The economic burden of physical inactivity in Canada

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Abstract

Background: About two-thirds of Canadians are physically inactive. As a risk factor for several chronic diseases, physical inactivity can potentially be a substantial public health burden. We estimated the direct health care costs attributable to physical inactivity in Canada, the number of lives lost prematurely each year that are attributable to a sedentary lifestyle and the effect that a reduction of 10% in inactivity levels (a Canadian objective for 2003) could have on reducing direct health care costs.

Methods: We calculated summary relative risk (RR) estimates from prospective longitudinal studies of the effects of physical inactivity on coronary artery disease, stroke, colon cancer, breast cancer, type 2 diabetes mellitus and osteoporosis. We then computed the population-attributable fraction (PAF) for each illness from the summary RR and the prevalence of physical inactivity (i.e., 62%) and applied the PAF to the total direct health care expenditures for 1999 and to the number of deaths in 1995 associated with each disease to determine the health care costs and lives lost prematurely that were directly attributable to physical inactivity.

Results: About $2.1 billion, or 2.5% of the total direct health care costs in Canada, were attributable to physical inactivity in 1999. A sensitivity analysis (simultaneously varying each of the health care costs and PAF by ±20%) indicated that the costs could be as low as $1.4 billion and as high as $3.1 billion. About 21 000 lives were lost prematurely in 1995 because of inactivity. A 10% reduction in the prevalence of physical inactivity has the potential to reduce direct health care expenditures by $150 million a year.

Interpretation: Physical inactivity represents an important public health burden in Canada. Even modest reductions in inactivity levels could result in substantial cost savings.

Given the convincing scientific evidence that physical inactivity leads to a host of chronic degenerative conditions and premature death, the promotion of a physically active lifestyle is an important public health objective. The health benefits of physical activity have been widely publicized in the 1998 *Canada's Physical Activity Guide to Healthy Active Living*[1] and the 1996 US Surgeon General's report on physical activity and health.[2] However, the results of a survey carried out in 1997[3] suggest that 62% of Canadians are still not active enough to reap the health benefits of a physically active lifestyle. Similarly, only 34% of Canadians aged 25 to 55 years are meeting the recommendation in *Canada's Physical Activity Guide to Healthy Active Living*,[1] which 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 to 7 days a week.[4] A recent public health objective of federal, provincial and territorial governments is a 10% reduction in the level of physical inactivity in Canada by 2003.[5]

The main risk factors for coronary artery disease (CAD), a primary cause of death in Canada, are cigarette smoking, high blood pressure, high blood cholesterol levels and physical inactivity, all of which have similar risk ratios.[6] Recent prevalence estimates indicate that 28% of Canadians currently smoke,[7] 20% have high blood pressure,[8] 26% have high blood cholesterol levels[9] and 62% are inactive.[3] Thus, in the context of population health, an increase in physical activity has the greatest poten-

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tial to effect a reduction in CAD. A recent study showed a 4.7% reduction in short-term (18 months) health care costs for each active day per week reported by participants.[10] These results support those of earlier studies indicating significant health care savings associated with corporate fitness and health promotion programs.[11,12] However, the results of analyses of short-term health care costs are difficult to interpret because it may take several years to accrue cardiovascular benefits from an active lifestyle.

Given the high prevalence of physical inactivity in Canada and its relation to degenerative conditions and premature death, the burden that sedentary living is placing on the economy through the health care system and its effect on longevity are presumed to be great. However, there have been only limited attempts to quantify the costs of physical inactivity in this country.[13] Our primary objective in this study was to estimate the economic burden of physical inactivity in Canada. Our secondary objectives were to estimate the number of lives lost prematurely each year because of a sedentary lifestyle and the effect that a reduction

Table 1: Studies used to estimate summary relative risks for physical inactivity in Canada

Disease, population	Sample size or no. of studies	Activity level classification	RR (and 95% CI)
CAD			
Meta-analysis[15]	9 studies	Low v. high	1.90 (1.60–2.20)
Stroke			
British men[25]	7 735	None v. moderate	1.67 (0.67–5.00)
NHANEFS men[20]	2 368	Low v. moderate	1.24 (0.63–2.41)
NHANEFS women[20]	2 713	Low v. moderate	3.13 (0.95–10.32)
Honolulu Heart Study men[17]	7 530	Low v. high tertile	3.70 (1.20–6.70)
Framingham Study men[21]	1 228	Tertile 1 v. tertile 2	2.44 (1.45–4.17)
Framingham Study women[21]	1 676	Tertile 1 v. tertile 2	1.03 (0.68–1.56)
Finnish men[24]	3 978	None v. some leisure	1.00 (0.65–1.62)*
Finnish women[24]	3 688	None v. some leisure	1.30 (0.73–2.16)*
Reykjavik men[18]	4 484	None v. some after age 40	1.45 (0.99–2.13)
ARIC women and men[19]	14 575	Low v. high quartile	1.12 (0.73–1.75)
Male physicians[22]	21 823	None v. vigorous exercise 2–4 times/wk	1.25 (1.01–1.54)
Harvard University alumni[23]	11 130	< 4184 kJ/wk v. 8368–12 548 kJ/wk	1.85 (1.32–2.63)
Hypertension			
Harvard University alumni[28]	14 998	< 8368 kJ/wk v. ≥ 8368 kJ/wk	1.30 (1.09–1.55)
Iowa women[26]	41 837	Low v. high tertile	1.43 (1.11–1.67)
Finnish men[27]	2 840	Low v. high tertile	1.73 (1.13–2.65)
ARIC men[29]	7 459	Low v. high quartile	1.52 (1.06–2.13)
Colon cancer			
Meta-analysis[16]	35 studies	Sedentary v. active	1.39 (1.27–1.51)
Breast cancer			
Meta-analysis[16]	13 studies	Sedentary v. active	1.22 (1.00–1.50)
Type 2 diabetes mellitus			
Female nurses[31]	87 253	None v. vigorous exercise once/wk	1.45 (1.00–2.08)
Male physicians[32]	21 271	None v. vigorous exercise once/wk	1.41 (1.10–1.79)
Finnish women[27]	2 840	Low v. high tertile	2.64 (1.28–5.44)
Female nurses[30]	27 546	Low v. high quintile	1.35 (1.12–1.61)
Osteoporosis			
Nonblack women[34]	9 704	< 1423 kJ/wk v. > 9209 kJ/wk	1.56 (1.12–2.22)
NHANEFS white women[33]	2 143	None v. much or moderate exercise	1.90 (1.04–3.30)

Note: RR = relative risk, CI = confidence interval, CAD = coronary artery disease, NHANEFS = National Health and Nutrition Epidemiologic Follow-up Study, ARIC = Atherosclerosis Risk in Communities Study.
*Estimated from 90% confidence intervals presented in the study.

of 10% in physical inactivity could have on reducing direct health care costs.

Methods

We determined the main diseases that are known to be significantly related to physical inactivity from comprehensive reviews on the topic,[2,14] together with more recent peer-reviewed articles obtained through searches on MEDLINE. First, we quantified the association between physical inactivity and chronic diseases known to be associated with physical inactivity. We used estimates from previously published meta-analyses[15,16] for CAD, colon cancer and breast cancer, and we obtained the relative risks (RRs) attributable to physical inactivity from large prospective epidemiologic studies for stroke,[17–25] hypertension,[26–29] type 2 diabetes mellitus[27,30-32] and osteoporotic fractures[33,34] (Table 1). We pooled the RR estimates from each chronic disease group using a general variance-based method of meta-analysis based on the estimate of RR and the 95% confidence intervals (CI) reported in each study[35] (details available from the authors). For 2 studies[24,36] we estimated the 95% CI from the 90% CI reported by the authors.

To estimate the proportion of chronic disease and of premature death in Canada that could theoretically be prevented by eliminating physical inactivity we calculated population-attributable fractions (PAF). The PAF is an estimate of the effects of an individual risk factor on a given disease. The PAF for each disease was calculated as $[P(RR - 1)] / [1 + P(RR - 1)]$, where P is the prevalence of physical inactivity in the population and RR is the relative risk for the disease in an inactive person. The prevalence of physical inactivity in Canada was estimated using data from the Physical Activity Monitor Survey[3] by the Canadian Fitness and Lifestyle Research Institute. The survey was based on telephone contact with a representative but weighted sample of 1875 Canadians, selected to reflect roughly the proportion of the Canadian population in each of the provinces. The results indicated that 62% of Canadians aged 18 years or more were inactive, defined as reporting less than 12.6 kJ/kg of body weight per day of physical activity. Thus, for the purpose of our study, we accepted 62% as the prevalence of physical inactivity.

Economic costs of physical inactivity

We estimated the direct health care costs of treating diseases related to physical inactivity and the fraction of the total costs that were attributable to physical inactivity from recent sources. We obtained the estimated health care costs for 1999 from analyses of the Canadian Health Expenditures Database[37] maintained by the Canadian Institute for Health Information. The database provides information using broad categories of spending and sources of funding; however, information on the cost of treating specific diseases is not available. We obtained this information from the *Economic Burden of Illness in Canada, 1993* (*EBIC*).[38] We extracted the costs of treating specific diseases associated with physical inactivity from the *EBIC* and inflated them to 1999 values using the estimates of global expenditures from the 1999 Canadian Health Expenditures Database.[37] The *EBIC* provided costs specific to CAD and stroke. We approximated the costs of treating the other chronic diseases from general categories as follows. The *EBIC* provided a cost for treating diabetes; we estimated the cost of treating type 2 diabetes using the proportion of total cases of diabetes that are type 2 (92.5%).[39] The *EBIC* provided the cost of treating cancer; we estimated the cost of treating colon cancer using the incidence of colon cancer relative to all cancers in Canada (8.6%).[40] The *EBIC* provided the cost of treating cancer specific to women; we estimated the cost of treating breast cancer using the incidence of breast cancer relative to all female-specific cancers (71.4%).[40] The *EBIC* reported the total cost of treating cardiovascular diseases; we estimated the cost of treating hypertension by multiplying the costs associated with treating hypertension relative to total cardiovascular disease costs in the United States (5.7% of hospital costs, 50.6% of drug costs and 28.7% of physician costs).[41] The costs of treating osteoporosis associated with physical inactivity could not be directly determined with this method. It has been reported that $1.3 billion is spent annually on the treatment of this disease in Canada,[42] and we adopted this value for the present analysis.

To determine the influence of variations in PAF and health care costs, we performed a 2-way sensitivity analysis similar to that of Birmingham and colleagues[43] in their study of the cost of obesity. We simultaneously varied each PAF and disease-specific health care cost by ±20% of the mean estimate.

Premature death due to physical inactivity

We obtained the number of deaths and cause of death among adults (20 years of age and over) in Canada in 1995 from Statistics Canada data[44] and multiplied the number of deaths from the main inactivity-related diseases (CAD, stroke, colon cancer, breast cancer and type 2 diabetes) by the PAF to estimate the number of deaths attributable to physical inactivity. The number of deaths due to colon cancer was not presented directly; only deaths from colorectal cancer were given. We, therefore, estimated the number of deaths due to colon cancer using the incidence of colon cancer relative to total colorectal cancers (67.1%).[40]

Savings from reduction in physical inactivity

We estimated the economic savings associated with a 10% reduction in physical inactivity levels by recalculating the PAFs, assuming the prevalence of inactivity to be 56% (i.e., 62% – 6.2% = 55.8%) rather than 62%. We then calculated the savings by taking the difference between the costs derived with the 2 inactivity prevalence rates.

Results

The summary RR estimates (and 95% CI) for physical inactivity for the various chronic diseases are given in Table 2. The RR estimates range from 1.2 (95% CI 1.0–1.5) for breast cancer to 1.9 (95% CI 1.6–2.2) for

Table 2: Relative risk and population-attributable fraction due to physical inactivity for major chronic diseases

Disease	RR (and 95% CI)		Population-attributable fraction, %*
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

*Assuming a prevalence of physical inactivity of 62%.

CAD. The PAF values suggest that 11.0%–35.8% of the cases of the various diseases might be eliminated if those who were sedentary became physically active.

The estimated health care costs attributable to physical inactivity in 1999 are presented in Table 3. In total, about $2.1 billion was estimated to have been spent on health care that was directly attributable to physical inactivity. This amount represents 2.5% of the total health care costs in that year (calculated at $86.0 billion[37]). The sensitivity analysis indicated that the health care costs for the major chronic diseases attributable to inactivity may have been as low as $1.4 billion and as high as $3.1 billion. The total cost attributable to physical inactivity represents 25.5% of the cost of treating CAD, stroke, hypertension, colon cancer, breast cancer, type 2 diabetes and osteoporosis in that year. The highest costs attributable to physical inactivity were associated with CAD ($891 million), osteoporosis ($352 million), stroke ($345 million) and hypertension ($314 million).

There were 207 408 deaths from all causes among Canadian adults in 1995,[44] of which 35.8% were due to the main diseases known to be associated with physical inactivity, namely, CAD, stroke, colon cancer, breast cancer and type 2 diabetes. Table 4 shows the estimated number of deaths attributable to physical inactivity for each of these diseases and for all causes. If physical inactivity were completely eliminated in Canada, we could theoretically increase life expectancy and save 21 340 lives that are lost prematurely each year — 10.3% of the total deaths among adults.

Recalculating the direct health care costs attributable to physical inactivity with a reduction of 10% in the prevalence of inactivity (56% v. 62%) yielded a cost of $1.97 billion. Thus, a 10% reduction would result in savings of about $150 million per year in direct health care expenditures.

Interpretation

Our results indicate that $2.1 billion, or about 2.5% of the total direct health care costs in Canada in 1999, are attributable to physical inactivity. A similar figure was recently reported for the United States ($24 billion or 2.4% of the US health care expenditures).[45] We found that 33% of deaths from CAD, colon cancer and type 2 diabetes could hypothetically be prevented by eliminating physical inactivity. Similarly, it has been estimated that about one-third of the deaths from CAD, colon cancer and diabetes in the US are attributable to inactivity.[46]

The cost of obesity in Canada was estimated to be $1.8 billion in 1997.[43] When this value is inflated to 1999 dollars using the increase of 10.3% that occurred in total health care expenditures between 1997 and 1999 (from $78.0 billion to $86.0 billion), the cost of obesity would be $2.0 billion. Thus, our cost estimates for physical inactivity are similar to those for obesity. 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.[47] However, it is unlikely that the costs attributable to inactivity and obesity are simply additive; the relative contributions of physical inactivity and excessive caloric intake to obesity have not been determined. More research is needed to determine the total costs attributable to physical inactivity, taking into account the overlapping costs of inactivity-related obesity.

Estimates from our study suggest a saving of $150 million per year with a reduction of 10% in the prevalence of physi-

Table 4: Number of deaths attributable to physical inactivity in Canadian adults in 1995

Disease	No. of deaths (and % of total deaths)		No. (and %) of deaths attributable to inactivity	
CAD	44 061	(21.2)	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 2 diabetes	5 492	(2.6)	1 093	(19.9)
All causes	207 408	(100.0)	21 340	(10.3)

Table 3: Health care costs for major chronic diseases in Canada in 1999 and estimated direct economic cost of physical inactivity

	Health care costs, $1000s					
Disease	Hospital care	Physician care	Drugs	Research	Total	Direct cost attributable to inactivity, $1000s
CAD	1 884 827	315 521	286 830	1 554	2 488 732	890 966
Stroke	1 508 418	89 701	133 802	555	1 732 476	344 763
Hypertension	332 306	298 298	949 640	NA	1 580 244	314 469
Colon cancer	254 424	46 139	24 109	7 531	332 203	66 108
Breast cancer	176 338	48 033	51 474	5 709	281 554	30 971
Type 2 diabetes	284 253	144 235	178 384	12 777	619 649	123 310
Osteoporosis	NA	NA	NA	NA	1 300 000	352 300
Total					8 334 858	2 122 887

Note: NA = not available.

cal inactivity.[5] Thus, even a modest reduction would have a significant effect on the health of Canadians. However, one would not expect sweeping health care savings immediately following a reduction in the level of inactivity because the benefits of a physically active lifestyle accrue over a lifetime.

Our methods have several limitations. The *EBIC* data were for 1993, and we assumed that the relative proportions of expenditures for each illness did not change dramatically between 1993 and 1999. Furthermore, the *EBIC* reported expenditures for major categories of disease, such that expenditures for colon cancer, breast cancer, type 2 diabetes and hypertension had to be estimated from prevalence and incidence data or from expenditure data from the United States. However, these limitations likely had only a marginal effect on our estimates, and the use of these methods allows a comparison of results to those for obesity derived using similar methods.[43]

Our estimates of the economic costs of physical inactivity are likely conservative. We calculated only the direct health care costs of inactivity and made no attempt to estimate indirect costs, which include lost productivity due to premature death and disability due to illness. In addition to the diseases included in our analysis, physical inactivity has been associated with dyslipidemia, anxiety, depression, poorer quality of life and premature admission to an institution or geriatric care.[2] However, the effect sizes for these conditions and situations are generally small, and there is little consensus on these issues. Like most behaviours, physical activity is difficult to measure accurately. Thus, in using estimates of physical activity rather than objective measures of physical fitness, the studies included in the meta-analysis likely underestimated the health effects associated with an active lifestyle.

Conversely, we have also not accounted for the potential costs of physical activity promotion. The implementation of nation-wide intervention programs and campaigns to promote physical activity is an expensive prospect; the costs are undoubtedly lower than the health care expenses associated with treating inactivity-related illnesses, however.

Our estimates are based on RRs from prospective longitudinal studies, which may not always translate into actual benefits when tested in randomized controlled trials. A fundamental assumption is that changes in physical activity (though promotion) will result in changes in disease risk. Although there are randomized controlled trials on the effects of physical activity on risk factors for disease (such as blood lipid levels), there is little information on whether physical activity interventions can change one's risk for disease per se. However, 2 longitudinal prospective studies[48,49] have shown that increases in physical fitness or physical activity levels can reduce the risk of death from all causes.

Given the limitations in the data and the lack of randomized controlled trials to evaluate the long-term effectiveness of exercise interventions, more research on the effects of changes in physical activity levels on health care costs is needed. In a public health context, the finding that physical inactivity accounts for about 2.5% of the current direct health care costs is very important. The costs attributable to cigarette smoking in Canada were estimated to be 3.8% of total health care costs in 1992.[50] 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.

Competing interests: None declared.

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