Serious psychological distress and its associations with body mass index: findings from the 2007 Behavioral Risk Factor Surveillance System

Guixiang Zhao[1], Earl S. Ford[1], Chaoyang Li[1], Tara W. Strine[1], Satvinder Dhingra[1], Joyce T. Berry[2], Ali H. Mokdad[3]

[1] Division of Adult and Community Health, National Center for Chronic Disease Prevention and Health Promotion, Centers for Disease Control and Prevention, Atlanta, GA, USA
[2] Substance Abuse and Mental Health Services Administration, Washington, D.C, USA [3]Institute for Health Metrics and Evaluation, University of Washington, Seattle, WA, USA

Abstract

Objectives: To examine the associations of body mass index (BMI) with serious psychological distress (SPD) after taking into consideration the obesity-related comorbidities (ORCs), lifestyle factors, or emotional support.

Methods: Self-reported data (n = 153,865) from the 2007 BRFSS were analyzed. Psychological distress was assessed by the Kessler-6 Questionnaire; respondents with a Kessler–6 score of ≥13 were defined as having SPD. The adjusted prevalence ratios (APRs) with 95% confidence intervals (CIs) were estimated using log-binomial regression analyses.

Results: Overall, 3.2% of U.S. adults had SPD. The prevalence of SPD was significantly higher among men who were underweight or obese, or among women who were underweight, overweight or obese, compared to those with a normal BMI. The APRs for SPD were 1.58 (95% CI: 1.06–2.35) in adults who were underweight, and were 1.21 (95% CI: 1.04–1.41), 1.31 (95% CI: 1.07–1.61), and 1.36 (95% CI: 1.13–1.63), respectively, in obese adults with BMI of $30-<35\,kg/m^2$, $35-<40\,kg/m^2$, and $\geq40\,kg/m^2$ (adults with a normal BMI as the referent).

Conclusion: An abnormal BMI is associated with an increased likelihood of having SPD independent of multiple ORCs, lifestyle factors, or emotional support.

Keywords: Body mass index – Mental illness – Serious psychological distress – Obesity-related co-morbidities – BRFSS.

Introduction

Obesity has been a growing public concern in the United States and worldwide.[1,2] During 2001–2004, about 34% of U.S. adults were overweight (body mass index [BMI]: $25-<30\,kg/m^2$) and 32% were obese(BMI $\geq30\,kg/m^2$),[1,3] which has increased slightly to 34% during 2005–2006.[4] Obesity is a leading cause of multiple chronic diseases including high blood pressure, diabetes, hypercholesterolemia, coronary heart disease, asthma, arthritis, and many others.[5–7] In addition, obesity increases the risk of cancers and is associated with increased all-cause, cardiovascular or cancer mortality.[7–10]

In addition to obesity-related physical illness, studies have shown that BMI is associated with mental health disorders,[11–15] which are a leading cause of disease burden (cost: \$150 billion per year on mental health disorders) in the United States and globally[16–18] and are associated with increased mortality, disability, and reduced quality of life.[19–21] However, most of these studies focused on the associations between BMI and current or lifetime diagnosed depression and anxiety, and the findings of these studies have been inconsistent. This may have resulted from the failure to control for confounding from obesity-related comorbidities (ORCs) or other lifestyle factors (such as smoking, heavy alcohol drinking, physical activity, and emotional support) because ORCs or lifestyle factors have been found to affect mental health status or are associated with mental health disorders.[22–28] By using a large nationally representative sample, we sought to examine the associations of BMI with provisional mental illness measured as serious psychological distress (SPD) by the Kessler-

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6 screening scale, after taking into consideration multiple risk factors including demographic characteristics, common ORCs, lifestyle factors, and emotional support.

Methods

Data for our analyses came from the 2007 Behavioral Risk Factor Surveillance System (BRFSS) – a population-based telephone survey of health-related behaviors regarding the leading causes of death among noninstitutionalized U.S. adults aged ≥18 years. The BRFSS survey design, sampling methods and weights have been described elsewhere[29] and detailed information on BRFSS is available at http://www.cdc.gov/brfss/. The median cooperation rate (the percentage of eligible persons contacted who completed the interview) of the 2007 BRFSS was 72.1 %.

We analyzed the data collected from survey participants in 35 states, the District of Columbia, and Puerto Rico, in which a Mental Illness and Stigma Module was implemented in the 2007 BRFSS. In this module, the Kessler−6 Questionnaire was used to assess participants' psychological distress status. Specifically, participants were asked about how often during the previous 30 days they felt 1) nervous, 2) hopeless, 3) restless or fidgety, 4) so depressed that nothing could cheer them up, 5) that everything was an effort, and 6) worthless. Their responses to each of the questions were categorized and coded as (by increased frequency with reported problems): "None of the time" = 0, "A little of the time" = 1, "Some of the time" = 2, "Most of the time" = 3, and "All of the time" = 4, with a total score for each participant ranged from 0 to 24. Participants with a Kessler−6 score of ≥13 were defined as having SPD according to the Kessler's scoring guideline.[30,31] Previous research has demonstrated the validity of the Kessler-6 Psychological Distress Scale in the general population.[30,32,33] In a telephone pilot survey sample, the Kessler-6 questionnaire showed an excellent internal consistency reliability (Cronbach's alpha = 0.89).[30]

Participants' BMI, calculated using self-reported weight (in kilograms) divided by the square of height (in meters), was categorized as 1) $< 18.5 \, kg/m^2$ (underweight), 2) $18.5 - < 25 \, kg/m^2$ (normal weight), 3) $25 - < 30 \, kg/m^2$ (overweight), 4) $30 - < 35 \, kg/m^2$ (class I obesity), 5) $35 - < 40 \, kg/m^2$ (class II obesity), and 6) $\geq 40 \, kg/m^2$ (class III obesity). The ORCs evaluated in the present study included diabetes, hypertension, hypercholesterolemia, heart attack (or myocardial infarction), angina pectoris, stroke, arthritis, and asthma, which were assessed by asking respondents whether they had ever been told by a doctor or other health professional that they had had these conditions (or still had asthma). For diabetes and hypertension, those who answered that they had not been so told or had been told that they had diabetes (or hypertension) only during pregnancy or had borderline diabetes (or hypertension) were categorized as "no diagnosed diabetes (or hypertension)".

The demographic variables in our analyses included the participants' age, sex, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and others), education (less than high school diploma, high school graduate, and ≥ some college or college graduate), employment (employed for wages, self-employed, unemployed, and retired), and marital status (married, divorced, never married, and others). In addition, the participants' status on smoking, heavy alcohol drinking, leisure-time physical activity, or the frequency of getting emotional support (always, usually, sometimes, rarely, and never) were included as covariates. Current smokers were those participants who had smoked ≥100 cigarettes during their lifetime and were still smoking. Current non-smokers were those who either had smoked <100 cigarettes during their lifetime or had smoked ≥100 cigarettes in their entire life but stopped. Heavy alcohol drinkers were women who had ≥1 drink per day or men who had ≥2 drinks per day. Leisure-time physical activity was assessed by asking participants whether during the previous month, other than their regular job, they had participated in any physical activities or exercises.

Statistical analyses

After excluding from the analyses participants who responded "don't know/not sure", refused to answer, or had missing responses for any of the questions described above, a total of 153,865 participants remained in our analyses. The prevalence estimates for SPD were age-standardized to the 2000 U.S. population. The prevalence ratios were obtained using the LOGLINK (log-binomial analysis) procedure in SUDAAN software (release 9.0; Research Triangle Institute, Research Triangle Park, NC) with adjustment for socio-demographics, lifestyle factors, emotional support, and ORCs (the sum of responses to each of the ORCs was coded from 0 to 8 and treated as a continuous variable). SUDAAN software was used to account for the multi-stage, disproportionate stratified sampling design.

Results

Among the participants included in our analyses, a total of 2,117 [weighted percent: 1.4 % (men: 0.6 %, women: 2.1 %)] people were underweight (BMI $< 18.5 \, kg/m^2$), 52,192 [35.6 % (men: 27.9 %, women: 42.9 %)] had a normal BMI ($18.5 - < 25 \, kg/m^2$), 57,114 [36.4 % (men: 44.2 %, women: 29.2 %)] were overweight (BMI $25 - < 30 \, kg/m^2$), and 42,442

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Table 1. Age-adjusted percentages of U.S. adults with serious psycho-
logical distress (SPD) by selected characteristics, 2007 BRFSS (n = 153,865).

	N	%	SE
Total	**153,865**	**3.2**	**0.1**
Age			
18–29	7,128	3.2	0.3
30–39	18,494	3.1	0.2
40–49	29,427	3.2	0.2
50–59	36,770	4.5	0.2
60–69	31,008	2.9	0.2
≥70	31,038	1.8	0.1
Sex			
Men	57,362	2.6	0.1
Women	96,503	3.7	0.1
Race			
Non-Hispanic white	124,877	2.8	0.1
Non-Hispanic black	10,258	4.4	0.4
Hispanic	9,702	4.9	0.4
Others	9,028	3.3	0.3
Education			
< high school	11,822	8.7	0.6
High school graduates	42,896	4.5	0.3
> high school diploma	99,147	2.1	0.1
Employment			
Employed for wages	70,334	1.6	0.1
Self-employed	13,921	1.8	0.3
Unemployed	27,299	8.7	0.3
Retired	42,311	5.1	1.5
Marital Status			
Married	91,029	2.2	0.1
Divorced	22,008	6.1	0.5
Never married	14,479	4.4	0.3
Others	26,349	6.5	0.5
Smoking			
Yes	24,877	7.4	0.3
no	128,988	2.3	0.1
Heavy drinking			
Yes	7,385	5.2	0.7
no	146,480	3.1	0.1
Exercise			
Yes	117,868	2.2	0.1
no	35,997	7.2	0.4
Emotional support			
Always	76,421	1.3	0.1
Usual	48,468	1.8	0.1
Sometimes	18,469	8.7	0.5
Rarely	5,618	18.9	1.3
never	4,889	11.5	1.2

SE: standard error
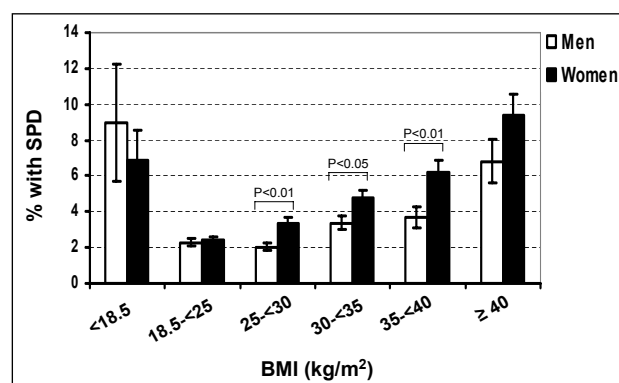
Figure 1. Age-adjusted percentages (with SEs) of U.S. men and women
who had serious psychological distress by BMI levels, 2007 BRFSS. SPD:
serious psychological distress.

[26.6 % (men: 27.4 %, women: 25.8 %)] were obese (BMI
≥30 kg/m^2). Among those who were obese, 26,774 [16.8 %,
(men: 18.8 %, women: 15.0 %)] people had class I obes-
ity (BMI 30–<35 kg/m^2), 9,759 [6.0 % (men: 5.8 %, women:
6.2 %)] had class II obesity (BMI 35–<40 kg/m^2), and 5,909
[3.8 % (men: 2.9 %, women: 4.6 %)] had class III obesity
(BMI ≥40 kg/m^2).

The age-standardized prevalence of SPD was 3.2 % (95 %
confidence interval [CI]: 3.0–3.4 %). Overall, women had a
significantly higher prevalence of SPD than men (3.7 % ver-
sus 2.6 %, P < 0.001, Table 1). After further stratified by BMI
levels, the significantly higher prevalence of SPD in women
than in men was observed only in those who were overweight
or had class I and II obesity (Figure 1). In addition, among
women, the prevalence of SPD was significantly higher in
those who were underweight than in those with a normal BMI
(P < 0.01) and thereafter increased linearly with increasing in
BMI (P < 0.01 for a linear trend). Among men, compared to
those with a normal BMI, a significantly higher prevalence of
SPD was observed in those who were either underweight or
obese, but not in those who were overweight.

Among four racial/ethnic groups, non-Hispanic whites had
the lowest prevalence of SPD (Table 1). In addition, the prev-
alence of SPD was the lowest in those who had educational
levels greater than a high-school diploma, were employed
(employed for wages or self-employed), were married, and
could always get emotional support. It was higher, however,
in those who were smokers, heavy drinkers, and engaged in
no leisure-time physical activity than in their respective coun-
terparts (Table 1).

Among all participants, 8.2 % (95 % CI: 8.0–8.5 %) of par-
ticipants had ever been diagnosed with diabetes, 3.9 % (95 %
CI: 3.7–4.0 %) with myocardial infarction, 4.1 % (95 % CI:
4.0–4.3 %) with angina pectoris, 2.5 % (95 % CI: 2.3–2.6 %)

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BMI	Model 1			Model 2			Model 3		
(kg/m²)	PR	95 % CI		PR	95 % CI		PR	95 % CI	
<18.5	2.73	1.85	4.02	1.60	1.08	2.36	1.58	1.06	2.35
18.5–<25	1.00			1.00			1.00		
25–<30	1.10	0.96	1.26	1.11	0.97	1.28	1.04	0.90	1.19
30–<35	1.66	1.43	1.93	1.43	1.24	1.66	1.21	1.04	1.41
35–<40	2.41	1.93	3.01	1.69	1.38	2.06	1.31	1.07	1.61
≥40	3.60	2.98	4.36	1.91	1.59	2.30	1.36	1.13	1.63

Table 2. Adjusted prevalence ratios for serious psychological distress among U.S. adults with different BMI levels (adults with a normal BMI as the referent), 2007 BRFSS.

Model 1: unadjusted; Model 2: adjusted for age, sex, race/ethnicity, education, employment, marital status, smoking, leisure-time exercise, heavy alcohol drinking, and emotional support; Model 3: adjusted for the same set of variables as in model 2 plus the number of chronic diseases (used as continuous variable).
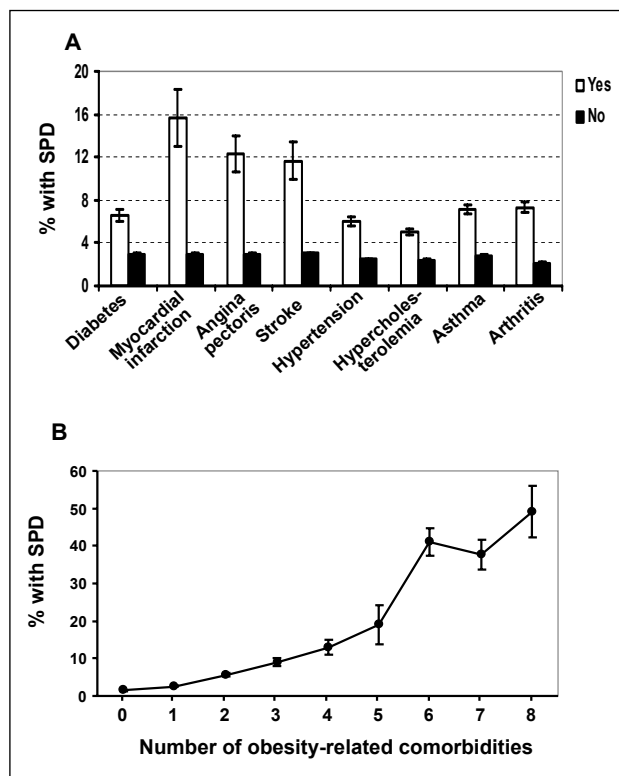

Figure 2. Age-adjusted prevalence (with SE) of serious psychological distress among U.S. adults with or without any of the obesity-related comorbidities (A) or among U.S. adults who had 0 to 8 of obesity-related comorbidites (B), 2007 BRFSS. SPD: serious psychological distress.

with stroke, 27.6 % (95 % CI: 27.2–28.1 %) with hypertension, 33.0 % (95 % CI: 32.4–33.5 %) with hypercholesterolemia, 26.7 % (95 % CI: 26.3–27.1 %) with arthritis, and 8.8 % (95 % CI: 8.4–9.2 %) still had asthma. Participants with any of the ORCs had a significantly higher prevalence of SPD than those without (Figure 2A). In addition, the prevalence of SPD generally increased as the number of ORCs increased except for participants with 7 of the ORCs (Figure 2B). The multivariate-adjusted prevalence ratios for SPD

were 1.64 (95 % CI: 1.36–1.99), 2.52 (95 % CI: 2.08–3.05), 3.01 (95 % CI: 2.46–3.69), 3.90 (95 % CI: 3.08–4.93), 4.13 (95 % CI: 3.06–5.59), 4.96 (95 % CI: 3.79–6.49), 4.92 (95 % CI: 3.47–6.97) and 10.97 (95 % CI: 4.01–30.05), respectively, among adults with 1 to 8 of ORCs (adults with none of the ORCs as the referent).

The log-binomial modeling analyses did not show significant interactions between gender and BMI for the measures of serious psychological distress. Compared to those with a normal BMI, the prevalence ratios for SPD were significantly higher in those who were underweight or obese and remained significant even after adjustment for socio-demographics, lifestyle factors, emotional support, and the number of ORCs (Table 2).

Discussion

Our results from a large, nationally representative sample suggest that BMI, either underweight or obesity, is associated with an increased likelihood of SPD among adults in the United States. These associations are independent of obesity-related chronic comorbidities, lifestyle factors, and emotional support. Although the causal link between abnormal BMI and SPD remains unknown, our findings potentially indicate a need for comprehensive efforts and/or joint intervention programs to improve obesity- (or abnormal body weight) associated mental health.

During the past 30 years, there has been a dramatic increase in obesity in the United States. By 2001–2004, the prevalence of overweight/obesity has increased by about 39 % and the prevalence of obesity has increased by about 113 % since 1976–1980.[3] The relationship of overweight/obesity to the development and progression of multiple chronic comorbidities has been well established. Presently, the associations between overweight/obesity and mental health are receiving increased attention. Previous studies have shown that an abnormal BMI

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is associated with psychiatric disorders meeting the criteria for one or more DSM-IV disorders (Diagnostic and Statistical Manual on Mental Disorders, fourth edition) such as depression and/or anxiety.[11–15] Pratt et al. recently reported that adults with SPD were more likely to be obese and had a higher prevalence of ever being diagnosed with heart disease, diabetes, arthritis and stroke than those without SPD.[28] Other studies reported that patients with diabetes or arthritis had a higher prevalence of SPD than those without,[21,34,35] and adults with three or more chronic conditions (including depression or another depressive disorders, chronic respiratory condition, heart disease, arthritis, diabetes, and current asthma) were 6 times as likely to have SPD as those with no conditions.[21] Our results also demonstrated that adults who had diagnosed diabetes, myocardial infarction, angina pectoris, stroke, hypertension, hypercholesterolemia, arthritis, or still had asthma have a significantly higher prevalence of SPD, and the prevalence of SPD (or the prevalence ratios for SPD) increased generally with increasing number of diseases. Moreover, our results showed that people with ≥3 of the 8 obesity-related diseases were 3.5 times as likely to have SPD as those with none of the conditions, which is consistent with the previous finding.[21] After we adjusted for these obesity-related chronic comorbidities, the findings that people who were either underweight or obese were more likely to have SPD remained statistically significant, suggesting that an abnormal BMI is independently associated with provisional mental health conditions. In addition, our results showed a similar pattern in the associations of SPD with socio-demographic characteristics as the associations of psychiatric disorders (i.e., depression and anxiety) with these same variables. Furthermore, although the prevalence of SPD differed by gender among those who were overweight or had class I and II obesity, we did not observe any interactive effects between gender and BMI on SPD after adjustment for a variety of potential confounders. Presently, limited evidence has shown that gender did not interactively affect the associations of psychological distress (assessed either by the 12-item General Health Questionnaire or by the 10-item Kessler Psychological Distress Scale) with obesity or weight perception,[36,37] which is consistent with our findings. In contrast, we previously reported a significant interaction between gender and BMI on the measures of current or lifetime diagnosed depression or anxiety.[38] Future studies may focus on the differential effects of gender on the relationship of specific measures of mental health disorders to BMI in the population.

Our study is subject to several limitations. First, all information including BMI, SPD, and chronic comorbidities was self-reported, and, thus subject to recall bias. It has been reported that the prevalence of overweight/obesity based on self-reported data was lower than that based on measured data,[39] so we may have underestimated the associations of BMI with SPD. Also, the obesity-related comorbidities were self-reported, ever being diagnosed conditions (except for asthma), therefore, we may have misclassified people with undiagnosed chronic conditions. Second, we did not have information on other conditions related to obesity such as sleep apnea, gallbladder disease, and cancers (breast, colon, endometrial, and prostate cancers), which may have affected the associations of BMI with psychological mental distress. Moreover, the causality of the association between BMI and SPD could not be inferred from our cross-sectional study. Nonetheless, a recent study showed that inflammatory markers, highly associated with obesity or central adiposity, independently accounted for about 25 % of the association between obesity and psychological distress,[36] suggesting inflammation might serve as an intermediate pathway. In fact, inflammation has played a major role in obesity, insulin resistance, and atherosclerotic cardiovascular disease,[40–42] all of which are associated with increased risk of SPD.[21,28,34]

In conclusion, our findings underscore the importance of abnormal BMI (i.e., underweight or obesity) as a predictor of SPD independent of chronic physical morbidities. Since both abnormal BMI and SPD are associated with impaired quality of life,[21,43,44] addressing obesity-related SPD may ultimately improve the quality of life among people with an abnormal BMI. In addition, given the rapid increase in the prevalence of obesity and the significant associations among obesity, obesity-related chronic comorbidities and SPD, healthcare providers can play a critical role in recognizing, assessing, and treating mental health impairment among people with an abnormal BMI.

Disclaimer

The findings and conclusions in this article are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention or the Substance Abuse and Mental Health Services Administration.

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Address for correspondence

Guixiang Zhao, MD, PhD
Centers for Disease Control and Prevention
4770 Buford Hwy., Mailstop K66
Atlanta, GA 30341
USA
Tel.: 770-488-2049
Fax: 770-488-8150
E-mail: GZhao@cdc.gov

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