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Obesity and Mental Disorders in the General Population: Results from the World Mental Health Surveys

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Abstract

Objectives—(i) To investigate whether there is an association between obesity and mental disorders in the general populations of diverse countries, and (ii) to establish whether demographic variables (sex, age, education) moderate any associations observed.

Design—Thirteen cross-sectional, general population surveys conducted as part of the World Mental Health Surveys initiative.

Subjects—Household residing adults, 18 years and over (n = 62,277).

Measurements—DSM-IV mental disorders (anxiety disorders, depressive disorders, alcohol use disorders) were assessed with the Composite International Diagnostic Interview (CIDI 3.0), a fully structured diagnostic interview. Obesity was defined as a body mass index (BMI) of 30 kg/m² or greater; severe obesity as BMI 35+. Persons with BMI less than 18.5 were excluded from analysis. Height and weight were self-reported.

Results—Statistically significant, albeit modest associations (odds ratios generally in the range of 1.2–1.4) were observed between obesity and depressive disorders, and between obesity and anxiety disorders, in pooled data across countries. These associations were concentrated among those with severe obesity, and among females. Age and education had variable effects across depressive and anxiety disorders.

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Conclusions—The findings are suggestive of a modest relationship between obesity (particularly severe obesity) and emotional disorders among women in the general population. The study is limited by the self-report of BMI and cannot clarify the direction or nature of the relationship observed, but it may indicate a need for a research and clinical focus on the psychological heterogeneity of the obese population.

Keywords

cross-sectional surveys; general population; mental disorders; obesity; sex

INTRODUCTION

While the physical health costs of obesity have become increasingly clear (1–3), the existence and nature of a relationship between obesity and mental health in the general population has been less clear. Early research on the relationship between obesity and mental disorder (depression in particular) has provided conflicting answers, in part due to methodological differences across studies (4,5). In a major critique of what they termed the first generation of studies investigating this issue, Friedman and Brownell cite the great variety in measures of psychopathology used, with few studies using diagnostic measures of mental disorder (4). They also cite the failure to consider demographic and socioeconomic variables that may moderate the relationship between obesity and mental disorders, and so may render some subgroups more vulnerable to accompanying mental disorders than others (5,6). The point here is that, given the large proportion of some populations that obesity affects, it is most unlikely to be a homogeneous disorder either in etiology or sequelae.

Sex, age and socio-economic status have been hypothesized as potential moderators of the obesity-depression relationship (4,7). Only a handful of studies have investigated demographic variation in the relationship between depressive disorder and obesity in the general adult population. Carpenter et al (8) and Oynike et al (5) in US surveys both found obesity was associated with depression in women but not in men. Recently, two countries from the World Mental Health (WMH) Surveys initiative have published findings with regard to obesity and mental disorders (9,10). The WMH surveys have been conducted in both developed and developing countries using the latest structured psychiatric interviews generating DSM-IV diagnoses for a range of mental disorders. In the US survey from the WMH group (the National Comorbidity Survey-Replication: NCS-R), Simon et al (9) found significant associations between obesity and a number of mental disorders, and that some of these associations were modified by ethnicity and education, but they did not find a difference in strength of association between men and women. By contrast, the New Zealand Mental Health Survey (NZMHS) found that overweight/obesity was associated with mental disorder only among women (10).

Most investigations of this issue have taken place in developed countries. Given the large cross-national variation in obesity prevalence (11,12), mental disorder prevalence (13), preference for slimness (14,15), and relationship between obesity and socioeconomic status (14), there is a need to research the relationship between obesity and mental disorders in a range of countries. The current study is the first cross-national investigation of the obesity - mental disorder relationship and aims to (i) investigate whether there is an association between obesity and mental disorder (any anxiety disorder, any depressive disorder, any alcohol use disorder) in data from 13 countries from the WMH consortium; and (ii) establish whether demographic variables (gender, age, years of education) moderate any associations observed.

METHODS

Samples

Thirteen surveys were carried out in the Americas (Colombia, Mexico, United States), Europe (Belgium, France Germany, Italy, Netherlands, Spain), the Middle East (Israel, Lebanon) and Asia/Pacific (Japan, New Zealand). All surveys were based on multi-stage, clustered area probability household samples. All interviews were carried out face-to-face by trained lay interviewers. Sample sizes (of those providing valid BMI data) range from 2,326 (Japan) to 12,782 (New Zealand) with a total of 62,277 respondents. Response rates range from 45.9% (France) to 87.7% (Colombia), with a weighted average response rate of 70.8%.

Interview

Internal sub-sampling was used to reduce respondent burden by dividing the interview into two parts. Part 1 included the core diagnostic assessment of mood disorders, alcohol use disorders, most of the anxiety disorders, and height and weight for the calculation of obesity. Part 2 included the remainder of mental disorders and additional information relevant to a wide range of survey aims, including assessment of chronic physical conditions. All respondents completed part1. All part-1 respondents who met criteria for any mental disorder and a probability sample of other respondents were administered part 2. Part-2 respondents were weighted by the inverse of their probability of selection to adjust for differential sampling. Additional weights were used to adjust for differential probabilities of selection within households and to match the samples to population socio-demographic distributions.

Training and Field Procedures

The central World Mental Health (WMH) staff trained bilingual supervisors in each country. Consistent interviewer training documents and procedures were used across surveys. The WHO translation protocol was used to translate instruments and training materials. The Dutch survey was carried out in bilingual form. Other surveys were carried out in the country's official language. Persons who could not speak these languages were excluded. Standardized descriptions of the goals and procedures of the study, data uses and protection, and the rights of respondents were provided in both written and verbal form to all potentially eligible respondents before obtaining verbal informed consent for participation in the survey. Quality control protocols, described in more detail elsewhere (16), were standardized across countries to check on interviewer accuracy and to specify data cleaning and coding procedures. The institutional review board of the organization that coordinated the survey in each country approved and monitored compliance with procedures for obtaining informed consent and protecting human subjects.

Mental disorder status

All surveys used the World Mental Health Survey version of the WHO Composite International Diagnostic Interview (now CIDI 3.0) (17), a fully structured diagnostic interview, to assess disorders and treatment. Mental disorders considered in this paper were present in the prior 12 months, and include anxiety disorders (generalized anxiety disorder, panic disorder and/or agoraphobia, post traumatic stress disorder, and social phobia), depressive disorders (dysthymia and major depressive disorder), and alcohol use disorders (abuse and dependence). Disorders were assessed using the definitions and criteria of the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV)* (18), without hierarchy. CIDI organic exclusion rules were imposed in making all diagnoses. Field Trials and later clinical calibration studies have showed that all the mental disorders considered here were assessed with acceptable reliability and validity in the original version of the CIDI 3.0 used in these surveys (19).

Obesity status

Obesity ('total obesity') was defined as a body mass index (BMI) of 30 kg/m² or greater. For some analyses obesity was further subdivided into class I obesity (BMI 30–34.9) and severe obesity (BMI 35+). Persons with BMI less than 18.5 were excluded from analysis as other research shows a u-shaped relationship between BMI and the prevalence of mood disorder (8). Height and weight were self-reported by all respondents. Previous research indicates that self-reported height and weight correlate highly with objective measures (20,21) but some individuals, particularly those who are overweight or obese, underestimate weight (22) so the prevalences of obesity reported here may be underestimates. It is noteworthy though that the New Zealand survey, the largest included in this study, obtained obesity estimates among males (19.6%) and females (21.2%) which were highly consistent with estimates for males (19.2%) and females (21.0%) from the 2002/03 New Zealand Health Survey which calculated BMI from objectively measured weights and heights (23).

Analytic methods

Part 1 weights were used for the "any depressive disorder" analyses and Part 2 weights for the "any anxiety" and "any alcohol use" analyses. Age, sex and education adjusted odds ratios for the association of obesity with mental disorders were calculated for each country in logistic regression equations. For these analyses obesity was classified in three ways: total obesity (BMI 30+); class I obesity (BMI 30–34.9) and severe obesity (BMI 35+). These three groups are not, therefore, mutually exclusive: the total obesity group is a composite of class I and severe obesity. The three obesity groups were compared with the reference group of non-obese persons (BMI 18.5–29.9).

Odds ratios for mental disorder among the total obesity group in subgroups defined by age, sex and education were also estimated for each survey, with the exception that the French survey did not provide data on education. Further subdivision of the total obesity group into class I and severe obesity was not possible for this set of analyses due to the smaller sample size of many of the surveys. Tests of the interaction between the total obesity group and each demographic covariate (age, sex, education) in predicting the odds of mental disorder were undertaken for each country. Education was categorized into two groups: those with less than completed secondary education and those with completed secondary education or more. Age groups were 18–34 years, 35–49 years, 50–64 years and 65 years and over. Ninety-five percent confidence intervals for the odds ratios were estimated using the Taylor Series method (24) with SUDAAN software (25) to adjust for clustering and weighting.

Using meta-analytic methods to summarize results across surveys, pooled estimates of the odds ratios were developed describing the association of mental disorders with obesity across surveys (26). The pooled estimate of the odds ratio was weighted by the inverse of the variance of the estimate for each survey (26). We also assessed whether the heterogeneity of the odds ratio estimates across surveys was greater than expected by chance (25). These tests were undertaken for the odds calculated between total obesity and each mental disorder group, and for each age/education/sex stratum within each mental disorder group. None of the results of these tests indicated greater than chance variability in pooled odds ratios using a more conservative alpha level of < 0.01, though a small number were significant at $p < 0.05$; the test results for each mental disorder group are cited below (the others are available on request).

RESULTS

Sample characteristics

The sample size numbers provided in Table 1 are the number of respondents providing valid BMI data. As noted above, some analyses used information on mental disorders only provided

in Part 2 of the interview, resulting in smaller sample sizes for those analyses. As the table makes clear, there was marked cross-national variability in the prevalence of obesity, ranging from 2.6% for BMI 30+ in Japan to 29.4% in Mexico.

Obesity and Depressive Disorders

Table 2 shows the prevalence of depressive disorder in the BMI groups, and the age, sex and education-adjusted odds of depressive disorder among people in the three obesity groups relative to the normal/overweight group. The pooled odds ratio of 1.1 for the total obesity group is statistically significant, but it is clear from the table that the association with depressive disorder is concentrated among those with more severe (BMI 35+) obesity, where the pooled odds ratio is 1.3. The results for the total obesity group should also be interpreted in the light of findings for population subgroups (below). Although the country-specific odds ratios are only significant in a minority of countries, there is a fair degree of consistency in the association of total obesity with depressive disorder, and in the association of severe obesity with depressive disorder, from country to country, despite the major differences between countries in obesity prevalence. The formal test for heterogeneity among the odds ratios for total obesity was not significant ($p = .35$).

In looking at the potential moderating effects of demographic variables on the total obesity-depressive disorders association, three main findings that emerge. First, for education, the significant pooled odds ratio of 1.2 for those with more education indicates that the relationship between obesity and depressive disorder only occurs in this group, rather than in the group with less education (Table 3). The individual countries where this moderating role of education on the obesity-depressive disorder relationship is significant are the United States and Belgium.

Second, as shown in Table 3, the relationship between total obesity and depressive disorder is also moderated by sex: it is only significant among females (pooled odds ratio of 1.2). The individual countries where the sex difference is significant are New Zealand and Lebanon. Females in the BMI 30+ group in the United States also show significantly elevated odds of depressive disorder, but the association for females does not vary sufficiently from males for the interaction between obesity and sex to be significant in the US. Third, there are no significant effects of age, either on an individual country, or pooled basis (data not shown but available on request).

Obesity and anxiety disorders

The overall relationship between obesity and any 12-month anxiety disorder is reported in Table 4. With a significant pooled odds ratio of 1.2 for total obesity and 1.4 for severe obesity with anxiety disorders, this relationship is a little stronger than that observed between obesity and depressive disorder, though again, these findings should be interpreted in the context of results among population subgroups (below). The association with anxiety disorders is more variable across countries, but the formal test for heterogeneity among the odds ratios for total obesity was not significant ($p = .15$), indicating that the pooled estimate is appropriately capturing the relationship.

When the relationship between total obesity and anxiety disorder was examined by sociodemographic subgroup, education and sex differences were again observed (Table 5). In contrast to the findings for depressive disorder, the relationship between obesity and anxiety disorder is significant only for those with less education. Consistent with the findings for depressive disorder, it is only females who show a significant relationship between total obesity and anxiety disorder with a pooled odds of 1.3 relative to 1.0 for males. There are also age differences in the relationship between obesity and anxiety disorders, with pooled odds of

anxiety disorder among obese persons in age groups as follows: 18–34 (1.3 [1.0, 1.5]), 35–49 (1.1 [0.9, 1.3]), 50–64 (1.1 [0.9, 1.4]), 65+ (1.7 [1.2, 2.3]).

Obesity and alcohol use disorder

The relationship between obesity and alcohol use disorder is not significant, with a pooled odds ratio of 0.9 (0.7, 1.1) for total obesity (data not shown but available on request). Again, the variability among the country-specific odds ratios was not greater than expected by chance ($p = .35$). Of individual countries, only the United States shows a significant relationship, in which people with BMI 30+ are less likely to have an alcohol use disorder (OR: 0.6 [0.4, 1.0]).

DISCUSSION

This investigation of obesity-mental disorder relationships among thirteen countries found statistically significant relationships, adjusted for age, sex and education, between obesity and depressive disorder, and between obesity and anxiety disorder, in pooled analyses across countries. These relationships are concentrated among those with more severe obesity (BMI 35+), though they are significant for the total obesity group (BMI 30+). Subgroup analysis confirmed suggestions from earlier research that sociodemographic variables are important moderators of obesity-mental disorder relationships, with associations between total obesity and both depressive and anxiety disorders occurring in females but not in males. Associations between obesity and anxiety disorders were stronger among younger and older persons. Education had variable effects across depressive and anxiety disorders. No relationship was observed between obesity and alcohol use disorders.

A salient feature of the associations observed in this study between obesity and both depressive and anxiety disorders is that although they are statistically significant, they are modest. Three observations need to be made about this. First, as Simon et al (9) point out, the small size of the odds ratio may belie relationships of considerable public health significance in countries where the prevalence of obesity and mental disorders is high and therefore where their overlap, even though small, amounts to substantial numbers of the population with obesity attributable to mental disorder, or mental disorder attributable to obesity. Second, given the inconsistency with which prior observations of population level relationships between obesity and mental disorder have been observed, it is all the more remarkable that the current associations should occur in data pooled across this range of countries, diverse in level of development, obesity prevalence, mental disorder prevalence, and size of survey sample. Third, it is clear that the relationship between obesity and mental disorder is stronger among those with more severe obesity. Small sample sizes for a number of the countries precluded our investigating the relationship between severe obesity and mental disorders in demographic subgroups, so the odds ratios reported here for those subgroups are underestimates of the strength of the relationship with mental disorder for those with BMI 35+.

A significant limitation of this study is the fact that height and weight were self-reported which has been found to result in underestimates of the prevalence of obesity (22), though as noted above, this did not appear to occur in the New Zealand survey. Nonetheless, the degree of underestimation of obesity in the other surveys is unknown, and the effect of depressed mood on estimates on self-reported weight is also unclear. To the extent that weight underestimation is motivated by distress about weight, the associations between obesity and mental disorder reported here could be attenuated relative to their true magnitude in the population. On the other hand, if depressed mood leads to overestimated weight among those with weight concerns, this would have the effect of elevating the true magnitude of the association.

Onyike and colleagues (5) measured height and weight and observed an odds of past year depression amongst obese persons of 1.4, and an odds of past month depression of 1.9. This

latter finding suggests that stronger associations between depression and obese persons may have been obtained in the current study had we used a measure of past-month depression rather than past year, but again the small sample sizes in some of the surveys included precluded this. A further limitation imposed by the small sample size of some of the surveys is that it prevented testing for interactions between population subgroups in the relationship between obesity and mental disorder (e., between age and sex).

A strength of this study is that the estimates are pooled across a large number of consistently conducted surveys. The individual surveys might appear to yield disparate results if examined individually, yet whether or not the country-specific odds ratios are statistically significant is greatly influenced by sample or cell size. More important is the fact that the country-specific odds ratios do not typically differ significantly from each other, allowing confidence in the pooled estimates.

There are two components of these findings that are of particular note. The first is that while depressive disorder has been the focus of prior research on this topic, these results indicate that anxiety disorders, too, are associated with obesity at greater than chance levels. Alcohol use disorders are not related to obesity. It is emotional disorders then, rather than depressive disorders specifically, or mental disorders generally, that appear to have a connection with obesity.

The second finding of note is that this relationship between obesity and emotional disorder is confined to women. This supports the hypothesis of Friedman and Brownell (4) and the findings of other investigators (5,8). It is a contrast, however, to the recent finding from the NCS-R (9) where no sex difference was found in the associations between obesity and either mood or anxiety disorders. Simon and colleagues suggest that the sex difference sometimes observed in prior research may be a function of differences in statistical power (because fewer males have emotional disorders). The current results do not support that explanation, given that the pooled odds of association between obesity and either depressive or anxiety disorders for males did not exceed 1.0. There are several analytical differences between the Simon et al. study and the current study (use of lifetime versus 12 month disorders, the number and type of disorders included in mental disorder groups, the inclusion or exclusion of those with BMI less than 18.5); at this point it is not possible to be conclusive about the exact source of the discrepancy between results. It is noteworthy though, that of the five studies (including the current study) that have investigated the relationship between diagnosed mental disorders and obesity in general population samples (5,8–10), four have observed a sex difference in the relationship between obesity and mental disorder.

There are a number of possible mechanisms that may explain the relationship between obesity and emotional disorder for women. Women appear to be more troubled by obesity than men, for although the prevalence of obesity is fairly similar across men and women, women are much more likely to present for treatment for obesity (4,27). They also experience more stigma in association with obesity (28,29). Women are under more pressure to be thin, and experience greater body dissatisfaction (14,30–32); these factors may trigger or maintain obesity through mechanisms such as the paradoxically disinhibiting effects of dietary restraint (33), or emotional eating (34). Women are known to be more likely to engage in binge eating unaccompanied by compensatory behaviour (31,35). The relationship between obesity and emotional disorders may represent a particularly uncomfortable juncture for some women between the pressures of the “toxic environment” (36) that fuel the global rise in obesity on the one hand, and the sociocultural pressures that encourage body dissatisfaction and a drive for thinness among women, on the other.

This does not presuppose any particular direction in the relationship between obesity and mental disorder. This study cannot inform on that issue, and the mechanisms cited here can be viewed as pathways from both obesity to emotional disorder (eg, through the effects of stigma (37), or obesity-related disability (38,39)) and from emotional disorder to obesity (eg, through psychologically-mediated disordered eating (27,34,40), the effects of psychotropic medication (41) or reduced physical activity (6)). It seems plausible that given the heterogeneous population of the obese, both pathways occur. Moreover, for some individuals the association of obesity and emotional disorder may be a function of other factors altogether, either biological (42), genetic (7) or environmental (6).

The effects of age were less consistent in this study than the effect of sex. The only other population study investigating age in the association between obesity and DSM mental disorders (9) found no significant interaction between age and obesity in the odds of either mood or anxiety disorders. However, that study did find that the one age group to show a significantly higher odds of anxiety disorder among the obese was the 60 years and over group with an odds ratio of 1.64 (1.02, 2.64). This is similar to the pooled odds observed in the current study of anxiety disorder among the obese aged 65 years and over of 1.7 (1.2, 2.3). This finding may warrant further research, but it needs to be interpreted in the context of insignificant overall effects of age in the relationship between obesity and anxiety disorders in both the NCS-R study, and for individual countries in the current study where the odds of anxiety disorder among the oldest obese were relatively high (New Zealand, France, United States: data not shown but available on request).

This first cross-national study of the relationship between obesity and mental disorders is suggestive of a modest relationship between obesity (particularly severe obesity) and emotional disorders for women, in the general population, in diverse nations. The study cannot clarify the direction or nature of that relationship, but it may indicate a need for a research and clinical focus on the psychological heterogeneity of the obese population (43,44).

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Table 1

Sample Characteristics, and Obesity Prevalence

Country	National Sample (N) ¹	Mean age ²	% 60 yrs. Or older	% women	% Secondary education or more	Obesity Prevalence (total obesity): BMI 30+		Obesity Prevalence (severe obesity): BMI 35+	
						Unweighted (N)	Weighted %	Unweighted (N)	Weighted %
<i>Americas</i>									
Colombia	4418	36.8	5.7	54.4	45.9	310	6.6	66	1.4
Mexico	5092	35.0	5.1	49.3	34.3	1659	29.4	772	13.5
United States	9125	44.8	21.2	51.4	84.0	2330	25.2	864	9.2
<i>Asia & S. Pacific</i>									
Japan	2326	51.4	35.4	52.6	71.8	58	2.6	3	0.1
New Zealand	12782	44.6	20.9	52.0	60.0	3531	20.0	1331	6.2
<i>Europe</i>									
Belgium	2417	47.0	27.4	51.0	67.7	317	13.8	67	3.1
France	2892	46.8	25.4	52.4	NA	307	10.9	61	2.2
Germany	3553	48.0	30.3	51.8	96.4	450	13.1	86	2.4
Italy	4706	47.5	28.5	51.9	40.1	478	10.3	94	2.1
Netherlands	2371	45.3	22.8	51.1	68.4	307	12.0	65	2.5
Spain	5451	45.6	26.0	52.0	42.7	788	14.4	154	3.0
<i>Middle East and Africa</i>									
Lebanon	2538	38.4	13.2	47.6	44.5	365	13.6	62	2.1
Israel	4606	44.2	19.8	50.9	79.7	731	15.6	129	2.9

¹ Number of people with valid BMI data for each survey. Demographic statistics in this table are proportions of the sample with valid BMI data.

² Age range ≥ 18 , except for Colombia, Mexico (18–65), Japan (≥ 20) and Israel (≥ 21)

Table 2
Prevalence of any 12-month depressive disorder by BMI group among the total population and odds of association

Country	Any 12-month depressive disorder						
	BMI 18.5–29.9 %	BMI30+ %	BMI 30–34.9 %	BMI35+ %	BMI 30+ OR ^I (CI) adj for age, sex, education	BMI 30 – 34.9 OR ^I (CI) adj for age, sex, education	BMI 35+ OR ^I (CI) adj for age, sex, education
Colombia	6.0	7.4	6.6	10.1	1.4 (0.8, 2.2)	1.2 (0.7, 2.1)	2.0 (0.8, 5.1)
Mexico	4.0	4.6	3.7	5.7	0.8 (0.6, 1.0)	0.7 (0.5, 0.9)*	0.9 (0.6, 1.2)
United States	8.0	9.6	8.3	11.8	1.2 (1.0, 1.4)	1.1 (0.8, 1.3)	1.4 (1.1, 1.8)*
Japan	2.1	3.7	3.9	0.0	1.8 (0.3, 9.4)	2.0 (0.4, 9.7)	- (-, -)
New Zealand	6.3	7.6	6.9	9.1	1.2 (1.0, 1.4)	1.1 (0.9, 1.3)	1.4 (1.0, 1.9)*
Belgium	5.2	5.4	4.6	8.0	1.1 (0.5, 2.6)	1.0 (0.4, 2.5)	1.6 (0.4, 7.2)
France	6.2	7.1	5.9	11.9	1.3 (0.8, 2.2)	1.1 (0.6, 2.1)	2.3 (1.0, 5.3)*
Germany	3.0	4.3	3.9	6.3	1.6 (0.8, 3.4)	1.5 (0.6, 3.5)	2.4 (0.7, 8.0)
Italy	3.4	3.0	2.8	4.0	0.8 (0.4, 1.4)	0.7 (0.4, 1.4)	1.0 (0.3, 2.8)
Netherlands	5.0	5.2	3.8	10.3	1.0 (0.4, 2.2)	0.7 (0.3, 1.6)	1.9 (0.5, 7.4)
Spain	4.2	4.8	4.4	6.6	1.1 (0.8, 1.7)	1.1 (0.6, 1.8)	1.4 (0.7, 2.5)
Lebanon	5.2	5.5	5.2	7.3	1.1 (0.6, 2.1)	1.1 (0.5, 2.1)	1.5 (0.5, 4.4)
Israel	5.9	6.5	5.6	10.6	1.1 (0.7, 1.5)	0.9 (0.6, 1.4)	1.7 (0.9, 3.4)
Pooled Odds Ratio	-	-	-	-	1.1 (1.0, 1.2)*	1.0 (0.9, 1.1)	1.3 (1.2, 1.5)*

^I Comparison group for all odds ratios is BMI 18.5–29.9

- (-,-) denotes that the odds ratio could not be calculated due to small cell size, or missing information

* p < .05

Table 3 Prevalence of any 12 month depressive disorder among sex and education groups, and odds of association

Country	Any depressive disorder										P-value [†]	
	< completed secondary education					Completed secondary education or more						
	BMI 18.5-29.9 %	BMI OR (CI) adj for age, sex	BMI 18.5-29.9 %	BMI OR (CI) adj for age, sex	P	BMI 18.5-29.9 %	BMI OR (CI) adj for age, sex	BMI 18.5-29.9 %	BMI OR (CI) adj for age, sex	P		
Colombia	6.0	1.3 (0.7, 2.2)	6.0	1.3 (0.5, 3.3)	0.940	4.4	2.8	0.8 (0.2, 3.1)	7.3	10.7	1.5 (0.9, 2.7)	0.252
Mexico	4.6	5.0 (0.7, 1.0)	3.0	3.3 (0.8, 1.5)	0.877	2.6	2.3	0.7 (0.4, 1.4)	6.0	5.4	0.8 (0.6, 1.1)	0.933
United States	9.8	0.8 (0.6, 1.1)	7.7	1.3 (1.0, 1.6)	0.027	6.2	6.5	1.0 (0.7, 1.4)	9.8	12.4	1.3 (1.0, 1.7) *	0.322
Japan	1.0	0.0 (-, -)	2.5	5.2 (-, -)	-	1.6	0.0	(-, -)	2.5	7.7	(-, -)	-
New Zealand	6.3	8.5 (1.0, 1.8)	6.4	6.8 (1.1, 0.8, 1.4)	0.366	5.1	4.3	0.8 (0.6, 1.2)	7.6	10.4	1.4 (1.2, 1.8) *	0.008
Belgium	5.9	1.2 (0.2, 0.0, 0.8)	4.9	8.7 (1.0, 4.6)	0.000	4.3	3.1	0.7 (0.1, 3.4)	6.1	7.7	1.6 (0.7, 3.3)	0.326
France	-	(-, -)	-	(-, -)	-	4.6	3.8	1.0 (0.4, 2.6)	7.6	10.6	1.6 (0.8, 3.2)	0.361
Germany	3.9	0.0 (-, -)	2.9	4.6 (1.7, 0.8, 3.6)	-	2.1	3.6	1.6 (0.5, 5.5)	3.8	5.1	1.6 (0.8, 3.5)	0.804
Italy	4.1	3.6 (0.8, 0.4, 1.5)	2.4	0.8 (0.5, 0.1, 3.9)	0.520	2.0	2.0	0.9 (0.3, 2.6)	4.7	4.0	0.7 (0.4, 1.5)	0.689
Netherlands	4.9	5.2 (1.1, 0.4, 3.1)	5.1	5.1 (0.9, 0.3, 2.5)	0.714	3.1	3.4	1.0 (0.3, 3.0)	7.0	6.3	0.9 (0.4, 2.6)	0.756
Spain	4.2	5.1 (1.2, 0.8, 1.9)	4.2	4.0 (1.0, 0.4, 2.5)	0.643	2.4	1.8	0.7 (0.2, 2.3)	5.9	8.0	1.3 (0.9, 2.0)	0.277
Lebanon	4.9	5.7 (1.2, 0.5, 2.7)	5.7	5.1 (-, -)	0.835	4.1	1.3	0.3 (0.1, 1.6)	6.5	11.8	1.8 (0.9, 3.6)	0.022
Israel	7.5	5.4 (0.7, 0.3, 1.3)	5.6	6.9 (1.3, 0.9, 2.0)	0.096	4.4	6.2	1.4 (0.8, 2.5)	7.5	6.7	0.9 (0.6, 1.4)	0.169
Pooled Odds Ratio	-	0.9 (0.8, 1.1)	-	1.2 (1.1, 1.4)	-	-	-	0.9 (0.8, 1.1)	-	-	1.2 (1.1, 1.4) *	-

[†] P value is for the interaction between obesity and the demographic variable (age, sex or education) in predicting mental disorder outcome, for each survey

(-, -) denotes that the odds ratio could not be calculated due to small cell size, or missing information

* p < .05

Table 4
Prevalence of any 12 month anxiety disorder by BMI group among the total population and odds of association

Country	Any 12-month anxiety disorder						
	BMI 18.5–29.9 %	BMI30+ %	BMI 30–34.9 %	BMI35+ %	BMI 30+ OR ^I (CI) adj for age, sex, education	BMI 30 – 34.9 OR ^I (CI) adj for age, sex, education	BMI 35+ OR ^I (CI) adj for age, sex, education
Colombia	6.0	5.0	5.5	2.9	0.8 (0.4, 1.6)	0.9 (0.4, 2.0)	0.4 (0.1, 2.5)
Mexico	3.5	4.5	4.7	4.4	1.0 (0.7, 1.6)	1.1 (0.6, 1.9)	1.0 (0.6, 1.5)
United States	13.3	14.6	13.0	17.3	1.1 (0.9, 1.3)	1.0 (0.8, 1.2)	1.2 (0.9, 1.5)
Japan	2.4	3.9	3.9	-	- (-,-)	- (-,-)	- (-,-)
New Zealand	9.3	13.8	12.6	16.7	1.5 (1.2, 1.8) *	1.4 (1.1, 1.7) *	1.7 (1.3, 2.3) *
Belgium	4.0	4.3	4.0	4.9	1.3 (0.6, 3.2)	1.3 (0.5, 3.2)	1.5 (0.4, 5.5)
France	6.8	6.9	4.1	16.9	1.3 (0.5, 3.1)	0.7 (0.3, 1.7)	4.0 (1.3, 12.6) *
Germany	3.4	2.2	2.1	2.6	0.8 (0.4, 1.9)	0.9 (0.3, 2.4)	0.7 (0.1, 3.6)
Italy	3.2	2.4	2.6	1.6	0.7 (0.3, 1.8)	0.8 (0.3, 2.3)	0.4 (0.1, 2.1)
Netherlands	4.8	12.6	7.2	28.2	2.5 (0.9, 7.1)	1.4 (0.7, 2.8)	6.8 (1.7, 26.9) *
Spain	2.5	3.2	2.9	4.2	1.4 (0.8, 2.4)	1.3 (0.7, 2.6)	1.7 (0.7, 4.1)
Lebanon	4.4	2.1	2.3	0.4	0.5 (0.1, 2.0)	0.6 (0.1, 2.4)	0.1 (0.0, 0.8) *
Israel	3.7	4.2	4.2	9.0	1.0 (0.6, 1.5)	0.9 (0.6, 1.4)	1.8 (0.9, 3.5)
Pooled Odds Ratio	-	-	-	-	1.2 (1.1, 1.3) *	1.1 (1.0, 1.2)	1.4 (1.2, 1.6) *

^I Comparison group for all odds ratios is BMI 18.5–29.9

- (-,-) denotes that the odds ratio could not be calculated due to small cell size, or missing information

* p < .05

Table 5

Prevalence of any 12 month anxiety disorder among sex and education groups, and odds of association

Country	Any anxiety disorder												
	< completed secondary education			Completed secondary education or more			Males			Females			
	BMI 18.5-29.9 %	BMI 30+ %	OR (CI) adj for age, sex	BMI 18.5-29.9 %	BMI 30+ %	OR (CI) adj for age, sex	BMI 18.5-29.9 %	BMI 30+ %	OR (CI) adj for age, education	BMI 18.5-29.9 %	BMI 30+ %	OR (CI) adj for age, education	P
Colombia	6.1	4.2	0.6 (0.3, 1.5)	5.9	6.5	1.0 (0.3, 3.4)	4.2	7.0	1.7 (0.6, 5.4)	7.6	3.8	0.5 (0.2, 1.1)	0.042
Mexico	3.9	4.5	0.9 (0.6, 1.5)	2.9	4.7	1.4 (0.6, 3.1)	2.6	1.5	0.6 (0.2, 1.9)	4.9	5.6	1.1 (0.7, 1.8)	0.207
United States	12.1	19.5	1.4 (0.9, 2.3)	13.5	13.6	1.0 (0.8, 1.2)	10.5	9.7	0.8 (0.6, 1.2)	15.9	19.0	1.2 (1.0, 1.5)	0.128
Japan	0.5	0.0	- (-, -)	3.3	5.1	- (-, -)	2.6	1.8	- (-, -)	2.2	11.7	- (-, -)	-
New Zealand	10.3	14.4	1.3 (1.0, 1.8)	8.7	13.3	1.6 (1.2, 2.1)	7.3	9.8	1.3 (0.9, 1.8)	11.3	17.4	1.6 (1.3, 2.0)*	0.382
Belgium	1.7	2.8	1.8 (0.4, 7.9)	5.0	5.0	1.3 (0.5, 3.6)	3.9	2.7	0.8 (0.2, 3.5)	4.1	6.0	2.0 (0.9, 4.7)	0.219
France	-	-	- (-, -)	-	-	- (-, -)	4.7	1.7	0.4 (0.1, 1.1)	8.6	15.8	2.2 (0.8, 6.3)	0.008
Germany	5.9	0.0	- (-, -)	3.3	2.2	0.9 (0.4, 2.0)	2.2	0.8	0.4 (0.0, 3.7)	4.5	3.4	1.1 (0.4, 2.7)	0.522
Italy	3.3	2.6	0.8 (0.3, 2.3)	3.0	1.7	- (-, -)	1.8	1.3	0.7 (0.2, 2.5)	4.5	3.6	0.8 (0.2, 2.5)	0.877
Netherlands	5.6	8.9	1.7 (0.7, 4.3)	4.5	16.0	3.3 (1.0, 10.6)*	2.9	3.0	0.8 (0.2, 3.0)	6.8	18.1	3.2 (1.1, 9.3)*	0.087
Spain	2.3	3.8	1.9 (1.0, 3.3)*	2.8	0.9	0.4 (0.1, 2.0)	0.048	1.8	0.5 (0.1, 2.0)	3.2	5.7	2.0 (1.1, 3.8)*	0.044
Lebanon	4.2	1.4	0.3 (0.1, 1.9)	4.7	3.7	- (-, -)	1.9	0.0	- (-, -)	7.4	4.5	0.7 (0.2, 3.1)	-
Israel	5.4	4.5	0.8 (0.3, 1.8)	3.4	4.1	1.1 (0.7, 1.9)	2.8	4.2	1.5 (0.8, 2.8)	4.7	4.2	0.8 (0.4, 1.4)	0.159
Pooled Odds Ratio	-	-	1.2 (1.0, 1.5)*	-	-	1.1 (1.0, 1.3)	-	-	1.0 (0.8, 1.2)	-	-	1.3 (1.2, 1.5)*	-

[†] P value is for the interaction between obesity and the demographic variable (age, sex or education) in predicting mental disorder outcome, for each survey

- (-, -) denotes that the odds ratio could not be calculated due to small cell size, or missing information

* p < .05