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Genuine Progress Index for Atlantic Canada / Indice de progrès véritable - Atlantique

MEASURING SUSTAINABLE DEVELOPMENT

APPLICATION OF THE GENUINE PROGRESS INDEX TO BRITISH COLUMBIA

THE COST OF PHYSICAL INACTIVITY *in* BRITISH COLUMBIA

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EXECUTIVE SUMMARY

Physical activity provides proven health benefits. It protects against heart disease, stroke, hypertension, type 2 diabetes, colon cancer, breast cancer, osteoporosis, obesity, depression, anxiety, and stress. Evidence indicates that in British Columbia, 15% of heart disease, 19% of stroke, 10% of hypertension, 14% of colon cancer, 11% of breast cancer, 16% of Type 2 Diabetes, and 18% of osteoporosis cases are attributable to physical inactivity.

Regular physical activity also protects against obesity and assists weight control; fosters development of healthy muscles, bones and joints; increases strength and endurance; improves behavioural development in children and adolescents; and helps maintain function and preserve independence in older adults. Studies show that regular exercisers have much less *overall lifetime morbidity* than those who are sedentary, indicating that avoided medical costs due to physical activity are not simply deferred to older ages.

According to the Canadian Fitness and Lifestyle Research Institute, 47% of British Columbians and 61% of Canadians in 1999 were too inactive to reap the health benefits of regular physical activity. According to the Canadian Community Health Survey, 38% of British Columbians are physically inactive. While B.C. still has the highest rate of physical activity in Canada, this rate has declined 1.1% from 27.2% in 1994 to 26.9% in 1999). This is due to a decrease in physical activity of 6.6% among men, which more than offsets an increase of 5.8% among women. Another 22% of British Columbians are moderately active.

It is estimated that physical inactivity costs the British Columbian health care system $211 million a year in direct costs (hospital, physician, drug, institutional and other costs) equal to 1.8% of total government spending on these services. This spending is currently added to the provincial Gross Domestic Product and economic growth statistics, and is thus mistakenly taken as a sign of prosperity and progress. The Genuine Progress Index counts this spending due to physical inactivity as a cost – not a gain – to the economy.

Physical inactivity costs the British Columbian economy an additional $362 million each year in indirect productivity losses due to premature death and disability. Adding direct and indirect costs, the total economic burden of physical inactivity in British Columbia is estimated at $573 million annually.

Just over 1400 British Columbians die prematurely each year due to physical inactivity, accounting for 5.0% of all premature deaths. These premature deaths result in the loss of more than 4,380 potential years of life every year in the province before age 70. In other words, if all British Columbians were physically active, the province would gain 4,380 productive years of life each year, with corresponding gains to the economy. In Canada, with a physical inactivity rate of 61%, premature deaths due to physical inactivity account for 10.3 % of all premature deaths.

If just 10% fewer British Columbians were physically inactive – that is, if the rate of physical inactivity were 34.2% instead of 38% - the province could save an estimated $18.3 million every year in avoided hospital, drug, physician and other direct costs. Added to an estimated $31.1

million in productivity gains, total economic savings to British Columbia from a 10 % reduction in physical inactivity amount to $49.4 million.

Given the enormous health care burden of a sedentary lifestyle, health campaigns aimed at promoting regular physical activity, including provision of adequate access to quality sport and recreation programs and facilities for all British Columbians, have the potential to reduce the enormous human and economic burden of physical inactivity.

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"If you could bottle everything you get from physical activity and sell it at a pharmacy, it would go for a hefty price."

George Sheehan, M.D.[1]

"Physical activity is the crux of healthy aging. Nowhere is the gap wider between what we know and what we do than in the area of physical activity, and nowhere is the potential pay-off greater."

National Center for Chronic Disease Prevention and Health Promotion, USA[2]

Physical activity has been glowingly referred to as a "magic bullet" because of its proven benefits in preventing disease, improving health, and promoting independence and quality of life in old age.[3] The United Kingdom Minister for Public Health has called physical exercise the best buy in public health.[4] And the most substantial body of evidence for achieving healthy active aging relates to the beneficial effects of regular exercise.[5] Physical activity has been called "the most obvious of variables which might reduce overall lifetime morbidity" and the "cornerstone" of any strategy aimed at prolonging disability-free life expectancy.[6]

In 1992, the American Heart Association officially recognized physical inactivity as one of the four major modifiable risk factors for cardiovascular disease, along with smoking, high blood pressure, and elevated blood cholesterol.[7] However, 24% of Canadians smoke, 11% have high blood pressure, and 18% have high blood cholesterol, while 61% of Canadians are not active enough to reap health benefits.[8] An increase in physical activity, therefore, has the greatest potential to reduce the incidence of heart disease in Canada.

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[1] Canadian Fitness and Lifestyle Research Institute, *The Research File,* 2000, Reference No. 00-01.
[2] National Center for Chronic Disease Prevention and Health Promotion, "Healthy Aging: Preventing Disease and Improving Quality of Life Among Older Americans," Atlanta, July 2001, available at http://www.cdc.gov/nccdphp/aag-aging.htm.
[3] Canadian Fitness and Lifestyle Research Institute, *The Research File,* 2000, Reference No. 00-01.
[4] Cooper, Y. Royal College of Physicians, London, June, 2000, cited in Simey, Piers and Dawn Skelton, "Older people need to be encouraged to exercise," *British Medical Journal* 322 (7289), 31 March, 2001, page 796.
[5] Andrews, Gary, "Promoting Health and Function in an Ageing Population," *British Medical Journal* 322 (7288), 24 March, 2001, pages 728-729.
[6] Fries, James, "Physical Activity, the Compression of Morbidity, and the Health of the Elderly," *Journal of the Royal Society of Medicine* 89, 1996, pages 64 and 67.
[7] American Heart Association, "Statement on Exercise: Benefits and recommendations for physical activity programs for all Americans, a statement for health professionals by the Committee on Exercise and Cardiac Rehabilitation of the Council on Clinical Cardiology, American Heart Association, *Circulation* 86, 1992, pages 340-344.
[8] Statistics Canada and Health Canada, *Canadian Tobacco Use Monitoring Survey* 2000; Blood pressure from Statistics Canada, *Health Statistics 1999,* CD-Rom, Table 0060121.IVT; Cholesterol prevalence from Logan, Alexander, *Lowering the Blood Total Cholesterol Level to Prevent Coronary heart disease,* Canadian Task Force on Preventive Health Care, June, 1994, available at: http://www.ctfphc.org/Full_Text/Ch54full.htm; Inactivity prevalence from Canadian Fitness and Lifestyle Research Institute, *2000 Physical Activity Monitor,* available at: http://www.cflri.ca/cflri/pa/surveys/2000survey/2000survey.html.

A Harvard Medical School meta-analysis estimated that 22% of coronary heart disease in the U.S. could be attributed to physical inactivity.[9] This means that more than one-fifth of heart disease incidence could be avoided if everyone were physically active. Given that cardiovascular diseases cost the British Columbia economy $2.2 billion a year, promotion of physical activity could potentially save substantial sums of money.

A 1999 Statistics Canada analysis of results from the National Population Health Survey, controlling for age, education, income, smoking, blood pressure, weight, and other factors, found that sedentary Canadians have *five times* the risk of developing heart disease as those who exercise moderately in their free time. The same analysis found that those with a low level of regular physical activity had 3.7 times the odds of developing heart disease compared to those who exercised moderately.[10]

The Harvard meta-analysis also found that 22% of colon cancer and osteoporotic fractures, 12% of diabetes and hypertension, and about 5% of breast cancer are attributable to lack of physical activity.[11] Physical inactivity is also linked to obesity, which is itself a risk factor for a wide range of chronic diseases. One source estimated that 19% of premature deaths in Canada are attributable to physical inactivity,[12] while Katzmaryk et al. found that 10.3% of all premature deaths are due to physical inactivity[13]

Physical activity has an obvious impact on obesity, which in turn has its own risk factors. Increased risk of disease associated with obesity ranges from 45% for colon cancer to 350 % for hypertension.[14] In addition, physical activity may provide protection against anxiety and depression. Statistics Canada found that sedentary Canadians are 60% more likely to suffer from depression than those who are active, and concluded that "physical activity has protective effects on heart health and mental health that are independent of many other risk factors."[15] Regular physical activity has also been shown to foster development of healthy muscles, bones and joints; to improve strength, endurance, and weight control; to improve behavioural development in children and adolescents; and to help maintain function and preserve independence in older adults.[15]

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[9] Colditz, G.A. (1999), cited in Canadian Fitness and Lifestyle Research Institute (CFLRI), "Physical Activity Pays Big Dividends," in *The Research File,* reference no. 00-01. A "meta-analysis" examines results from a large number of epidemiological studies. Statistical techniques are then used to estimate relative risks for particular behaviour patterns and the proportion of disease burden attributable to these risk behaviours, taking into account the findings of all studies examined as well as the sample sizes and methodologies of each study.

[10] Chen, Jiajian, and Wayne J. Millar, "Health Effects of Physical Activity," Statistics Canada, *Health Reports* 11 (1), Summer, 1999, catalogue no. 82-003-XPB, pages 21-30, especially, page 24.

[11] Colditz (1999), in CFLRI, op. cit.

[12] Canadian Fitness and Lifestyle Research Institute, "The Burden of Inactivity," *The Research File,* reference no. 98-01.

[13] Katzmarzyk, Peter T., Norman Gledhill and Roy Shephard 2000. The Economic Burden of Physical Inactivity in Canada. Canadian Medical Association Journal 163: 1435-40

[14] Katzmarzyk, Peter T. and Ian Janssen 2003. The Economic Costs Associated with Physical Inactivity and Obesity in Ontario, 2001. Leisure Information Network, Ontario Ministry of Health.

[15] Chen and Millar, op. cit., pages 21-30; U.S. Department of Health and Human Services, *Physical Activity and Health: A Report of the Surgeon-General,* Atlanta, Georgia, 1996, pages 7-8; Prof. Robert Malina (University of Texas), "Physical Activity and Behavioural Development," in Norgan, op. cit., pages 101-120; Prof. Andrew Steptoe (St. George's Hospital Medical Centre, London, "Physical Activity and Psychological Well-being," in

In sum, a very wide range of chronic diseases could be avoided through increased levels of physical activity in the population. Since the need and demand for medical services and their associated costs are directly linked to the prevalence of illness in society, a reduction in chronic ailments through higher levels of physical activity has the potential to reduce health care costs. Studies have demonstrated that regular exercisers have much less *overall lifetime morbidity* than those who are sedentary, indicating that avoided medical costs due to physical activity can be saved absolutely rather than simply deferred to older ages.[16]

United States health authorities have identified increasing physical activity as a key factor in controlling health care costs in that country, through the prevention of unnecessary illness, disability and premature death, and the maintenance of an improved quality of life into old age.[17] And the U.S. Surgeon-General has issued a "national call to action" to put increased physical activity on the same level as the use of seat belts and the discouragement of tobacco use, because of the strong evidence that it will produce comparable "clear and substantial health gains."[18]

1.1 Biological Pathways

The beneficial effects of physical activity on health have been confirmed by clinical studies identifying the potential biological mechanisms whereby physical activity can influence health. For example, physical activity may help prevent cardiovascular disease by improving the balance between myocardial oxygen supply and demand. It may protect against cancer by increasing the proportion of free radical scavenging enzymes and circulating T and B lymphocytes, thus improving immune function, and by increasing gastrointestinal motility and decreasing the transit time of ingested food.[19]

Physical activity can protect against overweight and diabetes by reducing body fat, increasing the resting metabolic rate and the rate of glucose disposal, and improving cell insulin sensitivity. Regular exercise in childhood can protect against osteoporosis in old age by promoting the development of bone mass, and at older ages it can help maintain bone mineral density. Physical activity can also safeguard mental health through reducing muscle tension (and thereby stress and anxiety) and through biochemical brain alterations and release of endorphins, thereby protecting against depression.[20]

Norgan, op. cit., pages 207-229; William P. Morgan (ed.), *Physical Activity and Mental Health,* Taylor and Francis, Washington D.C., 1997.

[16] Fries, James, C. Everett Koop, Jacque Sokolov, Carson Beadle, and Daniel Wright, "Beyond Health Promotion: Reducing the Need and Demand for Medical Care," *Health Affairs* 17 (2), page 71; Fries, James, "Physical Activity, the Compression of Morbidity, and the Health of the Elderly," *Journal of the Royal Society of Medicine,* 89, 1996, page 67.

[17] David Satcher, M.D., Ph.D, Director, U.S. Centers for Disease Control and Prevention, and Philip R. Lee, M.D., Assistant Secretary for Health, in Forward to *Physical Activity and Health: A Report of the U.S. Surgeon-General*, op. cit.

[18] Audrey F. Manley, M.D., Preface to *Physical Activity and Health: A Report of the U.S. Surgeon-General*, op. cit.

[19] This summary is from Slattery, Martha, "How Much Physical Activity Do We Need to Maintain Health and Prevent Disease? Different Diseases – Different Mechanisms," in *Research Quarterly for Exercise and Sport* 67 (2), 1996, page 210.

[20] Idem.

2. Physical Activity Trends in British Columbia

2.1 Definitions

There are a number of definitions of physical activity and inactivity that produce varying results when assessing trends in physical activity. Because of the wide range of definitions of physical activity and inactivity, the different types of surveys, the different age groups to which these surveys apply, and the lack of standardization that currently exists, the following analysis provides alternative measures of physical activity.

- Statistics Canada's National Population Health Surveys (NPHS) 1994/95 and 1996/97, and the 2000/01 Canadian Community Health Survey (CCHS) consider Canadians physically inactive or "sedentary" if they report a usual daily leisure-time energy expenditure of less than 1.5 kilocalories per kilogram of body weight per day (kcal/kg/day). Individuals are defined as moderately active if they expend 1.5-2.9 kcal/kg/day, and as "active" if they expend 3.0 or more kcal/kg/day. Calculations are made based on individuals' reporting of the frequency and duration of different types of physical activity, using independently established values for the energy demands of each activity. In this analysis, "regular" physical activity (at the levels indicated) is defined as at least 15 minutes of leisure time physical activity 12 or more times per month. The NPHS and CCHS results apply to Canadians 12 and older.[21]

- Other surveys have assessed physical activity levels according to whether respondents reported exercising three or more times weekly, once or twice weekly, less than once weekly, or never.[22]

- Health Canada's 1998 publication, *Canada's Physical Activity Guide to Healthy Active Living*, calls for an hour of low-intensity activity every day, or 30-60 minutes of moderate-intensity activity, or 20-30 minutes of vigorous-intensity activity 4-7 days a week.[23] Only 34% of Canadians aged 25-55 currently meet these recommendations.[24]

- The Canadian Fitness and Lifestyle Research Institute's "physical activity profiles" rate Canadians according to whether their physical activity levels are sufficient for "optimal health benefits." Physical inactivity, according to this measure, is defined as less than 12.6 kilojoules (kJ)/kg of body weight per day of physical activity, the minimum judged necessary

[21] Health Canada, *Statistical Report on the Health of Canadians,* 1999, Ottawa, page 189; Heart and Stroke Foundation of Canada, *The Changing Face of Heart Disease and Stroke in Canada 2000,* Ottawa, 1999, page 107; Chen, Jiajian, and Wayne J. Millar, "Health Effects of Physical Activity," Statistics Canada, *Health Reports* 11 (1), Summer, 1999, catalogue no. 82-003-XPB, pages 21-30, definitions on page 23.
[22] Statistics Canada, *CANSIM database,* Matrix #M1011.
[23] Health Canada, *Canada's Physical Activity Guide to Healthy Active Living,* Ottawa, 1998.
[24] Canadian Fitness and Lifestyle Research Institute, *Meeting Guidelines. Progress in Prevention Bulletin 31*, Ottawa, 1998, available at: http://www.cflri.ca/cflri/resources/pub_pip.php.

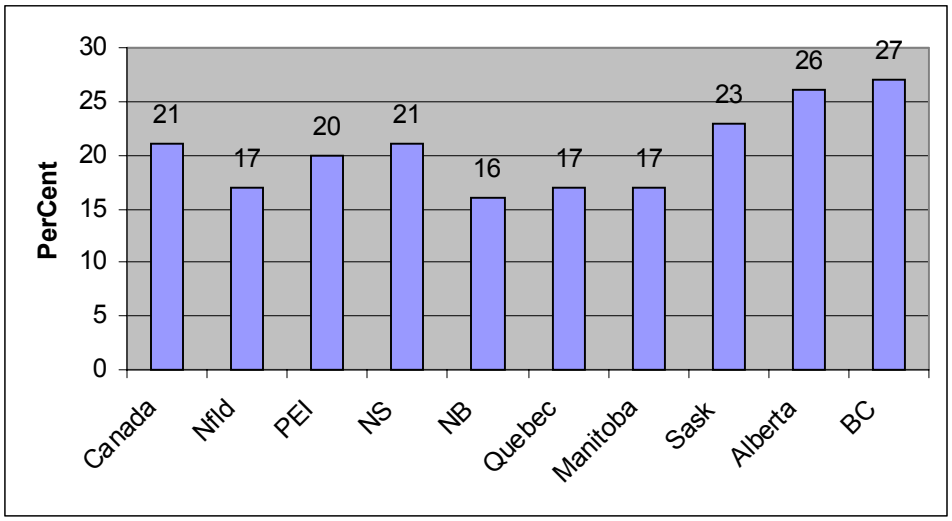
to obtain health benefits from physical activity.[25] The CFLRI results apply to Canadians 18 and older. The most recent 2000 Physical Activity Monitor Survey ranked 61% of Canadians and 47% of British Columbians as not active enough to reap the health benefits of a physically active lifestyle.[26]

- Because there are so many definitions of physical activity and inactivity, an "international consensus group" was formed in 1998 to develop an internationally agreed upon set of measures of physical activity participation. The group has now developed and pilot-tested a set of International Physical Activity Questionnaires (IPAQ), with Canada one of 12 countries participating in the validation and reliability phase of the project.[27]

2.2 Canadian Community Health Survey

According to Statistics Canada's 2000-2001Canadian Community Health Survey, only 27% of British Columbians and 21% of Canadians can be classified as physically active, expending 3.0 or more kilocalories of energy per kilogram of body weight per day. Another 22% of British Columbians are moderately active (1.5-2.9 kcal/kg/day), and 38% are inactive (less than 1.5). British Columbia has the most physically active people of any province. Figure 2 demonstrates an east-west gradient, with eastern Canadians generally more inactive than westerners.[28]

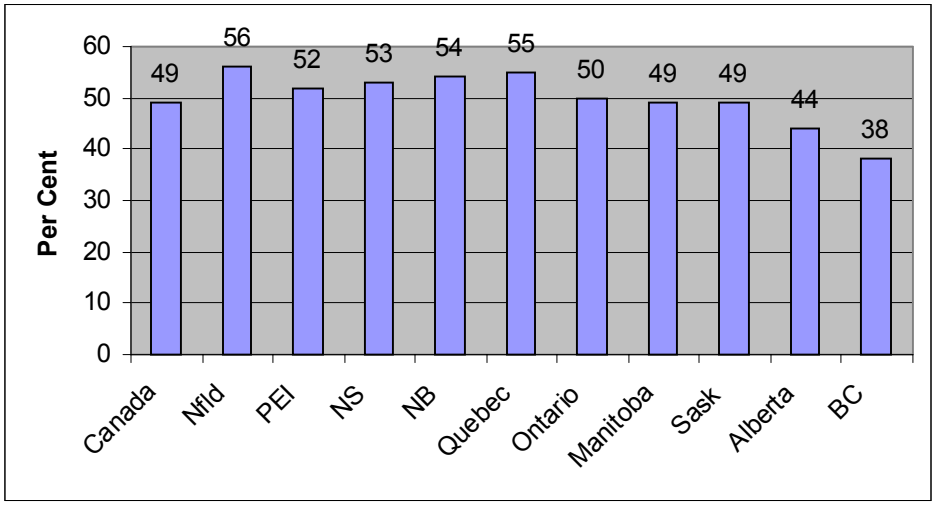
Figure 1. Physically Active Canadians (3.0 kcal/kg/day), Canada and Provinces, age 12+, 2000-2001 (Percent)



Source: Statistics Canada, *Health Indicators,* May 2002.

[25] Katzmarzyk, Peter, Norman Gledhill, and Roy Shephard, "The Economic Burden of Physical Inactivity in Canada," *Canadian Medical Association Journal* 163 (11), November 28, 2000, page 1437.
[26] Canadian Fitness and Lifestyle Research Institute, *2000 Physical Activity Monitor,* available at: http://www.cflri.ca/cflri/pa/surveys/2000survey/2000survey.html.
[27] Canadian Fitness and Lifestyle Research Institute, *International Consensus Project on Physical Activity Measurement,* Ottawa, available at: http://www.cflri.ca/cflri/research/ipaq.html.
[28] Statistics Canada, *Health Indicators,* May 2002, catalogue no. 82-221-XIE

Figure 2. Inactive Canadians (less than 1.5 kcal/kg/day), Canada and Provinces, age 12+, 2000-2001 (percent) [29]



Source: Statistics Canada, *Health Indicators,* May 2002.

2.3 Regular Exercise 1994-2001

Statistics Canada's *CANSIM* database provides information on trends over time for the number of Canadians who exercise regularly. The data indicate an increase in physical activity among Canadians as a whole (ages 12-65) , while the proportion of the population exercising regularly in British Columbia has remained stagnant, although still the highest rate in the country (Figure 3).[30]

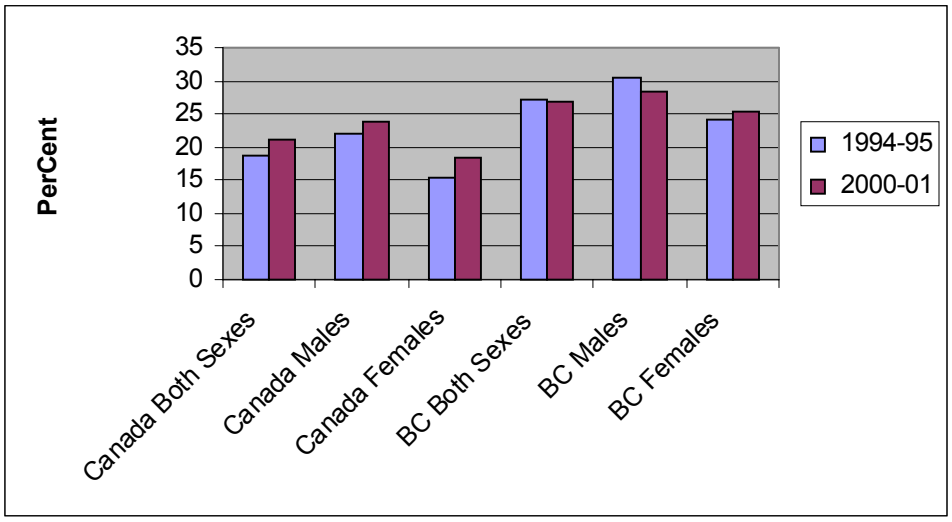
Interestingly, the averages conceal some important gender differences. Women have generally *increased* their rates of leisure time physical activity quite dramatically since 1994, by 19.5% in Canada and 5.8% in British Columbia. Overall this is a good prognosis for women's health and should help decrease the rate of cardiovascular disease and other chronic ailments among women.

By contrast, while more Canadian men than ever are exercising in other parts of the country, the physical activity rate for males in British Columbia has decreased by 6.6%. The increase in exercise by women has not quite compensated for the decrease by men, leaving British Columbia with an overall decrease in physical activity of 1.1%.

[29] Caution must be exercised in comparing CCHS and NPHS results, even though they use the same definition of physical inactivity. The most recent CCHS results, as reported in Statistics Canada's May 2002 *Health Indicators,* include a 13% "physical activity not stated" category for B.C. that is not included in the 1996/97 NPHS results recorded in the *Statistical Report on the Health of Canadians.*

[30] Statistics Canada, *CANSIM Database* Matrix #M1011, Tables H501100 - H501212.

Figure 3. Persons Who Exercise, 1994-2001(%)



Source: Statistics Canada, *CANSIM Database.*

2.4 CFLRI: Physical Activity Monitor 2000

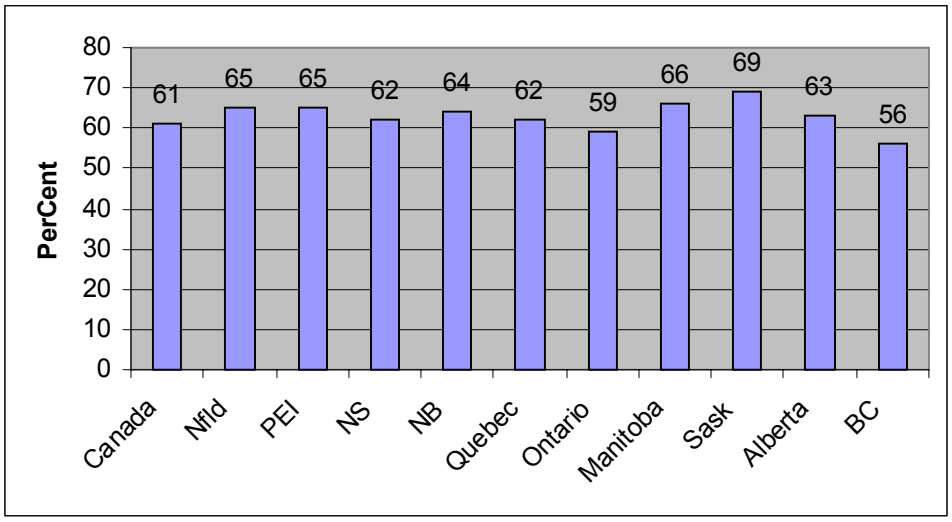
Since 1998, the Canadian Fitness and Lifestyle Research Institute (CFLRI) has produced provincial survey data on rates of physical activity and inactivity in Canada. Unlike the Statistics Canada data on regular exercise above, the CFLRI data show rates of inactivity in British Columbia declining from 51% in 1994 to 47% in 1999.

In Canada as a whole longer trend lines are possible, because nationwide data sets are available at irregular intervals since the first Canada Fitness Survey in 1981. They show considerable progress being made over 15 years, with physical inactivity rates falling from 79% in 1981 to 63% in 1995, and physical activity rates rising by an average of one percentage point each year, as awareness of the health benefits of physical activity spread. Since 1995, however, this progress has stalled, with little improvement since that time.[31]

Figure 4 below gives rates of physical inactivity in Canada from the CFLRI Physical Activity Monitor for 2000. A noted, these results are not comparable to those provided by the 2000/01 Canadian Community Health Survey (CCHS) in Figure 2 above. A similar gap between CFLRI and National Population Health Survey (NPHS) results is evident for earlier years. The 1996-97 CFLRI Physical Activity Monitor found that 66% of Canadians were not sufficiently active to reap the benefits of physical activity, while the NPHS data for those same years reported a physical inactivity rate of 57% for Canadians. The difference is due to the fact that CFLRI evaluation criteria are markedly different from those in the NPHS and CCHS, as noted in the discussion on definitions in section 2.1.

[31] Canadian Fitness and Lifestyle Research Centre, Physical Activity Monitors and Surveys, 1981-2000, available at: http://www.cflri.ca/cflri/pa/surveys/.

Figure 4. Percentage of Canadians Insufficiently Active for Optimal Health Benefits, 2000



Source: Canadian Fitness and Lifestyle Research Institute, *2000 Physical Activity Monitor.*

3. The Economic Cost of Physical Inactivity

Several studies have now been published on the economic cost of physical inactivity in Canada. The first, a study at the national level by Katzmarzyk et al. In November, 2000[32], provided methodology that allowed further studies. A second study by GPI Atlantic (2001) examined the same costs for Nova Scotia[33]. In February 2003, Katzmarzyk and Janssen [34]published a study for Ontario, and a similar study is underway in Alberta. This study of costs of physical inactivity in British Columbia follows the methodology provided by Katzmarzyk et al.[31] and Colman[32] , as updated by Katzmarzyk and Janssen[33]. While changes in methodology and updated statistics mean that the numbers are not always exactly comparable, these studies do allow a ballpark comparison of the costs of physical inactivity in various provinces and Canada. For convenience, these studies will be referred to in the text as Katzmarzyk CA, GPI NS, and Katzmarzyk ON, respectively.

3.1 Methodology

The following methodology estimates the economic costs of physical inactivity based on relative risk ratios for particular illnesses in the literature. The physical inactivity rates used in the calculations are from Statistics Canada's Canadian Community Health Survey and have a 95%

[32] Katzmarzyk, Peter, Norman Gledhill, and Roy Shephard, "The Economic Burden of Physical Inactivity in Canada," *Canadian Medical Association Journal,* 163 (11), November 28, 2000.
[33] Colman, Ron, GPI Atlantic 2002. The Cost of Physical Inactivity in Nova Scotia, prepared for Recreation Nova Scotia and Sport Nova Scotia. Available at www.gpiatlantic.org.
[34] Katzmarzyk, Peter and Ian Janssen 2003. The Economic Costs Associated with Physical Inactivity and Obesity in Ontario, 2001. Leisure Information Network, Ontario Department of Health.

confidence interval. Statistics Canada marks some of its data with an (E) to denote data with a coefficient of variation (CV) from 16.6% to 33.3%, which should be interpreted with caution. However, no such data have been used in this report, and there is therefore no reason to interpret any of the physical inactivity results in this report with caution. Cost-of-illness data are from Health Canada's Economic Burden of Illness in Canada.

To estimate the economic costs of physical inactivity (or of any other risk factor) in British Columbia, the following steps are necessary:

1) The epidemiological evidence is examined to ascertain the relationship between physical inactivity and various diseases. This is expressed as the "relative risk" (RR) of developing a particular disease for a physically inactive person compared to an active person.[35] The relative risk is determined by dividing the rate of the disease among sedentary people by the rate of disease among active people. For example, if sedentary people are twice as likely to develop heart disease, then the relative risk (RR) is 2.

   In this case, the relative risks for seven chronic diseases, and the methodology for assessing the economic cost of physical inactivity, are taken from an analysis in Katzmarzyk CA, as updated in Katzmarzyk ON. GPI Atlantic used the same method in early 2000, also based on a CMAJ analysis, to assess the cost of obesity in Nova Scotia.[36] To the best of our knowledge the Katzmarzyk CA article is the first Canadian study to use previously published meta-analyses and large prospective epidemiological studies to estimate the relative risks attributable to physical inactivity for various chronic diseases. This now makes it possible, for the first time, to assess the economic cost of physical inactivity in British Columbia.

2) The second step is to ascertain the prevalence of a risk factor within a given population. Although Katzmarzyk CA and GPI NS used the Canadian Fitness and Lifestyle Research Institute's Physical Activity Monitoring Survey results (2.4 above), Katzmarzyk ON used the 2000/2001 Canadian Community Health Survey[37], and this analysis does the same in order to obtain comparable results and maintain the same methodology. The CCHS provides rates of physical inactivity for the 16 health service delivery areas that are organized into five health authorities. To obtain a physical inactivity rate per health authority (referred to as health authorities), the rates from the health service delivery areas within each authority were used along with population figures to determine the total number of physically inactive people in a given authority. Then a percentage of physically inactive people in each authority was determined

3) To assess the public health burden of sedentary living, or of any other risk factor, the relative risk (step 1) is combined with the absolute frequency of physical inactivity (or other risk factor) in the population. The resulting population attributable risk (PAR) of a disease is an

[35] Methodological explanation from Canadian Fitness and Lifestyle Research Institute (CFLRI) "The Burden of Inactivity," *The Research File ,* reference no. 98-01; "Health Care Savings," *The Research File,* reference no. 97-02; "An Economic Case for Physical Activity," *The Research File,* reference no. 95-03.
[36] Colman, Ronald, *The Cost of Obesity in Nova Scotia,* Halifax, March, 2000. That study used the methodology of C. Laird Birmingham et al., in the *Canadian Medical Association Journal* 160 (4), 23 February, 1999.
[37] Statistics Canada. Health Indicators, May 2002. Catalogue No. 82-221-XIE., 2002.

estimate of the effects of an individual risk factor on a given disease, and the extent to which each disease is attributable to the risk factor. The population attributable risk (PAR) of a disease is, therefore, the proportion of each chronic disease that could theoretically be prevented by eliminating physical inactivity.[38]

The population attributable risk (PAR) for each disease is calculated as $[P(RR - 1)] / [1 + P(RR - 1)]$, where P is the prevalence of physical inactivity in the population (in this case 38%), and RR is the relative risk for the disease in an inactive person. The results from steps 1-3 are presented in Table 1 for B.C. as a whole and in Table 2 for each Health Authority.

4) The fourth step is to multiply the population attributable risk (PAR) for each disease by the total cost of treating that particular disease, using Health Canada's *Economic Burden of Illness in Canada* (EBIC),[39] which describes illness costs by diagnostic category. In other words, we estimate the direct health care costs of treating the particular diseases that are linked to physical inactivity by using the population attributable risk (PAR) of each disease to estimate the portion of those costs that are attributable to physical inactivity. To determine costs for health regions, the total cost of each disease in British Columbia is multiplied by the percentage of the BC population contained within that region and then by the PAR of that health region (health authority).

   This analysis is based on the basic methodology of Katzmarzyk CA and ON in assigning costs to particular diseases, but the costs are updated and adjusted for data specific to British Columbia, whenever possible. Katzmarzyk ON determined Ontario costs from EBIC 98 by multiplying the Canadian costs by the overall proportion of the Canadian direct and indirect costs incurred in Ontario. For greater accuracy and more relevance to British Columbia health care costs, this analysis uses costs specific to disease categories in British Columbia from the 1998 EBIC and 98 EBIC online. Also, the provincial incidence of particular diseases is used wherever such data are available.

   EBIC 98 provides total Canadian costs for direct and indirect health expenditures by category of spending. Direct categories include hospital, drug, physician, other institutions, and additional direct expenditures. Other institutions include residential care facilities for the chronically ill and disabled who reside there more or less permanently. Additional direct costs includes other health professionals, public health and health research, and capital expenditures. Katzmarzyk CA provided a separate category for research, but did not include costs for other institutions or additional direct costs. GPI NS included other institutions and additional direct costs in a category called other but also broke out costs for research. While the B.C. study follows GPI Atlantic in including the other category, it does not break out research costs, since these are included in additional direct costs in EBIC 98. Although

[38] Methodological explanation from CFLRI, "The Burden of Inactivity" and "The Economic Case for Physical Activity," op. cit.; and Katzmarzyk et al., op. cit., page 1437.

[39] Health Canada 1993. The Economic Burden of Illness in Canada available at: http://hc-sc.gc.ca/pphb-dgspsp/publicat/ebic-femc93.
Health Canada 1998. The Economic Burden of Illness in Canada (and on-line data) available at: http://www.ebic-femc.hc-sc.gc.ca.

Katzmarzyk ON does not break out direct and indirect costs among these categories, the current study does so since this gives a more detailed picture of health expenditures attributable to physical inactivity.

EBIC 98 provides the health expenditures in each of the above categories broken down by 18 diagnostic categories. The categories of concern for physical inactivity are cardiovascular diseases; cancer, endocrine and related diseases (including diabetes) and musculoskeletal diseases (including osteoporosis). Provincial totals are available from EBIC online for these categories, but the costs for specific disease categories within the classifications had to be derived through use of incidence rates, at the provincial level where possible, but if not then at the national level. For example, the total cancer costs for B.C. are multiplied by the percent of cancer cases in B.C. that are breast cancer to arrive at total B.C. costs for breast cancer.

In EBIC 98, for the *other* category (*other institutions* and *additional direct costs)* the costs are not broken into disease category at the provincial level. To estimate these costs by disease category for British Columbia, therefore, we calculated the national ratio of *other* costs to the sum of costs for *remaining direct costs* (hospital, doctor, and drug). For British Columbia, *other* costs amount to 72.6% of remaining direct costs (hospital/doctor/drug). Then for each disease category, we multiplied the sum of *remaining direct* costs by this percentage to determine the costs for this disease in the *other* category. This method assumes that the overall B.C. ratio is the same for each diagnostic category. While this method is not ideal, it is considered preferable to the option of omitting other direct costs, which would significantly underestimate costs.

Cost Calculations for Specific Diseases

Cardiovascular

The cardiovascular diseases associated with physical inactivity are coronary heart disease, stroke, and hypertension. The 1998 EBIC does not provide British Columbia data for these illnesses separate from the broader category of cardiovascular diseases. Katzmarzyk CA used costs specific to coronary heart disease and stroke from the 1993 EBIC. Katzmarzyk ON, using 1998 EBIC costs, determined costs of coronary heart disease and stroke by multiplying total costs by the percent of total cardiovascular costs attributable to coronary heart disease (28.2% direct; 42.8% indirect) and stroke (19.6% direct; 9.9% indirect) reported in EBIC 93.

For B.C. direct costs attributable to coronary heart disease, stroke, and hypertension, the current study used the most specific data available . For coronary heart disease, the national percentages from EBIC 93 were used for physician costs (30.3%), but for hospital (30.6%) and drug costs (28.9%), the EBIC 98 national percentage was used. For stroke, the 98 proportion was used for hospital costs (17.2%) and the EBIC 93 proportion was used for drug (7.1%) and doctor (8.6%) costs. Hypertension costs are assessed relative to total cardiovascular disease costs according to national proportions of hypertension costs to total cardiovascular costs in Katzmarzyk CA. These percentages were 5.7% for hospital costs, 50.6% for drugs, and 28.7% for physicians.

Colon cancer and breast cancer

Colon cancer and breast cancer costs are estimated in this report by using the incidence of these two cancers relative to all cancers in British Columbia, using the National Cancer Institute of Canada's *Canadian Cancer Statistics 2002*[40]. Colorectal cancers account for 12.5% of all cancers in British Columbia. According to Katzmarzyk CA, colon cancers constitute 67.1% of total colorectal cancers, so that colon cancers would amount to about 8.36% of all cancer incidence in British Columbia . This is very close to the 8.6% estimate used by Katzmarzyk CA. Breast cancer accounts for 13.2% of all cancers in British Columbia.

Type 2 Diabetes

The EBIC diabetes estimates are adjusted to account for the fact that type 2 diabetes constitutes 92.5% of diabetes cases. Again, the British Columbia specific cost estimates from the 1998 EBIC include diabetes in the endocrine and related disorders diagnostic category. In the 1993 EBIC, diabetes in Canada constituted 52.1% of all hospital costs, 32.2% of all drug costs, and 47.3% of all physician costs for direct endocrine and related disorder health care costs. Thus type 2 diabetes costs (92.5% of all diabetes) are estimated at 48.2% of hospital costs; 43.7% of physician costs; and 29.8% of drug costs for endocrine related diseases.

Osteoporosis

Estimating the costs of osteoporosis presents the biggest challenge of all the disease cost estimates. In British Columbia, 25% of women over age 50 and 50% of those over age 70 will develop osteoporosis. Twenty percent of those who survive an osteoporotic hip fracture require long-term care in a nursing home, and more than 50% of them will be disabled, thus producing very high indirect costs due to disability. [41]The most costly consequence of osteoporosis is hip fracture, which almost always requires hospitalization, is fatal 20% of the time, and disables 50% of patients, 70% of them permanently.[42] Acute and long-term care costs attributable to osteoporosis and consequent fractures (admission to hospital, outpatient care, drug therapy, long-term and chronic care hospitals) were estimated at $1.3 billion annually for Canada in 1993.[43] In the United States, direct expenditures on osteoporosis are estimated at $47 billion annually (National Osteoporosis Foundation, 2004).

The ICD-9 codes used to attribute costs in EBIC only list the "principal diagnosis", so a fall would likely be listed as an injury in EBIC, rather than under "osteoporosis". Similarly, in estimating indirect costs, death and disability resulting from hip injury (and its consequent productivity losses / indirect cost estimates) would not likely be listed under osteoporosis costs in EBIC even though the hip injury may be a direct result of osteoporosis. It should be noted that unintentional falls account for more than half of all hospital injury admissions in Canada, 67% of all hospital days due to injury, and 75% of all in-hospital injury deaths.

[40] National Cancer Institute of Canada 2002. Canadian Cancer Statistics 2002.. Available at http://www.cancer.ca.
[41] Heart Health Coalition of British Columbia 2002. B.C.- Setting the Pace- A plan to improve the health of British Columbians through physical activity. Available at www.heart-health.org/resources, accessed November, 2004.
[42] World Health Organization 2003. The Burden of Musculoskeletal Conditions at the Start of the New millennium. WHO Technical Report Series Number 919.
[43] Goeree R..B. O'Brien, D.B. Pettit, L. Cuddy, M. Feraz and J. Aldichi 1996. An Assessment of the Burden of Illness due to Osteoporosis in Canada. J. Soc. Obstet. Gynaecol. Can. 18 (Suppl July) 15-24.

Seniors 65 and older account for 48% of all fractures and dislocations of the lower limbs and 27% of all fractures and dislocations of the upper limbs.[44]

Katzmarzyk ON used an independent assessment by Goeree et al. of the direct burden of illness due to osteoporosis in Canada, pegged at $744.4 million (which included acute care costs and chronic care hospitalizations) in 1993. Katzmarzyk then divided this figure by the total cost of musculoskeletal diseases in 1993 to arrive at a percentage of musculoskeletal costs attributable to osteoporosis (30.3%).[45] The Goeree study included a survey of fractures (vertebral, wrist and hip) due to osteoporosis as well as actual treatment for the disease. The inclusion of osteoporotic fractures means that the Goeree estimates for costs of osteoporosis are much higher than the estimates provided in EBIC 98, which lists the costs of osteoporosis as 0.8% of the hospital costs and 9.8% of the drug costs for all musculoskeletal diseases. As noted, the EBIC estimates, like the estimate of direct osteoporosis costs as 2% of total musculoskeletal disease costs in Australia[46], count only direct treatment costs for osteoporosis and exclude most osteoporotic fractures. In order to account for the latter, we have based the costs of osteoporosis in this study on the estimate of 30.3% of musculoskeletal disease costs from Katzmarzyk ON, which in turn is based on Goeree's independent analysis for Canada. While the costs of osteoporosis require much more study, this method will allow a reasonable assessment of osteoporosis-related costs in British Columbia.

5) While GPI NS calculated costs for indirect losses due to premature mortality and disability for each disease category, Katzmarzyk ON simply used the total of indirect costs. Here we have chosen to separate out the indirect costs for premature death and disability, which allows for more in-depth analysis, and, in some cases is quite illuminating. Indirect productivity losses due to premature mortality and disability for each of these diseases are estimated as follows. EBIC 98 provides premature death, long-term and short-term disability costs for cardiovascular diseases, cancer, endocrine-related diseases and musculoskeletal diseases.

   The proportion of premature death costs for cardiovascular disease attributable to coronary heart disease and stroke were determined by using the national ratio of coronary heart disease and stroke to total cardiovascular costs for premature death: 58.7% for coronary heart disease and 15.2% for stroke. For hypertension costs, this ratio was taken from Katz CA (9.2%). For diabetes costs, the same type of ratio was used from EBIC 98: diabetes accounts for 72.4% of costs of endocrine and related diseases in Canada and Diabetes Type 2 costs are then 92.5% of this, or 67%, based on incidence. According to EBIC 98, colorectal cancer accounts for 9.1% of all mortality costs for cancer. Since colon cancer constitutes 67.1% of colorectal

[44] Heaney, Robert, "Hip Fracture: A Nutritional Perspective," *Proceedings of the Society for Experimental and Biological Medicine*, 200: 153-156, 1992, cited in Province of British Columbia (1996), *Cost Effectiveness/Value of Nutrition Services: An Annotated Bibliography*, prepared by the Nutrition Section, Prevention and Health Promotion, Ministry of Health, Province of British Columbia, July, 1996, page 37

[45] Goeree et al. 1996. Ibid.

[46] Mathers, C. and R. Penm 1999. Health System Costs of Injury, Poisoning and Musculoskeletal Disorders in Australia 1993-94. Health and Welfare Expenditure Series No. 6. Available at www.aihw.gov.au/publications , accessed November 2004.

cancer incidence, the costs of premature deaths from colon cancer would be 6.1% (67.1% x 9.1%) of all premature death costs for cancer. Breast cancer accounts for 10% of the premature death costs for cancer (EBIC 98) costs. For osteoporosis, as in Table 3, total provincial total costs for musculoskeletal diseases were multiplied by 30.3%.

The proportion of short-term and long-term disability costs attributable to coronary heart disease, stroke and hypertension was determined as follows. For coronary heart disease, the percentage from EBIC 98 was used (18.0%). For hypertension, the ratio of coronary heart disease or hypertension costs to total cardiovascular costs in Katzmarzyk CA (9.2%) was used. For stroke the percentage in EBIC 98 was used (13.2%). For diabetes, EBIC 98 attributes 64.9% of disability costs to diabetes, and Diabetes Type 2 costs are estimated at 60%. For hypertension, the Katzmarzyk CA percentage was used (9.2%). Colon cancer and breast cancer costs are estimated in the same way as for premature death, based on incidence rates. Disability costs from osteoporosis are estimated at 30.3%, as described above.

6) An important category of illness related to physical inactivity has been omitted in the Katzmarzyk et al. cost estimates – namely mental illness. As noted above, Statistics Canada has estimated that sedentary Canadians are 60% more likely to suffer from depression than physically active Canadians. Physical activity also protects against stress, which has been assessed in meta-analyses of medical costs as the most expensive risk factor, accounting for about 8% of health care costs.[47] For this reason, a rough estimate is added in this study, based on the 1998 EBIC figures for British Columbia, of the possible costs of mental illness attributable to physical inactivity in the province. Although it is not possible at this stage to derive an accurate population attributable risk (PAR) for mental illness in relation to physical inactivity, it is considered more accurate to attempt an estimate for this category than to assign it an arbitrary value of zero. The estimates for mental illness are provided in Appendix 1 and are not included in the costs of physical inactivity in the body of the paper.

   Other cost estimates omitted by Katzmarzyk CA and Katzmarzyk ON relate to association of physical activity with dyslipidemia, poorer quality of life, and premature admission to an institution or geriatric care. No attempt has been made here to provide cost estimates for these conditions or situations. Some costs of physical inactivity related to obesity are also omitted. Since obesity is linked to diseases such as gallbladder disease and pulmonary embolism in addition to those described here, physical inactivity may indirectly contribute to ailments that are not included in the costs estimates in Table 3.

7) The number of deaths attributable to physical inactivity in British Columbia is estimated by multiplying the number of deaths attributable to each inactivity-related disease by the population attributable risk(PAR) for that disease. Total deaths in 2001for cardiovascular disease, endocrine and related diseases and cancer were obtained from the B.C. Vital Statistics Report.

[47] Aldana, Steven, "Financial Impact of Health Promotion Programs: A Comprehensive Review of the Literature," in Goetzel, Ron, (ed.) "The Financial Impact of Health Promotion," *American Journal of Health Promotion* 15 (5), May/June, 2001.

8) Finally, the savings that could potentially be realized from a 10% reduction in physical inactivity are derived. Katzmarzyk CA estimated the savings that could be realized by a 10% reduction in physical inactivity in Canadians by recalculating the population attributable risks (PAR) of each disease and corresponding costs using a 56% prevalence of inactivity instead of a 62% prevalence. Katzmarzyk and his colleagues then estimated savings according to the difference between the two sets of costs. The 56% prevalence is 62% minus 6.2% representing a 10% reduction in physical inactivity). As the current British Columbia inactivity rate is 38%, a 10% reduction would lead to an inactivity rate of 34.2%. Therefore the PAR for British Columbia are recalculated based on inactivity rate of 34.2%.

3.2 Direct Costs of Physical Inactivity, British Columbia

Table 1 gives the relative risk (RR) estimates for each of seven chronic diseases that have been associated with physical inactivity, based on epidemiological studies reviewed by Katzmarzyk ON and the population attributable risks for each disease based on British Columbia's physical inactivity prevalence rate of 38%. Table 1 corresponds with Table 3 in Katzmarzyk ON. These values are slightly different from those used in Katzmarzyk CA and GPI NS. The major changes in these new relative risk calculations are for heart disease (1.45 compared to 1.9 in Katzmarzyk CA) and for stroke 1.6, compared to 1.4.

A relative risk of 1.45 for coronary heart disease (or coronary artery disease as it is also called) means that physically inactive people have a 45% greater chance of having that disease than those who are physically active. As noted above, this is a conservative estimate by comparison with the Statistics Canada analysis of National Population Health Survey results reported above. The bracketed numbers following the relative risk ratios represent the possible range of results based on a 95% confidence interval (CI).

A population attributable risk (PAR) of 14.6% for heart disease means that more than 14% of heart disease in B.C. could be avoided if all British Columbians were physically active. Table 1 also indicates that about 19% of stroke, 10% of hypertension, 14% of colon cancer, and 16% of type 2 diabetes, as well as 18% of osteoporosis and 11% of breast cancer, could be eliminated if British Columbians who are presently sedentary became physically active.

The B.C. and Ontario studies are the most closely comparable as they use the same relative risk per disease as well as the same method of determining physical inactivity. The B.C. physical inactivity rate in the CFLRI is 47%, whereas in the CCHS it is 38%. In order to keep the figures comparable we have chosen to use the CCHS. Also, as Katzmarzyk ON points out, CCHS is a much larger survey and may produce more robust results at the provincial level. Nevertheless it is well to note that this is the more conservative value for physical inactivity.

The PARs for B.C. are about 25% less than those for Ontario in each disease category. This makes sense, given that the physical inactivity rate for B.C. is about 29% less than that for Ontario. With the new relative risk factors used, stroke appears to account for more of disease due to physical inactivity than does heart disease in both Ontario and BC, which is a change from

the Canadian and Nova Scotia figures, in which heart disease accounts for 1.8 times as much disease due to physical inactivity as does stroke.

Table 2 shows the PARs for each disease by health authority. Since the physical inactivity rates for each authority are fairly close (range of 34.3% to 39.6%), the PARs are also fairly close. The lowest rate of physical inactivity is the Vancouver Coastal Authority (34.3%) and the highest is the Fraser Authority (39.6%).

Table 3 presents estimated direct health care costs attributable to physical inactivity in British Columbia. About $211 million is spent annually in direct health care costs due to physical inactivity. Theoretically, this is the annual amount that could be saved if all British Columbians were physically active. Physical inactivity accounts for 15% of the total costs of treating heart disease, stroke, hypertension, colon cancer, breast cancer, diabetes 2, and osteoporosis in British Columbia.

The $211 million cost estimate includes private spending on medical care, which includes spending on institutions other than hospitals, and on home care. Looking only at hospital, physician and drug costs, total spending attributable to the seven chronic illnesses in Table 3 is $834 million.[48] Applying the population attributable risks from Table 1 for these seven illnesses, physical inactivity would account for $122 million in hospital, physician and drug costs, or 15% of the total direct costs. B.C. spends a total of $6.9 billion ($6.7 in 1998 $) for drug, doctor, and hospital expenses (EBIC 98). The amount of this total due to physical inactivity is 1.8 % of total spending on hospitals, physicians, and drugs in B.C. in 1998.

Table 1. Relative Risk and Population Attributable Risk (PAR) due to Physical Inactivity for Major Chronic diseases, British Columbia, 2001.

Disease	RR (and 95% CI)	PAR (%)
Coronary heart disease	1.45 (1.38 - 1.54)	14.6
Stroke	1.60 (1.42 - 1.80)	18.6
Hypertension	1.30 (1.16 - 1.46)	10.2
Colon Cancer	1.41 (1.31 - 1.53)	13.5
Breast Cancer	1.31 (1.23 - 1.38)	10.5
Type 2 Diabetes	1.50 (1.37 - 1.63)	16.0
Osteoporosis	1.59 (1.40 - 1.80)	18.3

[48] Though not separately available, osteoporosis costs for hospitals, drugs, and physicians are attributed here in the same proportion as for all direct health care costs.

Table 2. Comparison of PAR (population attributable risks) for Health Authorities in British Columbia. (*Physical inactivity rates listed as PI for each authority*)

Disease	Interior 39.6% PI	Fraser 38.5% PI	Van. Coastal 34.3% PI	Van. Island 37.1% PI	Northern 36.5% PI
Coronary heart disease	15.1	14.8	13.4	14.3	14.1
Stroke	19.2	18.8	17.1	18.2	18.0
Hypertension	10.6	10.4	9.3	10.0	9.9
Colon Cancer	14.0	13.6	12.3	13.2	13.0
Breast Cancer	10.9	10.7	9.6	10.3	10.2
Type 2 Diabetes	16.5	16.1	14.6	15.6	15.4
Osteoporosis	18.9	18.5	16.8	18.0	17.7

PI is the percentage of the population surveyed that reported no physical activity. Based on physical inactivity rate for authorities provided by the Canadian Community Health Survey (CCHS 2001) and on Relative Risk Factors for each disease from Katzmarzyk and Janssen 2003.

Table 3. Health Care Costs for Chronic Diseases Linked to Physical Inactivity in British Columbia 1998 (2001$ millions*), and Estimated Direct Economic Cost of Physical Inactivity

Disease	Hospital	Doctor	Drugs	Other	Total Direct	Direct Cost Due to Inactivity
Heart Disease	172.31	43.73	58.26	199.14	473.45	69.12
Stroke	96.86	12.41	14.31	89.72	213.30	39.67
Hypertension	32.10	41.42	102.01	127.43	302.96	30.90
Colon cancer	20.79	4.89	2.00	20.09	47.77	6.45
Breast cancer	32.83	7.71	3.15	31.72	75.42	7.92
Type 2 diabetes	31.09	19.59	27.74	56.94	135.37	21.66
Osteoporosis	59.09	30.75	21.17	80.59	191.59	35.06
Total	**445.07**	**160.49**	**228.64**	**605.64**	**1439.85**	**210.79**

* 2001$ millions indicates that all amounts are converted into 2001 Canadian dollars, using the consumer price index to account for inflation and that each amount listed represents that amount times 1,000,000.

Paradoxically, these direct expenditures on hospitals, doctors, drugs and other medical services are conventionally counted in the Gross Domestic Product (GDP) and related economic growth statistics, and are therefore mistakenly taken as contributions to prosperity and wellbeing. In the Genuine Progress Index, by contrast, the $211 million in health care costs attributable to physical inactivity is counted as a cost, not a gain to the economy. If all British Columbians were physically active, the $211 million would presumably be available to be spent on more productive activities, including sport and recreation, that contribute to wellbeing.

Table 4 shows direct costs due to physical inactivity by health authority. Table 5 shows the same costs on a per capita basis.

Table 4. Estimated Direct Economic Cost of Physical Inactivity for British Columbian Health Authorities 1998 (2001$ millions)

Disease	BC	Interior	Fraser	Vancouver Coastal	Vancouver Island	Northern
Heart Disease	69.12	12.08	23.12	16.24	11.64	4.67
Stroke	39.67	6.92	13.23	9.34	6.68	2.69
Hypertension	30.90	5.43	10.40	7.21	5.21	2.10
Colon cancer	6.45	1.13	2.14	1.50	1.08	0.43
Breast cancer	7.92	1.39	2.66	1.85	1.34	0.54
Type 2 diabetes	21.66	3.77	7.19	5.06	3.63	1.46
Osteoporosis	35.06	6.12	11.70	8.24	5.93	2.37
Total	**210.79**	**36.84**	**70.45**	**49.45**	**35.52**	**14.27**

Note that although total direct costs per authority add up to total B.C. costs, the costs due to physical inactivity per authority do not add up to the total for B.C. This is because the authority figures were calculated individually based on PAR per authority and per disease.

Table 5. Estimated Direct Economic Cost of Physical Inactivity for British Columbia Health Authorities 1998 per capita (2001$)

Authority	Population	Physical Inactivity Rate %	Total Direct costs $millions	Per Capita $
British Columbia	3,527,754	38.0	$210.79	$59.75
Interior	595,857	39.6	$36.84	$61.83
Fraser	1,175,778	38.5	$70.45	$59.92
Van Coastal	901,908	34.3	$49.45	$54.83
Van Island	608,020	37.1	$35.52	$58.41
Northern	246,191	36.5	$14.27	$57.95

Population figures for health authorities are from Health Data Warehouse, B.C. Ministry of Health Planning and B.C. Ministry of Health Services, Apr. 16, 2003. Population Estimates and projections (P.E.O.P.L.E. 27) by User-defined Age Group. These figures are for people aged 12 and over.

It must be emphasized that these are conservative estimates based on the diseases that have PARs and does not account for the costs of mental health (see Appendix 1) or the cost of obesity and arthritis, which have a strong relationship to physical inactivity.

3.3 Indirect Costs of Physical Inactivity, British Columbia

Table 6 adds the direct and indirect costs for each category of disease and spending category. Table 6 also provides estimates for indirect productivity losses due to premature mortality and disability for each of the diseases that are related to physical inactivity. Total B.C. costs for premature deaths (mortality) are provided in EBIC 98 for cardiovascular disease, cancer, endocrine and related diseases and musculoskeletal diseases. Productivity losses due to premature mortality for the seven diseases related to physical inactivity were estimated as follows. For heart disease and stroke, the EBIC 98 national ratio of the cost of these diseases to

the total costs of cardiovascular disease was used [58.7% for heart disease (ischemic heart disease and acute myocardial infarction); 15.2% for stroke]. For hypertension, the Katzmarzyk CA percentage was used (9.2%). For colon cancer and breast cancer, as well as for diabetes, ratios are from EBIC 98 (9.1% for colorectal cancer x 0.671= 6.1% for colon cancer; 10% for breast cancer; 72.4% for diabetes and 66.9% for Type 2 diabetes). Costs for osteoporosis are estimated according to Katzmarzyk ON (30.3%).

Productivity losses due to disability were estimated for both short and long-term disability. Again, provincial costs for these categories are not broken down into the diseases of interest in EBIC 98. For heart disease, the national ratio from EBIC 98 was used (18%). For stroke, the national ratio from EBIC 98 was used (13.2%). For colon and breast cancer, the proportion of total cancer costs for disability for these two diseases was based on incidence of these two types of cancer as a proportion of all cancer in the Canadian Cancer Statistics 2002. This was 8.36% for colon cancer (based on colorectal incidence of 12.48%) and 13.2% for breast cancer. For diabetes, the ratio from EBIC 1998 was used: 64.9% of all long-term disability costs due endocrine and related indirect costs were due to diabetes, and , and 92.5% of these costs (60%) are attributed to Type 2 Diabetes. Osteoporosis costs were estimated as for premature deaths.

Table 6 indicates clearly that the greatest costs of chronic illness are due to the premature death and disability they produce, resulting in substantial productivity losses to the economy. Physical inactivity is responsible for $362 million annually in productivity losses. In other words, the B.C. economy would be worth $362 million more each year than it currently is if it had the productive services of the hundreds of British Columbians disabled or killed prematurely by a sedentary lifestyle. When direct medical costs and economic productivity losses are added, Table 6 shows that the total economic burden of physical activity to British Columbia exceeds $572 million annually.

Table 6. Productivity Losses due to Physical Inactivity (2001$ millions) and Total Economic Costs of Physical Inactivity in British Columbia, 1998

Disease	Premature Death	Long Term Disability	Short Term Disability	Total Indirect Costs	Indirect Costs Due to Physical Inactivity	Direct Costs Due to Physical Inactivity	Total Economic Cost of Physical Inactivity
Heart disease	$673.40	$93.39	$7.71	$774.49	$113.08	$69.12	$182.20
Stroke	$174.37	$68.48	$5.65	$248.51	$46.22	$39.67	$85.90
Hypertension	$105.54	$47.73	$3.94	$157.21	$16.04	$30.90	$46.94
Colon cancer	$90.10	$13.25	$2.45	$105.80	$14.28	$6.45	$20.73
Breast cancer	$147.71	$20.92	$3.87	$172.49	$18.11	$7.92	$26.03
Diabetes	$94.30	$80.56	$5.22	$180.08	$28.81	$21.66	$50.47
Osteoporosis	$5.30	$628.30	$51.79	$685.39	$125.43	$35.06	$160.49
TOTALS	$1,290.72	$952.62	$80.63	$2,323.97	$361.97	$210.79	$572.75

* 2001$ millions indicates that all amounts are converted into 2001 Canadian dollars, using the consumer price index to account for inflation and that each amount listed represents that amount times 1,000,000.

It should be noted that long-term disability costs are highest for musculoskeletal diseases, accounting for 39% of costs nationally (EBIC 98). In B.C., musculoskeletal disease accounts for 42.4% of long-term disability costs. Hence B.C. has a proportionately higher disability costs for osteoporosis.

Tables 7 and 8 show costs for long-term disability and short-term disability by B.C. Health Authority. Table 9 shows the costs of premature death, and Table 10 shows the total productivity losses due to physical inactivity on a per capita basis. Although the per capita costs are very similar among the Health Authorities, Vancouver Coastal, which has the lowest physical inactivity rate, also has the lowest per capita indirect costs.

Table 7. Long-Term Disability Costs due to Physical Inactivity by Health Authority, British Columbia, 1998 (2001 $ millions)

Disease	BC	Interior	Fraser	Van Coastal	Van Island	Northern
Heart disease	$13.63	$2.38	$4.60	$3.20	$2.30	$0.92
Stroke	$12.74	$2.22	$4.29	$3.00	$2.14	$0.86
Hypertension	$4.87	$0.86	$1.65	$1.14	$0.82	$0.33
Colon cancer	$1.79	$0.31	$0.60	$0.42	$0.30	$0.12
Breast cancer	$2.20	$0.39	$0.75	$0.51	$0.37	$0.15
Diabetes II	$12.89	$2.25	$4.32	$3.01	$2.16	$0.87
Osteoporosis	$114.98	$20.07	$38.71	$27.02	$19.45	$7.78
TOTALS	$163.09	$28.47	$54.91	$38.30	$27.55	$11.04

Table 8. Short-Term Disability Costs due to Physical Inactivity by Health Authority, British Columbia, 1998 (2001$ millions)

Disease	BC	Interior	Fraser	Van Coastal	Van Island	Northern
Heart disease	$1.13	$0.20	$0.38	$0.26	$0.19	$0.08
Stroke	$1.05	$0.18	$0.35	$0.25	$0.18	$0.07
Hypertension	$0.40	$0.07	$0.14	$0.09	$0.07	$0.03
Colon cancer	$0.33	$0.06	$0.11	$0.08	$0.06	$0.02
Breast cancer	$0.41	$0.07	$0.14	$0.10	$0.07	$0.03
Diabetes II	$0.83	$0.15	$0.28	$0.19	$0.14	$0.06
Osteoporosis	$9.48	$1.65	$3.19	$2.23	$1.60	$0.64
TOTALS	$13.63	$2.38	$4.59	$3.20	$2.30	$0.92

Table 9. Premature Death Costs due to Physical Inactivity by Health Authority, British Columbia, 1998 ($2001 $ millions)

Disease	BC	Interior	Fraser	Van Coastal	Van Island	Northern
Heart disease	$98.32	$17.18	$33.19	$23.10	$16.56	$6.65
Stroke	$32.43	$5.66	$10.92	$7.63	$5.46	$2.20
Hypertension	$10.77	$1.89	$3.66	$2.51	$1.82	$0.73
Colon cancer	$12.16	$2.13	$4.08	$2.84	$2.05	$0.82

Breast cancer	$15.51	$2.72	$5.26	$3.63	$2.62	$1.05
Diabetes II	$15.09	$2.63	$5.08	$3.52	$2.53	$1.02
Osteoporosis	$0.97	$0.17	$0.33	$0.23	$0.16	$0.07
TOTALS	$185.25	$32.38	$62.51	$43.47	$31.19	$12.53

Table 10. Total Indirect Costs due to Physical Inactivity by Health Authority, British Columbia, 1998

Authority	Population	Physical Inactivity Rate %	Premature Death Costs ($ 000's)	Short-Term Disability Costs ($ 000's)	Long-Term Disability Costs ($ 000's)	Total Indirect Costs ($ 000's)	Per Capita
British Columbia	3,527,754	38	185,250	13,630	163,090	$361,970	$102.61
Fraser	1,175,778	38.5	$62,510	$4,590	$54,910	$122,010	$103.77
Interior	595,857	39.6	$32,380	$2,380	$28,470	$63,230	$106.12
Van. Island	608,020	37.1	$31,190	$2,300	$27,550	$61,040	$100.39
Northern	246,191	36.5	$12,530	$920	$11,040	$24,490	$99.48
Van. Coastal	901,908	34.3	$43,470	$3,200	$38,300	$84,970	$94.21

Note: These tables were produced by multiplying the total costs by the percentage of the population contained by each health authority and then by the PAR for that region. The percentage populations figures are as follows: Interior, 16.9%; Fraser, 33.3%; Vancouver Coastal, 25.6%; Vancouver Island, 7.2%; Northern, 7%. Population figures for health authorities are from Health Data Warehouse, B.C. Ministry of Health Planning and B.C. Ministry of Health Services, Apr. 16, 2003. Population Estimates and projections (P.E.O.P.L.E. 27) by User-defined Age Group. These figures are for people aged 12 and over. Totals may not add up exactly because of rounding.

3.4 Premature Deaths due to Physical Inactivity in British Columbia

The indirect costs and productivity losses due to premature death in section 3.3 above are a function of two variables:

1) the number of premature deaths attributable to each diagnostic category that could have been avoided if all British Columbians were physically active; and
2) age at death, which determines the potential years of life lost due to physical inactivity.

Table 11 identifies the first of these two variables explicitly by applying the population attributable risks for physical inactivity to five key illnesses. Osteoporosis and hypertension are not included in this estimate because they are rarely direct causes of death, but are rather implicated in other causes of death. For example, an osteoporotic fracture can result from a fall, but the consequent death may be reported as due to injury rather than to osteoporosis, which is the underlying cause.

Total number of deaths per major disease category for 2001 were obtained from the B.C. Vital Statistics Agency. Deaths from heart disease was based on ischaemic heart disease. Type 2 Diabetes deaths were estimated at 92.5% of deaths from diabetes. Deaths from colon cancer was

estimated at 67.1% of deaths from colorectal cancer. Table 11 shows that if all British Columbians were physically active, life expectancy could be increased in the province, and 1,402 premature deaths could be avoided each year. This is 5.0% of all deaths among British Columbians.

Katzmarzyk CA attributes 10.3% of all premature deaths in Canada to physical inactivity, and states that we could theoretically save 21,340 Canadian lives that are lost prematurely each year if all Canadians were physically active. Katzmarzyk and his colleagues used different sources for death data and based their estimate on total *adult* deaths, while Table 11 is based on total British Columbian deaths, regardless of age.

Table 11. Number of Premature Deaths Attributable to Physical Inactivity, British Columbia

Disease	# of Deaths	% of total BC deaths	Deaths attributable to physical inactivity	% of deaths attributable to physical inactivity
Heart Disease	4,915	17.5%	718	14.6%
Stroke	2,272	8.1%	423	18.6%
Colon Cancer	480	1.7%	65	13.5%
Breast cancer	600	2.1%	63	10.5%
Type 2 Diabetes	725	2.6%	133	18.3%
Total	**8,992**	**31.9%**	**1,402**	**N/A**
All Causes	**28,164**	**100.0%**	**N/A**	**5.0%**

Table 12 estimates the potential years of life lost annually due to physical inactivity. These estimates take into account both the number of deaths and the average age of death attributable to various illnesses. *The B.C. Vital Statistics Agency* considers deaths before age 75 as "early" deaths, and it counts the difference between these early deaths and age 75 as potential years of life that have been lost.[49]

Table 12. Potential Years of Life Lost (PYLL) due to Physical Inactivity, British Columbia[50]

Disease	PYLL	% of total BC PYLL	PYLL attributable to physical inactivity	% of PYLL attributable to physical inactivity
Heart Disease	14,205	7.7%	2,074	14.6%
Stroke	4,240	2.3%	789	18.6%
Colon cancer	2,743	1.5%	370	13.5%
Breast cancer	6,140	3.3%	645	10.5%
Diabetes 2	3,140	1.7%	502	16.0%

[49] Health Canada, *Statistical Report on the Health of Canadians,* page 319.

[50] All figures are from Selected Vital Statistics and Health Status Indicators, Annual Report 2001, Division of Vital Statistics, Ministry of Health Planning, Government of British Columbia, available at http://www.vs.gov.bc.ca/annual2001/. No figures were given for colon cancer, so the figure for colorectal cancer (4,088) was multiplied by the proportion of colorectal cancers that are colon cancers (67.1%). No figures were given for Diabetes 2, so the total for diabetes (3,395) was multiplied by the percentage of diabetes cases that are diabetes 2 (92.5%).

Total	30,468	16.5%	4,380	n/a
All causes	**184,468**	**100.0%**	**n/a**	**2.4%**

Potential years of life lost were provided for heart disease and stroke, and breast cancer for B.C. for 2001. PYYL was given for colorectal cancer, and this was multiplied by the proportion of colorectal cancers that are colon cancers (67.1%). PYYL was also given for diabetes and this was multiplied by the percentage of diabetes cases that are Diabetes Type 2 (92.5%).
Table 12 shows that British Columbians each year lose about 4,380 potential years of life due to physical inactivity. This constitutes 2.4% of all potential years of life lost each year in the province due to all causes. If all British Columbians were physically active, society and the economy would benefit from an additional 4,380 productive person-years each year.

3.5 Potential Savings from Higher Rates of Physical Activity

Katzmarzyk and his colleagues, in the *Canadian Medical Association Journal,* recalculated the direct health care costs attributable to physical inactivity with a reduction of 10% in the prevalence of inactivity. That is, they assumed the rate of physical inactivity to be 56% of the adult population instead of the current rate of 62%. This is in line with the 1996 public health objective proclaimed by Canadian federal, provincial, and territorial governments to achieve a 10% reduction in physical inactivity by 2003.[51]

Katzmarzyk et al. found that a 10% reduction in physical inactivity would reduce health care costs attributable to physical inactivity by 7%, resulting in health care savings of $161 million nationwide. Although British Columbians are already the most physically active in Canada, we are applying a 10% decrease in physical inactivity (rate of physical inactivity set at 34.2%, rather than 38%), which yields savings as follows:

- Total direct health care costs $18.3 million
- Economic productivity gains (avoided early death and disability) $31.1 million
- Total annual economic savings $49.4 million

Thus, only a 10% reduction in physical inactivity rates would save the B.C. economy nearly $50 million annually. A 10% reduction in physical inactivity could also save 139 lives a year in British Columbia, and avoid 385 potential years of life lost annually.

Needless to say, even a 34.2 % rate of physical inactivity is still fairly high. If B.C. males increased their physical activity by 10%, this would more than compensate for the decrease in activity of males since 1994. Smoking is still regarded as a major avoidable health problem even with a prevalence rate half as high as that of physical inactivity. Therefore, the potential for far more substantial long-term savings through promotion of sports, exercise, and recreation is very large indeed.

[51] Health Canada, Federal, Provincial and Territorial Fitness and Recreation Committee, *Physical Inactivity: A Framework for Action,* Ottawa, 1996.

Katzmarzyk and his colleagues conclude their *Canadian Medical Association Journal* analysis with a strong recommendation:

> *"Given the considerable efforts that have been aimed at curbing the prevalence of smoking in Canada, public health campaigns directed at increasing physical activity in the population should be no less aggressive and persistent."*[52]

[52] Katzmarzyk et al., op. cit., page 1439.

APPENDIX 1. Mental Health Costs due to Physical Inactivity

Accounting for Mental Health Costs due to Physical Inactivity

Katzmarzyk CA and ON omit estimates of mental illness costs attributable to physical inactivity. As noted above, Statistics Canada estimates, based on the 1996-97 National Population Health Survey results, indicate that sedentary Canadians are 60% more likely to suffer from depression than physically active Canadians. Physical activity also protects against stress and anxiety.

According to EBIC 98 (online), mental illness costs B.C. $ 613.6 million in drugs, hospital and physician costs and another estimated *other* cost of $ 445.5 million, for a total of $1059 million in 1998. This amount, when adjusted for inflation to 2001, is $1109 million in direct costs. If just 5% of these costs could be avoided through physical activity that reduces the incidence of depression, anxiety, and stress, then $55.5 million a year in direct mental health care costs might be ascribed to physical inactivity. Including mental illness costs therefore raises the estimate of total direct health expenditures due to physical inactivity in B.C. from $210.8 million to $266.3 million annually.

Similarly, if 5% of the $642.6 ($613.3 1998) million currently expended on treating mental health through hospitals, drugs, and physician services can be attributed to physical inactivity, then physical inactivity would account for a total of $32.1 ($30.7) million in hospital, drug, and physician costs. This amounts to 0.47% of total provincial spending on hospitals, drugs, and doctors that can be attributed to physical inactivity.

Productivity losses due to mental illness were $515.2 million in 2001 ($491.9 million in 1998). It is important to note that the portion of this that is attributable to physical inactivity would add an estimated $25.8 million to indirect costs, again on the assumption that 5% of mental illness could be avoided through physical activity.[53] Added to the estimated $55.5 million in direct health care expenditures on mental illness that can be attributed to physical inactivity, the total economic cost of physical inactivity in British Columbia for this category can be estimated at $81.2 million annually.

It must be emphasized that population attributable risks for mental ailments like depression, anxiety, and stress were not available for this study, and the 5% attribution here is an arbitrary, if conservative, estimate. However, since mental health has been reliably linked to physical activity, it is more accurate to include some estimate of mental illness costs due to physical inactivity than to assign such costs an arbitrary value of zero, which is implied by omitting the diagnostic category entirely.

[53] Based on 1998 EBIC estimates for British Columbia adjusted for inflation to 2001.