The economic consequences of obesity and overweight among adults in Quebec

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ABSTRACT

OBJECTIVES: This article presents the first study of the economic consequences of obesity and overweight in the Canadian province of Quebec. The article examines three types of direct costs: hospitalizations, medical visits and drug consumption; and one type of indirect cost: productivity loss due to disability.

METHODS: The National Population Health Survey, conducted in all Canadian provinces by Statistics Canada between 1994 and 2011, provides self-reported longitudinal data for body mass index and the frequency of health care utilization and disability.

RESULTS: When we compared obese adults in Quebec to those with a normal weight at the beginning of the follow-up period, we observed that the former had significantly more frequent visits to the physician, more frequent hospital stays and higher consumption of drugs between 1994 and 2011. We estimated the annual cost of the excess health care utilization and excess disability at more than CAD \$2.9 billion in 2011.

CONCLUSION: The results confirm that, similar to what had been found elsewhere in Canada and abroad, there are important economic consequences associated with overweight and obesity in Quebec.

KEY WORDS: Obesity; economic burden; Quebec

La traduction du résumé se trouve à la fin de l'article.

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In the last 20 years, a growing body of literature has examined the economic burden associated with obesity. The majority of studies have focused on the United States, but researchers in Europe, Australia and other countries have also investigated this question. In a review of 129 studies, with very few exceptions, researchers have found that obesity is associated with increased medical expenditures (direct costs) as well as losses of productivity in the labour market (indirect costs).¹ However, as a result of variations in the methods used, these studies have produced variable estimates for a given country. For example, in Canada, the Public Health Agency of Canada (PHAC) estimated that, in 2008, obesity engendered direct costs of nearly \$2 billion,² whereas Anis et al. calculated direct costs of \$6 billion for 2006.³ The difference between the findings can be explained by the fact that Anis et al. included the costs of overweight in addition to the costs stemming from obesity in their calculation and covered 18 diseases associated with excess weight, while PHAC confined itself to obesity and only 8 diseases.

This article presents the results of a study on the economic burden of obesity and overweight among adults in the province of Quebec, for which no estimates have previously been produced. It examines three types of direct costs: hospitalizations, medical visits and drug consumption; and one type of indirect cost, productivity loss due to disability. This investigation is the first database study for the Quebec population (on the distinction between modeling studies and database studies, see reference 4). We used self-reported

data from a national longitudinal survey to compare health services utilization of obese and overweight adults to utilization by the reference group (normal weight individuals) during the follow-up period (1994–2011). We also compared obese and overweight adults to the reference group with regard to their number of weeks of disability during the follow-up period. Using the information about the additional services utilization, we estimated the monetary value of the economic burden of obesity.

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Conflict of Interest: None to declare.

METHODS

Data sources

We used Statistics Canada's National Population Health Survey–Household component (NPHS)⁵ to obtain estimates of the self-reported number of health services utilizations and number of weeks of disability by BMI (body mass index) group. The longitudinal part of this survey has been conducted in nine cycles every two years between 1994 and 2011 in households in the ten Canadian provinces. We have used the “square longitudinal sample” of the NPHS, which is composed of all respondents, including those who had partial answers to the questionnaire and those who had missed one or several cycles. The Canadian sample is composed of 14,117 adults (≥ 18 years of age), whereas the Quebec sample includes 2,417 adults. Of this number, we have excluded individuals whose BMI was unknown in the first cycle (402 in the Canadian sample, 58 in the Quebec sample). All survey-derived quantities have been produced using weighted analyses, as recommended by Statistics Canada.

Given that the NPHS provides only information about the frequency of health services utilization and not the level of expenditures associated with the utilization, we have also used data from the National Health Expenditure Database (NHEX) of the Canadian Institute for Health Information in order to quantify the cost.⁶ This database includes annual health spending from governments, private insurers and individuals in each Canadian province since 1975. We used the data for Quebec from the calendar year 2011 for adult expenditures on medical visits (outpatient), hospitalizations and drugs (prescription and non-prescription). This information on health expenditures allowed us to translate the excess utilization associated with obesity and overweight into an annual monetary value.

To calculate the latter, we estimated the number of Quebec adults in each BMI category in 2011. This self-reported information came from the Canadian Community Health Survey (CCHS), an annual cross-sectional survey by Statistics Canada. In order to estimate the cost associated with disability, we derived the median income for Quebec adults from Statistics Canada's National Household Survey (NHS) of 2011.

Independent variable: Body mass index

We used the World Health Organization's (WHO) classification based on the BMI to classify individuals in the NPHS as being obese, overweight or normal weight. In the NPHS, each individual declares his height and weight at each cycle, which can be used to calculate their BMI. For our study, BMI at the first cycle of the survey (1994–1995) was used. Longitudinal studies of the economic burden of obesity usually use BMI at time 1 as their independent variable.¹ We cannot know the BMI of survey participants before 1994. This measure therefore serves as a proxy for the level of exposure to this risk factor.

Dependent variables

Our study examined three measures of health care utilization: the number of medical visits (general practitioners and specialists) in the 12 months preceding the interview, the

number of nights spent at the hospital in the 12 months preceding the interview, and the number of drugs consumed in the last two days (with and without prescriptions). These measures of health care utilization are based on self-reported information provided by the participants at each of the nine cycles of the NPHS (1994–2011).

We have examined one type of indirect cost in our study, the loss of productivity associated with disability. We define as disabled those individuals between the ages of 18 and 64 years who, for health reasons, are not in the labour market. This status can be permanent or temporary, but refers to absence of beyond a few days. This definition aligns with those used in the literature.⁷ To estimate the loss of productivity, we used the earnings that an employee would have received without his or her health-related prolonged absence. This is based on the premise that earnings reflect the contribution an individual worker makes to the economy.⁸

Several questions in the NPHS questionnaire allow researchers to determine whether an individual is not working because of health problems. During cycles 1–3, respondents were asked if they had done paid work in the last 12 months (LFS-Q2). Those who had not worked were asked why. If they chose the answer “sickness or incapacity”, we classified them as disabled and attributed 52 weeks of disability for that cycle.

For cycles 4–9, the questions were slightly different than in the previous cycles. First, to the question “Have you worked last week?”, a new category of answer was added: “Permanent disability”. Those who chose this answer were classified as disabled for 52 weeks. We also classified as disabled all those who, for health reasons, had not worked or looked for work in the previous year during a number of non-consecutive weeks.

The distribution of the number of weeks of disability is very asymmetrical with two modes at the end of the distribution (0 weeks and 52 weeks). Therefore, we decided to dichotomize this variable in two ways in order to examine the risk of disability, which is estimated as an odds ratio using logistic regression. In the first dichotomization, termed the “overall disability” model, respondents who have not declared any weeks of disability in the last 52 weeks are contrasted with those who have declared at least 1 week. In the second dichotomization, termed the “severe disability” model, those who have declared less than 4 weeks of disability are contrasted with those with ≥ 4 weeks in the last year.

Control variables

Five control variables have been included in our statistical models to take into account the confounding effects between body weight and our dependent variables in the estimated risks. Similarly to most studies on this question, we have selected three socio-demographic variables (age, gender, education) and two behavioural variables (tobacco use and fruits and vegetable consumption as a proxy for healthy diets). We have not included the level of physical activity as one of the potential confounding variables. Being sedentary can have an impact on weight and on health services utilization, however, being overweight or obese can also limit the capacity of an individual to be physically active. A confounding variable cannot also be influenced by the independent variable.⁹

STATISTICAL ANALYSIS

The relationship between health services utilization and BMI has been estimated using a Poisson regression model, adjusted for the confounding variables and presented as relative risk. The correlation between the error terms associated with a given individual (unobserved individual fixed effects) has been taken into account by using “Generalized estimating equation” (GEE) models. The choice of the type of correlation matrix was based on the quasi-likelihood Information criteria for each of the models.

Modeling of the frequency of disability as a dependent variable represented an important methodological challenge because its distribution entails two modes: one at 0 weeks (the majority of cases) and another mode at 52 weeks. Many regression models were tested and caused important convergence problems. The most stable model was the GEE-type logistic regression which takes into account dependence between the observations originating from the same individual.

The survey plan was considered in the variance estimation of the parameters using bootstrap weights provided by Statistics Canada. This GEE-type method also takes into consideration the overdispersion found in the models. Bootstrap 95% confidence intervals were calculated using Wald method. The GENMOD procedure of SAS (version 9.3) was used.

METHODS TO TRANSLATE EXCESS UTILIZATION AND DISABILITY INTO ANNUAL MONETARY VALUE

Direct costs

For the three direct costs, we defined excess costs due to obesity and overweight as the difference between observed and “expected” costs. The expected costs refer to the counterfactual scenario where obese and overweight individuals would have the same level of utilization of health services as normal weight individuals, within each socio-demographic stratum. The observed costs are the costs associated with the level of utilization observed in our sample between 1994 and 2011. Appendix A presents in more detail how the calculation was undertaken.

Indirect costs

In order to assign a monetary value to the observed difference in the number of weeks of disability by BMI groups, we had to choose between two methods used in the literature: the human capital method, which is most commonly used, or the less conventional friction costs method.¹⁰

The human capital method adopts a societal perspective on the cost generated by illness. It estimates the contribution of an individual to society by using his employment income as a measure of his productivity.¹¹ All employment income not generated during the period of disability is calculated. In the case of permanent disability, the lost income starting from the beginning of the disability period until retirement age (65 years of age) is assessed.

The friction costs approach adopts a perspective centered on the employer and estimates the cost generated by a worker's disability only during the period required to hire and train a new employee to the level of being a replacement for the disabled worker, i.e., at a similar productivity level.¹² This period is called the friction period and can last between 6 and 12 months, depending on the labour

market conditions and the type of work. This period is generally shorter than the one during which the disabled worker is outside the labour market. Therefore, the cost estimates using this method tend to be much lower than those using the human capital method.

In order to be coherent with the approach adopted overall in our project, we used the human capital method. To do so, we used the median weekly employment income in Quebec in 2011 reported in Statistics Canada's NHS.

Excess costs for the loss of productivity due to disability associated with obesity or overweight is defined as the difference between observed expected costs. The expected cost represents the cost that would have been incurred if overweight and obese individuals had the same number of weeks of disability as those with normal weight. The observed cost corresponds to the productivity loss linked to the duration of the disability for each weight category, as reported in the NPHS.

We used the median weekly income by age, sex and education along with observed and expected costs within each level of control variables.^{13,14} We used the average number of weeks of disability of each combination of weight category and control variables in the NPHS. Appendix B provides more detail on this method.

RESULTS

Health services utilization

We observed that, compared with their normal weight counterparts, obese adults in Quebec have more frequent visits to the physician, more frequent hospital stays and higher consumption of drugs. The differences are statistically significant. The level of utilization was 13% higher for outpatient visits, 94% higher for hospitalization and 40% higher for drug consumption (Table 1). These estimates are based on the model presented earlier which includes five control variables and health services utilization during the whole follow-up period (1994–2011).

The difference between overweight adults and normal weight adults was only statistically significant in the case of drug consumption (17% higher for overweight).

Disability

When we compare obese Quebecers to those in the normal weight category, the difference as to their risk of disability is not statistically significant (Table 2, odds ratio of 1.40 for severe

Table 1. Health services utilization per year among adults, by weight category, for Quebec, NPHS 1994–2011

BMI at 1 st cycle	Relative risk (95% CI)*		
	Medical visits	Nights in hospital	Drug consumption
Normal weight (reference group)	1	1	1
Overweight	0.95 (0.85–1.06)	1.13 (0.76–1.65)	1.17 (1.05–1.30) [†]
Obesity	1.13 (1.02–1.26) [†]	1.94 (1.24–3.01) [†]	1.40 (1.23–1.60) [†]

* Weighted and adjusted for potential confounding variables: age, gender, education status, smoking status, consumption of fruits and vegetables; Assessed by GEE-type Poisson regression. 95% CI obtained by bootstrap.

[†] Difference with reference group is statistically significant.

disability defined as 4 weeks or more of disability in the last 12 months). Even though this odds ratio is not significant at a threshold of 5%, the observed relation in Quebec follows closely what we see in the Canadian sample, which shows a strongly significant odds ratio. For overweight individuals, we do not observe any significant odds ratio.

What are the costs associated with this additional utilization of services and disability?

We calculated for the year 2011 the monetary value of the excess utilization of health services and the excess level of disability. Using the information on health expenditures from the NHEX, on obesity prevalence in Quebec in 2011 (CCHS), and the relative risk estimates we produced, we reached a total of more than \$2.2 billion in direct costs (Table 3). This amount includes \$110 million for additional expenses related to medical visits, \$1.3 billion for hospital stays and \$860 million for drugs. This amount represents more than 10% of expenses for these three categories for Quebec adults in 2011.

As for disability, we decided to calculate the loss of productivity among obese Quebecers, despite the fact that the difference was

not statistically different in the Quebec sample. Indeed, given the small size of the sample for the outcome “disability” which targets only a subgroup of survey participants (those in the labour market), the statistical power is not sufficient to result in statistical significance, even though the risk appears important. This decision relies on the comparison of the results from the Quebec and Canadian samples, the latter showing a statistically higher odds ratio of disability for obese individuals. We have concluded that it is plausible that the obesity was associated with a higher odds ratio of disability in Quebec than in Canada. We have calculated the loss of productivity using the median income of Quebec adults and have estimated that the burden linked to disability is equivalent to \$630 million in 2011 (Table 3).

DISCUSSION

The results confirm that, similar to what had been found elsewhere in Canada and abroad, there are important economic consequences associated with overweight and obesity in Quebec.¹ We have applied the models we developed for the Quebec sample of the NPHS to the Canadian sample of the same survey (Tables 4 and 5). We note that, in the Canadian sample, the relative risk for a medical visit for an overweight individual is statistically different (1.08) than that for a normal weight individual, which was not the case for the Quebec sample. We also note that the risk ratio for obese individuals in the Canadian sample is higher than that in the Quebec sample for medical visits, but lower for hospital stays (44% more utilization for

Table 2. Odds ratio measuring the association between self-declared disability (two definitions) and BMI, for Quebec, NPHS 1994–2011

BMI at 1 st cycle	Overall disability* OR [‡] (95% CI)	Severe disability† OR [‡] (95% CI)
Normal weight (reference group)	1	1
Overweight	1.07 (0.71–1.62)	1.07 (0.71–1.60)
Obesity	1.31 (0.81–2.11)	1.40 (0.86–2.28)

Source: National Population Health Survey, Statistics Canada.

* Overall disability: existence = from 1 to 52 weeks of disability in the last 52 weeks; absence = 0 weeks of disability.

† Severe disability: existence = from 4 to 52 weeks of disability in the last 52 weeks; absence = from 0 to 3 weeks of disability.

‡ Odds ratio adjusted for potential confounding variables: age, gender, education status, smoking status, consumption of fruits and vegetables; Assessed by GEE-type weighted logistic regression of the presence of disability. 95% CI obtained by bootstrap.

Table 3. Estimates of economic burden associated with obesity and overweight in Quebec in 2011, direct and indirect costs, millions of Canadian dollars

Type of cost	BMI	Additional expenses (CAD \$ millions)
Medical visits	Obesity	\$110
Hospitalization	Obesity	\$1300
Drug consumption	Overweight	\$390
	Obesity	\$470
Disability	Obesity	\$630*
Total		\$2900

Source: Estimates produced from the master files of the National Population Health Survey (1994–2011), the Canadian Community Health Survey (2011–2012 survey), the National Household Survey (2011) of Statistics Canada.

* The odds ratio on which the calculation for the economic burden is based is not statistically significant. However, the trend observed in Quebec follows closely the one for Canada which shows a clear significant ratio. The lack of statistical power, given the small size of the sample of individuals <65 years of age having declared being disabled, can be the explanatory factor.

Table 4. Health services utilization per year among adults, by weight category, for Canada, NPHS 1994–2011

BMI at 1 st cycle	Relative risk (95% CI)*		
	Medical visits	Nights in hospital	Drug consumption
Normal weight (reference group)	1	1	1
Overweight	1.08 (1.03–1.14) [†]	1.06 (0.88–1.26)	1.17 (1.12–1.24) [†]
Obesity	1.30 (1.23–1.37) [†]	1.44 (1.23–1.37) [†]	1.49 (1.41–1.58) [†]

Source: National Population Health Survey, Statistics Canada.

* Weighted and adjusted for potential confounding variables: age, gender, education status, smoking status, consumption of fruits and vegetables; Assessed by GEE-type Poisson regression. 95% CI obtained by bootstrap.

† Difference with reference group is statistically significant.

Table 5. Odds ratio measuring the association between self-declared disability (two definitions) and BMI, for Canada, NPHS 1994–2011

BMI at 1 st cycle	Overall disability* OR [‡] (95% CI)	Severe disability† OR [‡] (95% CI)
Normal weight (reference group)	1	1
Overweight	1.21 (0.95–1.54)	1.21 (0.97–1.53)
Obesity	1.59 (1.25–2.04) [§]	1.66 (1.30–2.11) [§]

Source: National Population Health Survey, Statistics Canada.

* Overall disability: existence = from 1 to 52 weeks of disability in the last 52 weeks; absence = 0 weeks of disability.

† Severe disability: existence = from 4 to 52 weeks of disability in the last 52 weeks; absence = from 0 to 3 weeks of disability.

‡ Odds ratio from the modelization with logistic regression of the presence of disability, taking into account control variables.

§ Difference with reference group is statistically significant.

obese compared to normal weight in the Canadian sample, vs. 94% more in the Quebec sample).

We have not undertaken statistical tests to examine the differences between and the estimates from these two samples.

Limitations related to the independent variable

Many authors have raised limitations of BMI as a measure of obesity, given that it is not a measure of the distribution of adiposity, and that abdominal adiposity has been clearly identified as a health risk.¹⁵ Moreover, studies now point to increase in waist size in all weight categories (normal, overweight, obese) in recent years.¹⁶ This implies that, even among normal weight individuals, the risks of poor health are now higher than before. Also, the thresholds used to delineate the different weight categories raised questions. For example, individuals in the normal weight category whose BMI is under 22 kg/m² have much greater health risks than those with a BMI between 22 and 25 kg/m².¹⁷ Despite these limitations, the vast majority of studies continue to use the BMI classification proposed by WHO, as there are very few data collected using other measurements, such as waist size.

Another limitation comes from the self-reported nature of our data on weight and height of individuals. A systematic review has highlighted the bias of underestimation linked to self-reported BMI data.¹⁸ In 2005, Statistics Canada compared self-reported weight and height data to measured data for a subsample of 4,567 respondents to the CCHS.¹⁹ Obese and overweight individuals tend to underestimate their weight and overestimate their height. For example, the prevalence of obesity in Canada in 2005 based on measured data was 22.6% compared to 15.6% based on self-reported data. We have decided against applying a correction factor to the BMI data. We do not have measured data from 1994 which would allow us to determine an appropriate correction. It would be risky to base such a correction on the information from 2005, as there appears to be an increase of this bias in time, as the prevalence of obesity keeps rising.^{20,21} We should note that this bias can lead to conservative estimates of the economic burden of obesity.

Limitations related to the dependent variables

Our data on health services utilization are self-reported, and thus also subject to a recall bias. Many studies in the US have observed, when comparing self-reported data to medical or administrative data on health services utilization, that patients tend to underestimate their utilization.^{22,23} The gap is especially large for outpatient services, and much lower, or inexistent, for hospital stays. The gap between self-reported and administrative data increases among frequent users. In the case of drug consumption, the recall period for the indicator we used from the NPHS was only two days (compared to 12 months for outpatient services and hospital stays), which reduces the risk of recall bias.²⁴

As to our self-reported indicator of disability, studies have indicated that recall biases are minor, but that a long recall period can lead to an underestimation of the length and the frequency of the episodes of disability.^{25–28} The 12-month recall period for this indicator is sufficiently long to be subject to such a bias.

The NPHS provided us with information on the frequency of services utilization, but not on the actual expenses disbursed for

these services. The pairing of survey data with Quebec government administrative data, i.e., the Régie d'assurance-maladie du Québec which is the public insurer, could have yielded more precise estimates. Given the time and resources constraints of this project, we were not in a position to do such a pairing. Therefore, our estimates cannot take into account the fact that certain drugs, medical visits or hospital stays can cause higher expenses than others and we cannot affirm whether this limitation leads to an under- or overestimation of the economic burden of obesity.

CONCLUSION

This study on the economic consequences of obesity and overweight among adults in the province of Quebec examined three types of direct costs: hospitalizations, medical visits and drug consumption; and one type of indirect cost: productivity loss due to disability. The results confirm that, similar to what had been found elsewhere in Canada and abroad, there are important economic consequences associated with overweight and obesity in Quebec. These types of studies can be tools to support policy-making processes and guide allocation of resources for obesity prevention.

APPENDIX A. FORMULAS FOR THE CALCULATION OF THE EXCESS COSTS ASSOCIATED WITH HEALTH SERVICES UTILIZATION OF OVERWEIGHT AND OBESE INDIVIDUALS

First step: From the National Population Health Survey (NPHS), build a Poisson regression model in order to estimate the average number of health services utilizations according to BMI category, gender, age, smoking status, and education level of the household.

These averages are deducted from the exponential function of the coefficients of the corresponding parameters in the regression model. This model can include interaction terms, as long as they are statistically significant. For example, in the case where none of the interaction terms are in cause, the average of the estimated numbers ($\widehat{NU}$) for individuals of BMI category, of gender j , of age group k , of smoking status l and of education level of the household m , is

$$\widehat{NU}_{ij,k,l,m} = \exp(\alpha + \beta_i + \beta_j + \beta_k + \beta_l + \beta_m)$$

Second step: From the Canadian Community Health Survey (CCHS) 2011–2012, estimate the total number of individuals in the population according to BMI category i , gender j , age k , smoking status l and education level of the household m , thus:

$$N_{ij,k,l,m}$$

Third step: Determine the total number of health services utilizations in the population according to BMI category.

The total number of health services utilizations T_i in the population for the BMI category i is the sum, for all the combinations of gender j , age group k , smoking status l and education level of the household m , of the product of the average of the estimated number of drugs ($\widehat{NU}$), as described in step 1, by the total number of individuals in the population for this same BMI category, thus:

$$T_i = \sum_{j,k,l,m} \widehat{NU}_{i,j,k,l,m} \times N_{i,j,k,l,m}$$

Fourth step: Determine the annual average cost per health services utilization.

According to the data from the National Health Expenditure Database (NHEX), the annual cost for medical visits (outpatient), hospitalizations and drugs in Quebec in 2011 were 4,763.6, 10,536.5 and 7,487.1 million dollars respectively. To obtain the annual average cost per health services utilization, we have to divide this total cost by the total number of health services utilizations in the population for all the BMI categories in this manner:

$$\text{Average cost} = \frac{\text{Total cost}}{\sum_i T_i}$$

Fifth step: Calculation of excess costs.

Excess costs for the BMI category i is the difference between the total observed costs and the total expected costs

$$\text{Excess}_i = \text{Observed cost}_i - \text{Expected cost}_i$$

The observed cost is simply the product of the total number of health services utilizations by the average cost

$$\text{Observed cost}_i = T_i \times \text{average cost}$$

The expected cost for obese or overweight individuals is obtained by applying the risk attributable to normal weight individuals. Then, one has to divide the observed cost by the adjusted relative risk of the corresponding BMI category, RR_i , obtained with the Poisson regression, that is

$$\text{Expected cost}_i = \frac{\text{Observed cost}_i}{RR_i}$$

APPENDIX B. FORMULA TO CALCULATE THE EXCESS COSTS FROM LOST INCOME RELATED TO DISABILITY AMONG OVERWEIGHT AND OBESE INDIVIDUALS

First step: From the NPHS, estimate the average number of weeks of disability by BMI category, gender, age, smoking status, and education level of the household.

Given the atypical distribution of the variable “number of weeks in disability”, it was not possible to propose an adequate regression model, as we did for the consumption of drugs, without going beyond the hypotheses that underlie such models. Therefore, we have estimated the averages of the number of weeks in disability ($\widehat{NI}_{i,j,k,l,m}$) directly from the NPHS data for each combination of BMI category i , gender j , age group k , education level l and smoking status m . Even though we used only the broad categories of this variable (for instance the BMI category “underweight” was not considered), the estimation of the averages were presenting strong variability given the low number of respondents for certain combinations of these variables. When precision was judged too low, we imputed Canadian averages instead of the Quebec averages.

Second step: Determination of the total number of weeks in disability in the population by BMI category, gender, age, smoking status, and education level of the household.

From the Canadian Community Health Survey (CCHS) 2011–2012, estimate the number of individuals by BMI category, gender, age, smoking status, and education level of the household. Then, the total number of weeks in disability for a given combination is

$$T_{i,j,k,l,m} = \widehat{NI}_{i,j,k,l,m} \times N_{i,j,k,l,m}$$

Third step: From the National Household Survey (NHS) 2011, estimate the median weekly income by gender, age, and education level of the household.

In the ideal world, we would like to derive median weekly income estimates for the same combination as those for the average number of weeks of disability. But it is not possible to have some information about smoking status and BMI in the NHS. So we obtain Median income $_{j,k,l}$.

Fourth step: Calculation of excess costs.

Excess costs for the BMI category i is the difference between the total observed cost and the total expected cost

$$\text{Excess}_i = \text{Observed cost}_i - \text{Expected cost}_i$$

The observed cost by BMI category is simply equal to the sum of the product of the corresponding total number of weeks in disability by the median weekly income

$$\text{Observed cost}_i = \sum_{j,k,l,m} T_{i,j,k,l,m} \times \text{Median income}_{j,k,l}$$

The expected cost of obese and overweight individuals is obtained by using the average numbers of weeks in disability associated with individuals in the normal weight BMI category. Thus,

$$\begin{aligned} \text{Expected cost}_i &= \sum_{j,k,l,m} \widehat{NI}_{\text{Normal},j,k,l,m} \times N_{i,j,k,l,m} \\ &\quad \times \text{Median income}_{j,k,l} \end{aligned}$$

Therefore the “excess” cost is equal to:

$$\begin{aligned} \text{Excess}_i &= \sum_{j,k,l,m} (\widehat{NI}_{i,j,k,l,m} - \widehat{NI}_{\text{Normal},j,k,l,m}) \times N_{i,j,k,l,m} \\ &\quad \times \text{Median income}_{j,k,l} \end{aligned}$$

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RÉSUMÉ

OBJECTIFS : Cet article présente les résultats de la première étude sur les conséquences économiques de l'obésité et de l'embonpoint au Québec. Il examine trois types de coûts directs (hospitalisation, consultations médicales et consommation de médicaments) et un type de coût indirect (les pertes de productivité liées à l'invalidité).

MÉTHODES : L'Enquête nationale sur la santé de la population, qui a été menée par Statistiques Canada dans toute les provinces canadiennes entre 1994 et 2011, offre des données auto-rapportées longitudinales sur l'indice de masse corporelle, la fréquence d'utilisation de services de santé et l'invalidité.

RÉSULTATS : Lorsqu'on compare les adultes québécois obèses avec ceux de poids normal au début de la période de suivi, nous observons que ceux-ci ont consulté plus fréquemment le médecin, ont eu de plus nombreuses nuits d'hospitalisations et ont consommé plus de médicaments entre 1994 et 2011. Nous estimons le coût annuel de l'excédent d'utilisation de service de santé et d'invalidité à plus de CAD \$2,9 milliards en 2011.

CONCLUSION : Les résultats confirment, comme l'indiquent les études ailleurs au Canada et à l'étranger, que l'obésité et l'embonpoint sont associés à d'importantes conséquences économiques.

MOTS CLÉS : obésité; fardeau économique; Québec