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Association between physical multimorbidity, body mass index and mental health/disorders in a representative sample of people with obesity

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ABSTRACT

Background Obesity is known to be associated with poor mental health. Studies suggested that multimorbidity might explain the consequences of obesity on mental health. The objective of the present study was to examine to what extent physical multimorbidity and the severity of obesity were associated with mental health and with mental disorders.

Methods Cross-sectional study including a weighted representative sample of individuals in obesity from the province of Quebec included in the 2013–2014 Canadian Community Health Survey (N=1315) and test of the replicability of the association in the three previous cycles (2011–2012, N=1180; 2009–2010, N=1166; 2007–2008, N=1298).

Results Adjusted logistic regressions showed that when obesity classes and physical multimorbidity were considered, the latter was preferentially associated with poor perceived mental health (OR 3.58, 95% CI 2.07 to 6.22), psychological distress (OR 3.71, 95% CI 2.14 to 6.42), major depressive episode (OR 5.16, 95% CI 2.92 to 9.13), mood disorders (OR 2.31, 95% CI 1.41 to 3.78) and anxiety disorders (OR 2.46, 95% CI 1.46 to 4.16). The same associations were confirmed in the previous cycles. Obesity class was only associated with stress (OR 2.05, 95% CI 1.36 to 3.07), but this association was not confirmed in the other cycles. Both physical multimorbidity and severe obesity were associated with mental multimorbidity.

Conclusion Among people with obesity, physical multimorbidity is preferentially associated with poor mental health/disorders. There is an existence of a somatic-mental multimorbidity which should be assessed and prevented in the management of obesity.

INTRODUCTION

Obesity, defined as an accumulation of fat with adverse effects on health, is a prevalent condition worldwide and particularly in North America.¹ In Canada, the prevalence of obesity is 13% and future projections indicate an increase for the next decade.² Obesity is also known to be associated with several physical or mental comorbidities such as type 2 diabetes, sleep apnoea, hypertension or depression.^{3,4} Given its multiple effects on health, obesity has been described as the entrance port to multimorbidity⁵ (defined as the presence of two or more chronic conditions simultaneously). A previous study highlighted that the odds ratio (OR) of developing a cardiometabolic multimorbidity increased by nearly two times per each 5

kg/m² increase in body mass index (BMI)⁶ which illustrated the importance of obesity. However, despite being a prevalent condition, the impact of obesity on the development of multimorbidity has been rarely considered.^{7,8} In a systematic review addressing multimorbidity, only 5 studies over the 39 included considered obesity.⁸ Though the prevalence of multimorbidity in Canadian adults is 3.9% (considering three diseases or more according to Public Health Agency of Canada) or 13% (considering two diseases or more),⁹ in adults with obesity, 31% were found to have multimorbidity⁷ and this prevalence could reach 86% in the most severe types of obesity (BMI >60 kg/m²).¹⁰ Moreover, studies underlined that higher BMI was associated with an increased prevalence of multimorbidity¹¹ with men and women in class III obesity being seven and nine times more likely to have multimorbidity compared with their normal-weight counterparts.¹²

Also, studies showed that multimorbidity was a new challenge for the different healthcare systems¹³ due to its association with unplanned admissions to hospital,¹⁴ impaired quality of life,¹⁵ psychological distress¹⁶ and ultimately with the reduced life expectancy.¹⁷ Regarding the association between multimorbidity and mental health, in the general population, about 11% were found to have a combination including vascular (eg, hypertension, hyperlipidemia) and psychological (eg, depression, anxiety, insomnia) morbidities.¹⁸ Among young adults, the presence of a mood and/or anxiety disorder explained 52% of physical/mental multimorbidity.⁹ In addition, it has been pointed out that about 30% of people in primary care with physical multimorbidity had a positive screening for depressive symptoms with a dose-response relationship between the number of morbidities and the prevalence of depression.¹⁹

Although important, none of the previous studies exclusively included people with obesity, while obesity and multimorbidity are contributors of impaired mental health. Also, none of these studies examined the impact of the co-occurrence between physical multimorbidity and the severity of obesity on mental health. Moreover, between BMI and multimorbidity, it is unknown whether one or the other is preferentially associated with poor mental health.

So, the objective of the study was to examine the relationship between BMI and physical multimorbidity in regards to mental health outcomes. The second objective was to examine these associations



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in several representative samples to test for their replication.²⁰ It was expected that obesity classes, particularly severe obesity, and physical multimorbidity would be associated with poor mental health.

METHODS

Procedure and settings

The current study was based on data collected by Statistics Canada in the Canadian Community Health Survey (CCHS) which is a health population survey.²¹ Analyses were conducted using data collected in 2013–2014 and the replicability of the associations was tested using data collected in 2011–2012, 2009–2010 and 2007–2008 when possible. The CCHS provides cross-sectional information related to health status, healthcare utilisation and health determinants, and the sample represents approximately 98% of the Canadian population aged 12 years or older (approximately 28.3 million Canadians) living in private dwellings in the 10 provinces and the 3 territories.²² People excluded from the CCHS are those living on Indian Reserves or Crown lands, residing in institutions, full-time members of the Canadian Forces and residents of certain remote regions. Respondents were interviewed by telephone or by face-to-face interview. All the measures were self-reported.

Study-specific inclusion criteria

In the present study, the inclusion criteria were adults (≥ 18 years old), with obesity ($\text{BMI} \geq 30 \text{ kg/m}^2$), inhabitants from the province of Quebec and provided complete answers to the questionnaires. BMI was calculated ($\text{weight (kg)/height (cm)}^2$), and by definition, BMI was defined in three classes being class I: $30.0\text{--}34.9 \text{ kg/m}^2$, class II: $35.0\text{--}39.9 \text{ kg/m}^2$ and class III: $\geq 40.0 \text{ kg/m}^2$.

Physical comorbidities

Participants responded to a module on chronic diseases. In the present study, the same 11 different physical morbidities present in the four CCHS cycles (2007–2014) were selected and were asthma, arthritis, type 2 diabetes, high blood pressure, migraines, heart disease, cancer, cerebrovascular disorders, stomach ulcer, back ache and intestinal problems. All data were self-reported and health conditions were expected to last or have already lasted 6 months or more and should have been diagnosed by a health professional. The prevalence of these physical comorbidities had already been described in previous studies using these health population surveys.^{9,23}

Definition of physical multimorbidity

In order to be consistent with the previous study using the CCHS and to follow the recommendations from the Public Health Agency of Canada,⁹ physical multimorbidity was defined as the presence of three or more physical comorbidities excluding obesity given it was an inclusion criterion.

Mental health markers

The different indicators of mental health selected were perceived mental health, psychological distress and daily stress. Data were available in the four CCHS cycles for perceived mental health, perceived daily stress and in three cycles for psychological distress (no data available in the 2011–2012 cycle).

Perceived mental health was evaluated using a single item with the following wording: “In general, would you say your mental health is...”, with response options being poor, fair, good, very good and excellent. In the present study, a poor health was the combination of those who reported poor or fair.

Psychological distress was assessed using the K6 scale.²⁴ This scale has been validated according to the DSM-IV criteria and higher scores (ranging from 0 to 24) represent a higher presence of psychological distress.²⁴ In the present study, participants were considered as having high level of psychological distress when their scores were greater than or equal to 10.

Perceived daily stress was evaluated using a single item with participants being asked: “Thinking about the amount of stress in your life, would you say that most days are...”. Five possibilities of responses were provided: extremely stressful, quite a bit stressful, a bit stressful, not very stressful and not at all stressful. The respondents who reported extremely stressful or quite a bit stressful were considered as stressed.

Mental health disorders

Indicators selected were major depressive episode, mood disorders and anxiety disorders. Data were available in the four CCHS cycles for mood and anxiety disorders, and in three cycles for major depressive episode (no data available in the 2011–2012 cycle).

Major depressive episode was evaluated using the composite international diagnostic interview short-form questionnaire²⁵ and express the probability of having experienced a major depressive episode over the last 12 months. This questionnaire is a structure diagnostic instrument that was designed to produce diagnoses of a major depressive episode according to the DSM-IV and the ICD-10. In the present study, a major depressive episode was considered when participants exceed a 90% risk of having experienced an episode.

To assess the presence of a mood disorder, participants were asked whether they had been diagnosed for a mood disorder, such as depression, bipolar disorder, mania or dysthymia, by a health professional. Those who responded positively were considered as having a mood disorder. This classification has already been used in previous studies and was found to be reliable given its association with other mental health outcomes or physical comorbidities.^{23,26,27}

Similarly, anxiety disorder was evaluated with one item and participants were asked whether they had a diagnosis of anxiety disorders such as phobia, obsessive compulsive disorder or panic disorder diagnosed by a health professional.

Mental multimorbidity

Given the absence of previous definition regarding mental multimorbidity, in the present study, it was defined as the presence of two or more mental morbidities.

Statistical analyses

The CCHS used a complex survey design that resulted in unequal probabilities of selection for respondents. Briefly, the CCHS used three sampling frames to select the sample of included households (40.5% using an area frame, as defined by the Canadian Labour Force Survey; 58.5% using a list frame of telephone numbers; and 1% using a random digit dialling). Based on the Canadian Labour Force Survey, each province is divided into three types of regions being major urban centres, cities and rural regions and different geographical and socioeconomic strata are created. So, to be representative of the Quebec population, a weight was attributed to each participant included in the sample. In this study, we computed normalised weight by dividing the raw weight by its mean. The normalised weight takes into account disproportionate sampling but does not assume a simple random sample. The design effect must be included to account for the

clustered design and this was done by dividing the normalised weight by the average design effect (which is 2.87 in the 2013–2014 cycle, 2.97 in 2011–2012, 2.78 in 2009–2010 and 2.47 in 2007–2008). The analyses were conducted by applying the new weights. When these weights were applied to the data, the results reflected the underlying population.²⁸ When an association was detected between physical multimorbidity or obesity with a dependent variable (mental health/disorders), the replicability of this association was tested using the previous cycles (2011–2012, 2009–2010 and 2007–2008). In the present study, an association was considered reliable if it was detected in three cycles over the four (or in two cycles over the three when data were not available for four cycles). To calculate the prevalence of physical multimorbidity, a prevalence ratio with its 95% CI was calculated.

To evaluate whether physical multimorbidity or the severity of obesity was preferentially associated with (1) mental health/disorders and (2) mental multimorbidity, logistic regressions analyses were performed. BMI were separated (class II vs class I, and class III vs class I) to better consider the influence of obesity severity on mental health outcomes. Physical multimorbidity and obesity classes were added as independent variables along with sex (men=0; women=1), age (≤ 44 years old=0; ≥ 45 years old=1) and education (post-secondary school graduation=0; secondary school graduation or less=1) as covariates. Statistical analyses were performed with SPSS V.21.

RESULTS

Sample characteristics

Using the 2013–2014 CCHS cycle, a weighted representative sample of 1315 participants with obesity including 589 women (44.8%, 95% CI 42.2 to 47.6) was included. A majority of the population was 45 years old or older (62.0%, 95% CI 59.4 to 64.7), completed more than a secondary school degree (64.3%, 95% CI 61.7 to 66.9), was married (41.4%, 95% CI 38.8 to 44.1) and had two persons in their household (41.9%, 95% CI 39.3 to 44.6). The mean BMI was 33.92 ± 4.08 kg/m² (2011–2012: 33.72 ± 3.93 kg/m²; 2009–2010: 33.97 ± 4.07 kg/m²; 2007–2008: 33.91 ± 3.91 kg/m²). About half of participants were evaluated using phone (51.1%, 95% CI 48.5 to 53.9). Although there was variation according to the sampling frame and number of people included in the different CCHS cycles, participants' sociodemographic characteristics were similar across cycles. All information about participants including in the other CCHS cycles are in [table 1](#).

Prevalence of physical multimorbidity

Using the 2013–2014 cycle, the weighted prevalence of each individual morbidity according to BMI classes is provided in [table 2](#). Otherwise, in the same cycle, the prevalence of physical multimorbidity was 18.0% (95% CI 16.0 to 20.2) while it was 16.2% (95% CI 14.3 to 18.3) in the 2007–2008 CCHS cycle. Nevertheless, the examination of 95% CI showed an overlap between the two cycles which indicates no difference between the prevalence.

Association between mental health outcomes, physical multimorbidity and obesity

When perceived mental health was evaluated, logistic regression showed that participants with obesity and physical multimorbidity were more likely to report poor perceived mental health (OR 3.58, 95% CI 2.07 to 6.22) and no significant association with obesity classes was detected. This association between poor

perceived mental health and physical multimorbidity was found in three cycles out of the four and an upward trend (OR 1.72, 95% CI 0.39 to 2.50, $p=0.09$) was found in the 2011–2012 cycle ([table 3](#)).

Regarding psychological distress, participants with obesity and physical multimorbidity were three times more likely to report psychological distress (OR 3.71, 95% CI 2.14 to 6.42) and obesity classes showed no association with psychological distress. This significant association remained stable across the three CCHS cycles ([table 3](#)).

For daily stress, participants with obesity and physical multimorbidity did not report a higher likelihood of feeling more stressed ([table 3](#)). However, compared with class I, participants in class III obesity were more likely to report feeling stressed (OR 2.05, 95% CI 1.36 to 3.07) ([table 2](#)). The occurrence of the association between stress and class III obesity was found only one time (in the 2013–2014 cycle) over the four possibilities. A significant association between physical multimorbidity and daily stress was observed in one cycle (2009–2010) over the four ($p<0.001$) ([table 2](#)).

Association between mental disorders, physical multimorbidity and obesity

Regarding major depressive episode, people with obesity and physical multimorbidity were five times more likely to report a major depressive episode in the last year (OR 5.16, 95% CI 2.92 to 9.13) and a trend with class III obesity was observed (OR 1.90, 95% CI 0.96 to 3.77, $p=0.06$). In terms of replicability, the association between physical multimorbidity and major depressive episode was found in all the three CCHS cycles (see [table 4](#)). Otherwise, no other association between obesity classes and major depressive episode was noted in the CCHS cycles.

Regarding mood disorders, people with obesity and physical multimorbidity were two times more likely to report a positive diagnosis (OR 2.31, 95% CI 1.41 to 3.78) while no association was found with obesity classes. This association with mood disorders was consistently found across the four CCHS cycles ([table 4](#)).

Regarding anxiety disorders, participants with obesity and physical multimorbidity were also more likely to report anxiety disorders (OR 2.46, 95% CI 1.46 to 4.16) and this association was respectively found in the four CCHS cycles. Otherwise, no association with the severity of obesity was noted.

Association between mental multimorbidity, physical multimorbidity and obesity

In the present study, the prevalence of any mental multimorbidity was 15%. Regarding mental multimorbidity, people with obesity and physical multimorbidity were five times more likely to report a mental multimorbidity (OR 5.02, 95% CI 3.35 to 7.50) and a significant association was also found with severe obesity (OR 1.88, 95% CI 1.14 to 3.10). In terms of reliability, the association between mental and physical multimorbidity was found over the three CCHS cycles ([table 5](#)) and in two cycles out of the three for severe obesity ([table 5](#)).

DISCUSSION

In the present study conducted with a representative sample of the population, our objective was to analyse among people with obesity, to what extent physical multimorbidity or obesity classes were preferentially associated with mental health, and whether any detected association was replicable. First, with 18% of our population with a physical multimorbidity, the prevalence

Table 1 Descriptive characteristics of the four included samples

	CCHS 2013–2014 (N=1315)			CCHS 2011–2012 (N=1180)			CCHS 2009–2010 (N=1166)			CCHS 2007–2008 (N=1298)		
	N	%	95% CI	N	%	95% CI	N	%	95% CI	N	%	95% CI
Sex												
Male	725	55.2	52.6 to 57.9	609	51.6	48.9 to 54.6	621	53.3	50.5 to 56.2	686	52.9	50.2 to 55.6
Female	589	44.8	42.2 to 47.6	570	48.4	45.6 to 51.3	545	46.7	44.0 to 49.7	612	47.1	44.5 to 49.9
NA	1			1			–	–		–		
Age												
18 to 44	500	38	35.5 to 40.7	432	36.7	34.0 to 39.5	439	37.7	35.0 to 40.5	503	38.8	36.2 to 41.5
45 and more	815	62	59.4 to 64.7	747	63.3	60.7 to 66.2	727	62.3	59.6 to 65.2	795	61.2	58.7 to 64.0
NA	–			1			–	–		–		
Level of education												
Secondary school graduation or less	461	35.7	33.2 to 38.4	409	36.2	33.5 to 39.1	418	36.7	34.0 to 39.6	486	38.6	36.1 to 41.4
Post-secondary school graduation	829	64.3	61.7 to 66.9	720	63.8	61.0 to 66.6	720	63.3	60.5 to 66.1	771	61.4	58.7 to 64.1
NA	25			51			28			41		
Marital status												
Married	543	41.4	38.8 to 44.1	513	43.5	40.8 to 46.4	509	43.8	41.0 to 46.8	559	43.1	40.5 to 45.9
Common-law partner	305	23.2	21.1 to 25.6	248	21.1	18.8 to 23.5	219	18.8	16.7 to 21.2	266	20.5	18.4 to 22.8
Widowed—divorced	203	15.4	13.6 to 17.5	201	17.1	15.0 to 19.3	181	15.6	13.6 to 17.8	214	16.5	14.6 to 18.6
Single	262	19.9	17.9 to 22.2	217	18.4	16.3 to 20.8	253	21.8	19.5 to 24.3	258	19.9	17.8 to 22.2
NA	2			1			4			1		
No of persons in the household												
One person	261	19.9	17.8 to 22.1	218	18.5	16.4 to 20.8	232	19.9	17.7 to 22.3	225	17.4	15.4 to 19.5
Two persons	550	41.9	39.3 to 44.6	482	40.8	38.1 to 43.8	466	40	37.3 to 42.9	481	37.1	34.5 to 39.8
Three persons and more	503	38.2	35.7 to 41.0	480	40.7	38.0 to 43.6	468	40.1	37.4 to 43.0	592	45.5	43.0 to 48.4
NA	1			–	–		–			–	–	
Sample frame												
Telephone frame	670	51.1	48.5 to 53.9	536	45.8	43.1 to 48.8	504	43.3	40.5 to 46.2	513	39.8	37.2 to 42.6
Area frame	640	48.9	46.2 to 51.6	634	54.2	51.4 to 57.1	660	56.7	53.9 to 59.6	775	60.2	57.6 to 62.9
NA	5			10			2			10		
Physical multimorbidity												
Two and less	1062	82	79.9 to 84.1	972	83.3	81.2 to 85.5	963	83.4	81.3 to 85.6	1074	83.8	81.8 to 85.9
Three and more	233	18.0	16.0 to 20.2	195	16.7	14.7 to 19.0	192	16.6	14.6 to 18.9	207	16.2	14.3 to 18.3
NA	20			13			11			17		

CCHS, Canadian Community Health Survey; NA, not available.

was found to be higher than in the Canadian general population which is 3.9% (p20).^{9 29} This increased prevalence can be explained notably by the fact the study was realised among people with obesity which is known to largely contribute to multimorbidity.^{7 11}

Regarding the association between mental health indicators, physical multimorbidity and obesity classes, in summary, we found that physical multimorbidity was preferentially associated with most of our indicators compared with the severity of obesity. The only exception was for daily stress, but this occurrence was found only once. For the other outcomes, all detected associations were found to be replicable across cycles which increase their values. The present results underlined that though both, obesity classes and physical multimorbidity were associated with poor mental health,^{13 16 23 30 31} physical multimorbidity had greater associations among individuals with obesity. This consistent association between mental health and physical multimorbidity could probably be explained by the consequences of physical multimorbidity on health and life such as unplanned hospitalisations,¹⁴ polypharmacy³² or more work absenteeism.³³ Indeed, a previous study reported that multimorbidity involving

the cardiometabolic system (eg, obesity, diabetes) led to worsened self-reported health.³⁴

Regarding the association with mental disorders, people with obesity and physical multimorbidity were also more likely to report mental disorders with the largest association found with major depressive episode. Therefore, our results corroborate previous studies showing on one hand the association between multimorbidity and depressive symptoms,¹⁹ and on the other hand that obesity is closely associated with mental disorders.^{23 27}

Regarding mental multimorbidity, people with obesity and physical multimorbidity were more likely to also report a mental multimorbidity. Interestingly, this association was also found with severe obesity while it was not the case with previous morbidity when considered separately. This finding clearly highlights that severe obesity contributes to highlight the existence of a somatic-mental multimorbidity which should be prevented.³⁵ A previous study on the somatic-mental multimorbidity showed its prevalence to be at 8% while it was 15% in our study what underlines the detrimental effects of obesity on mental health.

In terms of practice, the present results might have some applications. First, our study suggests that the association between

Table 2 Weighted prevalence of morbidity according to obesity classes

	Obesity classes					
	Class I		Class II		Class III	
	Prevalence	95% CI (LB–UB)	Prevalence	95% CI (LB–UB)	Prevalence	95% CI (LB–UB)
Asthma	10.4	8.7 to 12.5	16.8	12.6 to 22.4	18	12.4 to 26.3
Arthritis	14.4	12.3 to 16.8	21.2	16.5 to 27.2	15.7	10.4 to 23.7
Back ache	18.5	16.2 to 21.1	29.3	24 to 35.8	25.8	19.1 to 35
Hypertension	29.3	26.6 to 32.3	36.6	31 to 43.4	46.3	38.2 to 56.1
Migraine	7	5.5 to 8.8	12.9	5.7 to 13.1	10.7	6.4 to 18
Diabetes	14.9	12.8 to 17.3	17.7	13.4 to 23.3	28.7	21.7 to 37.9
Heart disease	7.4	5.9 to 9.3	9.9	6.7 to 14.6	5.8	2.8 to 11.9
Cancer	2.3	1.5 to 3.5	2.2	1.0 to 5.2	2.5	0.8 to 7.8
Stomach ulcer	2.9	2.0 to 4.2	6.9	4.3 to 11.1	3.3	1.8 to 8.7
Cerebrovascular disease	1.1	0.6 to 2.1	0.9	0.2 to 3.4	1.7	0.4 to 6.5
Intestinal problems	4	2.9 to 5.4	5.6	3.3 to 9.5	7.4	3.9 to 13.8
Mental health perception	5.2	4.0 to 6.8	9.9	6.7 to 14.6	8.3	4.6 to 15
Psychological distress	5.9	4.5 to 7.6	9.9	6.7 to 14.7	10.3	6.1 to 17.7
Stress	25.2	22.6 to 28.1	29.9	24.5 to 36.4	40.5	32.6 to 50.3
Major depressive episode	5	3.7 to 6.6	9	5.9 to 13.7	12.1	7.4 to 19.7
Anxiety disorder	6.7	5.3 to 8.4	11.3	7.9 to 16.2	10.7	6.7 to 17.8
Mood disorder	6.6	5.2 to 8.3	9.5	6.4 to 14.1	9.8	5.7 to 16.4

LB, lower bound; UB, upper bound.

obesity and mental health/disorders might be explained by the elevated number of physical multimorbidity. Nevertheless, at the present stage, we do not know, between obesity, physical multimorbidity and mental disorders, which one was present first.

Furthermore, given we know from previous studies using the CCHS, with the same inclusion criteria and measures, that the physical multimorbidity included in the present study is related to obesity,^{23 36} the present study is more likely to indicate that

Table 3 Adjusted OR related to physical multimorbidity and the severity of obesity on mental health markers

	CCHS 2013–2014			CCHS 2011–2012			CCHS 2009–2010			CCHS 2007–2008		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Poor perceived mental health												
Sex	0.89	0.56 to 1.44	0.66	1.39	0.84 to 2.33	0.2	1.07	0.63 to 1.84	0.79	0.81	0.49 to 1.32	0.4
Age	0.45	0.27 to 0.77	0.003	0.56	0.32 to 0.97	0.03	0.5	0.27 to 0.91	0.02	0.73	0.43 to 1.25	0.25
Education	1.47	0.91 to 2.38	0.12	1.89	1.13 to 3.18	0.01	2.22	1.28 to 3.87	0.005	1.17	0.71 to 1.94	0.53
Multimorbidity	3.58	2.07 to 6.22	<0.001	1.72	0.92 to 3.24	0.09	4.13	2.28 to 7.47	<0.001	2.99	1.70 to 5.27	<0.001
BMI class I vs class II	1.54	0.89 to 2.68	0.12	1.08	0.57 to 2.08	0.79	0.96	0.48 to 1.92	0.9	1.23	0.64 to 2.19	0.48
BMI class I vs class III	1.24	0.59 to 2.61	0.57	0.99	0.39 to 2.50	0.99	1.15	0.48 to 2.77	0.75	0.74	0.28 to 1.95	0.54
Psychological distress												
Sex	1.75	1.08 to 2.82	0.02	NA			2.08	1.22 to 3.55	0.007	2.13	1.32 to 3.45	0.002
Age	0.38	0.23 to 0.65	<0.001	NA			0.3	0.17 to 0.54	<0.001	0.73	0.44 to 1.22	0.23
Education	1.69	1.04 to 2.76	0.03	NA			1.31	0.76 to 2.25	0.33	0.53	0.32 to 0.90	0.02
Multimorbidity	3.71	2.14 to 6.42	<0.001	NA			3.99	2.18 to 7.30	<0.001	3.74	2.19 to 6.37	<0.001
BMI class I vs class II	1.45	0.84 to 2.53	0.18	NA			1.44	0.77 to 2.68	0.25	0.78	0.42 to 1.44	0.42
BMI class I vs class III	1.23	0.58 to 2.56	0.58	NA			1.68	0.77 to 3.69	0.19	0.79	0.35 to 1.78	0.57
Stress												
Sex	1.08	0.84 to 1.40	0.52	1.28	0.98 to 1.67	0.07	0.75	0.57 to 0.98	0.04	1.18	0.92 to 1.53	0.19
Age	0.71	0.54 to 0.93	0.01	0.55	0.41 to 0.73	<0.001	0.5	0.38 to 0.67	<0.001	0.61	0.47 to 0.79	<0.001
Education	0.57	0.43 to 0.76	<0.001	0.49	0.36 to 0.66	<0.001	0.65	0.48 to 0.87	0.004	0.62	0.47 to 0.82	0.001
Multimorbidity	1.25	0.88 to 1.76	0.2	1.25	0.86 to 1.82	0.24	2.22	1.55 to 3.16	<0.001	1.21	0.84 to 1.73	0.3
BMI class I vs class II	1.24	0.89 to 1.72	0.21	1.13	0.79 to 1.61	0.51	0.99	0.71 to 1.41	0.98	0.69	0.49 to 0.97	0.04
BMI class I vs class III	2.05	1.36 to 3.07	0.001	1.14	0.69 to 1.87	0.59	1.47	0.93 to 2.33	0.09	1.32	0.85 to 2.06	0.22

BMI, body mass index; CCHS, Canadian Community Health Survey; NA, not available.

Table 4 Adjusted ORs related to physical multimorbidity and the severity of obesity on mental health disorders

	CCHS 2013–2014			CCHS 2011–2012			CCHS 2009–2010			CCHS 2007–2008		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Major depressive episode												
Sex	2.51	1.51 to 4.19	<0.001	NA			3.75	2.06 to 6.83	<0.001	2.45	1.47 to 4.08	0.001
Age	0.35	0.20 to 0.60	<0.001	NA			0.42	0.23 to 0.76	0.005	0.53	0.31 to 0.89	0.02
Education	0.69	0.40 to 1.22	0.21	NA			0.53	0.28 to 1.00	0.05	0.68	0.39 to 1.16	0.15
Multimorbidity	5.16	2.92 to 9.13	<0.001	NA			3.59	1.87 to 6.89	<0.001	2.77	1.55 to 4.94	0.001
BMI class I vs class II	1.43	0.79 to 2.56	0.23	NA			0.63	0.29 to 1.34	0.23	1.08	0.58 to 2.00	0.8
BMI class I vs class III	1.9	0.96 to 3.77	0.06	NA			0.47	0.15 to 1.51	0.21	1.66	0.82 to 3.35	0.16
Mood disorders												
Sex	2.36	1.52 to 3.65	<0.001	1.5	0.93 to 2.41	0.09	2.42	1.53 to 3.83	<0.001	2.08	1.32 to 3.26	0.002
Age	0.61	0.38 to 0.97	0.03	0.65	0.39 to 1.08	0.1	0.49	0.30 to 0.79	0.004	0.82	0.51 to 1.34	0.44
Education	1.11	0.71 to 1.73	0.65	1.47	0.92 to 2.37	0.11	0.63	0.38 to 1.03	0.06	0.77	0.48 to 1.23	0.28
Multimorbidity	2.31	1.41 to 3.78	0.001	1.99	1.14 to 3.49	0.02	3.31	1.96 to 5.59	<0.001	3.17	1.93 to 5.23	<0.001
BMI class I vs class II	1.51	0.91 to 2.48	0.11	1.49	0.85 to 2.63	0.16	0.92	0.51 to 1.64	0.77	1.01	0.58 to 1.75	0.96
BMI class I vs class III	1.27	0.65 to 2.49	0.48	1.64	0.78 to 3.42	0.19	1.27	0.63 to 2.58	0.49	1	0.48 to 2.11	0.99
Anxiety disorders												
Sex	2.33	1.47 to 3.69	<0.001	1.32	0.83 to 2.09	0.24	2.31	1.43 to 3.75	0.001	2.79	1.68 to 4.23	<0.001
Age	0.51	0.31 to 0.83	0.006	0.52	0.32 to 0.86	0.01	0.42	0.25 to 0.70	0.001	0.99	0.58 to 1.67	0.97
Education	1.08	0.68 to 1.75	0.73	1.32	0.82 to 2.12	0.25	1.19	0.73 to 1.94	0.49	0.91	0.56 to 1.48	0.69
Multimorbidity	2.46	1.46 to 4.16	0.001	1.99	1.12 to 3.52	0.02	2.44	1.39 to 4.28	0.002	2.47	1.45 to 4.21	0.001
BMI class I vs class II	1.22	0.71 to 2.11	0.46	1.63	0.95 to 2.78	0.07	0.65	0.33 to 1.27	0.2	1.18	0.67 to 2.07	0.56
BMI class I vs class III	1.22	0.60 to 2.45	0.58	0.88	0.36 to 2.18	0.79	1.18	0.56 to 2.47	0.66	1.11	0.51 to 2.42	0.79

BMI, body mass index; CCHS, Canadian Community Health Survey; NA, not available.

physical multimorbidity can be the driver of obesity-related health issues and complicate its management. A previous study also underlined that when related to obesity, multimorbidity increases healthcare costs.³⁷ To another extent, practitioners should be aware of mental disorders in their office given this population were more likely to have a physical multimorbidity.

Important strengths of this study include the use of a representative sample of the population, the same set of chronic diseases in the different CCHS cycles and the replicability of the detected association with the previous health population surveys. Nevertheless, some limitations should be reported. First, although the measures were validated, all data were self-reported, so we cannot exclude the possibility of a bias in reporting. Nevertheless, the consistency of our results across the four cycles underlined that this bias is probably minimised. Also, our study design was cross-sectional, so we cannot infer causality in our associations and we did not have the possibility to merge the different CCHS cycles to evaluate any temporal association between

physical multimorbidity, obesity and mental health/disorders. Finally, mental health markers and mental disorders have been merged to create a new mental multimorbidity while they are known to have different consequences on health. Therefore, the somatic-mental multimorbidity association should be interpreted in light of this limitation.

In conclusion, our study highlights the importance of physical multimorbidity among people with obesity as a risk factor for mental health issues. Researchers and health professionals should be aware of the potential consequences of physical multimorbidity on mental health. Moreover, the somatic-mental multimorbidity should be better considered in people with obesity as it seems to be prevalent. Future interventions should consider assessing and preventing physical multimorbidity in people with obesity. Moreover, future longitudinal studies should try to disentangle the specific contribution of obesity or physical multimorbidity in the development of poor mental health.

Table 5 Adjusted ORs related to physical multimorbidity and the severity of obesity on mental multimorbidity

	CCHS 2013–2014			CCHS 2011–2012			CCHS 2009–2010			CCHS 2007–2008		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
Mental multimorbidity												
Sex	1.51	1.07 to 2.11	0.02	NA			1.87	1.31 to 2.65	0.001	1.65	1.18 to 2.28	0.003
Age	0.48	0.33 to 0.71	<0.001	NA			0.45	0.30 to 0.66	<0.001	0.84	0.58 to 1.20	0.34
Education	0.57	0.62 to 1.30	0.57	NA			1.06	0.73 to 1.54	0.75	0.98	0.70 to 1.38	0.02
Multimorbidity	5.02	3.35 to 7.50	<0.001	NA			5.08	3.35 to 7.69	<0.001	3.12	2.12 to 4.58	<0.001
BMI class I vs class II	1.27	0.84 to 1.95	0.26	NA			1.01	0.65 to 1.58	0.96	1.01	0.667 to 1.53	0.95
BMI class I vs class III	1.88	1.14 to 3.10	0.01	NA			1.54	0.88 to 2.70	0.13	1.95	1.18 to 3.22	0.009

BMI, body mass index; CCHS, Canadian Community Health Survey; NA, not available.

What is already known on this subject

- There is a strong association between obesity and poor mental health.
- There is a dose–response association between the number of comorbidities and depression in the general population.

What this study adds

- In people with obesity, compared with body mass index, physical multimorbidity was associated with impaired mental health and with mental disorders.
- These associations between physical multimorbidity and mental health were found to be replicable over years.
- Physical multimorbidity should be monitored and prevented in people with obesity.
- The somatic-mental multimorbidity is prevalent in people with obesity.

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