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# Association between depression and BMI in young adults

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**Abstract.** Globally, depression significantly affecting people's quality of life with a range of negative health outcomes. Previous studies have confirmed a link between BMI and depression. Consequently, this study focused on data spanning from 2017 to March 2020, encompassing individuals aged 18 to 30 years within the National Health and Nutrition Examination Survey (NHANES). The study included 1635 participants, with complete data and selected covariates. Then, used weighted logistic regression models to investigate the connection between depression and BMI. Given the significant influence of gender, subgroup analysis was performed to compare the varying impact of BMI between males and females. Ultimately, the analysis of model results revealed a noteworthy positive correlation between BMI and depression within the 18-30 age group, with women experiencing a more pronounced effect than men. In conclusion, reducing BMI emerges as a potential strategy to mitigate the risk of depression.

**Keywords:** depression; BMI; logistic regression model; physical and mental health.

## 1. Introduction

Depression significantly adds to the global health challenges and ranks among the primary drivers of disability on a worldwide scale. According to the World Health Organization's report in 2020, people are probably going to get depressed, and may even have potential symptoms of depression [1]. What's more, severe depression can result in suicidal tendencies, health problems, and diseases, for youth (15-29 years old), depression leads to unhealthy behaviors (alcohol and smoking) and even stands as one of the top five factors contributing to suicide [1]. In this circumstance, the presence of depression is common and severe, so the study of depression is particularly important.

Body Mass Index (BMI) is an important measurement of people's health risks which is easy to examine and calculate, and BMI also can show an initial assessment of health status. According to depression, BMI is an important factor. As Floriana S. Luppino indicated in a meta-analysis study, notes that BMI and depression are interrelated, especially in America's clinics, depression risk was found to be raised by obesity [2]. Besides, Lee JH's study confirms that obesity and underweight are both associated with depression [3]. Besides these direct associations, high BMI increases the risk of several diseases (hypertension, diabetes, etc.) [4, 5] and the quality of life(difficulty with physical functioning)[6], all of which is the influential factors of depression [1].

Based on a review of current literature, it is evident that there exists a population gap in current research, with certain subpopulations remaining underexplored. While a substantial portion of research has traditionally focused on individuals of all age groups. However, recent data from 2021 revealed alarming statistics, half of students feel sadness or hopelessness and have experienced significant changes in their mental health [7]. Moreover, some students not only consider suicide seriously but also make suicide attempts. Additional investigations have highlighted that depression and anxiety among college students can profoundly impact their overall development and lead to various adverse health outcomes, including risky sexual behavior, illicit drug use, and excessive alcohol consumption [7]. In addition, according to the report given by Disability Adjusted Life Years (DALYS), depression's health burden is notably pronounced among the younger population. Remarkably, this health burden tends to reach its zenith when 25 to 30 years old, exhibiting an ascending trajectory that commences during the student's period [8].

In summary, it is imperative to recognize that mental health issues exert a profound influence on the lives of young adults and may lead to irreparable harm. To fill in this gap, this study focuses on the young adult population aged 18-30 and hypothesizes BMI and depression have a positive correlation in young adults.

This study's main objective is to probe the relevance between BMI and depression. Hypotheses suggest a strong correlation between them with potentially differing results based on gender. The significance of these findings can draw public attention to mitigate stigmas surrounding mental health. Through this study, by disseminating accurate information and creating a more inclusive and supportive environment for those affected by depression, people can gradually realize that mental health plays an important role in their lives. While its subtlety may render it less conspicuous, timely intervention can provide positive outcomes and avoid potential adversity.

## 2. Method

### 2.1. Data Sources and Participants

Data came from the National Health and Nutrition Examination Survey (NHANES) which is a population-based cross-sectional study program[9]. This research analyzed the data in '2017 - March 2020 Pre-pandemic' period [9]. There were 15561 participants throughout this time. Then, participants aged 18-30 years old (1976 participants are remaining) were selected in this study and excluded the participants who had missing data. At last, 1635 participants qualified and completed data.

### 2.2. Study variables

#### 2.2.1. Outcome Variables

The NHANES questionnaire database nine-item depression screener (variable prefix is DPQ) was used to measure depression levels [10]. Summary all numbers in the screener and divided into five groups: Normal (under 9), Moderate (10-14), Moderately Severe (15-20) and Severe (21 and above) [10]. Therefore, in this study, 10 points were used as the limit [10]. Depression screeners less than 10 were normal and scores greater than 10 were prone to depression.

#### 2.2.2. Independent variable

The NHANES examination clearly presented the participant's BMI. According to WHO's standard, four categories were divided by BMI value: Underweight (under 18.5), Normal (18.5-24.9), Overweight (25.0-29.9), and Obesity (30.0 and more).

#### 2.2.3. Covariates

In this research, demographic information and other influential factors were also added as covariates. Age (years), gender, race (Other Hispanic, Non-Hispanic White, Non-Hispanic Black, etc.), and income were included as covariates. Other influential factors including whether people were diagnosed with diabetes (question "QDIN010") and the status of physical activity (question "PAQ605") were also included as confounders. More detailed information is provided on the NHANES website.

### 2.3. Statistical analysis

R software program (version 4.3.1, http://www.R-projrct.org). were employed in this study, and 0.05 was set as the significance level. Relying on NHANES' recommendations, weighted the data for its complex sampling design. This study uses multiple logistic regression. All covariates (age, gender, BMI, BMI category, race, physical activity, diabetes, income) were added in Model 1, and according to the result of Model 1, a parsimonious model was conducted as Model 2. Model 3 and Model 4

showed separate models in different gender, facilitating a more focused and comparative analysis of the relationships under investigation.

## 3. Result

### 3.1. Baseline Characteristics of Participants

Table 1 illustrates the distribution of each categorical variable category and the features of continuous variables for 1635 individuals. Regarding the data in the table, the median of the independent variable BMI value is 26.60 (Overweight), over one-third of the participants in this data are obese (35.35%), about one-quarter are overweight (23.49%) and the overall BMI level is high. The gender distribution is very even. Among races, Non-Hispanic White (30.95%) and Non-Hispanic Black (25.26%) account for half of the data. Only 1 in 10 people develop diabetes. Regarding physical activity, one-third of people engage in high-intensity exercise in a week. Family income is relatively extreme, wealth and poverty respectively account for two-fifths in this study.

**Table 1.** Distribution characteristics of NHANES participants aged 18-30 (n=1635) in 2017-March 2020 Pre-pandemic

| | N (%)[a] |
|---|---|
| Depression | |
| Normal(score≤10) | 89.36% |
| Depression(score≥10) | 10.64% |
| Depression Screener | |
| Normal | 89.36% |
| Moderate | 7.09% |
| Moderately severe | 2.75% |
| Severe | 0.80% |
| Age | 24.00[a] |
| Body Mass Index | 26.60[a] |
| Gender | |
| Male | 48.13% |
| Female | 51.87% |
| Race | |
| Mexican American | 15.29% |
| Non-Hispanic Asian | 11.74% |
| Non-Hispanic Black | 25.26% |
| Non-Hispanic White | 30.95% |
| Other Hispanic | 10.03% |
| Others | 6.73% |
| Body Mass Index (BMI) Category | |
| Normal | 37.06% |
| Obese | 35.35% |
| Overweight | 23.49% |
| Underweight | 4.10% |
| Diabetes | |
| Yes | 1.10% |
| No | 98.17% |
| Borderline | 0.73% |
| Physical activity | |
| Active | 31.50% |
| Inactive | 68.50% |
| Income | |
| Wealth | 43.24% |
| Middle | 14.62% |
| Poverty | 37.55% |
| Don’t Know | 4.59% |
| [a] Median of continuous variables | |

### 3.2. Logistic Regression

Table 2 shows the results of the logistic regression model, in which Model 2 is optimized on Model 1. It can be seen from the model that BMI value and depression have a significantly positive association ($B = 0.07$, $p < 0.05$) in each model, especially in Model 2 ($p = 0.006$). For different BMI categories, the significance of obesity is close to 0.05, underweight is statistically significant in Model 2 ($p = 0.03$). Physical activity, diabetes, and income have no significant associations with this relationship.

**Table 2.** Multivariate logistic regressions among the association between BMI and depression.

| | BMI | BMI Category | | |
|---|---|---|---|---|
| | | Obese | Over weight | Under weight |
| Model 1[a] | | | | |
| B | 0.07 | -0.98 | -0.08 | 0.62 |
| SE | 0.02 | 0.49 | 0.29 | 0.36 |
| p-value [c] | 0.01* | 0.07. | 0.79 | 0.13 |
| Model 2[b] | | | | |
| B | 0.07 | -0.98 | -0.18 | 0.82 |
| SE | 0.02 | 0.46 | 0.30 | 0.35 |
| p-value [c] | 0.006** | 0.05. | 0.56 | 0.03* |

a Model 1: multivariable logistic regression model, considers all covariates (age, BMI, BMI category, race, physical activity, diabetes, income).
b Model 2: multivariable logistic regression model, adjusted by model1, leaving only the most significant variables (age, BMI, BMI category, race).
c p<0001: '***' p<0.01: '**' P<0.05: '*' P<0.1: '.'

### 3.3. Subgroup Logistic Regression

Table 3 explores the relationship between male and female differences in BMI and depression through subgroup analysis of gender. Both male and female BMI have statistically significant associations with depression, with females exhibiting a more pronounced significance than males. In model 3, the p-value is 0.04, while in model 4, the p-value is 0.008. Based on the BMI categories, it is noteworthy that the underweight category in males is statistically significant with a p-value of 0.04 in model 3. For females, although none of the BMI categories show statistical significance, it's worth mentioning that both underweight and overweight categories exhibit a positive association with depression, with coefficients of $B = 0.46$ and $B = 0.19$, respectively.

**Table 3.** Subgroup logistic regressions among the association between BMI and depression in gender.

| | BMI | BMI Category | | |
|---|---|---|---|---|
| | | Obese | Over weight | Under weight |
| Model 3[a] | | | | |
| B | 0.09 | -1.41 | -0.54 | 1.42 |
| SE | 0.04 | 0.77 | 0.55 | 0.65 |
| p-value [c] | 0.04* | 0.09. | 0.34 | 0.04* |
| Model 4[b] | | | | |
| B | 0.05 | -0.61 | 0.19 | 0.46 |
| SE | 0.02 | 0.51 | 0.35 | 0.37 |
| p-value [c] | 0.008** | 0.25 | 0.59 | 0.23 |

[a] Model 3: multivariable model in only male, consist variables (age, BMI, BMI category, race).
[b] Model 4: multivariable model in only female, consist variables (age, BMI, BMI category, race).
[c] p<0001: '***' p<0.01: '**' P<0.05: '*' P<0.1: '.'

## 4. Conclusion

By using NHANES 2017–March 2020 data, this study examined the link between BMI and depression and came up with some key results. In this research, it was found that there exists a non-linear relationship between BMI and depression. And with women experiencing a higher degree of influence compared to men.

Mirroring the findings of Tyrrell J's study demonstrated an association between BMI and depression [11]. This research also found that BMI and depression have a significantly positive association. Also, the result of gender is similar to Nolen-Hoeksema S's research which suggested that female may be more susceptible to depression due to higher stress levels [12]. However, Lee JH suggested that BMI and depression have a U-shaped relationship, which means individuals who are either obese or underweight may have a higher risk of experiencing depression [3]. Additionally, it was found in the previous study that physical activity is beneficial for reducing depression [13], that family poverty is more likely to cause mental health problems [14] and that people with diabetes are more susceptible to depression [15]. These findings were inconsistent with the results of this study. Notably, although the correlation has been proven in this study, the coefficients for obesity and depression consistently showed a negative relationship and except for the male model, the underweight category exhibited an insignificant relationship to depression. Moreover, none of the covariates showed a significant relationship with depression.

Consequently, the outcomes of this study were in contradiction with those of some prior studies., the reasons for this result may be as follows. The number of samples was insufficient in each category, especially the small proportion of people suffering from depression, in the distribution of the participants the gap between the subgroup's category is deep. In addition, the overall BMI value of American residents is relatively high, and the study of Lee JH is concentrated on Korean people[3], and regional differences and cultural differences affect the result.

The presence study has several limits. First, as a result of the NHANES cross-sectional examination [9], this research cannot establish a cause-and-effect connection between depression and BMI. In addition, the NHANES database is a survey of U.S. citizens. They cannot focus on a single issue and do detailed research based on assumptions. This leads to problems such as unbalanced sample data and lack of pertinence. Third, using data from different parts of NHANES led to missing data in some covariates, lacking pertinence. At last, the questionnaire data participants have subjective consciousness and the answers lack objectivity, which may lead to biased results, moreover, some people choose 'I do not know' or 'refuse to answer'.

Despite these problems, this study can still draw inspiration from the result. It was confirmed that women have a higher BMI than men and there are also differences in body image between genders. Under the influence of these, the impact of BMI and depression on different genders can be explored more deeply. More confounders and mediating factors can be added to further studies to fix the limitations caused by imbalanced sample data.

In conclusion, through this article, would like to broaden the public's understanding of the value of mental health and the relationships across physical and mental health. Encouraged everyone to pursue physical health in order to reduce the occurrence of depression.

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