1999
[10] Health Canada, Health Protection Branch – Laboratory Centre for Disease Control. Facts & figures – Diabetes Division, Bureau of Cardio-Respiratory Disease. http:// www.hc-sc.gc.ca/hpb/bcrdd/diabetes/facats/e.html
[11] End-stage renal disease in Canada: Prevalence projections to 2005. Canadian Medical Association Journal. June 1, 1999
[12] Health Canada, Health Protection Branch – Laboratory Centre for Disease Control. Economic Burden of Illness in Canada, 1993, Summary of Results: http://www.hc-sc.gc.ca/hpb/lcdc/publicat/burden/burd4_e.html
[13] Health Canada, Health Protection Branch, - Laboratory Centre for Disease Control. Diabetes in Canada Economic Burden, 1998
[14] Premiers' Advisory Council: http://www.scisc.gc.ca/cinfo00/850080012_e.html
[15] Young TK. Population Health: Concepts and methods, Oxford University Press, 1998
[16] Health Canada. Towards a common understanding: Clarifying the core Concepts of population health: A discussion paper, December 1996
[17] Ontario Tobacco Research Unit. The health effects of tobacco use. National Clearinghouse on Tobacco and Health, 1995
[18] Doll R et al. Mortality in relation to smoking: 40 years' observation on male British doctors. British Medical Journal; 309:901-11
[19] US Department of Health and Human Services. Reducing the health consequences of smoking: 25 years of progress: A report of the Surgeon General. Washington DC: Office on Smoking and Health, DHHS publication (CDC) 89-841, 1989
[20] Heinenman EF, Hoar Zahm S, McLaughlin JK, et al. Increased risk of colorectal cancer among smokers: results of a 26-year follow-up of US veterans and a review. International Journal of Cancer, 1995; 59:728-738
[21] Lung Facts Update 1994, Canadian Lung Association, 1993
[22] AHA Scientific Position, References 38 and 87 in Heart Disease & Stroke in Canada, 1997
[23] Faccinini FS, Hollenbeck CB, Jeppsen J, et al. Insulin resistance and cigarette smoking. Lancet. 1992;339;1128-1230
[24] Haire-Joshu D, Glasgow RE, Tibbs TL. Smoking and diabetes. Diabetes Care. November 1999; 22(11):1887-1898
[25] U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program: Ninth Report on Carcinogens, Revised January 2001
[26] Law MR, Morris JK, Ward NJ. Environmental tobacco smoke exposure and ischaemic heart disease and evaluation of the evidence. British Medical Journal, 1997: 315(71): 973-80
[27] Bonita R, Duncan J, Trueisen T. et al. Passive smoking as well as active smoking increases the risk of acute stroke. Tobacco Control, 1999; 8:156-160
[28] American Academy of Pediatrics Committee on Environmental Health. Environmental tobacco smoke: A hazard to children. Pediatrics, 1997; 99(4);639-42
[29] US Department of Health and Human Services. The health consequences of using smokeless tobacco: a report of the advisory committee to the Surgeon General. Rockville, MD: US Department of Health and Human Services, Public Health Service, Office on Smoking and Health. DHHS publication no. (NIH) 86-2874, 1986

[30] Winn DM, Blot WJ, Shy CM, et al. Snuff dipping and oral cancer among women in the southern United States. New England Journal of Medicine, 1981; 304:745-749
[31] Kohl III HW. Physical activity and cardiovascular disease evidence for a dose response. Medicine and Science in Sports and Exercise, June, 2001; 33(6)Suppl:S472-S483
[32] Thompson PD, Crouse SF, Goodpaster B et al. The acute versus the chronic response to exercise. Medicine and Science in Sport and Exercise. June, 2001; 33(6)Suppl:S438-S445
[33] Fagard RH. Exercise characteristics and the blood pressure response to dynamic physical training. Medicine and Science in Sports and Exercise. June, 2001; 33(6)Suppl:S484-S492
[34] Leon AL, Sanchez OA. Response of blood lipids to exercise training alone or combined with dietary intervention. Medicine and Science in Sports and Exercise. June 2001; 33(6)Suppl:S502-S515
[35] Rauramaa R, Li G, Vaisanen B. Dose-response and coagulation and hemostatic factors. Medicine and Science in Sports and Exercise. June, 2001; 33(6)Suppl:S516-S527
[36] Shephard R. Absolute versus relative intensity of physical activity in a dose-response context. Medicine and Science in Sports and Exercise. June, 2001; 33(6)Suppl:S400-S418
[37] Ross R, Janssen I. Physical activity, total and regional obesity: Dose-response considerations. Medicine and Science in Sports and Exercise. June, 2001; 33(6)Suppl:S521-S527
[38] Kelley DE, Goodpaster BH. Effects of exercise on glucose homeostasis in Type 2 diabetes mellitus. Medicine and Science in Sports and Exercise. June, 2001; 33(6)Suppl:S495-S501
[39] Thune I, Furberg A. Physical activity and cancer risk: Dose response and cancer, all sites and site-specific. Medicine and Science in Sports and Exercise. June, 2001; 33(6)Suppl:S530-S550
[40] Marrett LD, Theis B, Ashbury FD et al. Workshop Report: Physical activity and cancer prevention. Chronic Disease in Canada, 2000; 21(4). www.hc-sc- c.ca/hpb/lcdc/publicat/cdic214a_e.html
[41] Spirduso WW, and Cronin DL. Exercise dose-response effects on quality of life and independent living in older adults. Medicine and Science in Sports and Exercise, 2001: S598-608
[42] Birmingham CL, Muller JL, Palepu A, et al, The cost of obesity in Canada. Canadian Medical Association Journal, February 23, 1999; 160(4):483-488
[43] Colditz GA, et.al. Harvard Report on Cancer Prevention, Cancer Causes and Control. 1996; 1(7) http://www.hsph.harvard.edu/Organizations.Canprevent/intro.html
[44] Heart and Stroke Foundation of Canada. Women, heart disease and stroke in Canada: Issues and options, 1997
[45] National Institutes of Health, National Heart, Lung and Blood Institute, National High Blood Pressure Education Program. The sixth report of the joint national Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure. NIH Publication 98-4080, November 1997
[46] Reeder BA, Angel A, Ledoux M, et al. Obesity and its relation to cardiovascular disease risk factors in Canadian adults. Canadian Medical Association Journal 1992; 146(11):2009-2019.
[47] Eriksson J, Lindstrom J, and Tuomilehto J. Potential for the prevention of type 2 diabetes. British Medical Bulletin, 1999; 60:183-199
[48] Logan AG. Lowering the Blood Total Cholesterol Level to Prevent Coronary Heart Disease. Canadian Task Force on Preventive Health Care. http://www.ctfphc.org/Full_Text/Ch54full.htm
[49] Hunter DJ, Manson JE, Colditz GA et al. A prospective study of vitamins C, E, and A and breast cancer risk. New England Journal of Medicine, 1993; (329):234-40
[50] Tremblay MS, Willms JD. Secular trends in the body mass index of Canadian children. Canadian Medical Association Journal 2000; 163(11):1429-33
[51] Health Canada. 1994 Youth Smoking Survey. Ottawa: Minister of Supply and Services, Canada, 1996
[52] World Cancer Research Fund and the American Institute for Cancer Research (WCRF/AIFCR). Food, nutrition and the prevention of cancer: A global perspective. American Institute for Cancer Research, 1997
[53] Zollner H, Lessof S. Population Health – putting concepts into action. World Health Organization – Regional Office for Europe, August 1998
[54] Hamilton N, Bhatti T. Developing a population health promotion model. Population Health Promotion, Health Promotion Development Division, Health Canada. February 1996
[55] Godlee F. Clinical Evidence. London: British Medical Journal Books 1999
[56] Aboderin I, Kalache A, Ben-Shlomo Y et al. Life Course perspectives on coronary heart disease, stroke and diabetes: Key issues and implications for policy and research. Geneva, World Health Organization, 2002
[57] Berenson GS, Srinivasan SR, Webber LS et al. Cardiovascular risk in early life: The Bogalusa Heart Study. Current concepts series, Kalamazoo, Michigan: Upjohn, 1991

[58] Berenson GS, Srinivasan SR. Nicklas TA. Atherosclerosis: A nutritional disease of childhood. American Journal of Cardiology. 1998; 82:22T-29T
[59] Twisk JW, Kemper HC. Van Mechelen W. Tracking activity and fitness and the relationship with cardiovascular disease risk factors. Medicine and Science in Sports and Exercise, 2000; 32:1455-1461
[60] Fogelholm M, Nuutinen O, Pasanen M. et al. Parent-child relationship of physical activity patterns and obesity. International Journal of Obesity-Related Metabolic Disorders, 1999. 23:1262-1268
[61] Burke V, Beilin LJ, Dunbar D. Family lifestyle and parental body mass index as a predictor of body mass index in Australian children: A longitudinal study, International. Journal of Obesity Related Metabolic Disorders, 2001; 25:147-157
[62] WHO. Women and the Tobacco Epidemic. Challenges for the 21st Century. World Health Organization. Geneva, 2001
[63] Luepker RV, Rosamond WD, Murphy R, et al. Socioeconomic status and coronary heart risk factor trends: The Minnesota Heart Survey. Circulation. 1993; 88:2171-2179
[64] Lynch JW, Kaplan GA, Salonen JT. Why do people behave poorly? Variations in adult health behviours and psychosocial characteristics by stages of the socioeconomic lifecourse. Social Sciences and Medicine, 1997; 44:809-818
[65] Brunner E, Shipley MJ, Blane D. When does cardiovascular risk start? Past and present socioeconomic circumstances and risk factors in adulthood. Journal of Epidemiology and Community Health, 1999; 53:757-764
[66] Blane D, Hart CL, Davey-Smith G. et al. Association of cardiovascular disease risk with socioeconomic position during childhood and during adulthood. British Medical Journal, 1996; 313:1434-1438.
[67] Lantz PM, House JS, Lepkowski JM et al. Socioeconomic factors, health behaviours, and mortality: Results from a nationally representative prospective study of US adults. Journal of the American Medical Association, 1998; 279(21):1703-1708
[68] Bronfenbrenner U. The Ecology of Human Development. Cambridge, Mass. Harvard University Press, 1979
[69] McLeroy KR, Bibeau D, Steckler A. et al. An ecological perspective on health promotion programs. Health Education Quarterly, 1988; 15(4):351-377
[70] Stokols D. Translating social ecological theory into guidelines for community health promotion. American Journal of Public Health, 1996;10(4):282-98
[71] Prochaska , JO. (1994). Systems of psychotherapy: a transtheoretical analysis: 3rd ed. Pacific Grove, Calif.: Brooks/Cole Pub. Co
[72] Prochaska JO, Velicer WF, Rossi JS, et al. Stages of change and decisional balance for 12 problem behaviours. Health Psychology, 1994;13:39-46
[73] Hughes JR. An algorithm for smoking cessation. Archives of Family Medicine, 1994;3:280-5
[74] Calfas KJ, Sallis JF, Oldenburg B, French M. Mediators of change in physical activity following an intervention in primary care: PACE. Preventive Medicine, 1997;26:297-304
[75] Glanz K, Patterson RE, Kristal AR, et al. Stages of change in adopting healthy diets: fat, fiber, and correlates of nutrition intake. HealthEducatgion Quarterly, 1994;21:499-519
[76] Campbell MK, DeVellis BM, Strecher VJ, et al. Improving dietary behaviour: The effectiveness of tailored messges in primary care settings. American Journal of Public Health; 1994:84:783-7
[77] Hancock L, Sanson-Fisher RW, Redman S, et al. Community action for health promotion: A review of methods and outcomes 1990-1995. American Journal of Preventive Medicine, Jul-Aug 1997; 13(4):229-39
[78] Nissen A., Berrios X., and Puska P. Community-based non-communicable disease interventions: Lessons from developed countries for developing ones. Bulletin of the World Health Organization 2001; 79(10):963-70
[79]Weinehall L, Hellsten G, Boman K et al. Can a sustainable community intervention reduce the health gap? --10-year evaluation of a Swedish community intervention program for the prevention of cardiovascular disease. Scandinavian Journal of Public Health, Suppl 2001; 56:59-68
[80] Farquhar JW. The community-based model of lifestyle intervention trials. American Journal of Epidemiology, 1978; 108:103-111
[81] Farquhar JW, Wood PD, Brietrose H. et al. Community education for cardiovascular health. Lancet, 1977; 1:1192-1195
[82] Maccoby N, Farquhar JW, Wood PD et al. Reducing the risk of cardiovascular disease: Effects of a community-based campaign on knowledge and behavior. Journal of Community Health, 1977; 3:100-114
[83] Puska P, Kaskela K, McAllister A. et al. Use of lay opinion leaders to promote diffusion of health innovations in a community program: Lessons learned from the North Karelia Project. Bulletin of the World Health Organization. 1986; 64(3):437-446

[84] Vartiainen E, Puska P, Jousilahti P, et al. Twenty-year trends in coronary risk factors in North Karelia and in other areas of Finland. International Journal of Epidemiology, 1994; 23(3):495-504
[85] Vartiainen E, Puska P, Pekkanen J, et al. Changes in risk factors explain changes in mortality from ischemic heart disease in Finland. British Medical Journal, 1994; 309:23-27
[86] Jousilahti P, Vartiainen E, Tuomilehto, J et al. Effects of risk factors and changes in risk factors on coronary mortality in three cohorts of middle-aged people in eastern Finland. American Journal of Epidemiology, 1995; 141(1):50-60
[87] Puska P. The North Karelia Project: From community interventions to national activity in lowering cholesterol levels and CHD risk. European Heart Journal Supplements, 1999; Suppl S:S000
[88] Puska P, Tuomileto J, Nissinen A et al. (eds). The North Karelia Project: 20 year results and experiences. National Public Health Institute, Helsinki 1995
[89] Farquhar JW, Fortmann SP, Flora JA. et al. The Stanford Five-City project: Effects of community wide education on cardiovascular disease risk factors. Journal of the American Medical Association, 1990; 264:359-365
[90] Farquhar JW, Fortmann SP, Maccoby N. et al. The Stanford Five-City Project design and methods. American Journal of Epidemiology, 1985; 122:323-334
[91]Luepker RV, Rastam L, Hannan PJ, et al. Community education for cardiovascular disease prevention: Morbidity and mortality results from the Minnesota Heart Health Program. American Journal of Epidemiology, Aug 15, 1996; 144(4):351-62
[92] Flora JA, Lefebvre RC, Murray DM, et al. A community education monitoring system: methods from the Stanford Five-City Project, the Minnesota Heart Health Program and the Pawtucket Heart Health Program. Health Education Research, Mar,1993; 8(1):81-95
[93] Luepker RV, Murray DN, Jacobs, DR et al. Community education for cardiovascular disease prevention: Risk factor changes in the Minnesota Program. American Journal of Public Health, 1994; 84:1383-1393
[94] Carleton RA, Lasater TM, Assaf AR, et al. The Pawtucket Heart Health Program: community changes in cardiovascular risk factors and projected disease risk. American Journal of Public Health, June 1995; 85(6):777-85
[95] Winkleby MA, Feldman HA, Murray DM. Joint analysis of three U.S. community intervention trials for reduction of cardiovascular disease risk. Journal of Clinical Epidemiology. Jun, 1997; 50(6):645-58
[96] Rose G. The Strategy of Preventive Medicine, Oxford Medical Publication, 1992
[97] Schooler C, Farquhar JW, Fortmann SP, Flora JA. Synthesis of findings and issues from community prevention trials. Annals of Epidemiology, 1997: S7:S54-S68
[98] Tuomilehto J, Lindstrom J, Eriksson JG, et al. Prevention of type 2 diabetes mellitus by changes in lifestyle among subjects with impaired glucose tolerance. New England Journal of Medicine, 2001; 344:1343-1350
[99] Eriksson KF, Lindgarde F. Prevention of type 2 (non-insulin-dependent) diabetes mellitus by diet and physical exercise. The six-year Malmo feasibility study. Diabetologia, December 1991; 34(12):891-898
[100] Pan XR, Li GW, Hu YH, et al. Effects of diet and exercise in prevnting NIDDM in people with impaired glucose tolerance. The Da Qing IGT and Diabetes Study. Diabetes Care, 1997; 20(4):537-544
[101] Heart and Stroke Foundation of Canada. Heart Disease and Stroke in Canada, 1997
[102] National Clearinghouse on tobacco and Health. The Health Effects of Tobacco Use. National Clearinghouse on Tobacco and Health: Ottawa, 1995
[103] Single E, Robson L, Xie X et al. The Costs of Substance Abuse in Canada. Canadian Centre on Substance Abuse, 1996
[104] Health Canada On-Line – Economic Costs due to smoking: wysiwyg:9/http://www.hc-sc.gc.ca/english/media/releases/1996/costs.html
[105] Finkelstein MM. Obesity, cigarette smoking and the cost of physicians' services in Ontario. Canadian Journal of Public Health, 2001; 92(6):437-440
[106] Pronk NP, Goodman MJ, O'Connor PJ, et al. Relationship between modifiable health risks and short-term health care charges. Journal of the American Medical Association, 1999; 282:2235-2239.
[107] Katzmarzyk PT, Gledhill. N, Shepherd R. J. The economic burden of physical inactivity in Canada, Canadian Medical Association Journal, Nov 28, 2000; 163(11):1435-1440
[108] Conference Board of Canada, Health Canada. Physical activity and the cost of treating illness. Ottawa: Health Canada and Conference Board, 1996
[109]Stephenson J, Bauman A, Armstrong T, et al. The Costs of illness attributable to physical inactivity in Australia: A preliminary study. The Commonwealth Department of Health and Aged Care and the Australian Sports Commission, 2000

[110] Victorian Burden of Disease Study. Public Health and Development Division, Department of Human Services, Melbourne, Australia, July 1999
[111] Mathers CD, Vos, ET, Stevenson CE, et al. The Australian Burden of Disease Study: measuring the loss of health from diseases, injuries and risk factors. MJA 2000; 172:592-596
[112] Farquhar JW. The case for dissemination research in health promotion and disease prevention. Can J Public Health. 1996;87 Supplement 2 Nov/Dec S44-S49
[113] Stoto MA, Green LW. Eds. Linking Research in Public Health Practice: A Review of the CDC's Program Centers for Research and Demonstration of Health Promotion and Disease Prevention. Institute of Medicine, Washington, DC: National Academy Press: 1997
[113] Stoto MA, Green LW. Eds. Linking Research in Public Health Practice: A Review of the CDC's Program Centers for Research and Demonstration of Health Promotion and Disease Prevention. Institute of Medicine, Washington, DC: National Academy Press: 1997
114 Nutbeam D. Improving the fit between research and practice I health promotion: overcoming structural barriers. Canadian Journal of Public Health, Nov/Dec 1996; 87 Suppl2:S18-23
[115] McKenna MT, Taylor WR, Marks JS et al. Current issues and challenges in chronic disease control. In: Brownson RC, Remington PL, Davis JR, eds. Chronic Disease Epidemiology and Control. 2nd Edition. Washington, DC. American Public Health Association, 1998:1-26.
[116] Brownson RC, Simoes EJ. Measuring the impact of prevention research on public health practice. American Journal of Preventive Medicine, 1999; 16(3S):72-79.
[117] .Green LW,George MA,Daniel M et al. Study of Participatory Research in Health Promotion: Review and Recommendations for the Development of Participatory Research in Health Promotion in Canada. Ottawa: Royal Society of Canada. 1995
[118] Lancaster B. Closing the gap between research and practice. Health Education Quarterly, 1992;19:408-411
[119] Schwartz R, Smith C, Speers MA et al. Capacity building and resource needs of state health agencies to implement community-based cardiovascular disease programs. Journal of Public Health Policy. 1993;14:489-494
[120] Cameron R, Brown KS, Best JA. The dissemination of chronic disease prevention programs: Linking the science and practice. Canadian Journal of Public Health, 1996;87(S2):S50-S53