Association of obesity with mood and anxiety disorders in the adult general population

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Abstract

Obesity is a major health concern. It has been implicated as a risk factor for several physical illnesses, functional limitations and poor quality of life. However, while the physical consequences of obesity are well established, the relationship between obesity and mental health is still unclear. This study used data collected in the Canadian Community Health Survey, cycle 3.1 (2005) to examine this relationship in adults 20 to 64 years old. Obesity was significantly associated with mood disorders, but not with anxiety disorders. When adjusting for sex, place of birth, smoking, and functional limitations, all of which were significantly associated with obesity, the odds of obesity remained significantly higher in persons with mood disorders (with or without anxiety disorders). It is still unclear whether the relationship between obesity and depression is causal, and if so, whether obesity causes depression or depression causes obesity. Implications for health care providers and suggestions for future research are discussed.

Key words: *obesity, mood disorders, anxiety disorders, Canada, adult*

Introduction

Obesity is a growing public health concern in modern societies. Recent studies indicate that between 10% and 23% of adults in Europe and between 22% and 35% of adults in the US are classified as obese, i.e. have a body mass index (BMI) of 30 kg/m^2 or higher.[1] In the US, the prevalence of adult obesity has doubled since 1980[2] and is presently the second major cause of preventable death after smoking.[3] In Canada, the adult obesity rate has also doubled in the last three decades to reach 15.2% in 2003[4] with an estimated economic burden of $4.3 billion.[5]

Physical inactivity and unhealthy diet have been identified as major risk factors for obesity.[6] Prevalence of obesity in women was also found to increase with advanced age, low income and lower levels of education.[7] The decline in the prevalence of smoking among adults may also have contributed to the observed increase in the prevalence of obesity.[8]

Ample research has highlighted the role of obesity as a risk factor for a large number of chronic health complications, such as cardiovascular disease, hypertension, type 2 diabetes, stroke, sleep apnea and certain types of cancer, as well as complications in pregnancy and surgery.[9] Obesity has also been implicated as a risk factor for functional limitations and poor health-related quality of life.[10] However, while the physical consequences of obesity are well established, the relationship between obesity and mental health is still unclear and reported findings have been mixed. Some researchers examined prevalence of obesity in individuals with mental disorders[11,12] and others examined the prevalence of mental disorders in obese individuals.[13] However, most of these studies examined simple associations between depression/depressive symptoms and body fat without accounting for possible mediators and/or moderators of their relationship.[14]

In a review of four longitudinal studies and 20 cross-sectional studies of the effects of obesity on depression, Atlantis and Baker[15] found that longitudinal studies provided consistent evidence that obesity may increase the odds of developing depression or depressive symptoms. They also found most cross-sectional studies from the US supported the above association for women but not men. In contrast most cross-sectional studies from populations other than the US consistently failed to find such associations. But Bruffaerts and colleagues[1] analysed data from six European countries and found that obese individuals were more likely to have mood disorder (odds ratio [OR] = 1.3) and more than one mental disorder (OR = 1.4) compared with individuals of adequate weight. On the other hand, Blaine[16] conducted a meta-analysis of 16 longitudinal studies of the effect of depression on obesity. In five of the studies, initial depression led to weight loss but this association was statistically significant in only one study.[16] After controlling for baseline BMI and background variables, depressed adults were at significantly higher risk for developing later obesity (OR = 1.08) and the risk was particularly high for adolescent females (OR = 2.57) compared to non-depressed people.[16] Yet, some studies found the relationship between obesity and depression non-significant[17] or negative.[18]

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Associations between obesity and other mental disorders have also been reported. Petry and colleagues[19] found obese individuals to have significantly elevated odds (ORs ranging from 1.21 to 2.08) of any mood, anxiety and alcohol use disorders as well as any personality disorder.[19] Scott and colleagues[13] found obesity to be significantly associated with any mood disorder (OR = 1.23), major depressive disorder (OR = 1.27) and any anxiety disorder (OR = 1.46). However, when they adjusted for the comorbidity between anxiety and mood disorders, the association between obesity and anxiety disorders remained significant (OR = 1.36) but the association between obesity and mood disorders became statistically insignificant (OR = 1.05).[13] Similarly, Simon and colleagues[20] found obesity to be associated with an approximately 25% increase in odds of mood and anxiety disorders.

Prior research also indicated that individuals' socio-demographic characteristics moderated the relationship of obesity with mental disorders, and especially that with mood disorders.[13] McLaren and colleagues[21] found the association between obesity and mental disorders to vary by type and severity of mental illness, and by gender and age. For example, substance use disorders were elevated among obese men at younger compared to older ages and mood disorders were elevated among obese women compared to women of adequate BMI, while subclinical anxiety/depression was reduced among obese men compared to adequate weight men and to adequate weight women.[21] On the other hand, Simon and colleagues[20] found no gender differences in the association between obesity and mood and anxiety disorders, but noted differences across racial groups and education levels. Based on a review of the literature on the obesity-mood disorders relationship, McElroy and colleagues[22] concluded that obesity is associated with depression in women while abdominal obesity may be associated with depression in both men and women. Gender difference in the relationship between relative body weight and depression was also reported by Carpenter and colleagues[23] who examined data on over 40 000 US adults and found a significant positive association between BMI and depression in women and a significant negative association in men. In the latter study, the authors compared prevalence of depression in obese persons to that in persons of normal weight or overweight. Yet, other researchers did not find such gender differences.[20,24,25] These findings highlight the importance of examining the relationship between obesity and each type of mental disorder separately while taking individual's socio-demographic characteristics into account.

Examination of factors associated with obesity and identification of subgroups of men and women who are at high risk of being obese provide the knowledge required for planning public health policies aimed at curbing the spread of this unhealthy and costly epidemic. The main objective of the present study was to examine the associations between obesity and mood and anxiety disorders while controlling for potential confounders. The potential confounders examined in this study were those that had been identified in the literature as risk factors for mental health and obesity. For example, positive associations between obesity and poor physical health and increased functional limitations,[9,10] and between physical decline and mental ill-health[26,27] have been reported. Thus, number of chronic physical conditions and limitations in daily activities were examined as potential confounders together with socio-demographic and economic characteristics. In addition, the study examined the association between being overweight and mood and anxiety disorders while controlling for the above variables. Further, the above analyses were conducted in the total sample as well as in men and women samples separately.

Methods

Sample

This research was based on data collected by Statistics Canada in the Canadian Community Health Survey-cycle 3.1.[28] The survey was conducted in 2005 and used a multistage stratified cluster probability sampling in which a sample of dwellings was randomly selected from lists of telephone numbers. One person aged 15 years or older was randomly selected from each household to participate in the survey. The survey sample was stratified by province and urban versus rural regions. Introductory letters were mailed to selected participants assuring them of the confidentiality laws governing the release and/or publication of collected data. Participation was voluntary and the response rate was 85%. The sample represented approximately 98% of the Canadian population aged 12 years or older who resided in private dwellings in the ten provinces and the three territories. Fifty percent of the respondents were randomly selected to be interviewed face-to-face using the computer-assisted personal interviewing method, and 50% were interviewed by telephone using the computer-assisted telephone interviewing method.[28] The sample used in this study included 73 110 survey participants 20 to 64 years old for whom complete records of variables used in the analysis were available.

Measures

Body mass index. Each participant's BMI was calculated based on the participant's self-reported height and weight. This variable was not calculated for female participants who were pregnant or did not answer the pregnancy question. BMI was used to assign adults aged 20 years and over (except pregnant women) to one of the following categories: underweight (BMI < 18.5), adequate weight (18.5 ≤ BMI < 25), overweight (25 ≤ BMI < 30) or obese (BMI ≥ 30). These BMI categories are adopted from the widely used body weight classification system recommended by Health Canada and the World Health Organization (WHO).

Mood and anxiety disorders. Participants were asked whether they had been diagnosed by a health professional as having a mood disorder (such as depression, bipolar disorder, mania or dysthymia), or anxiety disorders (such as any type of phobia, obsessive-compulsive disorder, generalized anxiety disorder, post-traumatic stress disorder or panic disorder) in the past year. A categorical variable with four mutually exclusive groups was created and used in the present study: participants with neither disorder, participants with mood disorders

only, participants with anxiety disorders only and participants with both disorders.

Physical Activity Index. This variable categorizes respondents as being "active," "moderately active," or "inactive" based on their average daily energy expenditure values (kcal/kg/day) during their leisure time activities in the past three months. Participants were asked about their leisure physical activities and the length of time they spent on each during the three months prior to the interview. The energy expenditure (EE) of participants' leisure activities was calculated using the frequency and time per session of the physical activity, as well as its metabolic equivalent of task (MET). Metabolic equivalent of task was expressed as a multiple of the resting metabolic rate. Thus, an activity of 4 METs requires four times the amount of energy as compared to when the body is at rest. Survey participants were not asked to specify the intensity level of their activities; therefore, the MET values calculated here correspond to the low intensity value of each activity. This approach was adopted because individuals tend to overestimate the intensity, frequency and duration of their activities.[29] Participants were then classified as active (EE ≥ 3.0), moderately active (1.5 ≤ EE < 3.0) and inactive (EE < 1.5).

Chronic conditions. Participants were asked about certain chronic health conditions that were expected to last or had already lasted six months or more and that had been diagnosed by a health professional. This variable was a count of the number of chronic physical illnesses participants were diagnosed for in the 12 months prior to the interview.

Functional limitations. Survey participants were asked a series of questions about whether they needed help with instrumental activities of daily living such as preparing meals, shopping for groceries and other necessities, getting to appointments, doing everyday housework, personal care or moving about their home because of a long-term health condition. A long-term health condition was defined as a condition that is expected to last or has lasted six months or more. This variable indicated whether participants required help with their usual daily activities.

Smoking. This variable indicates the type of smoker the respondent was, based on his/her answer to the question: "At the present time, do you smoke cigarettes daily, occasionally or not at all?

Socio-demographic characteristics and health indicators used in this research included sex, age group (20 to 34 years, 35 to 49 years, 50 to 64 years, 65 years or older), marital status (married/common law versus divorced/separated/widower/never married), length of time in Canada (9 years or less, 10 years or more, Canadian born), educational level (less than secondary school degree, secondary school graduate, some post secondary education, post secondary graduate) and income level (low, 30%; middle, 40%; and upper, 30%) of the income distribution in their province of residence.[28] The income level variable was derived by Statistics Canada to measure the rank of adjusted household income as a ratio of the provincial low-income cut-off. The low-income cut-off is defined as the income below which a family is likely to spend a significant portion of its income to purchase necessities such as food, lodging and clothing. First, the ratio of the participant's total household income to the low-income cut-off corresponding to their household size and community size was calculated. Second, these ratios were rescaled to range between zero and 100 within each province. For example, if the highest ratio was 21, i.e. adjusted personal income was 21 times the low-income cut-off, this would be the 100. Similarly, the lowest ratio would be the zero.

Data analysis

Chi-square tests were used to assess bivariate relationships between BMI classification and prevalence of mood and/or anxiety disorders, smoking, limitations in daily living activities, number of chronic physical conditions and socio-demographic and economic characteristics. All variables that were found in the bivariate analysis to be significantly associated with obesity (at the $p = .05$ significance level) were included in the multivariate logistic analysis. A block logistic regression analysis was used to test the association between obesity and a diagnosis of mood and/or anxiety disorders while controlling for potential confounders. Block regression is similar to sequential analysis in which the second block of variables is entered in the model after having accounted for the effects of the variables in the first block. The outcome variable was obese versus adequate weight. The first block of variables included sex, age, living arrangement, length of time in Canada, income level, education level, functional limitations, number of chronic physical conditions, smoking frequency and level of physical activity; the second block included having a diagnosis of mood and/or anxiety disorders. All independent variables were treated as categorical variables to allow for possible curvilinear relationships with the outcome variable. The block logistic regression analysis was conducted on the total sample as well as on men and women samples separately. The above analyses were repeated with the outcome variable being overweight versus adequate weight. Sampling weights were rescaled and used in all analyses. Rescaling the weights takes into account the unequal probabilities of selection of survey participants without inflating the sample size in hypothesis testing.[28]

Results

Of the 73 110 participants in this sample, 1769 (2.4%) were classified as underweight, 34 087 (46.6%) were classified as adequate weight, and 25 145 (34.4%) were classified as overweight and 12 109 (16.6%) were classified as obese (Table 1).

As seen in Table 1, 6.4% of obese individuals had been diagnosed with a mood disorder, compared with 3.6% of those with adequate weight. The prevalence of anxiety disorders in obese individuals is 3.0%, compared with 2.6% in individuals with adequate weight. Additionally, 3.4% of individuals classified as obese had been diagnosed with both mood and anxiety disorders, compared with only 1.9% among those classified as having adequate weight. A chi-square test indicated a significant association between obesity and mood/anxiety disorders (chi-square = 363.83, df = 9, $p < .0005$).

Table 2 includes numbers and percentages of obese and adequate weight individuals

BMI classification	Sample size	Neither mood nor anxiety	Mood disorders	Anxiety disorders	Mood and anxiety disorders
	(*n*)	*n* (%)	*n* (%)	*n* (%)	*n* (%)
Underweight	1 769	1 565	74	57	73
(BMI < 18.5)		(88.5)	(4.2)	(3.2)	(4.1)
Adequate weight	34 087	31 326	1 227	886	648
(18.5 ≤ BMI < 25)		(91.9)	(3.6)	(2.6)	(1.9)
Overweight	25 170	23 083	1 031	629	427
(25 ≤ BMI < 30)		(91.8)	(4.1)	(2.5)	(1.7)
Obese	12 109	10 559	775	363	412
(BMI ≥ 30)		(87.2)	(6.4)	(3.0)	(3.4)
Total	73 135	66 533	3 107	1 935	1 560
		(91.0)	(4.3)	(2.6)	(2.1)

Chi-square = 363.83, df = 9, *p* < .0005

Abbreviations: BMI, body mass index; df, degrees of freedom; *n*, sample size; *p*, significance level

by levels of all variables used in the analysis. The table also includes results of the multiple logistic regression analysis. The bivariate chi-square tests revealed a significant association (*p* < .0005) between obesity and sex, age, living arrangement, length of time in Canada, income level, education level, number of chronic physical conditions, limitations in daily living activities, smoking frequency and level of physical activity. The prevalence of obesity increased steadily with advancing age and number of chronic physical conditions and decreased steadily with higher education and physical activity levels. It is also worth noting that the prevalence of obesity among individuals born in Canada was more than double that of recent immigrants.

The likelihood of obesity for men was twice that of women (OR = 2.00, 95% CI = 1.92, 2.10), increased with advancing age (OR = 1.48, 95% CI = 1.40, 1.57 for the 35 to 49 age group; OR = 1.68, 95% CI = 1.58, 1.79 for the 50 to 64 age group) and was higher in individuals living with a partner compared with those living without (OR = 1.22, 95% CI = 1.16, 1.28). Further, the odds of obesity was 2.63 times higher (95% CI = 2.33, 2.96) for those born in Canada compared with recent immigrants. Persons in the low and middle income groups had higher odds of being obese compared with persons in the highest income level (OR = 1.12, 95% CI = 1.05, 1.19 for the low income group;

OR = 1.12, 95% CI = 1.06, 1.18 for the middle income group). Those with less than high school education had significantly higher odds of being obese compared with post-secondary graduates (OR = 1.60, 95% CI = 1.49, 1.72). Although the results did not indicate a gradient of risk of obesity with income level (OR = 1.12 for both low and middle income groups), there was an apparent gradient of the odds of obesity with lower levels of education. Odds ratios presented in Table 2 also show a gradient of risk of obesity with level of physical activity with inactive individuals having double the odds of being obese compared with active individuals (OR = 2.01, 95% CI = 1.89, 2.13). Lastly, regular and occasional smokers were less likely to be obese compared with non-smokers (OR = 0.58, 95% CI = 0.55, 0.63 for regular smokers; OR = 0.63, 95% CI = 0.56, 0.69 for occasional smokers).

Results of the logistic regression analysis further indicated that after controlling for the above variables, the odds ratios of obesity were 1.50 (95% CI = 1.36, 1.66) among those with mood disorders and 1.48 (95% CI = 1.29, 1.69) among persons with both mood and anxiety disorders, compared with the odds of obesity in those with neither disorder (Table 2). There was no significant association between the odds of obesity and having been diagnosed with anxiety disorders (OR = 1.02, 95% CI = 0.89, 1.17).

Results of the logistic regression analysis conducted on men and women separately revealed slight differences with regards to sex in the association between obesity and mood and anxiety disorders. Adjusting for socio-demographic and economic characteristics, chronic physical conditions, activity limitations and smoking frequency, the odds ratios of obesity in men and women with anxiety disorders remained insignificant (OR = 0.88 for men; 1.10 for women). The odds ratio of obesity in women with mood disorders was 1.48 (95% CI = 1.30, 1.68, *p* < .005) and in men with mood disorders was 1.50 (95% CI = 1.27, 1.79, *p* < .0005). The odds ratio of obesity among women with both disorders increased to 1.45 (95% CI = 1.22, 1.72, *p* < .0005) and to 1.32 (95% CI = 1.04, 1.67, *p* = .02) among men with both disorders, compared with the odds of obesity in women and men with neither disorders.

Similar logistic regression analysis was conducted with overweight versus adequate weight as the dependent variable. Results of this analysis indicated that after controlling for socio-economic and health characteristics, the odds of being overweight for persons with mood disorders was 1.23 times that for persons with neither mood nor anxiety disorder (95% CI = 1.12, 1.34, *p* < .0005). There was no significant difference between the odds of being overweight for persons with anxiety disorders (OR = 1.04, 95% CI = 0.93, 1.16) nor for

TABLE 2

**Association between obesity (BMI ≥ 30) and socio-demographic and economic characteristics and mental health indicators
in Canadians 20 to 64 years old (n = 46 196 obese or adequate weight)**

	Total	Obese n (%)	Odds Ratio (95% CI)
Block 1:			
Sex			
Women	24 578	5 391 (21.9)	1 (ref)
Men	21 618	6 718 (31.1)	2.00 (1.92, 2.10)**
Age in years			
20-34	15 641	2 843 (18.2)	1 (ref)
35-49	18 107	4 918 (27.2)	1.48 (1.40, 1.57)**
50-64	12 448	4 348 (34.9)	1.68 (1.58, 1.79)**
Living arrangement			
With a partner	30 869	8 697 (28.2)	1.22 (1.16, 1.28)**
Without a partner	15 327	3 412 (22.3)	1 (ref)
Length of time in Canada			
0-9 years	2 859	356 (12.5)	1 (ref)
10 years or more	6 710	1 391 (20.7)	1.42 (1.25, 1.62)**
Canadian-born	36 626	10 361 (28.3)	2.63 (2.33, 2.96)**
Income level			
Lowest 30%	12 195	3 207 (26.3)	1.12 (1.05, 1.19) *
Middle 40%	18 740	5 081 (27.1)	1.12 (1.06, 1.18) **
Highest 30%	15 261	3 821 (25.0)	1 (ref)
Education level			
Less than high school	4 856	1 867 (38.4)	1.60 (1.49, 1.72)**
High school graduate	7 253	2 032 (28.0)	1.22 (1.15, 1.30)**
Some post-secondary	4 156	1 066 (25.6)	1.14 (1.06, 1.24)*
Post secondary graduate	29 930	7 144 (23.9)	1 (ref)
Number of chronic conditions			
None	16 643	3 125 (18.8)	1 (ref)
One	13 510	3 311 (24.5)	1.35 (1.27, 1.43)**
Two	7 807	2 256 (28.9)	1.61 (1.50, 1.72)**
Three	4 197	1 484 (35.4)	2.09 (1.93, 2.26)**
Four or more	4 039	1 933 (47.9)	3.27 (3.00, 3.56)**
Functional limitations			
None	41 583	10 246 (24.6)	1 (ref)
Any	4 586	1 860 (40.6)	1.28 (1.19, 1.38)**
Physical activity index			
Active	11 597	2 086 (18.0)	1 (ref)
Moderately active	12 002	2 897 (24.1)	1.40 (1.31, 1.49)**
Inactive	22 596	7 125 (31.5)	2.01 (1.89, 2.13)**
Type of smoker			
Daily	9 480	2 238 (23.6)	0.58 (0.55, 0.61)**
Occasionally	2 715	495 (18.2)	0.63 (0.56, 0.69)**
Not at all	34 001	9 376 (27.6)	1 (ref)

Abbreviations: BMI, body mass index; CI, confidence interval; p, significance level; ref, reference.

* p < .005, ** p < .0005

TABLE 2 (*continued*)
Association between obesity (BMI ≥ 30) and socio-demographic and economic characteristics and mental health indicators
in Canadians 20 to 64 years old (*n* = 46 196 obese or adequate weight)

	Total	Obese *n* (%)	Odds Ratio (95% CI)
Block 2:			
Mood and/or anxiety disorder			
Neither	41 858	10 549 (25.2)	1 (ref)
Mood only	1 994	768 (38.5)	1.50 (1.36, 1.66)**
Anxiety only	1 233	359 (29.1)	1.02 (0.89, 1.17)
Mood and anxiety	1 059	417 (39.4)	1.48 (1.29, 1.69)**

Abbreviations: BMI, body mass index; CI, confidence interval; *p*, significance level; ref, reference.

* *p* < .005, ** *p* < .0005

persons with both disorders (OR = 0.94, 95% CI = 0.83, 1.08) compared to those with neither disorder.

Discussion

This research examined a range of socio-demographic, economic, physical health and behavioural correlates of obesity using a nationally representative sample of Canadians. It then examined the associations between obesity and mood and anxiety disorders while controlling for the above factors. The above associations were examined in the total sample as well as in men and women samples separately.

Findings of this research revealed significantly elevated levels of obesity in men compared with women, Canadian born compared with recent immigrants, persons living with a partner compared to those not living with a partner, non-smokers compared with smokers, and persons with functional limitations compared to those with no such limitations. Findings also revealed an educational gradient in prevalence of obesity. Further, prevalence of obesity was positively associated with advancing age and number of chronic physical conditions. When adjusting for the above variables, the odds of obesity remained significantly higher in persons with mood disorders (with or without anxiety) compared to those with neither mood nor anxiety disorders.

Based on the results of this study, about 16.6% of the Canadian population 20 to 64 years old were classified as obese (BMI ≥ 30). This is slightly higher than rates reported for European countries[1] and much lower than

the 31% observed in the US population.[36] However, the fact that the Canadian obesity rate was based on self-reported data while the US rate was based on measured data could explain some of the difference between the two rates. The association between obesity and physical inactivity, less smoking, advancing age, low income, and lower levels of education are consistent with findings of previous studies (e.g. Bryan and Walsh,[7] Perez,[6] Simon et al.,[20] Torrance et al.[8]). The strong association between obesity and functional limitations and chronic physical conditions are also in line with findings of previous studies (e.g. Larsson et al.,[10] Li et al.[9]).

Results of this research indicated a moderate association between obesity and mood disorders. This result is in line with previously reported reports (e.g. Blaine,[16] Bruffaerts et al.,[1] Jorm et al.[18]). Simon and colleagues[20] reported similar association between obesity and lifetime diagnosis of mood disorders. In addition, the lack of apparent sex difference in the obesity-mood disorders relationship is consistent with results of other studies (e.g. Carr et al.,[24] Dong et al.,[25] Simon et al.[20]).

However, data used in this study revealed a non-significant association between obesity and anxiety disorders. This result contrasts with that reported by Simon and colleagues.[20] Differences in measurement and methodology may account for the different findings. In their study, Simon and colleagues[20] compared the prevalence of mental disorders among obese versus adequate/overweight individuals. They also used the criteria of the Diagnostic and

Statistical Manual Disorders (DSM-IV) to identify people with these disorders.

With regard to the association between being overweight and having mood and/or anxiety disorders, findings of this study revealed a significant association of overweight with mood disorders and insignificant association of overweight with anxiety disorders. These findings are different from those reported by Bruffaerts et al.[1] and McLaren et al.[21] who did not find an association of overweight with having mood disorders.

Although the methodology of the present study does not allow for the examination of specific conceptual models that could account for the observed associations between obesity and poor psychological health, a brief discussion of possible explanations that have been put forward regarding them is warranted. One explanation highlights the role of poor physical health, increased functional limitations and interpersonal stressors, such as social stigma[30] experienced by obese persons as mediators in the obesity-poor mental health relationship. For example, Carr and colleagues[24] reported that once these physical and interpersonal stressors were controlled for, obese persons had better psychological health, compared with persons with adequate weight. A theoretical model, which stipulates a bidirectional causal pathway between obesity and depression and defines potential behavioural, cognitive, physiological and social mediators, has also been suggested.[31] Additionally, a genetic susceptibility to both obesity and depression has been proposed, whereby both conditions share some common

genes.[32,33] Stankard and colleagues[33] also emphasized the role of adverse childhood experiences in promoting both conditions. In their review of the literature on obesity and mood disorders, McIntyre and colleagues[11] concluded that both conditions share aspects of phenomenology, comorbidity, family history and biology. More research examining this potential explanation is warranted. If indeed, the relationship between obesity and mood and/or anxiety disorders is causal, more research is needed to establish the direction of this causal relationship.

A number of limitations should be considered when interpreting the findings of this research. First, BMI calculated from self-reported height and weight is known to be lower than that calculated from measured height and weight because of people's tendency to overestimate their height and underestimate their weight.[34] When Shields and colleagues[35] compared self-reported against measured heights and weights in a sample of the Canadian Community Health Survey participants, they concluded that the prevalence estimates of obesity calculated from self-reported data were approximately 9% and 6% lower than estimates based on measured data for men and women, respectively. Similar estimates were reported by Flegal and colleagues[36] who examined the difference between self-reported and measured obesity measures in the US surveys. Second, although the BMI classification system is a useful indicator for comparing body weight patterns and related health risks within and between populations, it does not take into account individual differences in body leanness and/or muscularity. Hence, the health risk associated with each BMI category varies considerably between individuals.

Third, the identification of individuals as having mood disorders and/or anxiety disorders was not done by clinicians. It was based on respondents' answers to the question of whether they had been diagnosed with the disorder. Given the frequently reported under-diagnosis of mental disorders, the data could possibly underestimate the prevalence of mood and anxiety disorders. Additionally, the survey

did not include individuals living in nursing homes, mental institutions or chronic care hospitals; thus, the data could further underestimate the prevalence of both disorders. Fourth, participants were not asked about each mood disorder separately. Instead, depression, bipolar disorder, mania or dysthymia were combined in one question. Consequently, the association between obesity prevalence and impact of each of these disorders on quality of life cannot be inferred. Additionally, the cross-sectional nature of the data precluded an examination of the temporal sequence of onset of obesity and mood and anxiety disorders. Thus, a causal relationship between obesity and mood and/or anxiety disorders cannot be inferred.

Given these limitations, the present study determined the prevalence and correlates of obesity using the most up-to-date data available on a representative sample of Canadians. In addition, the study examined the association between obesity and mood and/or anxiety disorders while adjusting for a range of socio-demographic, economic and behavioural characteristics, physical health and smoking frequency. To the authors' knowledge, this is the first study to examine the associations between obesity and mood and anxiety disorders in this population.

Detrimental ramifications of the obesity epidemic are enormous, both to the individuals and society. Health care providers are encouraged to consider an integrated treatment modality to investigate depression in obese patients whereby psychologists and mental health care professionals participate in the assessment and treatment plan of obese patients.[37,31] There is an urgent need for behavioural interventions aimed at targeting unhealthy eating and physical inactivity, especially among the high risk populations identified in this study. There is also a need for more longitudinal research to clarify the temporal relationship between obesity and mood disorders as well as the biological, psychological and socio-demographic moderators and mediators of this important relationship. Specifically, as results of this study revealed a large difference in the prevalence of obesity between new immigrants

and Canadian born, more research on the role of ethnicity as a determinant of obesity and possibly as a moderator in the obesity-mental health relationship needs further scrutiny.

Acknowledgements

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