

Income and heart disease

Neglected risk factor

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Abstract

Objective To determine the unadjusted and adjusted effects of income on heart disease; its main disease intermediary, high blood pressure; and its main behavioural risk factors, smoking and physical inactivity.

Design Random-digit dialing telephone survey collected through the Canadian Community Health Survey by Statistics Canada.

Setting Saskatchewan.

Participants A total of 27 090 residents aged 20 years and older; each health region in Saskatchewan was represented.

Main outcome measures Overall, 178 variables related to demographic characteristics, socioeconomic factors, behaviour, life stress, disease intermediaries, health outcomes, and access to health care were analyzed to determine their unadjusted and adjusted effects on heart disease.

Results The mean age of the sample was 52.6 years. Women represented 55.9% of the sample. Most respondents were married (52.3%) and had some postsecondary or graduate education (52.5%). The mean personal income was \$23 931 and the mean household income was \$37 533. All models statistically controlled for age. Five covariates independently associated with heart disease included high blood pressure, household income of \$29 999 or less per year, being a daily smoker, male sex, and being physically inactive. Five covariates independently associated with high blood pressure included being overweight or obese, being a daily smoker, household income of \$29 999 or less per year, male sex, and being physically inactive. Five covariates independently associated with daily smoking included being a visible minority, household income of \$29 999 or less per year, not being overweight or obese, education level of less than secondary school, and male sex. Six covariates independently associated with physical inactivity included being a visible minority, being overweight or obese, education level of less than secondary school, male sex, household income of \$29 999 or less per year, and being a daily smoker.

Conclusion Household income was strongly and independently associated with heart disease; its main disease intermediary, high blood pressure; and its main behavioural risk factors, smoking and physical inactivity. Income inequality is a neglected risk factor worthy of appropriate public debate and policy intervention.

EDITOR'S KEY POINTS

- This study using telephone survey data aimed to determine the effects of income on heart disease. It found that household income was strongly and independently associated with heart disease; its main disease intermediary, high blood pressure; and its main behavioural risk factors, smoking and physical inactivity.
- Before statistical adjustment, the results suggested that low income had a more important association with heart disease than conventional risk factors such as smoking and physical inactivity did. After statistical adjustment, lower-income residents were still 52% more likely to have heart disease than higher-income residents were. This suggests that a re-ordering of risk factors is required.
- Low income is a neglected risk factor; appropriate public action and policy intervention should be taken to reduce income inequality.

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Revenu et maladie cardiaque

Un facteur de risque qu'on oublie

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Résumé

Objectif Déterminer les effets du revenu, avec ou sans ajustement, sur la maladie cardiaque; sur l'hypertension, son principal responsable; et sur le tabagisme et la sédentarité, ses principaux facteurs de risque.

Type d'étude Enquête téléphonique à composition aléatoire effectuée dans le cadre de l'Enquête de Statistique Canada sur la santé des collectivités canadiennes.

Contexte La Saskatchewan.

Participants Un total de 27 090 personnes de 20 ans ou plus, incluant des représentants de chacune des régions sanitaires de la Saskatchewan.

Principaux paramètres à l'étude On a analysé 178 variables en lien avec les caractéristiques démographiques, les facteurs socioéconomiques, le comportement, le stress de la vie, les maladies intermédiaires, les issues de santé et l'accès aux soins de santé, et ce, afin d'établir leurs effets ajustés ou non ajustés sur les maladies cardiaques.

Résultats L'âge moyen des participants était de 52,6 ans, avec 55,9 % de femmes. La plupart des répondants étaient mariés (52,3 %) et certains avaient un niveau de scolarité postsecondaire ou un baccalauréat (52,5 %). Le revenu

personnel moyen était de 23 931 \$, et le revenu familial moyen de 37 533 \$. Tous les modèles étaient contrôlés pour l'âge. Les 5 covariables indépendamment associées à la maladie cardiaque comprenaient une tension artérielle élevée, un revenu familial annuel inférieur à 30 000 \$, l'usage quotidien du tabac, le sexe masculin et la sédentarité. Les 5 covariables indépendamment associées à l'hypertension étaient le surpoids ou l'obésité, l'usage quotidien du tabac, un revenu familial annuel inférieur à 30 000 \$, le sexe masculin et la sédentarité. L'absence de surpoids ou d'obésité, un niveau de scolarité inférieur au secondaire et le sexe masculin. Les 5 covariables indépendamment associées au tabagisme quotidien comprenaient l'appartenance à une minorité visible, un revenu familial annuel inférieur à 30 000 \$, l'absence de surpoids ou d'obésité, un niveau de scolarité inférieur au secondaire et le sexe masculin. Les 6 covariables indépendamment associées à la sédentarité comprenaient l'appartenance à une minorité visible, le surpoids ou l'obésité, un niveau de scolarité inférieur au secondaire, le sexe masculin, un revenu familial annuel inférieur à 30 000 \$ et l'usage quotidien du tabac.

POINTS DE REPÈRE DU RÉDACTEUR

- Dans cette étude, les données d'une enquête téléphonique ont été utilisées pour déterminer l'influence du revenu sur la maladie cardiaque. Les résultats montrent une association forte et indépendante entre le revenu et la maladie cardiaque, l'hypertension, son principal responsable, et le tabagisme et la sédentarité, ses principaux facteurs de risque.
- Avant ajustement statistique, les résultats suggéraient que les maladies cardiaques étaient plus fortement associées à un faible revenu qu'aux facteurs de risque conventionnels comme le tabagisme et la sédentarité. Après ajustement, les personnes ayant un plus faible revenu demeuraient 52 % plus susceptibles d'avoir une maladie cardiaque que celles possédant un revenu plus élevé. Un reclassement des facteurs de risque paraît donc nécessaire.
- Un faible revenu est un facteur de risque généralement négligé; il y aurait lieu d'instaurer des mesures et interventions appropriées afin de réduire l'inégalité des revenus.

Cet article fait l'objet d'une révision par des pairs.
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Conclusion Il existe une association forte et indépendante entre un faible revenu et la maladie cardiaque, l'hypertension, son principal responsable, et le tabagisme et la sédentarité, ses principaux facteurs de risque comportementaux. L'inégalité des revenus est un facteur de risque négligé qui mériterait un débat public et des mesures d'intervention appropriées.

Cardiovascular disease is a substantial burden in Canada. The Public Health Agency of Canada (PHAC) reports that the disease is responsible for 32.1% of all deaths and 16.9% of all hospitalizations in Canada.¹ The Public Health Agency of Canada also reported that the corresponding economic cost of the illness was \$22.2 billion in 2000, which represents \$7.6 billion in direct costs and \$14.6 billion in indirect costs.^{1,2}

Many of the risk factors for cardiovascular disease have been well documented. In an important report on heart disease in Canada, PHAC reported that the risk factors included smoking, physical inactivity, eating less than the recommended amounts of fruit and vegetables, stress, being overweight or obese, high blood pressure, and diabetes.¹ The Heart and Stroke Foundation of Canada reported the same risk factors but also included high blood cholesterol levels and excessive alcohol consumption.³ In another publication from PHAC, this one specifically devoted to addressing risk factors, excessive sodium consumption was added.⁴ In a joint report from the Heart and Stroke Foundation of Canada, the Canadian Cardiovascular Society, and the Canadian Institutes of Health Research, 10 priority areas of the health system were recommended for the Canadian government to invest in.⁵ While these reports are important, none of them lists income as a risk factor, let alone a priority area to address.

That said, the association between income and heart disease is known. An analysis of data collected by Statistics Canada from 491 083 Canadians over an 11-year period found that 2.9% of high-income Canadians had heart disease compared with 5.2% of upper-middle-income residents, 8.7% of lower-middle-income residents, and 9.2% of lower-income residents. Over the 11-year study period, heart disease increased by 27% and 37% in the lower-income and lower-middle-income groups, respectively, compared with 12% and 6% in the upper-middle-income and high-income groups, respectively.⁶ In response, Canada's first Chief Public Health Officer report was devoted to understanding and addressing income inequality.⁷

The focus on conventional biomedical risk factors while not adequately addressing the social determinants of health is possibly associated with reported higher heart disease prevalence, health care use, and costs.^{1,2,6} For this reason, the primary purpose of this study was to determine the unadjusted and adjusted effects of income on self-reported heart disease prevalence. The second purpose was to determine the adjusted effect of income on heart disease's main disease intermediary, high blood pressure, and its main behavioural risk factors, smoking and physical inactivity.

METHODS

Information was collected over 4 cycles of the Canadian Community Health Survey (CCHS) conducted by Statistics

Canada. Cycle 1 was collected from 2000 to 2001, cycle 2 was collected in 2003, cycle 3 was collected in 2005, and cycles 4 and 5 were collected from 2007 to 2008. The methodology of the CCHS has been documented in detail elsewhere.⁸ All cycles were random-digit dialing telephone survey samples with computer-assisted interviewing. The CCHS excludes First Nations members living on reserves, persons living in institutions (eg, penitentiaries), and full-time members of the Canadian Armed Forces and the Royal Canadian Mounted Police. The appropriateness of pooling CCHS data over cycles to increase the precision of estimates of independent risk indicators has been established previously.⁹⁻¹¹

The data set includes residents aged 20 years and older. In total, 178 variables related to demographic characteristics (eg, age, sex, marital status, ethnicity), socioeconomic characteristics (eg, household income, education level), behaviour (eg, smoking, physical inactivity, alcohol use, consumption of fruits and vegetables), life stress, disease intermediaries (eg, being overweight or obese, high blood pressure), health (eg, heart disease, self-reported health, diabetes, mental health), and access to health care were available for analysis.

Cross-tabulations were computed for all variables with the outcome of self-reported presence of heart disease. Income stratification was based on 3 groups of equal sample size (\leq \$29 999 per year, between \$30 000 and \$79 999 per year, and \geq \$80 000 per year). Four multivariate models for heart disease, high blood pressure, smoking, and physical inactivity were then built to determine the independent effect of income on each.

A hierarchal, well-formulated, stepwise modeling approach was used instead of a computer-generated stepwise algorithm. The unadjusted effect of each covariate was determined and then entered 1 step at a time based on changes in the results of the -2 log likelihood ratio test and the Wald test. Confounding was tested for by comparing the estimated coefficient of the outcome variable from models containing and not containing the covariates. Interaction was tested for with product terms. The R^2 correlation coefficient was used to determine the proportion of variance in the outcome variables explained by the knowledge of the explanatory variables but not as a measure of the appropriateness of the final models. Goodness of fit of the final models was assessed with the Hosmer-Lemeshow statistical test.^{12,13}

RESULTS

The total sample size was 27 090. Every health region in Saskatchewan was represented, with 4243 residents from Regina Qu'Appelle; 4630 from Saskatoon; 6161 from Cypress, Five Hills, and Sun Country; 4180 from Sunrise and Kelsey Trail; 3899 from Prince Albert Parkland, Athabasca,

Mamawetan Churchill River, and Keewatin Yatthé; and 3977 from Heartland and Prairie North. The mean age of the sample was 52.6 years and the mean household income was \$37533. The sample is similar to the overall Saskatchewan population, although statistically significant differences arise for each variable owing to large sample sizes (Table 1).¹⁴

Cross-tabulation began with all 178 variables available. There were 19 variables that initially had statistically significant associations with heart disease, including income. For example, 10.6% of those who had a household income of \$29 999 per year or less had heart disease, while 3.7% of those with household income between \$30 000 and \$79 999 had heart disease, and 2.7% of those with household income of \$80 000 or more per year had heart disease (Table 2).

After statistically controlling for age, only 5 covariates were independently associated with heart disease including high blood pressure (130% more likely to have heart disease), household income of \$29 999 per year or less (92% more likely), being a daily smoker (86% more likely), male sex (75% more likely), and being physically inactive (20% more likely). The results are presented in Table 3.

When the main disease intermediary, high blood pressure, was cross-tabulated by household income, 27.6% of those with household income of \$29 999 per year or less had high blood pressure. In comparison, 15.4% of those with household income between \$30 000 and \$79 999 and 8.5% of those with household income of \$80 000 or more per year had high blood pressure.

Table 1. Characteristics of the study sample compared with the Saskatchewan population: Median household income was \$41 602 for the study sample and \$46 705 in the 2006 Saskatchewan census.

CHARACTERISTIC	STUDY SAMPLE, N (%)	2006 SASKATCHEWAN CENSUS, N (%)
Age, y		
• 20-29	4019 (14.8)	125 490 (17.8)
• 30-39	4253 (15.7)	111 490 (15.8)
• 40-49	4396 (16.2)	147 105 (20.8)
• 50-59	4572 (16.9)	128 460 (18.2)
• 60-69	3708 (13.7)	80 820 (11.5)
• 70-79	3569 (13.2)	64 285 (9.1)
• ≥ 80	2573 (9.5)	47 920 (6.8)
Sex		
• Male	11 951 (44.1)	475 240 (49.1)
• Female	15 139 (55.9)	492 915 (50.9)
Marital status		
• Married	14 177 (52.3)	396 500 (47.3)
• Common law	1503 (5.6)	57 535 (6.9)
• Widowed, separated, or divorced	6344 (23.4)	127 510 (15.2)
• Single or never married	5066 (18.7)	256 450 (30.6)
Ethnicity		
• White	24 126 (89.1)	822 875 (85.0)
• Visible minority	2964 (10.9)	145 280 (15.0)
Household income		
• ≤ \$29 999	12 056 (44.5)	NA
• \$30 000-\$79 999	10 024 (37.0)	NA
• ≥ \$80 000	855 (3.2)	NA
• Missing	4155 (15.3)	NA
Education level		
• Less than secondary	7453 (27.5)	231 730 (30.2)
• Secondary	5404 (20.0)	205 495 (26.8)
• Postsecondary or graduate	14 233 (52.5)	319 015 (41.6)

NA—not available.

Census data from Statistics Canada.¹⁴

Table 2. Statistically significant unadjusted associations with heart disease

CHARACTERISTIC	PREVALENCE OF HEART DISEASE, %	P VALUE
Age, y		<.001
• 20-29	0.5	
• 30-39	0.7	
• 40-49	1.9	
• 50-59	5.3	
• 60-69	10.1	
• 70-79	19.0	
• ≥80	25.2	
Marital status		<.001
• Married	6.9	
• Common law	2.1	
• Widowed, separated, or divorced	14.2	
• Single or never married	3.2	
Ethnicity		<.001
• White	8.0	
• Visible minority	4.8	
Household income		<.001
• ≤ \$29 999	10.6	
• \$30 000-\$79 999	3.7	
• ≥ \$80 000	2.7	
Education level		<.001
• Less than secondary	14.1	
• Secondary	4.5	
• Postsecondary or graduate	5.4	
Employment status		<.001
• Unemployed	16.1	
• Part time	4.2	
• Full time	2.1	
Owns a home		<.001
• Yes	7.2	
• No	9.3	
Food insecurity		.004
• Yes	3.1	
• No	7.2	
Daily smoker, y		<.001
• < 10	0.9	
• 10	1.0	
• 20	2.3	
• 30	5.6	
• 40	11.0	
• 50	16.4	
• ≥ 60	18.9	
Physical activity level		<.001
• Inactive	9.0	
• Moderate	6.3	
• Active	4.5	
Daily fruit and vegetable consumption		<.001
• < 5	6.6	
• ≥ 5	8.0	
Life stress		<.001
• Quite a bit or extreme	7.2	
• A bit	6.8	
• Not at all or very little	8.8	
Body mass index		.001
• Overweight or obese	7.2	
• Normal or underweight	6.0	
High blood pressure		<.001
• Yes	18.3	
• No	4.6	
Diabetes		<.001
• Yes	20.9	
• No	6.7	
Experienced the effects of a stroke		<.001
• Yes	41.7	
• No	6.9	
Cancer		<.001
• Yes	19.6	
• No	7.3	
Arthritis or rheumatism		<.001
• Yes	15.9	
• No	4.7	
Consulted a health care professional within the past 12 mo		<.001
• Yes	8.1	
• No	1.6	

Table 3. Independent and adjusted risk indicators of heart disease after controlling for age: Reference categories were normal blood pressure, household income ≥ \$80 000, being a non-smoker, female sex, and being physically active.

INDEPENDENT VARIABLE	ODDS RATIO	95% CI	P VALUE
High blood pressure	2.30	2.06 to 2.57	<.001
Household income ≤ \$29 999	1.92	1.70 to 2.16	<.001
Daily smoker	1.86	1.80 to 1.91	<.001
Male sex	1.75	1.67 to 1.84	<.001
Physically inactive	1.20	1.11 to 1.29	<.001

After statistically controlling for age, there were 5 covariates independently associated with high blood pressure. These included being overweight or obese (114% more likely to have high blood pressure), being a daily smoker (84% more likely), household income of \$29 999 per year or less (52% more likely), male sex (26% more likely), and being physically inactive (11% more likely). The results are presented in **Table 4**.

Cross-tabulating the main risk factor, smoking, by household income, 24.1% of those with household income of \$29 999 or less per year, 20.3% of those with household income between \$30 000 and \$79 999, and 14.7% of those with household income of \$80 000 or more per year were daily smokers.

After statistically controlling for age, there were 5 covariates independently associated with daily smoking prevalence. In order of importance, they were being a visible minority (105% more likely to be a daily smoker), household income of \$29 999 per year or less (29% more likely), not being overweight or obese (29% more likely), education level of less than secondary school (28% more

Table 4. Independent and adjusted risk indicators of high blood pressure after controlling for age: Reference categories were normal or underweight body mass index, being a non-smoker, household income ≥ \$80 000, female sex, and being physically active.

INDEPENDENT VARIABLE	ODDS RATIO	95% CI	P VALUE
Obese or overweight body mass index	2.14	1.97 to 2.33	<.001
Daily smoker	1.84	1.80 to 1.88	<.001
Household income ≤ \$29 999	1.52	1.41 to 1.63	<.001
Male sex	1.26	1.16 to 1.36	<.001
Physically inactive	1.11	1.06 to 1.17	<.001

likely), and male sex (16% more likely). The results are presented in **Table 5**.

Table 5. Independent and adjusted risk indicators of daily smoking after controlling for age: Reference categories were white ethnicity, household income \geq \$80 000, overweight or obese body mass index, postsecondary or graduate education, and female sex.

INDEPENDENT VARIABLE	ODDS RATIO	95% CI	P VALUE
Visible minority	2.05	1.86 to 2.27	<.001
Household income \leq \$29 999	1.29	1.22 to 1.37	<.001
Normal or underweight body mass index	1.29	1.25 to 1.34	<.001
Education level of less than secondary school	1.28	1.23 to 1.33	<.001
Male sex	1.16	1.10 to 1.21	<.001

When the second main risk factor, physical inactivity, was cross-tabulated by household income, 60.0% of those with household income of \$29 999 or less per year, 49.5% of those with household income between \$30 000 and \$79 999, and 47.5% of those with household income of \$80 000 or more per year were physically inactive.

After statistically controlling for age, there were 6 covariates independently associated with physical inactivity including being a visible minority (83% more likely to be physically inactive), being overweight or obese (32% more likely), education level of less than secondary school (25% more likely), male sex (17% more likely), household income of \$29 999 per year or less (15% more likely), and being a daily smoker (12% more likely). The results are presented in **Table 6**.

The R^2 values for the 4 regression models were 0.166, 0.198, 0.192, and 0.141, suggesting the models fit the data well because the differences between the observed values and the models' predicted values are small and unbiased. The goodness-of-fit test results ($P=.821$, $P=.871$, $P=.861$, and $P=.772$) suggest that the 4 regression models are appropriate. The estimated slope coefficients and standard errors are small so collinearity is not suspected. Confounding and interaction were not detected in the final regression models.

DISCUSSION

The focus on conventional biomedical risk factors while not adequately addressing the social determinants of

Table 6. Independent and adjusted risk indicators of physical inactivity after controlling for age: Reference categories were white ethnicity, normal or underweight body mass index, postsecondary or graduate education, female sex, household income \geq \$80 000, and being a non-smoker.

INDEPENDENT VARIABLE	ODDS RATIO	95% CI	P VALUE
Visible minority	1.83	1.73 to 1.93	.001
Obese or overweight body mass index	1.32	1.23 to 1.41	<.001
Education level of less than secondary school	1.25	1.19 to 1.31	<.001
Male sex	1.17	1.09 to 1.26	<.001
Household income \leq \$29 999	1.15	1.08 to 1.23	<.001
Daily smoker	1.12	1.08 to 1.17	<.001

health is possibly associated with higher reported heart disease prevalence, health care use, and costs.^{1,3,6}

In our study, household income was strongly and independently associated with heart disease; its main disease intermediary, high blood pressure; and its main behavioural risk factors, smoking and physical inactivity. For example, before statistical adjustment, 10.6% of those who had a household income of \$29 999 per year or less had heart disease compared with 2.7% of those who made \$80 000 or more per year. Before statistical adjustment, the results suggest that low income has a more important association with heart disease than conventional risk factors such as smoking and physical inactivity do. After statistical adjustment, lower-income residents were still 52% more likely to have heart disease than higher-income residents were. This suggests that a re-ordering of risk factors is required.

The results observed in Saskatchewan are similar to other findings. Another study found that 9.2% of low-income Canadians had heart disease compared with 2.9% of high-income Canadians.⁶ This study also reviewed the prevalence of high blood pressure by income level. The top income earners had a high blood pressure prevalence of 7.3% while the lowest earners had a prevalence of 15.4%,⁶ which is smaller than the 3-fold difference found in our study. For smoking, Statistics Canada reports daily smoking prevalence rates of 23.5% for low-income Canadians and 12.6% for high-income Canadians,¹ compared with the 24.1% and 14.7% found in our sample. A number of studies also suggest that adults who live in low-income neighbourhoods are less likely to be physically active.^{15,16}

The good news is that the World Health Organization has reported that rising incomes have been responsible for 75% of the increase in life expectancy observed in the past 50 years.¹⁷


Social causation theory and conflict theory suggest health and behavioural problems result when resources and rewards are offered, or restricted, differently to different populations.¹⁸ That said, increased individual stress is the most widely described explanation for health disparity by socioeconomic status. Lower-income individuals have more stress, including insecurity in income, housing, food, safety, and so on, while also having fewer resources to deal with these challenges. The mismatch between demands that individuals live with, coupled with the reduced capacity to cope effectively, results in increased distress, which leads to risk behaviour, which leads to chronic disease.¹⁸

In response, a number of agencies, including the Canadian Medical Association and the Ontario College of Family Physicians, have listed specific implications for primary care including the need to ask about income status, link patients with community services, integrate knowledge of income into treatment decisions and practice design, and advocate for patients at the individual and population level.^{19,20}

Limitations

A limitation of the study design is that it is cross-sectional and can therefore only imply association and not causation. As well, there are small differences in how data on income, education, sex, ethnicity, and marital status were collected in the various cycles of the survey. The effect on the results is unclear (Table 1).¹⁴

Conclusion

Household income was strongly and independently associated with heart disease; its main disease intermediary, high blood pressure; and its main behavioural risk factors, smoking and physical inactivity. We suggest that low income is a neglected risk factor, and that appropriate public action and policy intervention should be taken to reduce income inequality. 

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Contributors

All authors contributed to the concept and design of the study; data gathering, analysis, and interpretation; and preparing the manuscript for submission.

Competing interests

None declared

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