

Compilation of Evidence of Effective Active Living Interventions:
A Case Study Approach

**A Report Submitted to Health Canada
on Behalf of the Canadian Consortium of Health Promotion Research**

By

**John C. Spence, PhD
Assistant Professor
Faculty of Physical Education & Recreation
University of Alberta**

With contributions from:

Roy J. Shephard, MD, PhD, DPE, FACSM
Professor Emeritus of Applied Physiology,
Faculty of Physical Education & Health,
Dept. of Public Health Sciences,
Faculty of Medicine, University of Toronto

&

Cora Craig, MSc
Director
Canadian Fitness and Lifestyle Research Institute
Ottawa, ON

&

Kerry McGannon, MA
Research Coordinator
Alberta Centre for Active Living
University of Alberta

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Lise Gauvin, PhD

Associate Professor

Department of Social & Preventive Medicine

Université de Montréal

Montréal, QC

Kim Schmidt

Recreation Consultant

Alberta Community Development

Edmonton, AB

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Executive Summary

The objectives of this report were to discuss the cost-effectiveness and cost-benefits of physical activity interventions and to comment on the worthiness of an outcomes model for assessing the evidence.

Physical activity can make a major contribution to the prevention and treatment of a multitude of common chronic diseases, medical conditions, and psychological outcomes with few negative consequences. It is thus logical to infer that an increase in the proportion of the population who are physically active should reduce health care costs and enhance the quality of life of Canadians. Economists analyze such questions using cost-benefit or cost-effectiveness analysis. Cost-effectiveness analysis is particularly useful in comparing competing methods of achieving a given outcome; it requires an initial prioritization of outcomes. It is difficult to set dollar values on many items relating to population health and an increase of physical activity. Nevertheless, benefits appear to outweigh costs substantially. Costs and benefits are distributed between governmental, private and personal sectors of the economy, although there is much interaction between these three sectors.

An evaluation of Ontario Hospital Insurance Plan payments (Quasar, 1976) showed that yearly medical costs were \$18.29 lower in active men, and \$39.97 lower in active women. Likewise, analysis of worksite fitness programs has demonstrated increased productivity, a decrease in absenteeism and turnover, a decrease in medical costs and occupational injuries and a decrease in premature deaths, with a cost/benefit ratio as high as 5:1. Quasi-experimental studies suggest that medical costs can be reduced by \$100/year subsequent to introduction of a fitness program; further, this is achieved with no increase in demand for ECG or orthopedic services. Currently, 62% of the Canadian population engages in insufficient physical activity for health (i.e., less than 30 minutes of moderate-intensity activity 4 days a week). The Year 2003 Objective is to reduce the proportion that is inactive to 56% of the population. This could have a proportional impact on the 2.5% of direct health care costs that are due to physical inactivity (a saving of \$150 M/year), as well as reducing the number of premature deaths by 21,340 per year. US estimates support the magnitude of the postulated savings.

Some uncertainties remain. Can inactive people be encouraged to be more active, and if so, how much will this cost? Further, can an increase in physical activity bring the health of an inactive person to the level found in a habitually active person? Additional data should be collected to allow more precise modeling of outcomes, including the actual costs of initiating and sustaining active behaviour in those who are currently inactive. In particular, data should be accumulated to refute arguments sometimes advanced against physical activity, such as costs arising from competing illness, sports injuries, and extended pension payments.

While some positive information exists on the efficacy of physical activity interventions, less information exists on the effectiveness of these interventions, particularly in Canada. An extensive review by the Centers for Disease Control and Prevention (2001) revealed that two informational approaches (community-wide campaigns and “point-of-decision” prompts), three behavioural and social approaches (school-based physical education, social support interventions

in community contexts, and individually-adapted health behaviour change), and one intervention using environmental and policy approaches (creation of or enhanced access to places for physical activity combined with informational outreach activities) are effective interventions for increasing physical activity participation. It is clear that individually-oriented programs that are based in exercise facilities and advocate high-intensity activity do not serve the majority of the population and fail from a public health perspective (Dunn et al., 1998). Current thinking supports a more population-based approach to physical activity promotion including a key role for government and policy initiatives (McKinlay, 1995; Orleans et al., 2000).

We assessed an outcomes model for physical activity (adapted from International Union for Health Promotion and Education, 1999) and found it useful in that it works within an accepted health promotion framework. The language is familiar to most practitioners and health policy people. While fairly descriptive in nature, the model will facilitate identifying gaps in the knowledge base. For instance, little information exists on the role of social mobilisation or advocacy in physical activity promotion. Interestingly, several of the effective intervention strategies identified by Centers for Disease Control and Prevention. (2001) address some of the outcomes identified in this model. For instance, social support interventions in community contexts will lead to some of the outcomes identified under social action and influence. Similarly, creation of enhanced access to places for physical activity falls under healthy environments. So, within this model we can identify effective intervention strategies to achieve some of the stated outcomes for physical activity promotion in Canada.

The evidence for the benefits that a physically active society will accrue is strong in terms of enhanced quality of life, reduced disease and disability, and reduced health-care costs. Further, physical inactivity is no less of a public health threat than smoking. Some effective strategies have been identified for increasing population-level physical activity participation. A need exists to identify other effective interventions and programs that may be specific to the Canadian context (e.g., northern climate, rural population). In conclusion, federal funding in the active living area is a wise investment and should be continued.

Glossary

Cost-benefits: Analytical procedure for determining the economic efficiency of a program, expressed as the relationship between costs and outcomes, usually measured in monetary terms (Rossi, Freeman, & Lipsey, 1999). For example, in a physical activity promotion program, cost-benefits analysis would focus on the difference between the dollars spent on getting people to be active and the dollar savings from reduced medical care or job absenteeism.

Cost-effectiveness: The efficacy of a program in achieving given intervention outcomes in relation to the program costs (Rossi, Freeman, & Lipsey, 1999). Outcomes are expressed in substantive terms. In other words, cost-effectiveness analysis will indicate how much it costs to produce to a certain effect. For example, in a physical activity promotion program, cost-effectiveness analysis would estimate the dollars that had to be expended to convert each inactive person into an active person.

Effectiveness: Is a test of whether a technology, treatment, procedure, intervention, or program does more good than harm when delivered under real-world conditions (Flay, 1986).

Efficacy: Is a test of whether a technology, treatment, procedure, or program does more good than harm when delivered under optimum conditions (Flay, 1986).

Meta-analysis: Quantitative systematic review of the literature on a specific topic. The meta-analyst uses the results from individual research projects on the same topic as data points for a statistical study of the topic (Vogt, 1993).

Physical activity: Any body movement produced by skeletal muscles and resulting in a substantial increase over the resting energy expenditure (Bouchard & Shephard, 1994).

Population-attributable risk (PAR): The proportion of a given health outcome (e.g., diabetes) attributable to a risk factor (e.g., physical inactivity) in a population (Bauman, 1998). PAR depends upon the risk of exposure (see relative risk), and upon the prevalence of the risk factor in the population.

Relative risk (RR): A measure of the likelihood of occurrence of a given health outcome (e.g., diabetes) in those exposed and not exposed to the agent of interest (e.g., physical inactivity). If the value of RR is greater than 1, then it means that those exposed to the agent are more at risk for the particular health outcome.

Objective of Report

The objective of this report is to address the question “should further federal investments in active living be made?”. The evidence in the active living area was assessed in relation to an outcomes model for health promotion. This model was consistent with the Treasury Board Results-based Management and Accountability Framework and integrated the outcomes model of the International Union for Health Promotion and Education (International Union for Health Promotion and Education, 1999).

To achieve this objective, this report will (1) review and synthesize existing evidence on effectiveness and cost-effectiveness of active living interventions, and (2) assess the usefulness of an outcomes model to frame actions, identify outcomes and inform policy and program investment decisions, and document the lessons learned from this prototype initiative.

According to Bouchard & Shephard (1994) physical activity can be defined as “any body movement produced by the skeletal muscles that results in a substantial increase over the resting energy expenditure:” (p. 77). This definition “encompasses active physical leisure, exercise, sport, occupational work, and other chores” (p. 77). Active living is defined as “a way of life in which physical activity is valued and integrated into daily life” (Fitness Canada, 1991, p. 4). For matters of simplicity, this report will focus upon the behavior of physical activity as opposed to the way of life of active living. Ultimately, we hope that all Canadians live the good life and embrace active living.

In the fall of 1998, Health Canada in association with the Canadian Society for Exercise Physiology released *Canada’s Physical Activity Guide to Healthy Active Living* (CPAG). This guide was the first in a series of physical activity guides for Canadians and was developed for adults. A subsequent guide specifically aimed at older adults (Health Canada, 1999) was released 12 months later. The aim of the CPAG is to inform Canadians about the benefits of physical activity and to encourage participation through appropriate activities. According to CPAG (Health Canada 1998; 1999), it is best to incorporate endurance, flexibility, and strength activities to maintain health. The ideal dose of activity recommended in the guide is equivalent to 60 minutes of any intensity activity daily, or 30 minutes of moderate-intensity activity 4 days a week, or 20 minutes of vigorous-intensity activity 4 days a week (Canadian Fitness Lifestyle Research Institute, 1998).

A. Evidence on Effectiveness and Cost-Effectiveness

A.1 Issue Identification

The issue is that a substantial proportion of the Canadian population is not physically active enough to experience health benefits. Therefore, a need exists to identify effective intervention strategies for encouraging more activity participation. This issue is important because people who are more physically active experience physiological, psychological, and social benefits that

contribute to their overall health and well-being. Further, significant savings could be accrued by the health care system if more Canadians adopt an active lifestyle.

The Relationship Between Prevalence of Various Chronic Diseases and Physical Inactivity

The more active people are, and the more energy they expend being physical active, the longer they are likely to live (Lee & Paffenbarger, 2000). Sufficient epidemiological data exist to justify the claim that even modest participation in low intensity activities can reduce the risk of all-cause mortality in Canadians (Villeneuve, Morrison, Craig, & Schaubel, 1998). There is growing evidence that physical inactivity is associated with chronic diseases such as colon cancer, diabetes, and particularly, cardiovascular disease (Berlin & Colditz, 1990; Kriska, Hanley, Harris, & Zinman, 2001; Marret et al., 2000; U.S. Department of Human Services, 1996; Williams, 2001). Further, physically active adults are more likely to experience a higher quality of life and less functional decline in old age than inactive adults (Seeman et al., 1995; Stuck et al., 1999; Unger, Johnson, & Marks, 1997; Vaillant & Mukamal, 2001).

In order to establish a clear link between physical inactivity and various chronic diseases in Canada, researchers (Katzmarzyk et al., 2000) have calculated a) the relative risk (RR) of acquiring a particular chronic disease due to physical inactivity, and b) a population attributable risk (PAR), which is an estimate of the effects of an individual risk factor (i.e., physical inactivity) on a given disease. As can be seen from Table 1, physically inactive Canadians are 90% more likely to acquire coronary artery disease, 60% more likely to suffer from osteoporosis, and 40% more likely to experience a stroke, hypertension, colon cancer, or Type 2 diabetes (based on the RR's). Furthermore, based on the PAR, 36% of coronary artery disease, 27% of osteoporosis, and 20% of stroke, hypertension, colon cancer, and Type 2 diabetes are attributable to physical inactivity.

The data in Table 1, along with the fact that 62% of the population is physically inactive, provide evidence that physical inactivity should be of major concern from a public health perspective (see Rose, 1992). In fact, the link between physical inactivity and developing a) coronary artery disease (Berlin & Colditz, 1990; Miller, Balady, & Fletcher, 1997; Williams, 2001), b) colon cancer (Marrett et al., 2000), and c) hypertension, osteoporosis, and type 2 diabetes (Boule, Haddad, Kenny, Wells, & Sigal, 2001; U.S. Department of Human Services, 1996) is *convincing* (i.e., studies have shown consistent associations with little or no evidence to the contrary) while the link between physical inactivity and developing breast cancer has been deemed probable (i.e., the number and types of studies is not extensive enough to make a definite judgment).

Psychological Well-Being and Physical Activity

Good evidence exists to suggest that physical activity participation has beneficial effects on psychological well-being (see Gauvin & Spence, 1996; Gauvin, Spence, & Anderson, 1999; Landers & Arent, 2001). According to the results of meta-analyses, small to moderate decreases in anxiety and increases in self-esteem can occur as a result of exercise or physical activity participation while moderate to large decreases in depression can be expected (see Tables 2-4). This evidence is supported by the finding that Canadians who are moderately to highly active

experience better mental health (i.e., less generalized distress) than those who are inactive (Martin & Wade, 2000).

Current Status of Physical Activity in Canada

Given the evidence for the benefits of being physically active, let us consider the activity patterns of the Canadian population. Unless otherwise indicated, the following discussion on physical activity and barriers to participation in Canada is based upon data from the Canadian Fitness Lifestyle Research Institute (see Cameron, Craig, Russell, & Beaulieu, 1999; Canadian Fitness and Lifestyle Research Institute, 1997; Craig, Russell, Cameron, & Beaulieu, 1999).

Physical inactivity remains pervasive in Canada, with 64% of adults aged 18 and older still considered insufficiently active for optimal health benefits¹ in 1999, compared with 79% in 1981. While the physical inactivity rate is high in all regions of the country, it declines slightly moving from Eastern to Western Canada. More women (68%) than men (59%) are inactive. Physical inactivity levels also increase by age, with fewer 18-24 year-olds being inactive than adults in older age groups. Despite substantial inroads in reducing sedentary living in Canada during the eighties and early nineties, progress has now stalled. In 1981, over three-quarters of adults aged 18 and older were considered insufficiently active for health benefits. Inactivity levels decreased to 71% in 1988 and to 63% by the mid-nineties, and have remained at that level since.

Walking continues to be the most popular physical activity in Canada, with 81% of adults aged 18 and older reporting participation in this activity during the previous 12 months. This is followed by: gardening, yard work, 70%; swimming, 54%; dancing socially, 46%; home exercise, 45%; bicycling, 45%; weight training, 29%; bowling, 27%; golf, 26%; and jogging and running, 25%. The six most frequently reported activities tend to be those that can be done relatively close to home, with little equipment, relatively low levels of skill and at reasonable cost. Women are more likely than men to participate in exercise classes, to walk for exercise, and to take part in yoga or tai chi. Conversely, men are more likely than women to report activities including hockey, baseball or softball, soccer, bicycling, weight training, basketball, football, jogging and running, gardening, tennis, skating, and alpine skiing. In terms of participation, the fastest growing activity is golf while cross-country skiing, squash, and tennis experienced a decline over a 10-year period from 1987 to 1996 (Barber & Havitz, 2001).

Canadians are generally aware of the benefits of activity, with 72% holding very strong beliefs that regular physical activity helps to prevent heart disease, 61% that it helps to reduce stress and 57% that it helps maintain the ability of adults to perform the every day tasks of daily life with aging. Most Canadians have a positive attitude towards physical activity, finding it very beneficial (81%), pleasant (50%) and fun (50%). However, 33% find physical activity to be inconvenient to do, 20% find it difficult and 9%, unpleasant. The majority intends to be physically active in the next six months, with 39% fully intending and 18% strongly intending to

¹ expending less than an additional 3 kilocalories (or 12.6 kJ) per kilogram body weight per day, equivalent to participating in 30 minutes of moderate-intensity activity four days a week.

do so. Moreover, Canadians are taking steps to become more active, 53% read articles about physical activity for this purpose, 44% seek information about physical activity opportunities in the community, 35% seek advice about becoming more active from friends family and co-workers, 23% seek advice from health professionals. Most Canadians are making some active choices in their work routines and 46% report observing a class or trying some kind of physical activity to see if they might like to do it on a regular basis.

While most Canadians understand the concept of intensity and are reasonably knowledgeable about the type of activities that are required to increase endurance, flexibility and strength, the majority do not understand the minimum amount of activity required for targeted health benefits. Whereas 25% of adults report that they must be active for at least four or five days a week, (required for activities of at least moderate intensity), only 15% say that they must be active six or seven days a week (recommended for other activities). This means that the majority (60% of adults) report only three days a week of activity or less are required, less than the minimum four days a week recommended by CPAG (Health Canada, 1998). This fact is not surprising given that only 20% of Albertans are aware of the recent physical activity guidelines (Spence, Plotnikoff, & Mummery, 2001).

Barriers to Physical Activity Participation

For the general population, the most frequently cited perceived barriers to being physically active are individual level factors such as lack of time (69%), lack of energy (59%) and lack of interest (52%), excessive cost (37%), illness or injury (36%), feeling uncomfortable (29%) lack of skill (29%) and fear of injury (26%). Environmental factors also figure prominently: lack of facilities nearby (30%); lack of safe places (24%); lack of child care (23%); and lack of partner with whom to participate (21%). The top two barriers distinguishing women and men are lack of skill (35% and 22%, respectively) and lack of safe places (30% and 17%, respectively). Moreover, in probing a variety of resources, services and infrastructure supports that could help Canadians to be active, the three highest ranking were supportive environmental infrastructure: access to safe streets and public places (42%); affordable facilities, services and programs (42%); and paths trails and green spaces (35%). A range of supportive services, and then information and advice followed these.

A supportive physical and social environment is also seen as very important by parents in helping their children to be active. One in two parents rated four of the physical environmental supports highly: safe street and public places; access to school facilities, services and programs; access to other outdoor spaces; access to paths trails, and green spaces. This was followed in order of frequency by three factors in the child's social environment: people to take children to and from activities (48%); availability of teams, groups and other children with whom to participate (45%); and affordable coaching, instruction or classes (44%). The remaining factors probed were also rated highly in helping children to be active by a substantial number of parents: access to facilities outside of school (42%) and convenient public transportation (30%).

Potential Moderators of Physical Activity

Education, household income, gender, and age have all been shown to be moderators of physical activity participation (Frankish, Milligan, & Reid, 1998). That is, people who are described by one aspect of these variables are more active than people who are described by another aspect. For instance, on average, males, people with higher levels of education and income, and younger in age are the most active. In adults, education tends to be a more consistent moderator of physical activity participation than income (Choiniere, Lafontaine, & Edwards, 2000). Similarly, education level is a strong moderator of knowledge of risk factors (e.g., physical inactivity) for cardiovascular disease (Potvin, Richard, & Edwards, 2000) and awareness of recommended physical activity among Canadians (Spence et al., 2001). Children from low income families are the least likely to participate in sports, arts, and community programs (Offord, Lipman, & Duku, 1998). On a positive note, current older adults (55+ yrs.) are more likely to report being physically active on a regular basis than previous cohorts of the same age group (Barber & Havitz, 2001). Suggesting that the baby boomers are more active and will be more active in their old age than previous generations. While it is true that activity participation decreases as we age from early adolescence to middle to late adulthood, there is some indication that Canadian adults over the age of 65 years are just as, if not more, active than younger adults (Curtis, White, & McPherson, 2000). In fact, recent data shows that 51% of Canadian adults over the age of 55 years meet the current CPAG guidelines (e.g., 30 minutes of moderate intensity activity 4 days a week) while only 33% of those under the age of 55 years meet the guidelines (Canadian Fitness Lifestyle Research Institute, 1998). Of course older adults may not be expending the same amount of energy as younger adults but they are demonstrating a very positive behavior.

One important national public health objective is thus to achieve a 10% reduction in the prevalence of physical inactivity in Canada by the year 2003 (Federal, Provincial and Territorial Fitness and Recreation Committee, 1996). Since the number of Canadians who participate in regular physical activity has not increased substantially over the past several years, an effort to understand how to promote more physically active lifestyles should be of great importance to the federal, provincial, and territorial governments. If research can contribute to improving physical activity levels, then substantial benefits will likely accrue through enhanced well-being and the reduced risk of acquiring a chronic disease.

A.2. Options for Strategies/Interventions

According to McKinlay (1995) interventions can take place on three levels: downstream, midstream, or upstream. Downstream interventions are individually-oriented whereas more population-oriented interventions that aim to change program delivery or policy are mid to upstream. Any intervention or program that reaches many people and facilitates them being more active would be considered upstream (see Table 5). For instance, environmental initiatives such as ice-free sidewalks in winter-affected cities and building walking trails and pedways in major urban areas, can influence the activity choices of many people for relatively little cost. Population-based promotion of physical activity is considered a mid to upstream intervention. National campaigns supporting CPAG and *Summer Active* are good examples.

Within the downstream context, the promotion and maintenance of physical activity is likely, if the following conditions are met (Laitakari, Vuori, and Oja, 1995): (1) the promotional situation

is analyzed thoroughly, (2) the activity is chosen carefully with an emphasis on moderation in intensity and integration into the participant's lifestyle, (3) multiple promotional contacts are used, and (4) support from the participant's social and physical environment is provided. What does not work is downstream oriented interventions or programs that focus solely on the individual, are program-centered, and promote high-intensity activity. This approach has been used for the past thirty years and has not been effective from a public-health perspective.

Instead of focusing on the individual, another approach is to intervene at multiple levels along the stream continuum. Within this scenario, behaviour (e.g., physical activity) is thought to be influenced by many factors working at different levels (see Gauvin, Levesque, & Richard, 2001; Sallis & Owen, 1997; Spence & Lee, 2001). For instance, to understand physical activity participation, individual dispositions (e.g., self-efficacy, attitudes), culture, family support, school programs, community programs, neighbourhood facilities, climate, and physical environment, all play a role. Thus an intervention to increase physical activity in a community could include programs that enhance children's and older adult's efficacy for certain activities, along with a promotional campaign about the benefits of physical activity, and the construction of safe walking trails. Within this broader ecological framework, government and policy initiatives play an important role. A recent document by Health Canada (Fitness/Active Living, 1999), identifies four priority areas for investments in the promotion of fitness and active living (national leadership, coordination and policy development; knowledge development; public awareness/education; and capacity building) and three strategies (strengthening the case for physical activity; responding to environmental factors; and support the individual to make healthier choices) that fit with this type of framework.

For programs aiming to increase physical activity for sedentary adults, Dunn (1996) recommends the following: (1) determine the target population and the level of the intervention; (2) select a theory to guide intervention development; (3) include components of self-efficacy and realistic outcome expectancies; (4) take into account motivational readiness of the target population; (5) take into account important demographic factors such as education, socioeconomic status, and gender, and (6) perform evaluations of methods and results.

A.3. Analysis of Options for Effectiveness

As presented in previous sections, more than enough evidence exists confirming that physically active individuals are healthier than inactive individuals and are at less risk for many chronic diseases. Further, significant physical fitness changes do occur with interventions that successfully increase physical activity levels (Activity Counseling Trial Research Group, 2001; Anderson et al., 1999; Dunn et al., 1999). The key question to address here is how effective are current intervention strategies for increasing physical activity participation. To answer this question we will consider the evidence for both the efficacy and effectiveness of physical activity interventions.

According to Flay (1986, p. 451) efficacy trials "provide tests of whether a technology, treatment, procedure, or program does more good than harm when delivered under optimum conditions," whereas "effectiveness trials provide tests of whether a technology, treatment,

procedure, intervention, or program does more good than harm when delivered under real-world conditions”. Glasgow, Vogt, & Boles, (1999) further define effectiveness as evaluations taking place in “real-world settings by individuals who are not part of a research staff” (p. 1323). Thus efficacy gives us insight on how well interventions work in the best controlled situations whereas effectiveness informs us how well interventions apply and generalize to the real world. Further, to determine the impact of an intervention it is important to consider, along with other factors, the reach (i.e., the proportion of people with a risk factor who receive or are affected by the program or policy) and implementation (i.e., the extent to which the program is delivered as intended) of the program (Glasgow et al., 1999). According to Glasgow et al. (1999), effectiveness of an intervention is a product of efficacy and implementation of the program being delivered.

Efficacy of Interventions

Much of the available research on the impact of physical activity interventions is based upon efficacy trials. Literature reviews (Dunn, Anderson, & Jakicic, 1998; King, Rejeski, & Buchner, 1998; Simons-Morton, Calfas, Oldenburg, & Burton, 1998; Stone, Mckenzie, Welk, & Booth, 1998) and one meta-analysis (Dishman & Buckworth, 1996) support the idea that physical activity interventions targeting individuals can be efficacious in increasing physical activity behaviour. The bulk of these interventions emphasize self-regulation, focus upon manipulations of cognitive appraisals, and provide the participants with behavioural management skills. In their meta-analysis of 127 studies, Dishman & Buckworth (1996) found that large changes in physical activity behaviour ($d=0.75$) could be brought about by these interventions. Frequency of activity was increased by 10% to 25% in the short term. The most efficacious interventions were based on behaviour modification, utilizing mediated delivery, and promoting low to moderate intensity activity. Further, the success rate of the interventions ranged from 50% to 88%. In summary, the efficacy of our interventions for getting people to be physically active is good.

One notable exception to the above is a review of literature in which worksite interventions were not found to be very successful for increasing physical activity and/or physical fitness (Dishman, Oldenburg, O’Neal, Shephard, 1998). The authors, however, stated that the scientific quality of the studies reviewed were generally poor making it difficult to draw any definitive conclusions about worksite physical activity interventions.

In comparison to interventions dealing with five other “risk” behaviors (tobacco, alcohol, illegal drugs, risky sex, and diet), physical activity interventions are as efficacious as those in the diet area but not as efficacious as those in the tobacco or alcohol areas (Orleans et al., 1999). Overall, modest achievements have been gained in downstream and midstream physical activity interventions whereas limited data is available for upstream interventions (Gauvin, Richard, & Levesque, 2001; Marcus & Forsyth, 1999).

Effectiveness of Interventions

While there are numerous studies of efficacy trials in physical activity interventions, much less information is available on effectiveness trials (Clark, 1997; Gauvin, Levesque, & Richard,

2001). Using the definitions for effectiveness provided by Flay (1986) and Glasgow et al. (1999), almost no such evidence is available for studies conducted in Canada².

The US Centers for Disease Control and Prevention is in the process of developing a review on the effectiveness of public health interventions to reduce illness, disability, and premature death, entitled *Guide to Community Preventive Services: Systematic Reviews and Evidence-Based Recommendations* (Briss et al., 2000; Truman et al., 2000). Task forces were developed to review six risk behaviors: tobacco, alcohol, other addictive drugs, physical activity, nutrition, and sexual behaviour. Within the guide, effectiveness is defined as “improvement in health or behavioural outcome produced by an intervention in a community setting” (Truman et al., 2000, p. 19). This definition of effectiveness is somewhat less stringent than those discussed previously (cf. Flay, 1986; Glasgow et al., 1999). As indicated in Table 6, the task force on physical activity (Centers for Disease Control and Prevention, 2001) strongly recommended or recommended six interventions: two informational approaches (community-wide campaigns and “point-of-decision” prompts), three behavioural and social approaches (school-based physical education, social support interventions in community contexts, and individually-adapted health behaviour change), and one intervention using environmental and policy approaches (creation of or enhanced access to places for physical activity combined with informational outreach activities). See below for details.

Community-wide Campaigns: Large scale, high-intensity, community-wide campaigns with sustained visibility. Interventions were multicomponent including mass-media messages, support and self-help groups, physical activity counseling, risk factor screening and education, community events, and walking trails.

Point-of-decision Prompts: Single component interventions using motivational signs placed by elevators and escalators encouraging people to use nearby stairs for health benefits or weight loss.

School-based Physical Education: Modified curricula and policies to increase amount of moderate or vigorous activity, increase the amount of time spent in physical education class, or increase the amount of time students are active enough during physical education class.

Non-family Social Support: Focus is on changing physical activity behaviour through building, strengthening, and maintaining social networks that provide supportive relationships for behaviour change. Interventions typically involved setting up a “buddy” system, contracting with one another to complete specified levels of physical activity, or setting up walking groups or other groups to provide friendship and support.

² Harris (1998) describes a series of interventions being conducted to increase physical activity and appropriate dietary practice in the Sandy Lake community in northern Ontario. The population in the community are Native Canadians, predominantly Ojibwa-Cree, who are experiencing alarming rates of type 2 diabetes. The effectiveness of these interventions has yet to be determined (see also Kriska et al., 2001).

Individually-adapted Health Behaviour Change: Programs tailored to the individual's readiness for change or specific interests. Designed to help participants incorporate physical activity into their daily routines by teaching them behavioural skills, specifically, 1) goal setting and self-monitoring, 2) building social support, 3) behavioural reinforcement, 4) structured problem-solving, and 5) relapse prevention. All interventions delivered to groups of people either in group settings or by mail, telephone, or directed media.

Creation and/or Enhanced Access to Places for Physical Activity Combined with Informational Outreach Activities: Access to places for physical activity can be created or enhanced by building trails or facilities or by reducing barriers to places such as by reducing fees or providing time for use.

While Dunn et al. (1998) would concur with the finding that individually-adapted health behaviour change interventions could be efficacious for increasing physical activity, they determined that these types of interventions were not cost-effective. That is, because of the limited reach of these interventions they would have less impact and be less effective from a public health perspective. However these interventions could be more effective if included as part of a multicomponent community-based intervention.

One intervention where evidence was deemed to be insufficient in the Community Guide to Preventive Services, was in population-based mass-media campaigns. However, several studies in the United States and Australia have shown significant increases in awareness of the benefits of physical activity, on the part of the population, as a result of these campaigns (Blake et al., 1987; Crow et al., 1986; Owen, Bauman, Booth, Oldenburg, & Magnus, 1995). Booth, Bauman, Oldenburg, Owen, & Magnus (1992) presented evidence on the effectiveness of a mass-media campaign to promote physical activity in Australia. They found the campaign to be effective not only in promoting awareness but significant increases in walking also occurred.

In Canada, a study was recently conducted to determine the degree to which Albertans were aware of and used CPAG (Spence et al., 2001). It was found that 20% of Albertans state that they are aware of the CPAG and 5.5% have actually used or followed the recommendations in the guide. Interestingly, females and those with higher levels of education were more aware of the guide. In a one-year follow-up (Morrow et al., 1999) to the release of the Surgeon General's report on physical activity and health in the United States, approximately 32% of Americans stated they were aware of the report. With sufficient promotion, it is reasonable to hope that 30-40% of Canadians would be aware of CPAG within the next five years.

To assist us in evaluating how effective these campaigns are, future surveys of physical activity, both at the provincial and national level, should include some questions about the awareness and use of the CPAG and participation in *Summer Active*. Ultimately, if these programs are to be effective then they need support (e.g., financial) from both national and provincial governments.

The Cost-Effectiveness and Cost-Benefits of Physical Activity

The ever-rising costs of health care in Canada point to the need for a careful and objective evaluation of evidence concerning the effectiveness of all potential options for the prevention

and the treatment of disease. As discussed previously, it is now widely accepted that physical activity can make a major contribution to the prevention and treatment of a multitude of common chronic diseases and medical conditions (see Table 7), and that an active lifestyle has relatively few negative consequences. The overall health benefits of physical activity received renewed emphasis with publication of CPAG (Health Canada, 1998) and the US Surgeon General's report on physical activity and health (U.S. Department of Human Services, 1996). It has thus seemed logical to infer that the encouragement of active living should yield important national economic benefits through an enhancement of health and a reduction in both direct and indirect health care expenditures. The present section reviews and synthesizes existing evidence on the cost-effectiveness and cost-benefits of physical activity interventions.

A brief discussion is made of the relative value of cost-effectiveness vs. cost-benefit analysis, followed by a comment on the sectorial nature of both costs and benefits. After a description of the historic Quasar study, and a review of the corporate benefits of worksite interventions, analysis is made of the impact of enhanced physical activity upon medical costs. Finally, major technical limitations in current analyses are underlined.

Cost-Effectiveness vs. Cost-Benefit Analysis

Cost-effectiveness refers to how much it costs to produce a certain effect (e.g., more active population) whereas cost-benefits analysis looks at how resources can best be used (e.g., amount of dollars to get people active vs. the dollars saved by having a more active population).

In 1983, a detailed analysis of the costs and benefits of enhanced physical fitness was prepared for the Canadian Federal Government (Shephard, 1984), and the findings were summarized in two books (Shephard, 1986a; 1986b). These documents examined an important technical issue -- the relative merits of a cost-effectiveness versus a cost-benefit approach to the economic benefits of physical activity.

Since a substantial part of the indirect economic costs of ill-health reflects the loss of potential earnings, application of a cost-benefit approach to *individual* cases increases social inequities; it necessarily favours those with high salaries, and disadvantages the provision of services to those with low incomes, those who are retired, and those who are providing care to dependents within the home. Nevertheless, the cost-benefit tactic is widely used, and it has provided useful guidance in planning health policies for large populations. Application within the industrial setting, for instance, has suggested that a simple but effective worksite fitness and health promotion facility can be operated for \$100-200 1983 dollars per employee, substantially less than the estimated benefits to a corporation (about \$500 per employee per year, Table 8).

The cost-effectiveness approach is most helpful when applied to micro-analysis, as when comparing the relative costs of achieving a specific objective. This immediately requires a prioritization of competing objectives. For example, one might decide that physical activity was more important than attained fitness, and then ask how much funding would need to be invested in each of various competing types of physical activity program in order to achieve a 10% reduction in the prevalence of physical inactivity. Likewise, one might decide that ischemic heart disease was the most important of the preventable chronic diseases, and then ask the costs of

various proposals for realizing a 20% reduction in the prevalence of ischemic heart disease. In personal terms, a program is commonly considered effective if the cost of achieving an extra year of good quality life is in the range \$20,000 to \$100,000. Thus, ignoring problems of the discounting of future health benefits, fifty years of exercise programming at \$100/year would thus be warranted if it added at least six months to the average person's quality-adjusted life span. In fact, current data suggest a much larger benefit than this; if aerobic power, muscle strength, flexibility and bone strength are sustained by physical activity participation over a person's lifespan, the biological age may be reduced by 10 or more years, and the enhanced quality of life associated with a retarding of aging and maintenance of independence are in themselves strong grounds for advocating an active living program (Shephard, 1997).

Sectorial Nature of Costs and Benefits

The monographs cited above (Shephard, 1986a; 1986b) noted technical problems arising from the sectorial nature of both costs and benefits (Table 9). Some costs (for example, those associated with mass health promotion) and some benefits (for example, decreased expenditures on health care and a lesser need to provide support for the elderly) primarily affect the governmental balance-sheet.

Other items have their main impact on the corporate sector (for example, the costs of work-site fitness programs, and the benefits of enhanced productivity and reduced absenteeism). Yet other elements in a full economic analysis have their primary impact on the individual (for example, opportunity costs such as travelling to an exercise facility, personal expenditures on membership fees, clothing and equipment, and personal advantages such as an enhanced quality of life) (Table 9).

Nevertheless, there is also much interaction between the three sectors. For example, a company that is highly productive will contribute more to government revenues in the form of taxes, and a person who has a good quality of life is much less likely to seek medical attention for minor complaints, thus reducing health care expenditures.

The Quasar study. Canadian health economists first began to explore how far economic dividends might arise from the adoption of an active lifestyle more than 20 years ago. A historical study conducted by the Quasar Corporation (Quasar, 1976) made a cross-sectional comparison of Ontario Health Insurance Plan (OHIP) payments between individuals with low and those with average levels of physical fitness. The cost differential was \$18.29 for men and \$39.97 for women. Thus, it was estimated that Provincial health care costs would fall by some 5.5% if all adults aged 20-69 years could be brought to at least an average level of cardiorespiratory fitness. Further, future expenditures on ischemic heart disease in Ontario would be likely to drop by the equivalent of \$29M 1983 Canadian dollars if all adults were to attain at least average fitness.

The valuable features of the investigation were (i) the large sample size, and (ii) access to data for actual OHIP expenditures. However, critics noted certain important limitations to these estimates. In particular, there was no intervention. Thus (i) there was no guarantee that an increase of fitness in adult life would bring the health experience of a previously inactive person

to the level observed in individuals who had habitually maintained a good fitness level, and (ii) there was no proof that total Provincial Health Expenditures would actually fall if certain forms of ill-health were to be reduced or eliminated.

Corporate Benefits of Worksite Interventions

Detailed reviews of the economic benefits of enhanced physical activity have continued to appear (Shephard, 1990; Shephard, 1992; Shephard, 1996; Kaman & Patton, 1994; Kaman, 1995; Opatz, 1994), with a particular focus upon worksite fitness and health programs.

Typically, these reports have described short-term interventions, and as in many branches of health science, the practical constraints of the workplace have mitigated against conduct of a true randomized experiment, as currently advocated by experts in evidence-based medicine (Hart, 1994).

Often, inferences have been drawn from cross-sectional comparisons between active program participants and inactive individuals. Alternatively, there has been a simple uncontrolled pre- and post-test design, looking at data on participants before and after introduction of a worksite wellness program. Inevitably, such an analysis is vulnerable to secular trends and placebo effects.

In a few instances, a quasi-experimental approach has been used, drawing comparisons between a test-work site where an intervention was introduced and a closely matched control worksite. Even with this last design, interventions have commonly introduced items other than an active lifestyle (for instance, programs for smoking withdrawal, the control of substance abuse and weight reduction). Thus, it has been difficult to assess how far an increase in physical activity was responsible for any observed health benefits.

Almost all of these investigations have attempted to set dollar values upon such benefits as enhanced productivity, decreased absenteeism and employee turnover, reductions in medical costs and work loss from chronic disease, occupational injuries, premature death and enhancements of personal lifestyle. Nevertheless, in practice, it has proven difficult to set a precise economic value upon some of the benefits that probably should be included in the ledger, such as the recruitment of premium

employees, an enhancement of corporate image, and the development of a more satisfied labour force. Typical estimates set the cumulative corporate benefits at a company-wide value in excess of \$500 per worker per year, or with one third of the labour force participating in the program, \$1500 per participant year (Table 8); given that the cost of a modest program is around \$100 per worker per year, the cost-benefit ratio could be as high as 5:1.

WORKSITE FITNESS PROGRAMS

- **Increase productivity**
- **Decrease absenteeism & turnover**
- **Decrease medical costs**
- **Decrease occupational injuries**
- **Decrease premature deaths**
- **Cost/benefit ratio up to 5:1**

Because of economies of scale and the development of a healthy corporate culture, benefits per worker would likely be even larger if the proportion of employees using worksite programs were to be increased, and the program drop-out rate could be reduced. Currently, initial recruitment is unlikely to exceed a third of employees, some of whom were previously active elsewhere, and the long-term retention rate drops to about 16%.

A popular summary of recent data on work-site programs is available on the Health Canada website (“The Business Case for Active Living”): <http://www.activelivingatwork.com>.

Impact of Physical Activity Participation upon Medical Costs

Although governments may gain some indirect benefits from an enhancement of corporate profitability, the most pressing current issue for both Federal and Provincial agencies is the containment of medical costs. There is *a substantial* volume of cross-sectional data and more limited quasi-experimental evidence supporting the value of physical activity in reducing such costs.

Quasi-experimental studies. A quasi-experimental study at the Canada Life and North American Life Assurance companies in Toronto obtained OHIP data to demonstrate that in the year following implementation of the program, health-care claims at the experimental worksite were reduced by more than \$100 1983 Cdn \$ per employee relative to the control worksite (Shephard et al., 1982). This was equivalent to perhaps half a day of hospital care and three physician consultations per year. A few European trials have suggested that participation in vigorous sport can increase medical costs, at least for young adults, because of the need for entry screening or the treatment of athletic injuries (Nicholl, Coleman, & Williams, 1991). However, the Toronto study demonstrated that neither electrocardiographic nor orthopaedic claims were increased by a typical moderate intensity aerobic worksite program (Shephard et al., 1982).

A number of other work-site fitness and/or wellness programs have provided quasi-experimental evaluations of changes in medical care expenditures (Shephard, 1986b; Shephard, 1996; Pronk et al., 1999; Bly, Jones, & Richardson, 1986). One recent study showed a 4.7% reduction in short-term (18 months) health care costs for each active day per week reported by participants (Pronk et al., 1999). Such findings support earlier reports indicating that the introduction of corporate fitness and health promotion programs can yield significant health care savings (Shephard et al., 1982; Bly et al., 1986). Further, short-term health analyses of care costs (completed over a 1-2 year study) may well underestimate the long-term benefits of active living, because the immediate impact of an increase in physical activity is upon mood state rather than susceptibility to chronic disease. It probably takes several years to accrue the full benefits of an active lifestyle in terms of reductions in the risk of chronic cardiovascular disease, diabetes mellitus, osteoporosis, cancer, and other chronic medical conditions.

CANADA LIFE STUDY

- **Quasi-experimental design**
- **Medical costs at experimental company reduced by \$100/year**
- **No increase in demand for ECG or orthopaedic services**

Cross-sectional estimates of changes in direct medical costs. In recent years, Canadian investigators have completed several sophisticated cross-sectional analyses of the impact of enhanced physical activity on specific elements of medical costs (Wood, 1993a; Wood, 1993b; Conference Board of Canada, 1996; Katzmaryk et al., 2000). The first two reports provided a detailed description of methodology, but looked only at the costs associated with ischemic heart disease (Wood, 1993a; 1993b). The third report considered effects attributable to ischemic heart disease, colon cancer, and type II diabetes mellitus (Conference Board of Canada, 1996); generalization of the findings was limited because estimates of relative risk were based on single, and not necessarily representative, studies of physical activity and disease incidence.

The most recent study (Katzmaryk et al., 2000) calculated summary relative risk (RR) estimates, based on meta-analyses of prospective longitudinal studies which had examined the effects of physical inactivity on six relevant chronic diseases (coronary artery disease, stroke, colon cancer, breast cancer, type II diabetes mellitus and osteoporosis, see Table 1). Despite the number of conditions included in the calculations, the list still does not include all of the diseases and conditions which are likely to be influenced favourably by an increase in physical activity (Table 7). The population-attributable risk (PAR) was calculated for each of the six illnesses from the corresponding RR and the prevalence of inadequate physical activity. The PAR was calculated as $[P(RR - 1)] / [1 + P(RR - 1)]$, P being the prevalence of physical inactivity in the population and RR the relative risk of a given disease in an inactive person; the PAR estimates the effects of an individual risk factor on the prevalence of a given disease. The proportion of the Canadian population who took an inadequate amount of physical activity was estimated from the 1997 Physical Activity Monitor of the Canadian Fitness and Lifestyle Research Institute, a telephone-based questioning of a representative but weighted sample of 1875 Canadians. This had determined that some 62% of Canadians aged 18 years or more were insufficiently active, operationally defined as reporting an active energy expenditure of less than 12.6 kJ/kg of body

mass per day (or less than 30 minutes of moderate-intensity activity 4 days a week). Emphasizing the problems inherent in such definitions, the earlier studies had classified as inactive all individuals who failed to achieve a much higher leisure-time energy expenditure of approximately 18.5 kJ/kg per day (Paffenbarger, Hyde, Wing, & Hsieh, 1986).

The recent analysis (Katzymaryk et al., 2000) took estimated health care costs for 1999 from analyses of the Canadian Health Expenditures Database (Canadian Institute for Health Information, 1999). This data base provides information on broad categories of health care spending (hospital care, physician care, drugs and research) and sources of funding, but does not indicate the costs of treating specific diseases. The latter information was in general garnered from the Economic Burden of Illness in Canada, 1993 (Moore et al., 1997), the costs being inflated to 1999 dollar values (Canadian Institute for Health Information, 1999). The PAR was then applied to the corresponding total direct health care expenditures for 1999 and to the number of deaths in 1995 that were associated with each disease. This yielded figures for the health care costs and the number of lives that were apparently lost prematurely because of physical inactivity. The figures for population attributable fraction suggested that 11.0% to 35.8% of the cases of the various diseases might be eliminated if those who were sedentary could be brought to an adequate level of physical activity.

Current Canadian costs of physical inactivity. The direct health care costs attributable to physical inactivity in 1999, estimated in this fashion, are summarized in Table 10. In total, it seems that some \$2.1 billion of health care expenditures was directly attributable to physical inactivity. This amount represented 2.5% of the total annual health care costs (calculated at \$86.0 billion for that year; Canadian Institute for Health Information, 1999). As in the earlier estimates (Wood, 1993a; 1993b; Conference Board of Canada, 1996), a sensitivity analysis was performed. The 90% confidence limits of calculated savings are extremely broad (for example, \$44,000 to 1.3 million per year for colon cancer, Conference Board of Canada, 1996). The recent analysis simultaneously varied each of the health care costs and population attributable fraction by $\pm 20\%$. On this basis, the fraction of the cumulative health care costs for the major chronic diseases attributable to inadequate physical activity could have been as low as \$1.4 billion or as high as \$3.1 billion. The average of these estimates amounts to some 2.5% of the annual costs of treating coronary artery disease, stroke, hypertension, colon cancer, breast cancer, type II diabetes and osteoporosis. The highest costs attributable to inadequate physical activity were associated with coronary arterial disease (\$891 million), osteoporosis (\$352 million), stroke (\$345 million) and hypertension (\$314 million).

- **2.5% of direct health care costs due to physical inactivity (total cost \$2.1 B/year)**
- **Largest component due to ischemic heart disease**

Physical inactivity and premature death. The number of deaths and the causes of death among adults (20 years of age and over) in Canada during 1995 were obtained from Statistics Canada data (Statistics Canada, 1997). Out of 207,408 deaths from all causes, 35.8% were due to the main diseases associated with physical inactivity, namely coronary disease, stroke, colon cancer, breast cancer and type II diabetes (Table 11). If inadequate physical activity were to be completely eliminated in Canada, this suggests that we could increase the average life expectancy and avoid 21,340 premature deaths each year -- 10.3% of the total deaths among adults.

Elimination of physical inactivity would avoid 21,340 premature deaths per year in Canada

Economic impact of a reduction in physical inactivity. The economic savings that would result from a 10% reduction in the prevalence of inadequate physical activity were estimated by recalculating the population attributable fractions, assuming the prevalence of inactivity to have decreased from 62% to 56%. Based on this analysis, a 10% reduction in the prevalence of physical inactivity would reduce direct health care expenditures by \$150 million per year. One key assumption here is the ability of health agencies to augment physical activity by 10%. Although there was an increase in reported activity of about 1% per year between 1981 and 1988 (Stephens & Craig, 1990), some recent evidence suggests that despite a continuation of strong promotional efforts, the trend to an increase in physical activity has now halted (Craig et al., 1999).

10% reduction in physical inactivity would reduce direct health care expenditures by \$150 million per year in Canada

Supporting US data. Similar estimates of savings from an increase in physical activity have been reported from the United States; in that country, \$24 billion or 2.4% of total health care expenditures were attributed to physical inactivity (Colditz, 1999), and about one-third of deaths from coronary disease, colon cancer and diabetes were attributed to physical inactivity (Powell & Blair, 1994). The overall cost estimates for physical inactivity are similar to those for obesity (in Canada, about \$1.8 billion in 1997; Birmingham et al., 1999) or around \$2 billion if inflated to current dollars.

Given the significant association between physical inactivity and obesity, a portion of the health care costs attributable to obesity is also attributable to physical inactivity (Grundy et al., 1999). It seems unlikely that the costs of physical inactivity and obesity are simply additive; more research is thus needed to determine the overlapping costs arising from inactivity-related obesity.

Technical Limitations to Current Analyses

There were inevitably important technical limitations to each of the recent Canadian estimates of the costs of physical inactivity (Wood, 1993a; 1993b; Conference Board of Canada, 1996; Katzymaryk et al., 2000), and important assumptions were made which may not in fact be realized, as summarized in part by the report of the Conference Board of Canada (Conference Board of Canada, 1996) (Table 12).

As in earlier cross-sectional research, there is no guarantee that new recruits to an active lifestyle would enjoy the same health benefits as those who have been active since childhood. The available estimates of RRs are often based on cross-sectional studies, and the estimated effects do not always translate into actual benefits if tested in randomized controlled trials. Although some randomized controlled trials have examined the effects of an increase in physical activity upon the risk factors for chronic disease (such as blood lipid levels), there is as yet little information on whether population interventions can induce a sufficient increase in physical activity to change one's risk for disease *per se*. A limited number of longitudinal prospective studies (Blair et al, 1995; Paffenbarger et al., 1993) support the idea that increases in physical fitness or physical activity levels can reduce the risk of death from all causes. Nevertheless, there is no guarantee that if the prevalence of diseases associated with physical inactivity is reduced, that overall medical expenditures will fall. Possibly, the individuals who become active will die of some other costly chronic disease. Governmental funding may also be redirected to give a fuller and more costly treatment of other types of health problem. Finally, the costs of exercise program are fairly well established (Shephard, 1986a), and it is probable that older adults can obtain sufficient exercise for an improvement of health from low-cost activities such as regular walking. However, little analysis has been conducted on the potential costs of physical activity promotion. To date, attempts to promote an increase in physical activity have been mediocre (see Dishman et al., 1998; Stone et al., 1998; Taylor et al., 1998). However, more recent studies show promise (Dunn et al., 1999). The benefits observed in small-scale laboratory trials of well-motivated individuals have also been difficult to match in the community, and many worksite and community exercise programs have been marred by high drop-out rates. The implementation and maintenance of nation-wide intervention programs and campaigns designed to promote physical activity will almost certainly be expensive. By analogy with smoking cessation programs, it may take 40-50 years of publicity and extensive social engineering within our cities before there is a change public attitudes favouring a physically active lifestyle.

Despite these discouraging facts, other factors tend to offset what could prove over-estimates of benefit, and in certain respects the recent estimated costs of physical inactivity may be judged as conservative. Physical activity is notoriously difficult to measure accurately, and for this reason the studies included in the meta-analyses likely underestimated the health risks associated with an inactive lifestyle. Furthermore, none of the recent reports attempted to estimate the important elements of indirect costs, which include lost productivity due to premature death, disability due to illness, and the influence of ill-health on the effectiveness of significant others. Finally, various important sources of health care expenditure such as dyslipidemia, anxiety, depression, a poor quality of life and premature admission to a geriatric institution (U.S. Department of Human Services, 1996) were excluded from the calculations, in part there is little consensus on their economic consequences, and in part because the physical inactivity effect sizes for some of these conditions are small.

Some residual questions...

- **Can inactive people become active?**
- **How much will this cost?**
- **Can an increase in activity give the same level of health as found in a habitually active person?**

Conclusions

Given the limitations in current data, particularly the lack of randomized controlled trials to evaluate the effectiveness of exercise interventions, more research on the economic benefits of short- and long-term changes in physical activity levels is needed. Nevertheless, both work-site data suggesting a cost-benefit ratio as high as 5:1 and current cross-sectional estimate that physical inactivity accounts for about 2.5% of direct health care costs seem very important in a public health context. To set the latter figure in perspective, the costs attributable to cigarette smoking in Canada have been estimated at 3.8% of total health care costs in 1992 (Single et al., 1992). Considerable efforts have been directed at curbing the prevalence of smoking in Canada, and public health campaigns to encourage active living should be no less aggressive and persistent.

A.4. Consideration of Other Key Issues

1. Very little information exists on children's physical activity participation in Canada. Considering that childhood obesity is on the rise in this nation (Tremblay & Willms, 2000), a more concerted effort needs to be made to document the activity levels of children and adolescents on a regular basis. In particular, this information is needed at provincial and regional levels in order to support prevention programs.

2. Interventions aimed at changing environmental, institutional, and social factors related to physical activity remain largely unexplored. Furthermore, a need exists for more research that specifically targets inactive subgroups in relation to these factors.

3. Currently, it is difficult to gain access to schools, workplaces, and health care facilities in order to conduct physical activity interventions.

B. Application and Analysis of the Outcomes Model

B1. Using an Outcomes Model to Assess Evidence of Effectiveness and Cost-Effectiveness of Physical Activity Interventions

In order to understand the state of the evidence for the effectiveness of interventions it is useful to use some type of outcomes model. In this section we consider the evidence for physical activity in relation to the outcomes model of the International Union for Health Promotion and Education (1999) (see Table 13). A similar model has been presented by Frankish et al. (1998) for describing and explaining determinants of active living. Further, using an ecological framework, Gauvin, Levesque, & Richard (2001) provided an excellent overview of physical activity interventions. The reader is advised to see these documents for further information.

Health & Social Outcomes

As reviewed previously, strong evidence exists on the relationship between physical activity participation and health and social outcomes. Further, according to Katzmaryk et al. (2000), huge savings in health care costs could be attained if the Canadian population was more physically active.

Intermediate Health Outcomes

Healthy lifestyles. Physical activity interventions often do lead to increased physical activity participation. Further, cross-sectional studies find that physically active children and adolescents are less likely to smoke (Rainey, McKeown, Sargent, & Valois, 1996; Spence, Mummery, & Poon, 2001).

Effective health services. Some promise has been shown for the efficaciousness of primary-care physical activity promotion programs (Activity Counseling Trial Research Group, 2001; Bull, & Jamrozik, 1998; Swinburn, Walter, Arroll, Tilyard, & Russell, 1998). To the extent that these programs are effective and taken up by the health care providers, a more effective health service will exist. One of the major issues with this type of delivery is who will provide the service. Physicians recognize the potential preventive benefits of physical activity promotion/prescription, however they do not think that they have enough time to provide the service (Swinburn, Walter, Arroll, Tilyard, & Russell, 1997).

Healthy environments. The area in which people live has an influence on physical activity participation (Ecob & Macintyre, 2000; Gauvin, Richard et al., 2001). For instance, after controlling for individual-level factors (e.g., household income), adults living in higher SES neighborhoods are more active than those living in lower SES neighborhoods (Gauvin, Richard et al., 2001). Offord et al. (1998) found that the presence of good parks, playgrounds, and play spaces in the neighbourhood was strongly associated with increased rates of participation in sports by Canadian children. Interventions to enhance the environment have shown some promise in promoting physical activity participation (Brownson et al., 1996; Lewis et al., 1993).

Health Promotion Outcomes

Health literacy. The more efficacious people are about being physical activity (Culos-Reed, Gyurcsik, & Brawley, 2001) and the more positive attitudes and intentions they have about activity (Spence, Courneya, Blanchard, Wilson, & Becker, 2001), the more likely they will participate.

Social action and influence. Very little information on the causal pathways between social action and physical activity participation. One recent study found that the social environment was the strongest independent predictor of physical activity across six European countries (Stahl et al., 2001). Since social norms and public opinion are indicators of this outcome, the potential influence and role that *Participation* played in raising the activity levels of the Canadian population could be cited. Siedentop (1996) makes the case that society as a whole needs to value the physically active life, until that happens we will not see significant increases in population level physical activity. More research needs to be conducted on this topic.

Healthy public policy and organizational practice. Policy and organizational practice can influence physical activity participation (Sparling, Owen, Lambert, & Haskell, 2000). For instance, QDPE in schools as been shown to be an effective mechanism for increasing the activity levels of children.

Health Promotion Actions

Education. Patient education (e.g., Swinburn et al., 1998), quality daily physical education (e.g., Trudeau, Laurencelle, Tremblay, Rajic, & Shephard, 1999), and mass-media campaigns (e.g., Booth, Bauman, Oldenburg, Owen, & Magnus, 1992) can all lead to increased physical activity participation. However, apart from a few instances (Trudeau, Laurencelle, Tremblay, Rajic, & Shephard, 1999), almost no information exists on long-term follow-ups to these interventions.

Social mobilisation. Very little information available.

Advocacy. Very little evidence exists on the effectiveness of advocacy for physical activity. However, considering that only 31% of Canadian legislators see a major role for government in encouraging physical activity (Ashley, Cohen, Northrup, & Ferrence, 2001), there is a need for investigations in this area.

Potential Usefulness of an Outcomes Model to Inform Policy and Program Investment Decisions

In principle, most governmental policy and program investment decisions should be based on an outcomes model. This is particularly important in the case of physical activity, where an attempt is being made to manipulate the behaviour of a large segment of the Canadian population.

1. The outcomes model for physical activity is useful in that it works within an accepted health promotion framework, so the language should be familiar to most practitioners and health policy people.

2. The model is fairly descriptive in nature and will facilitate identifying gaps in the knowledge base. For instance, very little information exists on the role of social mobilisation or advocacy in physical activity promotion.

3. The model is attractive because it identifies actions and intermediate health outcomes. The latter is important because when investigating the relationship between behavior and physical and/or mental health outcomes, intermediate outcomes help document possible changes.

4. The model assumes equal weighting across categories within each level of outcomes. It is possible that one category may be more important than another depending on the organization or sector using the model. Or, there might be an order in which the categories should be addressed. For instance, it might be wise to have healthy environments in place before massive promotion campaigns to get people active.

5. In terms of cost analyses, the potential implementation of such a model is currently severely limited by deficiencies in our knowledge base. As Wood (1993b) has pointed out, any model linking physical activity, health status and the cost of treating illness makes “a very simple representation of complex epidemiological, demographic and utilization forces”. Although there is sufficient evidence to suggest that there may be substantial savings in health care costs from the encouragement of low cost forms of physical activity, there are sufficient gaps and uncertainties in available information that any estimate of either cost-effectiveness or cost-benefit remains very tenuous. Plainly, health economists should make further efforts to obtain the data needed in order to develop a comprehensive economic model (Hatziaandreu et al., 1988). This will be a long and difficult task, given that interest in physical activity must be sustained over a lifetime in order to obtain maximal benefits, the impact of health promotion upon environmental structures and societal attitudes towards exercise will likely evolve over 40-50 years, and a favourable impact of increased activity upon cancers and geriatric dependency may also not be seen for many years. Nevertheless, competing demands for governmental support are such that the gathering of conclusive evidence on the magnitude of the physical activity dividend

- **Cost-effectiveness and cost benefit models are simple representations of complex relationships**
- **Existing evidence is encouraging but insufficient to allow precise calculations**
- **Further data should be collected to allow detailed economic modelling**

should be initiated now.

6. Several of the effective intervention strategies identified by Centers for Disease Control and Prevention. (2001) address some of the outcomes identified in this model. For instance, social support interventions in community contexts will lead to some of the outcomes identified under social action and influence. Similarly, creation of enhanced access to places for physical activity falls under healthy environments. So, within this model we can identify effective intervention strategies to achieve some of the stated outcomes for physical activity promotion in Canada.

C. Lessons Learned

C. 2. Summary of the Effectiveness and Cost-Effectiveness of Active Living Interventions

Physical activity can make a major contribution to the prevention and treatment of a multitude of common chronic diseases and medical conditions, with few negative consequences. It is thus logical to infer that an increase in the proportion of the population who are physically active should reduce health care costs. Economists analyze such questions using cost-benefit or cost-effectiveness analysis. Cost-effectiveness analysis is particularly useful in comparing competing methods of achieving a given outcome; it requires an initial prioritization of outcomes. It is difficult to set dollar values on many items relating to population health and an increase of physical activity. Nevertheless, benefits appear to outweigh costs substantially. Costs and benefits are distributed between governmental, private and personal sectors of the economy, although there is much interaction between these three sectors.

An evaluation of Ontario Hospital Insurance Plan payments (Quasar, 1976) showed that yearly medical costs were \$18.29 lower in active men, and \$39.97 lower in active women. Likewise, analysis of worksite fitness programs has demonstrated increased productivity, a decrease in absenteeism & turnover, a decrease in medical costs and occupational injuries and a decrease in premature deaths, with a cost/benefit ratio as high as 5:1. Quasi-experimental studies suggest that medical costs can be reduced by \$100/year subsequent to introduction of a fitness program; further, this is achieved with no increase in demand for ECG or orthopaedic services. Currently, 62% of the Canadian population take insufficient physical activity for health (<12.6 kJ/kg per day). The Year 2003 Objective is to reduce the proportion who are inactive to 56% of the population. This should have a proportional impact on the 2.5% of direct health care costs which are due to physical inactivity (a saving of \$150 M/year), as well as reducing the number of premature deaths by 21,340 per year. US estimates support the magnitude of the postulated savings.

Some uncertainties remain. Can inactive people be encouraged to be more active, and if so, how much will this cost? Further, can an increase in physical activity bring the health of an inactive person to the level found in a habitually active person? Additional data should be collected to allow more precise modelling of outcomes, including the actual costs of initiating and sustaining active behaviour in those who are currently inactive. In particular, data should be accumulated to

refute arguments sometimes advanced against physical activity, such as costs arising from competing illness, sports injuries, and extended pension payments.

While some positive information exists on the efficacy of physical activity interventions, less information exists on the effectiveness of these interventions, particularly in Canada. An extensive review by the US Centers for Disease Control and Prevention (2001) revealed that two informational approaches (community-wide campaigns and “point-of-decision” prompts), three behavioural and social approaches (school-based physical education, social support interventions in community contexts, and individually-adapted health behaviour change), and one intervention using environmental and policy approaches (creation of or enhanced access to places for physical activity combined with informational outreach activities) are effective interventions for increasing physical activity participation. It is clear that individually-oriented programs that are based in exercise facilities and advocate high-intensity activity do not serve the majority of the population and fail from a public health perspective (Dunn et al., 1998). Current thinking supports a more population-based approach to physical activity promotion including a key role for government and policy initiatives (McKinlay, 1995; Orleans et al., 2000).

The evidence for the benefits that a physically active society will accrue is strong in terms of enhanced quality of life, reduced disease and disability, and reduced health-care costs. Further, physical inactivity is no less of a public health threat than smoking. Some effective strategies have been identified for increasing population-level physical activity participation. A need exists to identify other effective interventions and programs that may be specific to the Canadian context (e.g., northern climate, rural population). In conclusion, federal funding in the active living area should be continued.

C. 3. Lessons Learned From Application of the Model

1. Little evidence available in the advocacy, social mobilisation, and social action areas.
2. The model does not identify causal pathways between actions and the various levels of outcomes.

C. 4. Gaps and Priorities for Research/Knowledge Development

Lessons learned to date include the strong likelihood of a positive effect of physical activity upon many facets of health and thus the costs of providing medical services, the complexity of inter-relationships in this area, and the need for further data:

1. Very little information exists on children’s physical activity participation in Canada. Considering that childhood obesity is on the rise in this nation (Tremblay & Willms, 2000), a more concerted effort needs to be made to document the activity levels of children and adolescents on a regular basis. We know even less about access to physical activity for children living in poverty or with a disability. In particular, this information is needed at provincial and regional levels in order to support promotion programs.

2. Interventions aimed at environmental, institutional, and social levels remain largely unexplored and there is a need for more research that specifically targets inactive subgroups at these levels. While the existence of relationships between social inequities and involvement in physical activity is recognized, the existence of contextual effects and the presence of differences in the perceptions of availability of programs and services is just coming to light (see Gauvin, Richard, et al., 2001). ***We recommend that renewed emphasis be devoted to uncovering the processes underlying such relationships and on the development of public policies for overcoming these income and education gaps.***

3. There is a need to establish by careful direct experimentation how far the differences in health and health-related costs observed in cross-sectional comparisons between active and inactive individuals can be matched if an inactive group of people can be persuaded to become active. ***We recommend that any funded physical activity interventions, either federal or provincial, be required to conduct cost-effectiveness/benefits analyses of the intervention.***

4. Further data should be collected to refute arguments advanced against physical activity, such as costs incurred from “competing illnesses”, sports injuries, and the costs associated with prolonged pension payments.

5. Need to develop surveillance strategies for physical activity delivery systems (Gauvin, Richard, et al. 2001). While there are effective strategies for population surveillance of physical activity participation, less attention has been devoted to surveillance systems for monitoring changes in the physical activity delivery system. To the extent that the quality of the physical activity delivery system is associated with actual levels of involvement, a monitoring system is required to detect where and when changes are required. ***We therefore recommend that consideration be given to establishing a comprehensive nation-wide system of surveillance of physical activity delivery systems.***

6. Need to further disseminate physical activity promotion strategies among physical activity practitioners (Gauvin, Richard, et al. 2001). Research shows that only a limited portion of the potential public health practices for the promotion of physical activity are actually used by practitioners. In particular, physical activity promotion in Canada is characterized by a clinical approach (interventions targeted directly to individuals) rather than population approaches (interventions targeted towards higher order components of the human ecology e.g., organisation, communities). Understanding that these latter approaches are likely to be less well known by practitioners, ***we recommend that the nature, reach, and efficacy of population approaches to physical activity be disseminated to practitioners across Canada.***

7. Need to better coordinate physical activity promotion infrastructure into public health infrastructure (Gauvin, Richard, et al. 2001). Policy-makers note that there had been a change in focus from recreation toward health in dealing with the issue of physical inactivity (Gauvin et al., 2001). While this is a positive trend and likely reflects the increasing evidence about the health benefits of physical activity, it is also clear that there is a lesser commitment to exercise than would be desirable to effect change. ***We therefore recommend that consideration be given***

to developing policies and interventions that would lead to better coordination of physical activity promotion into the broader public health infrastructure.

8. Need for more information on evaluating interventions against criteria in the scientific literature (Gauvin, Richard, et al. 2001). There is no doubt that numerous interventions are being used in Canada to effect changes in physical activity in the population. Understanding that practitioners will want to use and apply the most efficacious and cost-effective strategies, *we recommend that consideration be given to establishing a best practices data base that contrasts initiatives conducted in various parts of the country against scientifically-established criteria for efficacious and effective interventions.*

C. 5. Recommendations for Modification of the Model as a Decision-Making Tool

1. Compare and contrast model with that presented by Frankish et al. (1998).
2. May want to couch outcomes model within the Precede-proceed model (Green & Kreuter, 1991). The precede-proceed model provides an overall framework for organizing models and is very effective in the planning process. It was recently used in a Canadian context to examine predictors of physical activity in participants in a health promotion program (Hill, 1996).
3. Consider if one set of outcomes is more important at this time. For instance, considering that there is a dearth of healthy public policy in regard to physical activity, perhaps that component of the model should be emphasised.

C. 6. Insights for the Development of an Action Plan on Effectiveness of Interventions

See C. 4.

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Table 1. Relative Risk (RR) and Population-Attributable Risk (PAR) due to Physical Inactivity for Major Chronic Diseases (Katzmaryk et al., 2000)

Disease	RR	(95% CI)	PAR(%)*
CAD	1.9	(1.6-2.2)	35.8
Stroke	1.4	(1.2-1.5)	19.9
Hypertension	1.4	(1.2-1.6)	19.9
Colon Cancer	1.4	(1.3-1.5)	19.9
Breast Cancer	1.2	(1.0-1.5)	11.0
Type 2 Diabetes	1.4	(1.2-1.6)	19.9
Osteoporosis	1.6	(1.2-2.2)	27.1

* Based upon a physical inactivity rate of 62%

Table 2. Physical Activity, Anxiety, and Stress: Findings from Meta-analyses (Gauvin et al., 1999)

Exercise Paradigm	Study	Special Characteristics	Outcome	K	Effect Size (d)
Chronic					
	Crew & Landers (1987)		stress reactivity	67	-0.59
	Kugler et al. (1994)	coronary patients	anxiety	13	-0.31
	Landers & Petruzzello (1994)	includes unpublished	trait anxiety	51	-0.40
			state anxiety	30	-0.38
	Long & van Stavel (1995)		trait anxiety	29	-0.38
			state anxiety	21	-0.34
	McDonald & Hodgdon (1991)	aerobic exercise studies only	trait anxiety	20	-0.25
			state anxiety	13	-0.28
	Petruzzello et al. (1991)	includes unpublished	trait anxiety	62	-0.34
			state anxiety	88	-0.25
			physiological	53	-0.40
	Schlicht (1994)	1980 - 1990	anxiety	22	-0.30
Acute					
	Crew & Landers (1987)		stress reactivity	25	-0.11
	Landers & Petruzzello (1994)	includes unpublished	state anxiety	25	-0.53
	Petruzzello et al. (1991)	includes unpublished	state anxiety	119	-0.23

K = number of effect sizes. Note, the effect size for Schlicht (1994) is from both chronic and acute studies.

Table 3. Physical Activity and Depression: Findings from Meta-analyses (Gauvin et al., 1999)

Exercise Paradigm	Study	Special Characteristics	K	Effect Size (d)
Chronic	Craft & Landers (1998)	clinical population	119	-0.72
	Kugler et al. (1994)	coronary patients	15	-0.46
	McDonald & Hodgdon (1991)	aerobic exercise studies only	17	-0.97
	North et al. (1990)	includes unpublished	226	-0.59
Acute	North et al. (1990)	includes unpublished	26	-0.31

K = number of effect sizes.

Table 4. Chronic Physical Activity and Self-Concept: Findings from Meta-Analyses (Gauvin et al., 1999)

Study	Special Characteristics	K	Effect Size (d)
McDonald & Hodgdon (1991)	aerobic exercise studies only	41	0.56
Spence et al. (1997)	includes unpublished	61	0.23

K = number of effect sizes.

Table 5. Level of Physical Activity Interventions (adapted from Marcus & Forsyth, 1999)

Level	Intervention
Upstream	Insurance reimbursement for physician counseling
	Tax incentives for physically active people
	Changing environment to facilitate activity (e.g., bike paths, safe walking areas)
	Insurance coverage for athletic facility membership
	Involving community leaders in physical activity campaigns
	Media campaigns and community events that target entire communities
	Worksite programs
Midstream	Training primary care physicians to do activity counseling
	Exercise training studies
	Clinical exercise interventions
Downstream	Cognitive-behavioral interventions

Table 6. Recommendations of Effectiveness for Interventions to Promote Physical Activity from the Task Force on Community Preventive Services (Centers for Disease Control and Prevention, 2001)

Intervention	Recommendation
Informational Approaches to Increasing Physical Activity	
Community-wide campaigns	Strongly Recommended
“Point-of-decision” prompts to encourage stair use	Recommended
Classroom-based health education focused on information provision	Insufficient Evidence
Mass media campaigns	Insufficient Evidence
Behavioural and Social Approaches to Increasing Physical Activity	
School-based physical education	Strongly Recommended
Non-family social support	Strongly Recommended
Individually-adapted health behaviour change	Strongly Recommended
Health education with TV/Video game turnoff component	Insufficient Evidence
College-age physical-education/health education	Insufficient Evidence
Family-based social support	Insufficient Evidence
Environmental and Policy Approaches to Physical Activity	
Creation and/or enhanced access to places for PA combined with informational outreach activities	Strongly Recommended
Transportation policy and infrastructure changes to promote non-motorized transit	Pending
Urban planning approaches – zoning and land use	Pending

Table 7. Summary of Chronic Diseases and Medical Conditions Where Physical Activity Influences Health, Morbidity and Mortality (see Bouchard, Shephard, & Stephens, 1994)

STRONG EVIDENCE OF BENEFIT

Coronary heart disease
Hypertension
End-stage Renal Disease
Type II Diabetes Mellitus
Osteoporosis
Colon cancer
Surgical trauma
Depression and Anxiety
Loss of function and independence in old age

SUGGESTIVE EVIDENCE OF BENEFIT

Peripheral vascular disease
Mild obesity
Chronic obstructive lung disease
Breast cancer

EQUIVOCAL EVIDENCE OF BENEFIT

Cerebrovascular accidents
Type I Diabetes Mellitus
Low back problems
Bladder problems
Immune disorders, resistance to infection
Smoking withdrawal, substance abuse

POTENTIAL RISKS

Musculo-skeletal injury
Exercise addiction/weight loss
Sudden death (very rare)

Table 8. Estimated Corporate Economic Benefits of a Work-Site Fitness Programme, Expressed in 1983 Canadian Dollars per Worker-Year (Shephard, 1986a)

Ledger Item	Fiscal saving per worker-year
Worker satisfaction	?
Productivity enhanced	\$116
Absenteeism reduced	\$30
Turnover of employees decreased	\$324
Industrial injuries reduced	\$43
Company image enhanced	?
TOTAL	\$513

Note: There are also governmental benefits from reduced health care claims

Table 9. Sectorial Nature of Costs and Benefits

COSTS	BENEFITS
<i>Governmental sector</i>	
Promotion of “Active Living”	Reduced health care costs
Support of research	Reduced institutional support for frail elderly
Provision of facilities for employees	
<i>Corporate sector</i>	
Provision of facility for employees (serviced space, equipment, staff insurance)	Increased volume and quality of productivity Reduced absenteeism and employee turnover Enhanced image
Potential time loss	Recruitment of premium workers Reduced medical premiums
<i>Personal sector</i>	
Opportunity cost, especially travel	Enhanced mood state and quality of life
Purchase of memberships, clothing equipment	Enhanced body image Enhanced health and overall lifestyle Social contacts and support

Table 10. Health Care Costs for Major Chronic Diseases in Canada in 1999, and Estimated Direct Health Cost of Physical Inactivity for the Same Year (Katzmaryk et al., 2000)

Disease	Health care costs, \$M					Direct costs of inactivity,
	<i>Hosp. Care</i>	<i>Medical Care</i>	<i>Drugs</i>	<i>Research</i>	<i>Total</i>	\$M
Coronary artery disease	1,884	315	287	1.55	2,488	891
Stroke	1,508	89.7	134	0.56	1,732	345
Hypertension	332	298	950	NA	1,580	314
Colon cancer	254	46.1	24.1	7.53	332	66.1
Breast cancer	176	48.0	51.5	5.71	282	31.0
Type II diabetes mellitus	284	144	178	12.8	620	123.3
Osteoporosis	NA	NA	NA	NA	1,300	352
Total					8,334	2,123

NA = not available.

Table 11. Annual Number of Deaths in Canada Attributable to Inadequate Physical Activity in 1995 (Katzymaryk et al., 2000)

<i>Disease</i>	<i>Number of deaths</i>	<i>% of</i>	<i>Number due to</i>	<i>% of</i>
		<i>total</i>	<i>inactivity</i>	<i>total</i>
Coronary artery disease	44,061	21.1	15,774	35.8
Stroke	15,517	7.5	3,088	19.9
Colon cancer	4,237	2.0	843	19.9
Breast cancer	4,923	2.4	542	11.0
Type II Diabetes Mellitus	5,492	2.6	1,093	19.9
ALL CAUSES	207,408	100.0	21,340	10.3

Table 12. Assumptions Inherent in Cross-sectional Estimates of Health Care Savings From an Increase in Physical Activity (based in part on Conference Board of Canada, 1996)

1. Physically active individuals with low medical costs are identical with those who are physically inactive and have high medical costs

(in fact, the active individuals tend to be male, better educated, younger and healthier than those who are inactive).

2. A proportion of those who are currently inactive can be persuaded to become active, and the increased proportion of active individuals does not generate any increase in costs

(in fact, it is difficult to change behaviour, and many of those who are persuaded to become active soon cease exercising. There are also some costs associated with equipment, facilities, programming, injuries and time-loss).

3. The group who can be persuaded to augment their physical activity are representative of the general population

(in fact, those who adhere to an activity programme tend to be younger, better educated, healthier, and non-smokers; they also have some genetic differences from those who remain inactive).

4. The reduction in health care costs occurs immediately there is an increase of physical activity

(in fact, benefit is rapid for metabolic disorders such as Type II diabetes mellitus, but for other conditions such as cancer and ischaemic heart disease, the risk of disease does not change for several years; allowance for such time lags can be made by use of discount rates, although the discount rate is in itself a matter of controversy).

5. Direct medical costs for a given year can be used to estimate potential savings associated with a reduced incidence of a disease

(in fact, relative risks commonly comprise both fatal and non-fatal events, although non-fatal events have the largest impact on costs. Diseases are also aggregated into broad categories, with considerable differences in both costs and the influence of physical activity between categories. Medical expenses are also concentrated disproportionately upon a few individuals, particularly those in the final months of life. Finally, there is no guarantee that expenditures on hospitals and physicians will fall proportionately with a decrease in the prevalence of disease).

Table 13. An Application of the Outcomes model of the International Union for Health Promotion and Education (1999) to Physical Activity

Health & Social Outcomes	Social outcomes – enhanced QOL and functional well-being		
	Health outcomes – reduced morbidity and mortality due to CVD and diabetes		
Intermediate Health Outcomes (modifiable determinants of health)	Healthy Lifestyles PA participation Smoking	Effective health services Provision of PACE	Healthy environments Safe parks and recreation areas Access to such facilities in low-income areas
Health Promotion Outcomes (intervention impact measures)	Health literacy Knowledge of benefits of PA Positive attitudes to PA Efficacy for PA	Social action and influence Valuing PA	Healthy public policy and organisational practice Provincial active living strategies The Business Case for Active Living Adoption of QDPE
Health Promotion Actions	Education Patient education Physical Education Mass-media campaigns (e.g., <i>Participation</i>)	Social mobilisation NA	Advocacy NA

NA = not available. PA = physical activity. PACE = patient-centered assessment and counseling for exercise and nutrition. QDPE = quality daily physical education.