



Research paper

Impact of obesity and mood disorders on physical comorbidities, psychological well-being, health behaviours and use of health services

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A B S T R A C T

Background: Albeit obesity and mood disorders frequently co-occur, few studies examined the impacts of this co-occurrence. The aim was to compare individuals with obesity and mood disorders (ObMD) to those with obesity without mood disorder in terms of physical comorbidities, psychological well-being, health behaviours and use of health services.

Methods: Cross-sectional study using the Canadian Community Health Survey including a weighted sample of individuals with obesity ($n = 1298$) representing inhabitants from the province of Quebec (Canada).

Results: Adjusted multivariate logistic regressions indicated that ObMD reported more physical conditions with odds ratio (OR) ranging from 1.8 [95%CI: 1.1 – 2.8] (hypertension) to 2.8 [95%CI: 1.3 – 6.0] (stomach ulcer). Also, ObMD reported poorer psychological well-being with OR ranging from 2.1 [95%CI: 1.4 – 3.3] (stress) to 25.6 [95%CI: 14.7 – 45.0] (poor perceived mental health). ObMD also reported more consultations with health professionals with OR ranging from 1.9 [95%CI: 1.0 – 3.5] (physicians) to 7.7 [95%CI: 4.2 – 14.3] (psychologists), and less healthy behaviours with OR ranging from 1.7 [95%CI: 1.1 – 2.6] (fruits and vegetables intake) to 2.1 [95%CI: 1.3 – 3.3] (tobacco).

Limitations: Self-reported data so we cannot discard the possibility of a bias in reporting. Also, given the cross-sectional design, no directional conclusion or causality about our results is possible.

Discussion: The co-occurrence of mood disorder and obesity seems to be an aggravating factor of obesity-related factors because it is associated with poorer health in several areas. Interventions to prevent or manage obesity in mood disorders are necessary.

1. Introduction

In Canada, obesity constitutes a health burden (Finkelstein et al., 2012), and a 200% increase in its prevalence was observed over the last three decades (Twells et al., 2014). Obesity, a multi-factorial condition, is defined as an accumulation of fat that has adverse effects on health (Mokdad et al., 2003). Among the most vulnerable populations, individuals with mood disorders (MD) such as bipolar disorder or major depressive disorders (MDD) are more likely to develop obesity compared to the general population (Mansur et al., 2015; Twells et al., 2014). Indeed, in Canada, while the prevalence of individuals with MD represents 13.4% of the population (including 12.2% for depression, and 2.4% for bipolar disorders (Public Health Agency of Canada, 2006)), up to 40–55% of them are in obesity (Amodeo et al., 2017)

compared to 18% in the Canadian general population (Twells et al., 2014). People with MD are more likely to develop obesity due to several causes such as psychotropic medications, inadequate health behaviours, environmental, genetics, and psychosocial factors (Gadalla, 2009; Mansur et al., 2015; Stunkard et al., 2003). As an illustration, two meta-analyses recently underlined the low levels of physical activity and the high levels of sedentary behaviours in people with bipolar disorders and also in MDD (Schuch et al., 2017; Vancampfort et al., 2016b).

Thus, over the last years, several studies underlined the bi-directional relationship between obesity and MD because these two pathologies frequently co-occurred (Jantarantotai et al., 2016; McElroy et al., 2004). Indeed, while MD can impact obesity, that latter was also found to aggravate the course of MD (Luppino et al., 2010; Simon et al., 2006). Several factors seem to be commonly associated with the

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development of obesity and MD (Gatineau and Dent, 2011; Stunkard et al., 2003). For example, in obesity as in MD, behavioural factors were found to be inadequate (low physical activity, unhealthy diet). Moreover, some patho-physiological (eg., inflammation), social (eg., stigma), or psychological factors (eg., stress) were also found to contribute to the development of both, MD and obesity (Mansur et al., 2015; Stunkard et al., 2003).

Recently, several studies and meta-analyses emphasized that MD are also known to be associated with several adverse health outcomes such as low psychological functioning, type 2 diabetes, metabolic syndrome, cancer, dementia, anxiety, low quality of life (Chapman et al., 2005; Goldstein et al., 2011; McElroy et al., 2004; McElroy and Keck, 2012; Scott and Happell, 2011; Vancampfort et al., 2015, 2016a) but also with premature mortality (Correll et al., 2017; Walker et al., 2015).

Among individuals with MD, obesity is an important issue to consider notably because these individuals are more likely to be affected by cardiovascular events and complications (Carney and Jones, 2006; Schoepf and Heun, 2014), and obesity is often the starting point of these events (Laursen, 2011; Lopresti and Drummond, 2013). Also, in adults with bipolar disorder, obesity was twice more likely to be associated with previous suicide attempts (Gomes et al., 2010). Afterwards, in individuals with MD, obesity was also found to decrease the effects of the antidepressant treatments (Jantarantotai et al., 2016).

However, despite this set of knowledge, the specific impact of MD linked to obesity is not well characterized. Consequently, it is difficult to disentangle whether MD can be a worsening factor of obesity.

Thus, the main objective of the study was to determine the impact of obesity and MD regarding physical comorbidities, psychological well-being, health behaviours and use of health services. It was expected that individuals with obesity and mood disorders (ObMD) were more likely to have physical comorbidities, poor mental health and psychological well-being, but also to have more at-risk health behaviours, and use of health services compared to obese individuals without MD (ObC).

2. Methods

2.1. Procedure and settings

The current study was based on data collected by Statistics Canada in the Canadian Community Health Survey (CCHS) conducted in 2007–2008. The CCHS provides cross-sectional information related to health status, health care utilization and health determinants. The sample represents approximately 98% of the Canadian population aged 12 years or older who resided in private dwellings in the ten provinces and the three territories. Persons living on Indian Reserves or Crown lands, those residing in institutions, full-time members of the Canadian Forces and residents of certain remote regions are excluded from this survey. Respondents were interviewed by telephone or by face-to-face interview. All measures were self-reported.

2.2. Study specific inclusion criteria

In the present study, participants were included if they were adults (age > 18 years old), with obesity (body mass index, BMI ≥ 30 kg/m²), inhabitants from the province of Quebec, provided complete answers to the questionnaires. Height and weight were self-reported and BMI was calculated (weight (kg) /height (cm)²). The different data used in the present study (physical comorbidities, psychological well-being, health behaviours, use of health services) were selected based on the fact they were known to be associated with obesity (Anon, 2010; Lau et al., 2007).

2.3. Mood disorder (variable of exposure)

To assess the presence of MD, a single item was used and participants were asked whether they had been diagnosed for a MD, such as

depression, bipolar disorder, mania or dysthymia, by a health professional. Those that responded positively were considered as having a MD. This classification has already been used in previous studies and was found to be reliable given its association with mental health outcomes (McIntyre et al., 2006, 2007).

2.4. Physical comorbidities

Participants responded to a module on chronic diseases. In the present study, 10 different physical conditions were considered: asthma, arthritis, type 2 diabetes, high blood pressure, migraines, heart disease, cancer, digestive disorders, stomach ulcer, and urinary incontinence. Those data were self-reported and concern health conditions that are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional.

2.5. Psychological well-being

Regarding psychological well-being, several indicators were selected. These were the presence of a major depressive episode, anxiety disorder, psychological distress, quality of life, stress, perceived global and mental health, and satisfaction with life in general. Major depressive episode was evaluated using the composite international diagnostic interview short-form questionnaire (Kessler et al., 2004; Robins et al., 1988). According to this scale, it is possible to compute a score expressing the probability of having experienced a major depressive episode over the last 12 months. A major depressive episode was considered when participants exceed a 90% odd of having experienced an episode.

Anxiety disorder was evaluated with one item. It was asked to participants whether they had been diagnosed by a health professional as being affected by anxiety disorders such as phobia, obsessive compulsive disorder, or panic disorder.

Psychological distress was assessed using the K6 scale (Kessler et al., 2002). This scale has been validated according to the DSM-IV criteria and higher scores represent a higher presence of symptoms (Kessler et al., 2002). In the present study, participants were considered as having high level of psychological distress when their scores exceed 10.

Health-related quality of life was evaluated with the Health Utilities Index (Feeny et al., 2002). This index is based on several attributes that respondents considered as the most important dimension of health status (Feeny et al., 1996) (e.g., vision, hearing, speech, ambulation, dexterity, emotion, cognition, pain, and discomfort). Then, considering these attributes, a final score was computed to reflect a health-related quality of life score.

Perceived stress was also evaluated using a single item with the following wording: “Thinking about the amount of stress in your life, would you say that most days are ...”. Possibilities of responses were coded in five categories: 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 are those considered as stressed.

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

Satisfaction with life in general was evaluated with one single item: “How satisfied are you with your life in general?”. The responses were coded in five categories: very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied, or very dissatisfied. In this study, we considered that respondents were dissatisfied if they reported one of the last three responses.

2.6. Health behaviours

Physical activity (PA), fruits and vegetables consumption, and tobacco consumption were the health risk behaviours that were considered. Alcohol and substance use disorders were not considered given that a previous population-level Canadian study did that investigation and showed an inverse association between obesity and substance abuse in people with bipolar disorders (McIntyre et al., 2007).

PA was based on leisure-time activities. In the CCHS, participants were asked about their recreational PA over the past three months (duration and frequency). Then, considering the metabolic equivalent of each PA, an index was created and participants were categorized in three different groups being inactive (< 1.5 kcal/kg/d), moderately active (1.5 to < 3 kcal/kg/d), and active (≥ 3 kcal/kg/d).

Fruits and vegetables consumption was evaluated regarding the number of portion eaten per day. Indeed, in the Canadian food guide (Canada and Health Canada, 2011), it is recommended to eat more than five portions of fruits and vegetables per day. So, participants were separated in two groups according to this criterion.

Tobacco consumption was assessed using the participants' reporting. In the present study, participants were separated in two groups, those smoking regularly (defined as smoking on a daily basis), or occasionally (defined as someone that did not smoke daily, or smoked less than 100 cigarettes in his lifetime), and those that do not smoke at all.

2.7. Use of health services

To analyze these outcomes, participants were asked whether they had a consultation with health professionals over the last years. The different health professionals were social workers, nurses, doctors and psychologist. Response to this data was provided on a yes or no response.

2.8. Statistical analyses

Survey data were weighted to reflect the population of the province of Quebec in 2007–2008. Briefly, to weight the data, the CCHS used a complex survey design that resulted in unequal probabilities of selection for respondents. In the present study, we reported results based on a rescaled version of the master survey weight, which was divided by its mean and again by the overall survey design effect, which was 2.47. To be representative of the population, the CCHS used a multistage stratified cluster design where a given weight (corresponding to the number of households in the entire population that are represented by the respondent) is attributed to each participant included in the final selected sample.

Given the cross-sectional design, a prevalence ratio was calculated by dividing the prevalence of people with obesity and MD by the prevalence of participants without MD for each variable of interest (psychological well-being, physical conditions, health behaviours and consultation with health professionals). Then, the coefficient of variation (a measure of sampling error that is the standard error of an estimate expressed as a percentage of this estimate) was used to ensure the reliability of our prevalence. Coefficient of variation between 0% and 16.5% is considered as acceptable, between 16.6% and 33.3% as marginal, and values exceeding 33.3% are considered as unacceptable (Statistics Canada et al., 2004). Chi-square tests were used to assess the bivariate relationship between the presence of a MD and the presence of the variables mentioned above. When data were continuous (e.g., number of comorbidities), independent sample Student's *t*-test was used. Finally, to understand whether comorbidities are due to obesity or to the presence of a MD and obesity, three models of logistic regressions were computed. In the three models, MD was an independent variable. In the first model of regression, no statistical adjustments were realized. In the second model, the regression was adjusted for age, sex and

education level. In the third model, the regression was adjusted for variables in the second model and on health behaviours (physical activity, fruits and vegetables consumption, tobacco) because that latter could have an influence on our variables of interest. These covariates were selected given their known association with obesity and MD. None of the models were adjusted on BMI because it was an inclusion criterion. Statistical analyses were performed with SPSS 21.

3. Results

3.1. Sample characteristics

A weighted sample size of 1298 participants including 612 females (47.1%) was included in the present study. The population had a mean BMI of 33.9 ± 3.9 kg/m². Most of our sample ($n = 562$; 43.3%) were between 45 and 64 years old, or between 30 and 44 years old ($n = 354$; 27.3%). Then, the majority of our sample had completed a high school degree ($n = 681$; 54.2%).

Our sample of obese individuals without reported MD (ObC), ($n = 1198$) was composed of a majority of men ($n = 651$; 54.3%), individuals between 45 and 64 years old ($n = 42.3\%$), and individuals having completed a high school degree ($n = 631$; 54.5%) (Table 1).

Regarding our specific population of people that screened positive for obesity and mood disorder (ObMD), their prevalence was 7.7% ($n = 100$). The ObMD group was mainly composed of women ($n = 65\%$), individuals between 45 and 64 years old (55%), and individuals having completed a high school degree (51%) (Table 1).

No significant differences between ObC and ObMD according to educational level ($\chi^2 = 4.3$; $df = 3$; $p = 0.23$), and BMI ($t = -1.3$; $df = 1295$; $p = 0.21$) were found. Two significant differences were noted according to gender and age distribution with more women ($\chi^2 = 13.9$; $df = 1$; $p < 0.001$) and more persons aged 65 or more ($\chi^2 = 9.7$; $df = 3$; $p = 0.02$) in the ObMD group than the ObC.

3.2. Physical comorbidities

In the ObC group, the prevalence of chronic conditions ranged from 3.5% [95% CI: 2.6 – 4.8] (stomach ulcer) to 30.5%, [95% CI: 28 – 33.2] (high blood pressure) while in the ObMD, it ranged from 10.1% [95% CI: 5.6 – 18.2] (stomach ulcer) to 41.4%, [95% CI: 32.8 – 52.4] (high blood pressure) (see Supplementary file 1). It should be noted that data related to cancer and digestive disorders were not reported because the coefficient of variation was above 33.3%.

Regarding most of examined physical comorbidities, the prevalence was significantly higher in the ObMD group compared to the ObC group (see Supplementary file 1). However, an absence of differences between ObMD and ObC groups, were noted for type 2 diabetes ($\chi^2 = 0.41$; $df = 1$; $p = 0.84$), and heart disease ($\chi^2 = 1.7$; $df = 1$; $p = 0.19$).

Table 1
descriptive characteristics of the included sample.

	ObC (n = 1198)	ObMD (n = 100)
BMI (kg/m²); Mean $\pm$ SD	33.87 $\pm$ 3.8	34.38 $\pm$ 4.3
Gender; n(%)		
Women	547 (45.7)	65 (65.0)
Men	651 (54.3)	35 (35.0)
Age; n(%)		
18 – 29	138 (11.5)	11 (11.0)
30 – 44	328 (27.4)	26 (26.0)
45 – 64	507 (42.3)	55 (55.0)
65 +	224 (18.7)	8 (8.0)
Level of education; n(%)		
Less than secondary school graduation	295 (25.5)	28 (28.6)
Secondary school graduation	231 (20.0)	20 (20.4)
Postsecondary graduation	631 (54.5)	50 (51.0)
NA	41	2

Table 2Association between mood disorder and physical comorbidities among persons with a BMI ≥ 30 kg/m².

Physical conditions	Unadjusted model OR [95% CI]	P value	Adjusted model 1 OR [95% CI]	P value	Adjusted model 2 OR [95% CI]	P value
Asthma						
ObMD	2.4 [1.4 – 4.0]	0.001	2.2 [1.3 – 3.7]	0.005	2.1 [1.2 – 3.7]	0.007
ObC	reference		reference		reference	
Arthritis						
ObMD	2.5 [1.6 – 3.8]	< 0.001	2.4 [1.5 – 3.9]	0.001	2.4 [1.4 – 4.1]	0.001
ObC	reference		reference		reference	
T2D						
ObMD	1.0 [0.6 – 1.9]	0.76	1.1 [0.62 – 1.9]	0.75	1.2 [0.6 – 2.2]	0.48
ObC	reference		reference		reference	
Hypertension						
ObMD	1.6 [1.1 – 2.5]	0.025	1.8 [1.1 – 2.8]	0.017	1.8 [1.1 – 3.0]	0.01
ObC	reference		reference		reference	
Migraines						
ObMD	2.9 [1.7 – 4.7]	< 0.001	2.5 [1.5 – 4.2]	0.001	2.2 [1.3 – 3.8]	0.004
ObC	reference		reference		reference	
Heart disease						
ObMD	1.5 [0.8 – 2.8]	0.169	1.6 [0.8 – 3.0]	0.168	1.6 [0.8 – 3.2]	0.14
ObC	reference		reference		reference	
Cancer*						
ObMD	1.2 [0.3 – 3.9]	*	1.2 [0.3 – 4.1]	*	1.2 [0.3 – 4.8]	*
ObC	reference		reference		reference	
Stomach ulcer						
ObMD	3.2 [1.6 – 6.6]	0.001	2.8 [1.3 – 6.0]	0.007	2.6 [1.1 – 5.7]	0.02
ObC	reference		reference		reference	
Urinary incontinence						
ObMD	2.7 [1.4 – 5.3]	0.004	2.4 [1.2 – 4.8]	0.018	2.4 [1.1 – 5.2]	0.01
ObC	reference		reference		reference	
Digestive disorders						
ObMD	2.5 [1.1 – 5.6]	*	2.1 [0.9 – 4.9]	*	1.6 [0.6 – 4.3]	*
ObC	reference		reference		reference	

Notes: ObC: Obesity without mood disorders; ObMD: Obesity with mood disorders; OR [95% CI]: Odds ratio and its 95% confidence interval; T2D: Type 2 diabetes * data should be interpreted with caution due to degree of variation > 33%.

When logistic regression were performed (see Table 2 for all data), in the unadjusted model, excepted for type 2 diabetes and heart disease for whom no significant difference were found, the OR were significant for all other studied physical conditions and ranged from 1.6, [95% CI: 1.1 – 2.5] (high blood pressure) to 3.2, [95% CI: 1.6 – 6.6] (stomach ulcer). After adjustments, OR values were attenuated but remained significant with the exception of type 2 diabetes and heart disease remaining non-significant (see Table 2).

3.2.1. Physical health multimorbidity

Concerning the total number of reported chronic diseases, ObMD significantly had a higher number of physical comorbidities ($t = -5.55$; $df = 1279$; $p < 0.0001$) compared to the ObC group (1.78 ± 1.62 vs 1.06 ± 1.18). Also, 28.7% of ObMD were found to have physical multimorbidity (defined in the present study as having 3 conditions or more) compared to 11.5% of ObC ($\chi^2 = 23.34$; $df = 1$; $p < 0.001$).

Unadjusted logistic regression showed that ObMD were more likely to report physical multimorbidity (OR: 3.1, [95% CI: 1.9 – 5.0]). After the first adjustment, the OR value was only slightly modified (OR: 3.3, [95% CI: 1.9 – 5.7]) and the second adjustment on health behaviours had no impact on the OR value (OR: 3.3, [95% CI: 1.8 – 5.7]).

3.3. Psychological well-being

Regarding psychological well-being outcomes, in the ObC group, the prevalence ranged from 2.8%, [95% CI: 2.0 – 3.9] (reporting a poor satisfaction with life) to 27.8%, [95% CI: 25.4 – 30.4] (reporting stress). In the ObMD group, the prevalence of poor psychological well-being outcomes ranged from 14.1%, [95% CI: 8.7 – 23.0] (reporting a poor satisfaction with life) to 57.3%, [95% CI: 48.2 – 68.1] (reporting a poor quality of life) (see Supplementary file 2). With the exception of stress

($p = 0.001$), all percentages were $p < 0.001$.

Regarding the unadjusted OR, significant differences were found on all outcomes and ranged from 2.0, [95% CI: 1.3 – 3.1] (reporting stressful day) to 20.6, [95% CI: 12.3 – 34.4] (poor perceived mental health). After adjustment, all OR remained significant (Table 3) with the ObMD group being more likely to report poor psychological well-being. After the second adjustment on health behaviours, OR values were slightly attenuated while remaining significant.

3.4. Health behaviours

As regard to the different health behaviour, in the ObC group, the prevalence ranged from 21%, [95% CI: 19.0 – 23.4] (smokers) to 66.7%, [95% CI: 64.1 – 69.39] (being inactive) while it ranged from 33.3%, [95% CI: 25.2 – 44.0] (smokers) to 78%, [95% CI: 71.7 – 87.3] (being inactive) in the ObMD group (see Supplementary file 3). Significant difference in prevalence was found for physical inactivity ($p = 0.013$) and smokers ($p = 0.004$). No differences were found between ObC and ObMD regarding their fruits and vegetables consumption ($p = 0.10$).

Unadjusted OR showed that ObMD are more likely to have poor health behaviour when compared to the ObC group. Indeed, ObMD were more likely to be inactive (OR: 1.9, [95% CI: 1.2 – 3.1]), and smokers (OR: 1.9, [95% CI: 1.2 – 2.9]) than ObC. However, no differences were noted regarding fruits and vegetables consumption. After adjustment, the OR remained quite similar with the exception of fruits and vegetables consumption that became significant. Indeed, ObMD were found to eat less fruits and vegetables than ObC (OR: 1.7, [95% CI: 1.1 – 2.6]) (Table 4).

Table 3Association between mood disorder and psychological well-being among persons with a BMI ≥ 30 kg/m².

Mental health and PWB	Unadjusted model OR [95% CI]	P value	Adjusted model 1 OR [95% CI]	P value	Adjusted model 2 OR [95% CI]	P value
Major depressive episode						
ObMD	12.2 [7.8 – 20.5]	< 0.001	11.8 [6.9 – 20.2]	< 0.001	10.2 [5.8 – 17.9]	< 0.001
ObC	reference		reference		reference	
Anxiety disorders						
ObMD	16 [9.8 – 26.3]	< 0.001	13.8 [8.3 – 23.0]	< 0.001	12.1 [7.0 – 20.6]	< 0.001
ObC	reference		reference		reference	
Psychological distress						
ObMD	13.9 [8.6 – 22.9]	< 0.001	12.9 [9.7 – 21.5]	< 0.001	11.5 [6.8 – 19.7]	< 0.001
ObC	reference		reference		reference	
Quality of life (HUI)						
ObMD	6.8 [4.4 – 10.4]	< 0.001	7.1 [4.6 – 11.2]	< 0.001	6.5 [4.1 – 10.3]	< 0.001
ObC	reference		reference		reference	
Stress						
ObMD	2 [1.3 – 3.1]	0.001	2.1 [1.4 – 3.3]	0.001	2.1 [1.3 – 3.3]	0.001
ObC	reference		reference		reference	
Poor perceived global health						
ObMD	3.2 [2.1 – 4.9]	< 0.001	3.6 [2.3 – 5.7]	< 0.001	3.2 [2.0 – 5.3]	< 0.001
ObC	reference		reference		reference	
Poor perceived mental health						
ObMD	20.6 [12.3 – 34.4]	≤ 0.001	25.6 [14.7 – 45.0]	≤ 0.001	24.2 [13.5 – 43.3]	< 0.001
ObC	reference		reference		reference	
Satisfaction with life						
ObMD	5.7 [2.9 – 11.1]	≤ 0.001	6.4 [3.1 – 13.1]	≤ 0.001	2.3 [1.4 – 3.8]	0.001
ObC	reference		reference			

Notes: HUI: Health Utilities Index; ObC: Obesity without mood disorders; ObMD: Obesity with mood disorders OR [95% CI]: Odds ratio and its 95% confidence interval; PWB: psychological well-being.

Table 4Association between mood disorder and risky health behaviours among persons with a BMI ≥ 30 kg/m².

Health risk behaviours	Unadjusted model OR [95% CI]	P value	Adjusted model 1 OR [95% CI]	P value
Inactivity				
ObMD	1.9 [1.2 – 3.1]	0.012	1.8 [1.1 – 3.0]	0.029
ObC	reference		reference	
Less than 5 fruits and vegetables consumed#				
ObMD	1.4 [0.9 – 2.2]	0.11	1.7 [1.1 – 2.6]	0.024
ObC	reference		reference	
Regular smoker				
ObMD	1.9 [1.2 – 2.9]	0.006	2.1 [1.3 – 3.3]	0.002
ObC	reference		reference	

Notes: ObC: Obesity without mood disorders; ObMD: Obesity with mood disorders; OR [95% CI]: Odds ratio and its 95% confidence interval; #: percentage eating less than 5 portions of fruits and vegetables.

3.5. Use of health services

Regarding the prevalence of participants having consulted a health professional over the last year, in the ObC group, it ranged from 2.8%, [95% CI: 2.0 – 4.0] (social worker) to 74.2%, [95% CI: 71.8 – 76.7] (physician) while in the ObMD group, it ranged from 13.1%, [95% CI: 7.9 – 21.8] (social worker) to 86.9%, [95% CI: 80.5 – 93.8] (physician) (see [Supplementary file 4](#)). All prevalence was significantly higher in the ObMD group compared to the ObC sample.

When we examined the associations, unadjusted OR ranged from 2.1, [95% CI: 1.3 – 3.3] (nurse) to 8.4%, [95% CI: 4.7 – 15.1] (psychologist). After adjustments, OR were attenuated but remained significant with ObMD group being more likely to consult health professionals ([Table 5](#)).

4. Discussion

In the present study, our objective was to analyze the impact of MD among individuals with obesity on physical comorbidities, psychological well-being, health behaviours and use of health services. Our results extend findings from previous studies showing that obesity is associated with poor health in general and increased risk of MD ([Luppino et al., 2010](#); [Petry et al., 2008](#)). Indeed, even after controlling for socio-demographic factors as on health behaviours, the association between MD and obesity remained associated with higher odds of developing physical comorbidities, poor mental health, and high use of health services but also the role of MD per se. These results are in line with previous studies highlighted that obesity is associated with more anxiety, stress and depression ([Jantarantnotai et al., 2016](#); [Petry et al., 2008](#)). Nevertheless, it was necessary to better understand the specific impact of the association between MD with obesity, and to the best of our knowledge, no previous similar research was conducted.

Pertaining to physical comorbidities, in the present study, after controlling for gender, education, age, and health behaviours, our results showed that ObMD individuals significantly had higher odds of being affected by a physical condition such as asthma (ORadj: 2.1), hypertension (ORadj: 1.8), arthritis (ORadj: 2.4), urinary incontinence (ORadj: 2.4), migraines (ORadj: 2.2), and stomach ulcer (ORadj: 2.6). These results is not surprising because it has been already highlighted that MD are more related to several physical comorbidities (e.g., asthma, hypertension, hyperlipidemia, heart failure) when compared to control individuals ([Carney and Jones, 2006](#); [Schoepf et al., 2014](#)). Also, ObMD were found to have higher odds of physical health multimorbidity compared to ObC and it is clearly in line with studies showing that multimorbidity is highly present in mental health conditions such as depressive, or anxiety disorders ([Stubbs et al., 2017](#); [Vancampfort et al., 2017](#)). Moreover, in our study, the prevalence of multimorbidity (28.7%) was found to be higher than in a previous meta-analysis on depression and multimorbidity with 13.7% ([Stubbs et al., 2017](#)). So, this result means that obesity increased the risk of developing physical comorbidities among individuals with MD and is a serious condition to consider. However, two exceptions should be

Table 5Association between mood disorder and consultations with health professionals in the last 12 months among persons with a BMI ≥ 30 kg/m².

Consultations	Unadjusted model OR [95% CI]	P value	Adjusted model 1 OR [95% CI]	P value	Adjusted model 2 OR [95% CI]	P Value
Physician						
ObMD	2.2 [1.24 – 4.1]	0.007	1.9 [1.0 – 3.5]	0.039	1.8 [1.0 – 3.4]	0.050
ObC	reference		reference		reference	
Nurse						
ObMD	2.1 [1.3 – 3.3]	0.002	1.9 [1.2 – 3.1]	0.007	2.0 [1.2 – 3.3]	0.005
ObC	reference		reference		reference	
Social worker						
ObMD	5 [2.6 – 9.9]	≤ 0.001	3.8 [1.9 – 7.8]	≤ 0.001	3.4 [1.6 – 7.1]	0.001
ObC	reference		reference		reference	
Psychologist						
ObMD	8.4 [4.7 – 15.1]	≤ 0.001	7.7 [4.2 – 14.3]	≤ 0.001	9.5 [4.9 – 18.1]	< 0.001
ObC	reference		reference		reference	

Notes: Notes: ObC: Obesity without mood disorders; ObMD: Obesity with mood disorders; OR [95% CI]: Odds ratio and its 95% confidence interval.

noted. In fact, no increased prevalence or risks were noted in heart diseases and type 2 diabetes between the ObMD and ObC groups. Indeed, the prevalence of type 2 diabetes was similar in both, ObC and ObMD, groups but was higher than in previous worldwide meta-analysis (Vancampfort et al., 2016a). Consequently, we may think that this effect may be due to the consequences of obesity. Indeed, previous studies had already underlined that obesity and MD share some pathogenic factors, notably the presence of abdominal obesity (Amodeo et al., 2017), that could impact the development of type 2 diabetes or other cardiovascular disease such as heart disease (Barefoot and Schroll, 1996; Lopresti and Drummond, 2013; McElroy et al., 2004; Vancampfort et al., 2016a, 2015).

Then, in terms of mental health and psychological well-being, not surprisingly, results showed that the ObMD group had a poorer mental health and psychological well-being compared to the ObC group. Indeed, even after statistical adjustment, the OR (as the effect size) remained very large on several factors. As such, the ObMD were nearly 24 times more likely to declare they had a poor perceived mental health. As well, they were also nearly 12 times more likely to have anxiety disorders, or 10 times to have experienced a lifetime major depressive episode. These results can be explained by the circular interrelationship between MD, obesity, physical comorbidities, and psychological well-being. As example, it is known that there is a strong association between MD and obesity (McElroy et al., 2004), that this association is considered as risk factor for physical comorbidities (McElroy et al., 2004) which in turn, are linearly associated with a higher odd of developing anxiety disorders (Vancampfort et al., 2017). So, regarding psychological well-being and mental health, our results outline that the MD – obesity association worsened these outcomes.

As regard to health behaviours, it is interesting to note that the magnitude of the OR was modest (range ORadj: 1.7 – 2.1). Indeed, the ObMD group was more likely to be inactive, smokers and to eat less than 5 fruits and vegetables intake per day. Regarding fruits and vegetables intake, our finding corroborates results from a previous epidemiologic study showing an inverse association between fruits and vegetables consumption and the presence of a mood disorder (McMartin et al., 2013). Regarding PA, our results underlined that ObMD individuals are more likely to be inactive. This results is in line with a previous study showing a trend towards a worsening combined effect of depression and obesity on PA reduction (Sander et al., 2017).

When we examined the consultation with health professionals, the same effect was detected. Indeed, the OR were moderate to large (ORadj: 1.8 – 9.5) according to the professional considered. This result can be explained by the fact that professionals such as social workers or psychologists are often included in the management of MD so the ObMD group was also more likely to report consultations with them. Besides, provided the higher prevalence of physical conditions in the

ObMD group, compared to ObC, it is also possible that they had more need to have recourse to health professionals (Wang et al., 2005).

The relationship between obesity and MD being complex (Faith et al., 2002), several factors can be involved in the explanation of our results. Biological factors that are present in both, obesity and MD, such as the micro-inflammation, oxidative stress, and a dysregulation in the hypothalamic-pituitary-adrenal axis could have negatively impacted the course of physical conditions, mental health and psychological well-being (Lopresti and Drummond, 2013). Nevertheless, even though they did not have an important impact on our results, the role of behavioural factors such as low physical activity, eating behaviour, alcohol, or tobacco cannot be neglected given they can also be involved in the development of physical conditions and poor mental health by further affecting some biological pathways (Gatineau and Dent, 2011). For instance, among individuals with bipolar disorders, weight cycling was found to affect the number of manic episode, as the micro-inflammation (Reininghaus et al., 2015). Also, psychological and social factors can also be evoked. In fact, previous study highlighted that people with obesity was more likely to report poor perceived health so the addition of MD had probably increased this reporting (Gatineau and Dent, 2011). Other psychological factors such as perceived weight discrimination or perceived weight stigma have the possibility to impact physical and mental health (Sutin et al., 2016) and to be related to low grade inflammation (Sutin et al., 2014).

Even though the present study is of interest, some limitations should be acknowledged. Indeed, data were self-reported so we cannot discard the possibility of a bias in reporting. Then, we do not have the possibility to check whether people declaring a MD, were effectively ill. However, this self-reported classification of MD was found to be reliable compared to several mental health outcomes (McIntyre et al., 2006, 2007). Also, only leisure-time PA was evaluated, and was also self-reported, while PA is clearly a multicomponent behaviour (Thompson et al., 2015). As well, pertaining to fruits and vegetables intake, this behaviour is only one facet of eating habits, consequently it does not represents the overall picture of eating behaviour. Moreover, data were cross-sectional so we cannot draw any directional conclusion or infer any causality about our results. Indeed, we do not know which one, between obesity and MD, was present first.

To conclude, in the present representative community-based study, it was found that the co-occurrence of obesity and MD is an increased risk factor of physical comorbidities, poor mental health and psychological well-being, and less healthy behaviours. Moreover, ObMD also had more consultation with professionals. Consequently, in individuals with mental disorders, physical comorbidities and also obesity should be better considered, and monitored, with the need to prevent weight gain (Romain, 2017) to avoid the exacerbation of its potential consequences when linked to MD. The systematic screening of obesity and

its associated risk factors should be better organized. In psychiatric settings, the management of obesity and its consequences would necessitate the inclusion of trained mental health professionals dedicated to the physical health improvement of individuals with mental disorders (Romain and Bernard, 2016). However, studies showed that mental health professionals judged physical health of secondary importance (Hyland et al., 2003). So, with approximately 25% of mental health professionals providing advices related to healthy behaviours to their high-risk patients (Bartlem et al., 2014; Chwastiak et al., 2013), there is a need to modify the training of these professionals to include the screening of physical health but also the different facets of health promotion as part of their professional role. Nevertheless, to modify the training of health professionals, policy makers should be convinced of its importance. Costs analyses on the impact of obesity and its consequences among individuals with MD on the health care system would be important data to favour investment in that direction.

In terms of clinical implications, our findings highlight the importance of developing and implementing lifestyle interventions, including physical activity and nutritional recommendations, in psychiatric setting given it can counteract or prevent the adverse effects of obesity and improve mental health (Firth et al., 2015; Teasdale et al., 2016), and psychological well-being (Penedo and Dahn, 2005).

In conclusion, our study underlined that obesity and mood disorders are increased risk factors associated with several poor health outcomes even after controlling for several factors including health behaviours. Future studies should assess whether the health-related associations between obesity and MD are cumulative, synergistic, or independent effects. The identification of mediators of the association between ObMD and its health impacts would constitute an asset. Also, future studies should examine the cost of obesity and its consequences among individuals with MD.

Authors statement

Contributors

All authors, Ahmed Jerome Romain (AJR), Jacques Marleau (JM), and Aurélie Baillot (AB) have read and approved the final version of the manuscript.

Seminal idea: AJR

First draft of the manuscript: AJR

Significant writing: AJR, JM, AB

Statistical plan: AJR, JM, AB

Statistical analyses: JM

Results interpretations: AJR, JM, AB

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Conflicts of interest

None to disclose.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at <http://dx.doi.org/10.1016/j.jad.2017.08.065>.

References

- Amodeo, G., Subramaniapillai, M., Mansur, R.B., McIntyre, R.S., 2017. Mood disorders and severe obesity: a case study. In: Sockalingam, S., Hawa, R. (Eds.), *Psychiatric Care in Severe Obesity*. Springer International Publishing, Cham, pp. 107–121. http://dx.doi.org/10.1007/978-3-319-42536-8_9.
- Barefoot, J.C., Schroll, M., 1996. Symptoms of depression, acute myocardial infarction, and total mortality in a community sample. *Circulation* 93, 1976–1980.
- Bartlem, K.M., Bowman, J.A., Freund, M., Wye, P.M., McElwaine, K.M., Wolfenden, L., Campbell, E.M., Gillham, K.E., Wiggers, J.H., 2014. Care provision to prevent chronic disease by community mental health clinicians. *Am. J. Prev. Med.* 47, 762–770. <http://dx.doi.org/10.1016/j.amepre.2014.08.003>.
- Bouchard, C., Katzmarzyk, P.T. (Eds.), 2010. *Physical Activity and Obesity*, 2nd ed. Human Kinetics, Champaign, IL.
- Canada, Health Canada, 2011. *Eating Well with Canada's Food Guide*.
- Carney, C.P., Jones, L.E., 2006. Medical comorbidity in women and men with bipolar disorders: a population-based controlled study. *Psychosom. Med.* 68, 684–691. <http://dx.doi.org/10.1097/01.psy.0000237316.09601.88>.
- Chapman, D.P., Perry, G.S., Strine, T.W., 2005. The vital link between chronic disease and depressive disorders. *Prev. Chronic Dis.* 2, A14.
- Chwastiak, L., Cruza-Guet, M.-C., Carroll-Scott, A., Sernyak, M., Ickovics, J., 2013. Preventive counseling for chronic disease: missed opportunities in a community mental health center. *Psychosomatics* 54, 328–335. <http://dx.doi.org/10.1016/j.psych.2012.10.003>.
- Correll, C.U., Solmi, M., Veronese, N., Bortolato, B., Rosson, S., Santonastaso, P., Thapa-Chhetri, N., Fornaro, M., Gallicchio, D., Collantoni, E., Pigato, G., Favaro, A., Monaco, F., Kohler, C., Vancampfort, D., Ward, P.B., Gaughran, F., Carvalho, A.F., Stubbs, B., 2017. Prevalence, incidence and mortality from cardiovascular disease in patients with pooled and specific severe mental illness: a large-scale meta-analysis of 3,211,768 patients and 113,383,368 controls. *World Psychiatry* 16, 163–180. <http://dx.doi.org/10.1002/wps.20420>.
- Faith, M.S., Matz, P.E., Jorge, M.A., 2002. Obesity-depression associations in the population. *J. Psychosom. Res.* 53, 935–942.
- Feeny, D., Torrance, G.W., Furlong, W., 1996. Chapter 2. Health utilities index. In: Spilker, B. (Ed.), *Quality of Life and Pharmacoeconomics in Clinical Trials*. Lippincott-Raven Publishers, Philadelphia, pp. 239–252.
- Feeny, D., Furlong, W., Torrance, G.W., Goldsmith, C.H., Zhu, Z., DePauw, S., Denton, M., Boyle, M., 2002. Multiattribute and single-attribute utility functions for the health utilities index mark 3 system. *Med. Care* 40, 113–128.
- Finkelstein, E.A., Khavjou, O.A., Thompson, H., Trogon, J.G., Pan, L., Sherry, B., Dietz, W., 2012. Obesity and severe obesity forecasts through 2030. *Am. J. Prev. Med.* 42, 563–570. <http://dx.doi.org/10.1016/j.amepre.2011.10.026>.
- Firth, J., Cotter, J., Elliott, R., French, P., Yung, A.R., 2015. A systematic review and meta-analysis of exercise interventions in schizophrenia patients. *Psychol. Med.* 1–19. <http://dx.doi.org/10.1017/S0033291714003110>.
- Gadalla, T.M., 2009. Association of obesity with mood and anxiety disorders in the adult general population. *Chronic Dis. Can.* 30, 29–36.
- Gatineau, M., Dent, M., 2011. *Obesity and Mental Health*. National Obesity Observatory, Oxford, England.
- Goldstein, B.I., Liu, S.-M., Zivkovic, N., Schaffer, A., Chien, L.-C., Blanco, C., 2011. The burden of obesity among adults with bipolar disorder in the United States. *Bipolar Disord.* 13, 387–395. <http://dx.doi.org/10.1111/j.1399-5618.2011.00932.x>.
- Gomes, F.A., Kauer-Sant'Anna, M., Magalhães, P.V., Jacka, F.N., Dodd, S., Gama, C.S., Cunha, A., Berk, M., Kapczynski, F., 2010. Obesity is associated with previous suicide attempts in bipolar disorder. *Acta Neuropsychiatr.* 22, 63–67. <http://dx.doi.org/10.1111/j.1601-5215.2010.00452.x>.
- Hyland, B., Judd, F., Davidson, S., Jolley, D., Hocking, B., 2003. Case managers' attitudes to the physical health of their patients. *Aust. N. Z. J. Psychiatry* 37, 710–714.
- Jantarantotai, N., Mosikanon, K., Lee, Y., McIntyre, R.S., 2016. The interface of depression and obesity. *Obes. Res. Clin. Pract.* <http://dx.doi.org/10.1016/j.orcp.2016.07.003>.
- Kessler, R.C., Andrews, G., Colpe, L.J., Hiripi, E., Mroczek, D.K., Normand, S.L.T., Walters, E.E., Zaslavsky, A.M., 2002. Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychol. Med.* 32, 959–976.
- Kessler, R.C., Abelson, J., Demler, O., Escobar, J.I., Gibbon, M., Guyer, M.E., Howes, M.J., Jin, R., Vega, W.A., Walters, E.E., Wang, P., Zaslavsky, A., Zheng, H., 2004. Clinical calibration of DSM-IV diagnoses in the World mental health (WMH) version of the World health organization (who) composite International diagnostic Interview (WMH-CIDI). *Int. J. Methods Psychiatr. Res.* 13, 122–139.
- Lau, D.C.W., Douketis, J.D., Morrison, K.M., Hramiak, I.M., Sharma, A.M., Ur, E., for members of the Obesity Canada Clinical Practice Guidelines Expert Panel, 2007. 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *Can. Med. Assoc. J.* 176, S1–S13. <http://dx.doi.org/10.1503/cmaj.061409>.
- Laursen, T.M., 2011. Life expectancy among persons with schizophrenia or bipolar affective disorder. *Schizophr. Res.* 131, 101–104. <http://dx.doi.org/10.1016/j.schres.2011.06.008>.
- Lopresti, A.L., Drummond, P.D., 2013. Obesity and psychiatric disorders: commonalities

- in dysregulated biological pathways and their implications for treatment. *Prog. Neuropsychopharmacol. Biol. Psychiatry* 45, 92–99. <http://dx.doi.org/10.1016/j.pnpbp.2013.05.005>.
- Luppino, F.S., de Wit, L.M., Bouvy, P.F., Stijnen, T., Cuijpers, P., Penninx, B.W., Zitman, F.G., 2010. Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Arch. Gen. Psychiatry* 67, 220–229.
- Mansur, R.B., Brietzke, E., McIntyre, R.S., 2015. Is there a “metabolic-mood syndrome”? A review of the relationship between obesity and mood disorders. *Neurosci. Biobehav. Rev.* 52, 89–104. <http://dx.doi.org/10.1016/j.neubiorev.2014.12.017>.
- McElroy, S.L., Keck, P.E., 2012. Obesity in bipolar disorder: an overview. *Curr. Psychiatry Rep.* 14, 650–658. <http://dx.doi.org/10.1007/s11920-012-0313-8>.
- McElroy, S.L., Kotwal, R., Malhotra, S., Nelson, E.B., Keck, P.E., Nemeroff, C.B., 2004. Are mood disorders and obesity related? A review for the mental health professional. *J. Clin. Psychiatry* 65, 634–651. <http://dx.doi.org/10.4088/JCP.v65n0507>.
- McIntyre, R.S., Konarski, J.Z., Wilkins, K., Soczynska, J.K., Kennedy, S.H., 2006. Obesity in bipolar disorder and major depressive disorder: results from a national community health survey on mental health and well-being. *Can. J. Psychiatry* 51, 274–280.
- McIntyre, R.S., McElroy, S.L., Konarski, J.Z., Soczynska, J.K., Bottas, A., Castel, S., Wilkins, K., Kennedy, S.H., 2007. Substance use disorders and overweight/obesity in bipolar I disorder: preliminary evidence for competing addictions. *J. Clin. Psychiatry* 68, 1352–1357.
- McMartin, S.E., Jacka, F.N., Colman, I., 2013. The association between fruit and vegetable consumption and mental health disorders: evidence from five waves of a national survey of Canadians. *Prev. Med.* 56, 225–230. <http://dx.doi.org/10.1016/j.ypmed.2012.12.016>.
- Mokdad, A.H., Ford, E.S., Bowman, B.A., Dietz, W.H., Vinicor, F., Bales, V.S., Marks, J.S., 2003. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA* 289, 76–79.
- Penedo, F.J., Dahn, J.R., 2005. Exercise and well-being: a review of mental and physical health benefits associated with physical activity. *Curr. Opin. Psychiatry* 18, 189–193.
- Petry, N.M., Barry, D., Pietrzak, R.H., Wagner, J.A., 2008. Overweight and obesity are associated with psychiatric disorders: results from the national epidemiologic survey on alcohol and related conditions. *Psychosom. Med.* 70, 288–297. <http://dx.doi.org/10.1097/PSY.0b013e3181651651>.
- Public Health Agency of Canada, 2006. *The Human Face of Mental Health and Mental Illness in Canada*. Public Health Agency of Canada, Ottawa.
- Reininghaus, E.Z., Lackner, N., Fellendorf, F.T., Bengesser, S., Birner, A., Reininghaus, B., Unterwiesing, R., Platzer, M., Wallner-Liebmann, S.J., Zelzer, S., Mangge, H., Fuchs, D., Kapfhammer, H.-P., McIntyre, R.S., 2015. Weight cycling in bipolar disorder. *J. Affect. Disord.* 171, 33–38. <http://dx.doi.org/10.1016/j.jad.2014.09.006>.
- Robins, L.N., Wing, J., Wittchen, H.U., Helzer, J.E., Babor, T.F., Burke, J., Farmer, A., Jablenski, A., Pickens, R., Regier, D.A., 1988. The composite international diagnostic interview. An epidemiologic instrument suitable for use in conjunction with different diagnostic systems and in different cultures. *Arch. Gen. Psychiatry* 45, 1069–1077.
- Romain, A.J., 2017. An ounce of prevent outweigh kilograms of weight loss. *Psychiatry Res.* <http://dx.doi.org/10.1016/j.psychres.2017.06.006>.
- Romain, A.J., Bernard, P., 2016. Expand the scope of somatic treatments in psychiatry to include prevention. *L'Encephale*. <http://dx.doi.org/10.1016/j.encep.2016.07.005>.
- Sander, C., Ueck, P., Mergl, R., Gordon, G., Hegerl, U., Himmerich, H., 2017. Physical activity in depressed and non-depressed patients with obesity. *Eat. Weight Disord. – Stud. Anorex. Bulim. Obes.* <http://dx.doi.org/10.1007/s40519-016-0347-8>.
- Schoepf, D., Heun, R., 2014. Bipolar disorder and comorbidity: increased prevalence and increased relevance of comorbidity for hospital-based mortality during a 12.5-year observation period in general hospital admissions. *J. Affect. Disord.* 169, 170–178. <http://dx.doi.org/10.1016/j.jad.2014.08.025>.
- Schoepf, D., Uppal, H., Potluri, R., Chandran, S., Heun, R., 2014. Comorbidity and its relevance on general hospital based mortality in major depressive disorder: a naturalistic 12-year follow-up in general hospital admissions. *J. Psychiatr. Res.* 52, 28–35. <http://dx.doi.org/10.1016/j.jpsychires.2014.01.010>.
- Schuch, F., Vancampfort, D., Firth, J., Rosenbaum, S., Ward, P., Reichert, T., Bagatini, N.C., Beginski, R., Stubbs, B., 2017. Physical activity and sedentary behavior in people with major depressive disorder: a systematic review and meta-analysis. *J. Affect. Disord.* 210, 139–150. <http://dx.doi.org/10.1016/j.jad.2016.10.050>.
- Scott, D., Happell, B., 2011. The high prevalence of poor physical health and unhealthy lifestyle behaviours in individuals with severe mental illness. *Issues Ment. Health Nurs.* 32, 589–597. <http://dx.doi.org/10.3109/01612840.2011.569846>.
- Simon, G.E., Von Korff, M., Saunders, K., Miglioretti, D.L., Crane, P.K., Van Belle, G., Kessler, R.C., 2006. Association between obesity and psychiatric disorders in the US adult population. *Arch. Gen. Psychiatry* 63, 824–830.
- Statistics Canada, Health Statistics Division, 2004. *Canadian Community Health Survey: Mental Health and Well-being: Public use Microdata File*. Statistics Canada, Ottawa.
- Stubbs, B., Vancampfort, D., Veronese, N., Kahl, K.G., Mitchell, A.J., Lin, P.-Y., Tseng, P.-T., Mugisha, J., Solmi, M., Carvalho, A.F., Koyanagi, A., 2017. Depression and physical health multimorbidity: primary data and country-wide meta-analysis of population data from 190 593 people across 43 low- and middle-income countries. *Psychol. Med.* 1–11. <http://dx.doi.org/10.1017/S0033291717000551>.
- Stunkard, A.J., Faith, M.S., Allison, K.C., 2003. Depression and obesity. *Biol. Psychiatry* 54, 330–337. [http://dx.doi.org/10.1016/S0006-3223\(03\)00608-5](http://dx.doi.org/10.1016/S0006-3223(03)00608-5).
- Sutin, A.R., Stephan, Y., Luchetti, M., Terracciano, A., 2014. Perceived weight discrimination and C-reactive protein: discrimination and CRP. *Obesity* 22, 1959–1961. <http://dx.doi.org/10.1002/oby.20789>.
- Sutin, A.R., Stephan, Y., Grzywacz, J.G., Robinson, E., Daly, M., Terracciano, A., 2016. Perceived weight discrimination, changes in health, and daily stressors: discrimination, health, and daily stress. *Obesity* 24, 2202–2209. <http://dx.doi.org/10.1002/oby.21598>.
- Teasdale, S., Ward, P.B., Rosenbaum, S., Samaras, K., Stubbs, B., 2016. Solving a weighty problem: systematic review and meta-analysis of nutrition interventions in severe mental illness. *Br. J. Psychiatry* 209, 1–9.
- Thompson, D., Peacock, O., Western, M., Batterham, A.M., 2015. Multidimensional physical activity: an opportunity, not a problem. *Exerc. Sport Sci. Rev.* 43, 67–74. <http://dx.doi.org/10.1249/JES.0000000000000039>.
- Twells, L.K., Gregory, D.M., Reddigan, J., Midodzi, W.K., 2014. Current and predicted prevalence of obesity in Canada: a trend analysis. *CMAJ Open* 2, E18–E26. <http://dx.doi.org/10.9778/cmajo.20130016>.
- Vancampfort, D., Stubbs, B., Mitchell, A.J., De Hert, M., Wampers, M., Ward, P.B., Rosenbaum, S., Correll, C.U., 2015. Risk of metabolic syndrome and its components in people with schizophrenia and related psychotic disorders, bipolar disorder and major depressive disorder: a systematic review and meta-analysis. *World Psychiatry* 14, 339–347. <http://dx.doi.org/10.1002/wps.20252>.
- Vancampfort, D., Correll, C.U., Galling, B., Probst, M., De Hert, M., Ward, P.B., Rosenbaum, S., Gaughran, F., Lally, J., Stubbs, B., 2016a. Diabetes mellitus in people with schizophrenia, bipolar disorder and major depressive disorder: a systematic review and large scale meta-analysis. *World Psychiatry* 15, 166–174. <http://dx.doi.org/10.1002/wps.20309>.
- Vancampfort, D., Firth, J., Schuch, F., Rosenbaum, S., De Hert, M., Mugisha, J., Probst, M., Stubbs, B., 2016b. Physical activity and sedentary behavior in people with bipolar disorder: a systematic review and meta-analysis. *J. Affect. Disord.* 201, 145–152. <http://dx.doi.org/10.1016/j.jad.2016.05.020>.
- Vancampfort, D., Koyanagi, A., Hallgren, M., Probst, M., Stubbs, B., 2017. The relationship between chronic physical conditions, multimorbidity and anxiety in the general population: a global perspective across 42 countries. *Gen. Hosp. Psychiatry* 45, 1–6. <http://dx.doi.org/10.1016/j.genhosppsych.2016.11.002>.
- Walker, E.R., McGee, R.E., Druss, B.G., 2015. Mortality in mental disorders and global disease burden implications: a systematic review and meta-analysis. *JAMA Psychiatry* 72, 334–341. <http://dx.doi.org/10.1001/jamapsychiatry.2014.2502>.
- Wang, J., Patten, S.B., Williams, J.V.A., Currie, S., Beck, C.A., Maxwell, C.J., El-Guebaly, N., 2005. Help-seeking behaviours of individuals with mood disorders. *Can. J. Psychiatry Rev. Can. Psychiatr.* 50, 652–659. <http://dx.doi.org/10.1177/070674370505001012>.