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# Title Page

Master of Public Health Research Project

## **Association between Obesity and Depression and Anxiety Disorders: Results from the 2008 National Health Interview Survey**

by

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## Abstract

**Introduction:** Obesity is one of the most important medical problems in the U.S. and is considered to be an epidemic with over 30% of the population being obese. Obesity is associated with increased risk of hypertension, diabetes, cardiovascular diseases, certain cancers and a shorter life expectancy. Recent studies have shown that higher BMI levels are also significantly associated with several lifetime mental disorders such as major depressive disorder, anxiety disorders as well as panic attacks and panic disorders.

**Purpose:** The purpose of this study was to quantify the extent to which higher BMI increased the likelihood of Depression, Anxiety Disorder and Panic Disorder and to observe if co-morbid illnesses such as Hypertension and Diabetes affect this association.

**Methods:** A cross-sectional secondary data analysis was conducted using the 2008 National Health Interview Survey. There were 20,593 adult respondents (over 18 years of age) who were included in the study. Logistic regression models were weighted to account for the complex weighting scheme.

**Main Determinant measures:** Based on their BMI, the participants were classified into 5 groups: Underweight (BMI <18.50), Normal Weight (BMI 18.50 – 24.99), Overweight (BMI 25.00 – 29.99), Obese (BMI 30.00-39.99) and Morbidly Obese (BMI > 40.00).

**Main Outcome Measures:** Presence or absence of Depression, Anxiety Disorder or Panic Disorder based on self-report.

**Results:** People who were obese or morbidly obese had higher odds of suffering from depression, anxiety disorder and panic disorder compared to people who were normal weight. Obese individuals were 35% as likely to suffer from depression, 22% as likely to suffer from anxiety disorder and 36% as likely to suffer from panic disorder relative to normal weight persons. Morbidly obese people were 85% as likely to suffer from depression, 27% as likely to suffer from anxiety disorder and 34% as likely to suffer from panic disorder. No interactions were observed based on the presence of hypertension or diabetes.

**Conclusion:** Obesity is associated with an increased prevalence of depression, anxiety disorder and panic disorder. With obesity rates steadily increasing, understanding the impact of obesity on the occurrence of mental disorders is important.

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## INTRODUCTION

Obesity is one of the most important medical problems in the United States and is considered to be an epidemic of the 21<sup>st</sup> century with over 60% of the population being either overweight or obese. This trend has persisted for the last decade.<sup>1,2</sup> Overweight and obesity is associated with increased risk of atherosclerosis, dyslipidemia, hypertension, type 2 diabetes mellitus, cardiovascular diseases, arthritis, disability, certain cancers, and a shorter life expectancy.<sup>3,4,5</sup> Obesity is also a major cause of morbidity and mortality in the U.S., with over 300,000 adult deaths related directly or indirectly to obesity.<sup>1,3,6</sup> By 2015, 2.3 billion individuals aged 15 years or older will be overweight and 700 million worldwide will be obese.<sup>7</sup> Overall, the direct costs of obesity and physical inactivity account for approximately 9.4% of U.S. health care expenditures.<sup>8</sup> If the current trend continues, obesity will account for more than \$860 billion in health care expenditures in the U.S. by 2030.<sup>7,8</sup>

Higher Body Mass Index (BMI) or overweight/obesity has been shown to be significantly and positively associated with several lifetime psychiatric disorders like major depressive disorder, anxiety disorders as well as panic attacks and panic disorder.<sup>9-11</sup> Depressive disorders like major depressive disorder, dysthymic disorder and bipolar disorder, affect approximately 18.8 million American adults or about 9.5% of the U.S. population age 18 and older in a given year. Anxiety disorders, as a group, are the most common mental illness in America. Anxiety disorders include panic disorder, obsessive-compulsive disorder, post-traumatic stress disorder, generalized anxiety disorder, and

phobias (social phobia, agoraphobia, and specific phobia). Approximately 40 million American adults ages 18 and older, or about 18.1 percent of people in this age group in a given year, have an anxiety disorder; 6 million of these adults suffer from panic disorder in a given year. Anxiety disorders as well as panic disorder frequently co-occur with depressive disorders.<sup>12</sup>

Gender, age, race, marital status, employment status and education status affects the association between obesity and depression, anxiety disorder and panic disorder.<sup>8,10-15</sup>

Obese females were more likely to be depressed or suffering from an anxiety disorder as compared to obese males; however abdominal obesity in males was closely related to depression. While adolescent obesity in females predicted an increased risk for major depression disorder and anxiety disorder, the same was not true for adolescent obesity in males.<sup>9,16,17</sup> Conversely, few studies have found no association between higher BMI and depression,<sup>18-21</sup> other studies have reported an inverse association (decreased risk of depression associated with greater BMI) and yet others have found a positive association (increased risk of depression associated with greater BMI).<sup>22-24</sup> A recent study showed that greater BMI and obesity were associated with a reduced risk of hospital admission for psychoses and depression/anxiety in both genders.<sup>25</sup>

A limited number of studies have investigated the association between higher BMI and mood and personality disorders. The NCS-R study<sup>23</sup> and NESARC study<sup>26</sup> have the most relevant data in this regard. The NESARC study, which had 41,654 respondents, provides a systematic and comprehensive assessment of the association between body

weight and psychiatric conditions, which included major depression, anxiety disorder and other mood and personality disorders. It showed that higher BMI was associated with depression and anxiety disorder, while being underweight was negatively associated with panic disorder. Although the NCS-R and NESARC studies offers some of the most comprehensive assessments of the association of obesity with psychiatric diagnoses, it did not take into account the presence of concomitant diseases like hypertension and diabetes in adults with higher BMI. Depression is more prevalent among adults with type 2 diabetes than in those without this condition.<sup>27</sup> A meta-analysis involving 42 cross-sectional studies by Anderson et al. shows that diabetes doubles the odds of a co-morbid depression, especially treated type 2 diabetes.<sup>28,29</sup> It has been argued that the relationship between depression and diabetes is bi-directional with type 2 diabetes related to modest increased risk of depression.<sup>30</sup> Population sample surveys revealed anxiety disorders and panic disorder occurred with somewhat greater frequency among persons with diabetes than those without diabetes.<sup>31,32</sup> There is a suggestion that there is a significant association between hypertension and anxiety disorder; and the association between panic disorder and hypertension is due to some common etiology that may affect blood pressure control and may also predispose an adult to panic disorder.<sup>33,34</sup>

The primary purpose of this study was to quantify the effect of higher body mass Index (BMI) on the increased prevalence of depression, anxiety disorder and panic disorder. This study intended to corroborate and extend the results of prior studies that suggested a positive association between higher BMI and mood and personality



disorders, by including comparisons with adults suffering from diabetes and/or hypertension. The study focused on the following questions: What are the current associations between higher BMI and depression, anxiety disorder and panic disorder in the US adult population? Are these associations affected by the presence or absence of Hypertension and/or Diabetes? Do these associations vary according to gender, age, race, marital status, employment status and education status?

## OBJECTIVES

This study includes two objectives:

- (1) To quantify the extent to which overweight/obesity increased the likelihood of depression, anxiety disorder and panic disorder
- (2) To evaluate the extent to which co morbid illnesses such as hypertension and diabetes affect this association.

## METHODS

### ***Study Design***

A cross-sectional secondary data analysis was conducted using the 2008 National Health Interview Survey (NHIS).<sup>35</sup> The National Health Interview Survey is a cross-sectional household interview survey and the sampling and interviewing are continuous throughout each year. The 2008 NHIS was conducted by the National Center for Health Statistics (NCHS) to measure and monitor the health status of the US population. The NHIS is a multi-purpose healthy survey and is the principal source of information on the health of civilian, noninstitutionalized, household population of the United States. The sampling plan follows a multistage area probability design that permits the representative sampling of households and noninstitutional group quarters. NHIS data are collected through a personal household interview by Census interviewers. Nationally, the NHIS uses about 600 interviewers, trained and directed by health survey supervisors in the 12 U.S. Census Bureau Regional Offices.

The interviewed sample for 2008 consisted of 28,790 households, which yielded 74,236 persons in 29,421 families and Hispanics, African Americans and Asians were oversampled. The Basic Module, which remains largely unchanged from year to year, consists of three components: the Family Core, the Sample Child Core, and the Sample Adult Core. For this study, only Sample Adult respondents were considered. The Sample Adult survey involved more than 20,000 American adults (18 years or older). One adult per family was randomly selected for the interview with the sample adult questionnaire. The conditional response rate was 74.2%.

### ***Inclusion Criteria***

Non-institutionalized NHIS 2008 adult respondents (over 18 years of age) were considered for the study. To be eligible, respondents had to have given a valid response to the determinant, outcome, confounder and effect modifier variables (n= 20,593).

### ***Determinant***

Body Mass Index (BMI) was based on self-reported height and weight. BMI was calculated using the formula:  $BMI = \text{weight kilograms} / \text{height meters}^2$ . Respondents were grouped according to 5 BMI levels: Underweight (BMI <18.50), Normal Weight (BMI 18.50 – 24.99), Overweight (BMI 25.00 – 29.99), Obese, Class I & II (BMI 30.00-39.99) and Morbidly Obese, Class III (BMI > 40.00). Various studies indicate that self-reported height and weight are highly correlated with direct physical measurements, even though self-reports may underestimate weight and overestimate height that may lead to lower estimates of overweight/obesity.<sup>36-38</sup>

## **Outcomes**

In 2008, 3 supplemental mental health questions were included which asked whether the participant ever had depression, generalized anxiety or panic disorder. The diagnoses of these mental disorders were based on the criteria of ICD-9-CM. Self-reported presence or absence of Depression, Anxiety Disorder or Panic Disorder was considered as outcomes in this study.

## **Potential Confounders and Effect Measure Modifiers:**

Gender, age, race, marital status, and employment status were considered as potential confounders. All the confounder variables were categorical ; Age ( 1-24 years, 25-44 years, 45-65 years, > 65 years), Race (White, Black, Native American, Asian, Other/Multiracial), Marital Status ( married / living with partner, never married / divorced / separated / widowed) and Employment status (employed, not employed). Diabetes and hypertension were evaluated for their potentially modifying effects of the association between obesity and mental health outcomes. Respondents were asked if they had been told that they suffered from diabetes or hypertension.

## **Statistical Analysis**

All analyses were conducted using the Statistical Analysis System (SAS V.9.2, SAS Institute Inc., Cary, North Carolina, USA). Descriptive statistics were calculated to describe the demographics of the sample population. To estimate the associations between BMI and depression, anxiety disorder and panic disorder; multivariable logistic regression analyses were conducted to calculate the crude odds ratios (ORs) and

adjusted odds ratios (AOR) and corresponding 95% confidence intervals (CI). Logistic regression models were used to control for confounding. A variable was considered a confounder if it changed the estimate of the odds ratio by 10% or more. All the multivariate associations between BMI and mental disorder outcomes were assessed using SAS PROC SURVEYLOGISTIC, which allowed the use of complex sample designs such as weight, strata and PSUs. Departures from additivity were evaluated to determine the extent to which effect measure modification was present using methods proposed by Rothman and Greenland. To assess the modification of the association between BMI and the three mental disorders, two separate models were used that included the individual interactive effects of diabetes and hypertension at different levels of BMI. For each potential effect measure modifier, we created three dummy variables: Overweight/Obese and hypertensive, Overweight/Obese and non-hypertensive and Underweight/Normal weight and hypertensive. The reference group was Underweight/Normal weight and non-hypertensive. Similar dummy variables were made to assess the effect modification of diabetes.

## RESULTS

Table 1 shows the demographic and clinical condition characteristics by Body Mass Index (BMI) levels. Fifty-one percent was women. More than 60% was either overweight or obese, with 4% being morbidly obese. Males were more likely to be overweight or obese. Sixty four percent was employed and 62% was either married or living with a partner. Married people or people living with partners were more likely to be overweight or obese. The majority of the respondents were Whites (77%), while only 1% of the respondents were Native Americans. 12% were Blacks, 3 % were Asians and 7% either belonged to other or mixed races. Blacks (6.3%) and Native Americans (7.5%) were more likely to be morbidly obese as compared to Whites (4%), Asians (1%) and other / mixed races (3.4%).

Overall, depression was the most prevalent disorder with 28% of the respondents suffering from it. Nearly one in five suffered from anxiety disorder, while only 8% of the respondents suffered from panic disorder. As seen in Figure 1, the prevalence rates of all three mental disorders were the highest in the morbidly obese category. Women were more likely to report depression (61%), anxiety disorder (61%) and panic disorder (66%). Among co-morbid conditions, 29% of the respondents suffered from hypertension while only 8 % of the respondents suffered from diabetes. Obese and morbidly obese people were more likely to have hypertension and diabetes as opposed to underweight and normal weight people.

Table 2 shows the association between BMI and depression. For the underweight, normal weight and obese groups, the crude and adjusted odds ratios were similar. Gender proved to be a confounder for the overweight group, while gender, age, marital status, employment status and race affected the association between the morbidly obese group and depression. After adjusting for confounders, obesity was associated with depression (AOR, 1.35; 95% CI, 1.22-1.49), as well as between morbidly obese people and depression (AOR, 1.85; 95% CI, 1.56-2.21). Underweight and Overweight groups were not associated with depression. Obese individuals (Class I and II Obesity) group were 35% as likely to suffer from depression, while morbidly obese individuals were 85% as likely to suffer from depression relative to persons of normal weight.

Table 3 shows the association between BMI and anxiety disorder. Associations were observed between obese people and anxiety disorder (AOR, 1.22; 95% CI, 1.09-1.35), as well as between morbidly obese people and anxiety disorder (AOR, 1.27; 95% CI, 1.06-1.53). Except for the morbidly obese group, all the other BMI groups had similar crude and adjusted odds ratio. Gender, age, marital status, employment status and race confounded the association between the morbidly obese group and anxiety disorder.

As evident from table 4, both underweight and overweight groups were not associated with panic disorder. Gender was a confounder for the overweight group, while gender, age, marital status, employment status and race confounded the association between the morbidly obese group and panic disorder. Both obese persons (AOR, 1.36; 95% CI, 1.15-1.60) and morbidly obese (AOR, 1.34; 95% CI, 1.00-1.77) groups were

significantly associated with panic disorder. However, obese individuals were 36% as likely to suffer from panic disorder as compared to morbidly obese individuals, who were 34% as likely to suffer from panic disorder.

No departures from additivity were observed based on the presence of hypertension or diabetes (all  $p > .07$ ).



## DISCUSSION

This study evaluated the association between higher BMI levels and depression, anxiety disorder and panic disorder in a large, national sample of US household population. The results corroborate and extend the results provided in earlier epidemiologic studies, such as the NESARC <sup>23</sup> and NCS <sup>26</sup> studies, demonstrating that obesity is significantly associated with the increased risk of depression, anxiety disorder and panic disorder. Even after controlling for gender, age, marital status, employment status and race; obesity was significantly associated with depression, anxiety disorder, but not panic disorder. This discrepancy could be due to differences in statistical power rather than differences in the magnitude of the association.

The findings in this study are in accord with the findings of the NESARC and NCS study, except for one detail. In the NESARC study, <sup>26</sup> overweight people had slightly higher odds of suffering from any anxiety disorder (including panic disorder without agoraphobia). This incongruity could again be attributed to differences in statistical power than differences in the magnitude of associations; or it could be due to the precise categorization of mood and anxiety disorders in the NESARC study in contrast to the generalized categorization of anxiety disorder in this study.

Distinctively, this study also assessed the effect of the presence of hypertension and diabetes on the association between BMI and mental disorders. This study exclusively

assessed the effect measure modification of these two co-morbid illnesses as prior studies show that independently; obesity, hypertension and diabetes increase the risk of depression and other mental disorders. Obesity is also a risk factor for hypertension and diabetes. However, no interactions were observed based on the presence of hypertension or diabetes. For all three mental disorders, the presence of hypertension or diabetes did not modify the association between BMI and those mental disorders.

Although the positive associations between obesity and mental disorders observed in this study are relatively modest (with ORs ranging from 1.2 to 1.85), the implications of these findings are important to public health. Over 30% of the U.S. adult population is obese, and more than 25% suffer from mood or anxiety disorders. The NCS study also indicates that more than one fifth of the cases of mood disorders in the general adult population can be attributable to the association with obesity. Consequently, it is necessary to prevent or reduce the impact of steadily rising obesity population on the prevalence rates of mental disorders.

Our data should be interpreted with caution. First, BMI and the diagnoses of the three mental disorders were based on self-report, which may or may not have resulted in non-differential misclassification causing diluted estimates of effect.<sup>36-38</sup> Second; this study could address only three mental disorders as opposed to the NESARC and NCS studies, which included several distinctive mental disorders. Third, due to the cross-sectional nature of the NHIS; causal relationships between BMI and mental disorders

could not be assessed. Being a cross-sectional study, we were unable to evaluate causal relationships. Previous studies that have focused on the association between obesity and depression have proposed some theories to explain this relationship. Social stigma attached to being obese (negative body image), especially for women, may contribute to depression.<sup>39,40</sup> Physical inactivity due to obesity or obesity related diseases may contribute to the increased risk of depression.<sup>41</sup> Another theory also expounds that obesity and depression might be linked through some third factor, which could be behavioral, environmental or biological.<sup>42</sup>

Despite these limitations, the study has several methodological strengths. The study included a large, nationally representative sample of U.S. household population. The response rate was high and the data was collected through personal interviews. Several confounding variables were considered and controlled for, thus showcasing the distinctive associations between BMI and depression, anxiety disorder and panic disorder. Lastly, the study exclusively assessed the extent to which effect measure modification was present based on the presence of hypertension and diabetes.

## CONCLUSION

In conclusion, this study demonstrates that obesity is associated with an increased risk of depression, anxiety disorder and panic disorder. People who are obese or morbidly obese have higher odds of suffering from depression, anxiety disorder and panic disorder; as opposed to people who are normal weight. Factors such as gender, age, employment status, marital status and race affect the association between BMI and depression, anxiety disorder and panic disorder indicating that certain populations may have an increased risk of suffering from these disorders. However, for obese individuals, being hypertensive or diabetic didn't significantly increase their risk of depression, anxiety disorder or panic disorder.

Despite the associations between BMI and depression, anxiety disorder and panic disorder being bi-directional; understanding the impact of rising obesity rates on the incidence and prevalence of mental disorders is important. There is a need to conduct more longitudinal and experimental studies to establish causality and to understand the mechanisms of the relationship between obesity and mental disorders. This information is of utmost important to public health professionals, as well as medical professionals, with the intention that these mental disorders can be prevented by targeted and well-timed interventions. With obesity being a risk factor for myriad chronic illnesses, there is a need to push for health policies and public health programs that will help curb the steadily rising rates of obesity; and in turn cap health care expenditure.



## **Disclaimer:**

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**Table 1: Respondent Characteristics by Body Mass Index (BMI) levels**

	<b>Underweight</b> <b>&lt; 18.50</b> <b>N = 2355</b> <b>WtN = 3740691</b> %	<b>Normal Weight</b> <b>18.50 - 24.99</b> <b>N = 7398</b> <b>WtN = 77494142</b> %	<b>Overweight</b> <b>25.00-29.99</b> <b>N = 7114</b> <b>WtN = 73938706</b> %	<b>Obese, I &amp; II</b> <b>30.00-39.99</b> <b>N = 4851</b> <b>WtN = 49482537</b> %	<b>Morbidly Obese, III</b> <b>&gt; 40.00</b> <b>N = 875</b> <b>WtN = 9079704</b> %
<b>Region</b>					
Northeast	20.1	17.2	17.6	15.4	12.2
Midwest	26	23.6	23.5	24.9	28.5
South	35.2	35.4	35.4	38.6	38.3
West	18.8	23.8	23.5	21.1	21.1
<b>Age</b>					
18-24 years	33.4	18.8	9.8	7.6	8.2
25-44 years	28.2	35.8	37	37	40.3
45-65 years	18	29.3	31.2	40	42
> 65 years	20.4	16.1	18	15.4	9.6
<b>Gender</b>					
Women	71.1	59	40.7	49.4	63.7
<b>Race</b>					
White	73.8	78.3	77.2	75.2	74.4
Black	9.8	9.6	11.2	15.1	17.5
Native American	1.2	0.6	0.7	1.5	1.6
Asian	5	4.7	2.9	1.1	0.7
Other, Multiracial	10.3	6.7	8	7.1	5.6
<b>Marital Status</b>					
Married or Living with Partner	42.5	58.5	65.9	65.2	53.9
<b>Employment Status</b>					
Employed	52	63.1	67.4	63.7	58.1
<b>Comorbid Conditions</b>					
Hypertensive	16.8	18.9	19.1	41.9	53.2
Diabetic	3.9	3.6	7	14.7	23.6

Data Source: CDC/NCHS, National Health Interview Survey, 2008

**Table 2: Association between body mass index and depression**

Exposure	Depression	Crude Odds Ratio		Adjusted* Odds Ratio	
	Prevalence %	[95% Confidence Interval]		[95% Confidence Interval]	
<b>Underweight</b>	31.2	1.28	[0.96 - 1.72]	1.23	[0.91 - 1.65]
<b>Normal weight</b>	26.1	1.00	[Reference ]	1.00	[Reference ]
<b>Overweight</b>	25.7	0.98	[0.89 - 1.08]	1.09	[0.99 - 1.20]
<b>Obese</b>	31.8	1.32	[1.21 - 1.45]	1.35	[1.22 - 1.49]
<b>Morbidly Obese</b>	43.0	2.14	[1.80 - 2.55]	1.85	[1.56 - 2.21]

Data Source: CDC/NCHS, National Health Interview Survey, 2008

\* Adjusted for Sex, age, marital status, employment, and race



**TABLE 3: ASSOCIATION BETWEEN BODY MASS INDEX AND ANXIETY DISORDER**

	<b>Anxiety Prevalence %</b>	<b>Crude Odds Ratio [95% Confidence Interval]</b>	<b>Adjusted* Odds Ratio [95% Confidence Interval]</b>
<b>Body Mass Index</b>			
<b>Underweight</b>	21.6	1.22 [0.90 - 1.66]	1.21 [0.89 - 1.64]
<b>Normal weight</b>	18.4	1.00 [Reference ]	1.00 [Reference ]
<b>Overweight</b>	17.9	0.97 [0.87 - 1.07]	1.06 [0.95 - 1.18]
<b>Obese</b>	21.3	1.20 [1.08 - 1.33]	1.22 [1.09 - 1.35]
<b>Morbidly Obese</b>	24.8	1.46 [1.22 - 1.75]	1.27 [1.06 - 1.53]

Data Source: CDC/NCHS, National Health Interview Survey, 2008  
 \* Adjusted for Sex, Age, Marital Status, Employment Status & Race

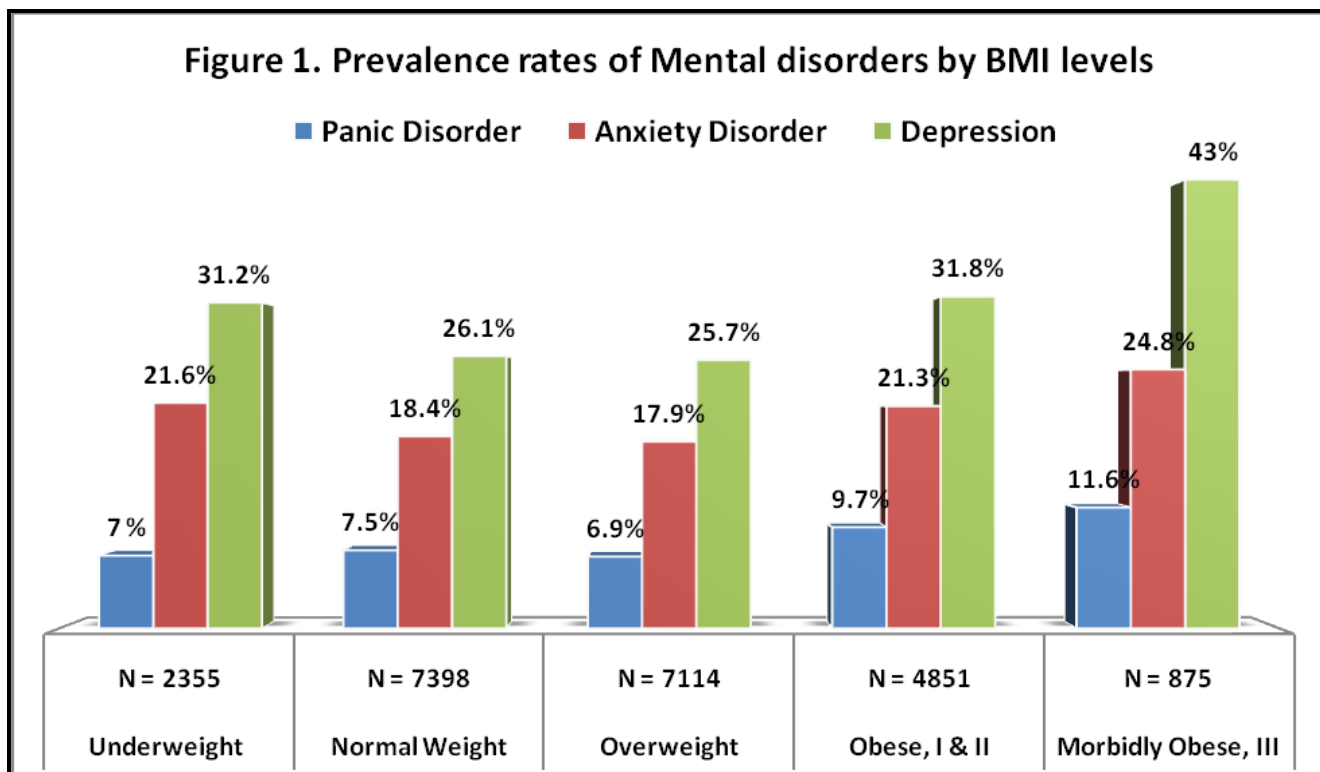
**TABLE 4: ASSOCIATION BETWEEN BODY MASS INDEX AND PANIC DISORDER**

	<b>Panic Disorder Prevalence %</b>	<b>Crude Odds Ratio [95% Confidence Interval]</b>	<b>Adjusted* Odds Ratio [95% Confidence Interval]</b>
<b>Exposure</b>			
<b>Underweight</b>	7	0.93 [0.59 - 1.45]	0.87 [0.55 - 1.37]
<b>Normal weight</b>	7.5	1.00 [Reference ]	1.00 [Reference ]
<b>Overweight</b>	6.9	0.91 [0.78 - 1.06]	1.03 [0.88 - 1.20]
<b>Obese</b>	9.7	1.33 [1.13 - 1.57]	1.36 [1.15 - 1.60]
<b>Morbidly Obese</b>	11.6	1.62 [1.22 - 2.17]	1.34 [1.00 - 1.77]

Data Source: CDC/NCHS, National Health Interview Survey, 2008

\* Adjusted for Sex

FIGURE 1: PREVALENCE RATES OF MENTAL DISORDERS BY BODY MASS INDEX



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