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The Relationship Between Body Mass Index and Depression in College Students

Bryn Kable

The Relationship Between Body Mass Index and Depression in College Students

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Bryn Kable

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Abstract

College student mental health has seen a serious decline over the last decade (Esaki-Smith, 2022). One factor that has been linked to both physical and mental disorders is obesity. A common way to operationalize weight is through body mass index (BMI) (Ilman et al., 2015). There is evidence that BMI and depression are correlated linearly in that individuals with higher BMIs have higher levels of depression (Badillo et al., 2022; Simon et al., 2008). The exact mechanisms of this relationship are still generally unknown; thus, the goal of this study was to investigate the relationship between BMI and depression in college students, particularly looking at how body image and cortisol reactivity may explain this relationship. I also investigate the moderating role of gender. The participants were 400 college students aged 18-25 (54.7% female). Participants answered survey questions and gave biological samples including salivary cortisol, height, and weight. Regression analyses first tested the main effects of BMI on depression and found no main effect. Next, a mediation model testing the mediating role of cortisol was also insignificant. A second mediation model testing body image as a mediator of the relationship was significant (B = 4.83, 95% CI [1.74, 8.34]) with results suggesting that as BMI increases, body image decreases, and with a decrease in body image, depression increases. I also examined whether gender moderates the relationship between BMI and depression and found that it was significant ($F(6, 379) = 2.98$, $p = .007$). However, simple slope analyses with gender did not reach significance, but overall patterns suggest that higher BMI was beneficial for males (B = -8.9, SE = 4.7, p = 0.06) whereas it was detrimental for females (B = 4.6, SE = 4.1, p = 0.26). The results of this study show that in this sample, it was the psychological/societal factors that explained and changed the relationship between BMI and depression rather than biological factors such as cortisol.

Keywords: body image, depression, body mass index, cortisol, college students

Introduction

In recent years, there has been a serious decline in the mental health of college students. One study found that between 2013 and 2021, there has been a 135% increase in depressive symptoms and a 110% increase in anxiety symptoms (Esaki-Smith, 2022). While the COVID-19 pandemic exacerbated this trend, student mental health had been declining long before its onset, and thus many factors could be contributing to this detrimental trend. Poor student mental health has many negative consequences including increased dropout rates, lower grades, increased campus suicides, and an overall increased burden on the individual, their networks, the campuses, and society as a whole (Suicide Prevention Resource Center, n.d.).

One factor that has been linked to mental health issues, such as depression, is body mass index (BMI). BMI is a measure of a person's weight divided by the square of their height and is usually used to give general weight categories such as underweight, healthy weight, overweight, and obese (CDC, 2022). BMI is a simple measurement that only considers one's height and weight, leaving out other key indicators of weight health such as muscle mass. Despite its simplicity, BMI has a fairly strong correlation with body fatness (CDC, 2022). One study of college students found a strong correlation between BMI and percent body fat for both men and women (Ilman et al., 2015). Some factors that can affect the accuracy of BMI as a measure of weight category are gender, race, age, and whether or not the individual is an athlete. On average, women have higher body fat than men, older people have higher body fat than younger individuals, and athletes have less body fat than non-athletes (CDC, 2022).

Obesity has been linked to many physical conditions including but not limited to, high blood pressure, high or low cholesterol, type 2 diabetes, coronary heart disease, strokes, gallbladder disease, osteoarthritis, breathing problems, chronic inflammation, increased oxidative

stress, and cancer (CDC, 2022). Additionally, obesity and being overweight have also been linked to mental health conditions such as depression. Badillo and colleagues found that BMI and depression or depression-like symptoms were positively correlated in a nationally representative sample (Badillo et al., 2022). Another study found that amongst middle-aged women, the prevalence of moderate to severe depression was the highest amongst women with a BMI over 35, showing that depression was strongly associated with higher BMIs (Simon et al., 2008). While these studies examined the linear relationship between the two variables, de Wit et al. (2009) found a u-shaped association between BMI and depression. Using a sample of 43,534 individuals between the ages of 18 and 90, this study calculated both the linear and quadratic associations between BMI and depression. The researchers found a significant U-shaped (quadratic) association between BMI and depression in that underweight and overweight individuals had higher depression than individuals of normal weight, and they did not find a linear association (de Wit et al., 2009). Whether a linear or quadratic relationship, this association between BMI and depression is evident in the extant literature.

Despite the vast body of literature on the association between BMI and depression, mechanisms for the linkage are not well understood. To further complicate the matter, some studies have found a reciprocal link between depression and high BMI, meaning that depression is predictive of becoming obese, and being obese increases the risk of developing depression (Tashakori et al., 2016). One study that looked at not only BMI but fat mass and nonfat mass in relation to depression found that fat mass was a risk factor for depression whereas nonfat mass was not (Speed et al., 2019). This study illustrates that it is not just a bigger size but the presence of body fat that influences depression. Because higher BMI is related to detrimental physiological changes, one potential factor linking BMI and depression is cortisol.

The Role of Cortisol

Cortisol is a steroid glucocorticoid hormone that is produced and released from the body's adrenal glands, primarily in response to stress (Cleveland Clinic, 2021). When a stressful event occurs, there is an initial surge in epinephrine followed by the activation of the hypothalamus-pituitary-adrenal (HPA) axis which keeps the sympathetic nervous system active and prompts the release of cortisol (Harvard Health, 2020). Cortisol increases the amount of sugar in the bloodstream and diminishes non-essential functions (Mayo Clinic, 2021). In addition to regulating the body's stress response, cortisol also plays a role in suppressing inflammation, regulating blood pressure and blood sugar, and controlling the body's metabolism (Cleveland Clinic, 2021). Long-term elevated levels of cortisol from chronic stress can increase appetite and increase the storage of unused nutrients as fat, inadvertently increasing the fat tissue and body weight (Harvard Health, 2020). Chronic stress can also put the body at risk for other physical and psychological disorders such as high blood pressure, heart disease, digestive problems, anxiety, and depression (Mayo Clinic, 2021).

Some research has been done linking cortisol levels to BMI. One study found that individuals with BMIs categorized as obese have higher hair cortisol levels than overweight or normal individuals (Wester et al., 2014). Similarly, another study found that salivary cortisol levels increased as BMI increased (Abraham et al., 2013). While these measures are of overall cortisol levels, another cortisol measure that is related to BMI is cortisol reactivity. All of these studies were correlational in nature, and a recent review found that there was a bidirectional relationship between chronic stress and obesity in that obesity could lead to chronic stress, or chronic stress could lead to obesity (van der Valk et al., 2018).

Not only are cortisol levels linked to BMI, but they are also linked to depression. Nandam and colleagues (2020), found that higher cortisol levels were associated with severe depression but not mild depression. Additionally, they found that there was a stronger relationship between the variability or reactivity of cortisol in stress-induced situations and depression than the relationship with baseline or absolute levels of cortisol (Nandam et al., 2020). Another study mimicked these findings that there was no simple relationship between overall cortisol levels and depression and rather, the variability of cortisol during stress tasks was strongly correlated with depression (Dienes et al., 2013). This existing research points to cortisol reactivity as a potential mediator in the relationship between BMI and depression.

The Role of Body Image

In addition to physiological mechanisms, BMI can also operate through psychological processes, namely body image. The western beauty ideal for women is being tall and skinny with a curvy physique, and for men is being very muscular but lean. The impact of these standards and diet culture can be very harmful to both men and women of all ages, specifically for their own body image and satisfaction. A study by Frederick et al. estimated that 20-40% of women and 10-30% of men are dissatisfied with their bodies (Frederick et al., 2012). Adolescents are particularly impacted by low body image, with an estimated up to 46% of adolescents in America are dissatisfied with their bodies. This poor body image can be highly detrimental to mental health leading to eating disorders, low self-esteem, and other psychological disorders, as well as obesity, and thus body image is a third factor that may play a role in the relationship between BMI and depression (Plain, 2019).

Specifically looking at the relationship between body dissatisfaction and depression, studies have shown an association between body dissatisfaction and depression in college

students (Manaf et al., 2016), as well as an association between dissatisfaction from being overweight and depressive symptoms in adolescents (Soares Filho et al., 2021). Unsurprisingly, body image dissatisfaction is also related to one's BMI. In a study of young adults, it was found that BMI was negatively associated with body image, meaning individuals who had higher BMIs had lower body image (Ahadzadeh et al., 2018). This lower body image in larger individuals could come from internalized opinions or could be because individuals with obesity often experience stigmatization and discrimination because of their size (Montgomery Sklar, 2015). While body image and depression are usually studied in women, this relationship exists in men as well. A study of college men found that BMI was associated with negative body image, in that overweight men had higher levels of negative body image as well as weight and shape concerns compared to normal or underweight participants (Watkins et al., 2008). Body image issues are likely psychological or societally-based, and are another potential factor to explain the relationship between BMI and depression.

The Role of Gender

While body image issues are prevalent amongst all genders, the "ideal" body is different between men and women. Thus, gender may moderate relations between BMI and depression. The ideal female body is very skinny, and the ideal male body is very muscular and lean. Because muscle is heavy, this may mean that the ideal male BMI is higher than the ideal female BMI, which can affect the relationship between BMI and depression. Additionally, women are two times more likely to develop depression than men, which is thought to be due to a mix of biology as well as life circumstances and cultural stressors (Mayo Clinic, 2019). A meta-analysis found that adolescence was the time period with the greatest disparity between genders in the prevalence of depression (Salk et al., 2017). Since depression is more common among women,

particularly in the college age group, there may be a stronger relationship between BMI and depression, or at the very least, it could confound this relationship when looking at men and women together.

There has been some preliminary research done on the differences in the relationship between BMI and depression among men versus women. One study found that depression in women was associated with a greater BMI, total body fat, and visceral fat mass, whereas depression in men was only associated with visceral fat mass (Li et al., 2017). This study highlights how in men, higher BMI may not be as indicative of unhealthy weight as it is in women because it is the presence of fat rather than a high BMI that is correlated, and therefore male BMI may have a different relationship with depression. The existing literature on the relationship between BMI and depression in men is quite mixed in that some studies find no relationship, others find lower BMI to be correlated with depression, and other studies find higher BMI to be correlated with depression. It seems that this relationship in men is more complicated, and other factors may be impacting the relationship between BMI and depression. Another study of US adults found that in women, a higher BMI was associated with major depression and suicidal ideations, whereas in men, a lower BMI was associated with major depression, suicide attempts, and suicide ideation (Carpenter et al., 2000). The results of this study once again point to the fact that societal impacts of ideal body images may be affecting this relationship, as the relationship is opposite in men and women. Therefore, by looking at gender together in these analyses, it may inadvertently mask trends that would otherwise be seen by looking at gender separately. This existing research points to gender as a potential moderator in the relationship between BMI and depression.

Finally, cortisol, gender, and body image are likely to be interrelated. A study by Jackson et al., found that individuals who had experienced weight discrimination had mean hair cortisol concentrations that were 33% higher than individuals who had not experienced weight discrimination (Jackson et al., 2016). Similarly, there are sex differences in cortisol levels. One study found that in response to a lab stress task, men had greater changes (higher reactivity) in cortisol levels than women did (Reschke-Hernández et al., 2016), but women on average have higher baseline cortisol levels than men (Larsson et al., 2009). Given the bi-directionality of many of these relationships, as well as the interrelations of the different factors, the exact mechanisms of the relationship between BMI and depression are unknown.

The Purpose of the Current Study

The purpose of this study is to better understand the relationship between BMI and depression in college students. The first aim is to see if there is a relationship between BMI and depression in our sample (**Figure 1, Aim 1**). The second aim is to see whether cortisol reactivity explains the relationship between BMI and depression (**Figure 1, Aim 2**). The third aim is to test the mediating role of body image on the relationship between BMI and depression (**Figure 1, Aim 3**). And the fourth and final aim of this study is to understand whether gender moderates the relationship between BMI and depression (**Figure 1, Aim 4**).

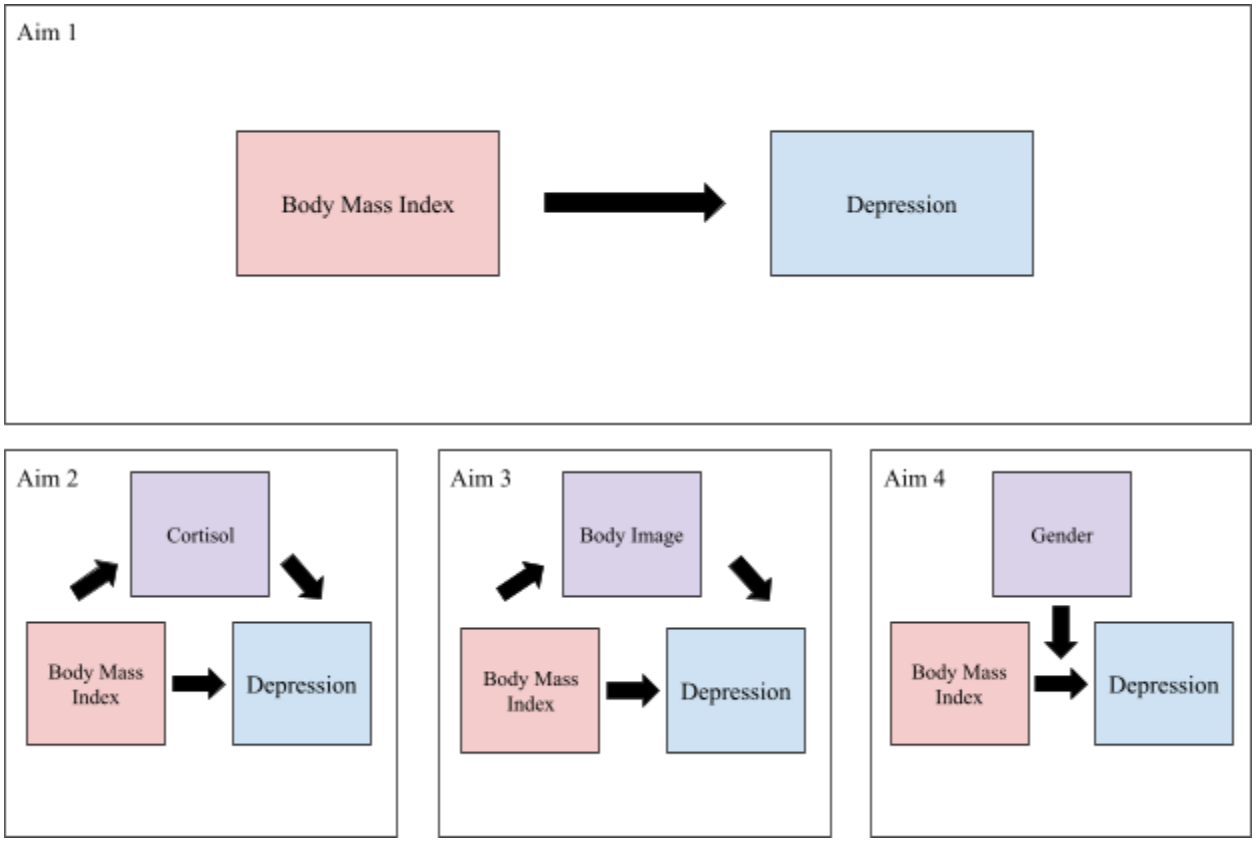

Figure 1: Visual representation of models tested in this study.

Methods

Data and Sample

The data for this research is from a study that was conducted at schools on the west coast and southern U.S. The sample consists of 400 college students from multiple colleges in the western and southern U.S. aged 18-25 (M = 19.27, SD = 1.07) who completed self-report surveys and gave biological samples. Of the 400 participants, 45.3% self-identified as male, and 54.7% identified as female. Additionally, 42.8% identified as white, 32.8% identified as black, 0.3% identified as middle eastern, 9.8% identified as Asian, 1.8% identified as Latinx, 11% identified as mixed, and 0.5% identified as other. The mean parental income average for participants was between $100,000 and $119,999 annually. The mean parental education of the sample was between graduating with a two-year degree and a four-year college degree.

Measures

Demographics

A generic demographic form asked participants to self-report their age, sex, race, parent education, and parent income. For both parent education and parent income, the mean was taken of both parents to get one average parental income and education per participant. Sex was coded as male or female, and race was coded into 8 categories: White, Black, Middle Eastern, Native American, Asian, Latinx, mixed, and other. For the purposes of analyses, race was coded as white and nonwhite.

Depression

The Beck Depression Inventory (BDI) was given to participants to measure depressive symptoms. While the BDI is a 21-question self-report survey, the version of the BDI used in this study removed the question about suicidal ideation, leaving 20 questions to be scored. The cutoffs were adjusted to reflect the question that was removed. Each question is scored on a 0-3 scale based on the severity of the symptom the individual is experiencing, with 0 being normal and 3 being the most severe (Beck et al, 1996). Additionally, Cronbach's alpha value for this sample is 0.813.

Cortisol

Cortisol was measured through participant saliva samples. The saliva sample was taken at five different times during the study. The first sample was taken 30 minutes after the beginning of the study visit, the second sample was taken before a stress test, the third sample was taken after the stress test, the fourth sample was taken 10 minutes after the third sample, and the fifth sample was taken 10 minutes after the fourth sample. The timing of these samples allows for the measurement of total systemic output of all salivary cortisol measures (AUCg) as well as the reactive changes in cortisol levels in relation to a stress task (AUCi) (Olivera-Figueroa et al., 2015). Two stress tasks were performed in this study, the Trier Social Stress Test (TSST) speech and math tests. These stress tests consist of performing a speech for a job interview and performing verbal arithmetic by counting down by 7 from 3728. These tests have been proven to systematically induce a stress response in individuals in order to measure their stress reactivity in laboratory settings (Birkett, 2011). The participant's saliva samples were sent out to a lab to measure the cortisol samples using the area under curve method to get both AUCg and AUCi values. Due to the existing literature, I decided to use the AUCi (stress reactivity) cortisol value

in analyses. The data for AUCi was not normally distributed, so it was winsorized and log transformed for use in analyses.

Body Image

To measure body image, participants answered the question "How strongly do you agree or disagree with each of the following? – My current body size is attractive", which was scored on a Likert scale from 1 being "strongly disagree" to 5 being "strongly agree". Four other questions about bodies in general were asked. An image of female bodies was numbered 1 to 9 with 1 being the skinniest body and 9 being the heaviest body, and participants were asked to pick the body number that represents the healthiest body size and the number that represents the most attractive body size. These questions were then repeated for male bodies as well. Only the first question about one's own body was used to represent "body image" for the purposes of analyses.

Body Mass Index

Body mass index (BMI) is a ratio of one's weight and height that is used to indicate one's potential body fatness and can be used to screen for groups of individuals more prone to health problems. The weight and height of each participant were measured, and BMI was calculated by dividing weight in kilograms by the square of height in meters. The BMI data was highly skewed and so to make it more usable for analysis I logged the BMI variable.

Self Esteem

Self-esteem was measured through the Rosenberg Self Esteem (RSE) self-report survey. The RSE is a 10-question scale that measures positive and negative feelings about oneself and each question is scored on a scale from 1-4 from 1 being "strongly agree" to 4 being "strongly

disagree". Half of the questions were then reverse-coded so that a higher score is indicative of higher self-esteem (Rosenberg, 1965). Self-esteem was only measured at one of the participating universities so the sample size that completed the survey was only 133 students, and reliability analyses gave a Cronbach's alpha value of -0.27, thus this variable could not be used in many of the analyses.

Results

To better understand the sample and data being used for this study, I started by running descriptive statistics (**Table 1**). Specifically, I was interested in seeing the spread of my main outcome variable (BDI) and my main predictor variable (BMI). Using the lab-adjusted BDI cutoffs, 85% of participants qualified as having minimal to no depression, 8.7% qualified as having mild depression, 5.3% qualified as having moderate depression, and 1% qualified as having severe depression. Using the Centers for Disease Control and Prevention's BMI cutoffs, 2.6% qualified as underweight, 57.3% qualified as having a healthy weight, 27% qualified as being overweight, and 13.1% qualified as being obese (CDC, 2022). In terms of the other main variables being examined, 45.3% of participants self-identified as male, and 54.7% self-identified as female. The mean score on the body image question was 3.4, indicating a neutral to a slightly positive agreement with the statement that they find their body size attractive.

Table 1

Means and Standard Deviations of Key Measures

Measure	*n*	*M*	*SD*	*Range*
Depression	393	7.14	6.87	0-41.00
Body Mass Index	396	25.05	5.33	16.18-55.49
Body Image	263	3.40	0.99	1-5
Self Esteem	133	30.65	5.42	18-40
Cortisol	392	6.33	0.59	0-7.98

Next, I ran correlations between demographic information, depression, BMI, cortisol, body image, and self-esteem (**Table 2**). There were a few significant correlations between the variables ($p < 0.05$), notably including depression and body image, depression and self-esteem, BMI and body image, cortisol and gender, and cortisol and self-esteem. More notably, many

variables that have been correlated in previous studies are not correlated in this sample, including between BMI and gender, BMI and depression, BMI and cortisol, and depression and cortisol. I also tested a quadratic relationship between BMI and depression by running a correlation between depression and a variable that was the BMI values squared and found no significant correlation (p = 0.89).

Table 2

Correlation Matrix for Key Measures (N = 400)

Variable	2	3	4	5	6	7	8	9
1. Gender	.16**	-.04	-.05	.12*	-.09	-.09	-.29***	-.13**
2. Race		-.05	-.25**	.13*	.10*	-.05	-.10	-.02
3. Mean Parental Ed			0.45***	-.10*	-.04	.01	.19*	-.03
4. Mean Parental Inc				-.10	-.09	.06	.25**	-.05
5. Depression					-.01	-.22***	-.63***	-.05
6. Body Mass Index						-.31***	.06	.02
7. Body Image							c	.03
8. Self Esteem								.19*
9. Cortisol (AUCi)								

Note. Ed = Education; Inc = Income. c = cannot be computed. Race coded as 0 = white, 1 = nonwhite.
* $p < .05$ (two-tailed). ** $p < .01$ (two-tailed). *** $p < .001$ (two-tailed).

Despite the lack of correlation between BMI and depression, I tested the main effect of the relationship between BMI and depression by running a linear regression in SPSS (**Table 3**). The covariates in the regression model were gender, race, parental income, parental education, body image, and cortisol. Race, parental income, and parental education were used as covariates given they have all been shown to be correlated with depression and thus were used as controls (Bailey et al., 2019; Torvik et al., 2020; Tracy et al., 2008). The overall model was significant and explained 5.5% of the variance ($F(7,247) = 3.10$, $p = .004$). Of the covariates, only the effect of body image ($B = -0.24$, $SE = 0.45$, $p < 0.001$) and race ($B = 0.15$, $SE = 0.96$, $p = 0.030$) were significant. The effect of BMI ($B = -0.11$, $SE = 4.02$, $p = 0.085$) approached significance, but was not, therefore showing that there is no main effect of BMI on depression in this model.

Table 3

Predicting Depression from BMI

Predictor	*b*	SE	β
Step 1			
Race	1.71	0.94	0.12
Gender	0.58	0.87	0.04
Mean Parental Inc	-0.05	0.07	-0.05
Mean Parental Ed	-0.06	0.23	-0.02
Body Image	-1.50	0.43	-0.21***
Cortisol	0.82	0.70	0.07
Step 2			
Race	2.07	0.96	0.15*
Gender	0.51	0.86	0.04
Mean Parental Inc	0.00	0.07	0.00
Mean Parental Ed	-0.07	0.23	-0.02
Body Image	-1.70	0.45	-0.24***
Cortisol	0.89	0.70	0.08
Body Mass Index	-6.95	4.02	-0.11

Note Ed = Education; Inc = Income. Race coded as 0 = white, 1 = nonwhite.
* $p < .05$ (two-tailed). ** $p < .01$ (two-tailed). *** $p < .001$ (two-tailed).
Fit for model 2 $R^2 = .28$, Adjusted $R^2 = .06$, $F(7, 247) = 3.097$, $p = .004$.

To test mediation and moderation models, I used the macro PROCESS on SPSS (Hayes, 2013). A mediating variable in a model explains the way in which two other variables are related, as it provides a causal pathway in the relationship. A full mediator in a model is when the mediating variable fully explains the relationship, in that there is no relationship between the independent and dependent variables without the presence of the mediating variable. On the other hand, a moderating variable influences the direction or strength of the relationship between the independent and dependent variables and shows under what circumstances or for whom the relationship exists.

The first model used cortisol as a mediator of the relationship between BMI and BDI. I chose to use cortisol as a mediator because of how the existing literature points to cortisol as a mechanism to explain why BMI and BDI are related. My hypothesis for this model is that a higher BMI leads to higher cortisol reactivity, and higher cortisol reactivity in turn leads to higher levels of depression. I used gender, race, parental education, and parental income as covariates in the model. I found no total effect between BMI and BDI (B = -1.16, p = 0.71). Similarly, there was no indirect effect of cortisol (B = -0.02, 95% CI [-0.35, 0.50]). Given the lack of total or indirect effect, cortisol does not mediate the relationship between BMI and depression.

A second model used body image as a mediator in the relationship between BMI and BDI. Similarly to cortisol, the existing literature on body image suggests that it would be a mediator since it could mechanistically explain why BMI and BDI are related if high BMI leads to lower body image and low body image leads to higher depression. The covariates in the model were gender, race, parental education, and parental income. There was no total effect between BMI and BDI (B = -2.27, p = 0.56), however, there is an indirect effect of body image (B = 4.83, 95% CI [1.74, 8.34]) demonstrating full mediation. The relationship between BMI and body image is significant (B = -2.85, $p < 0.001$), as is the relationship between body image and BDI is significant (B = -1.70, $p < 0.001$) (**Figure 2)**. This means that as BMI increases, body image decreases, and with a decrease in body image, depression increases. Body image is a mechanism that explains the relationship between BMI and BDI as no relationship exists between the variables without the addition of body image.

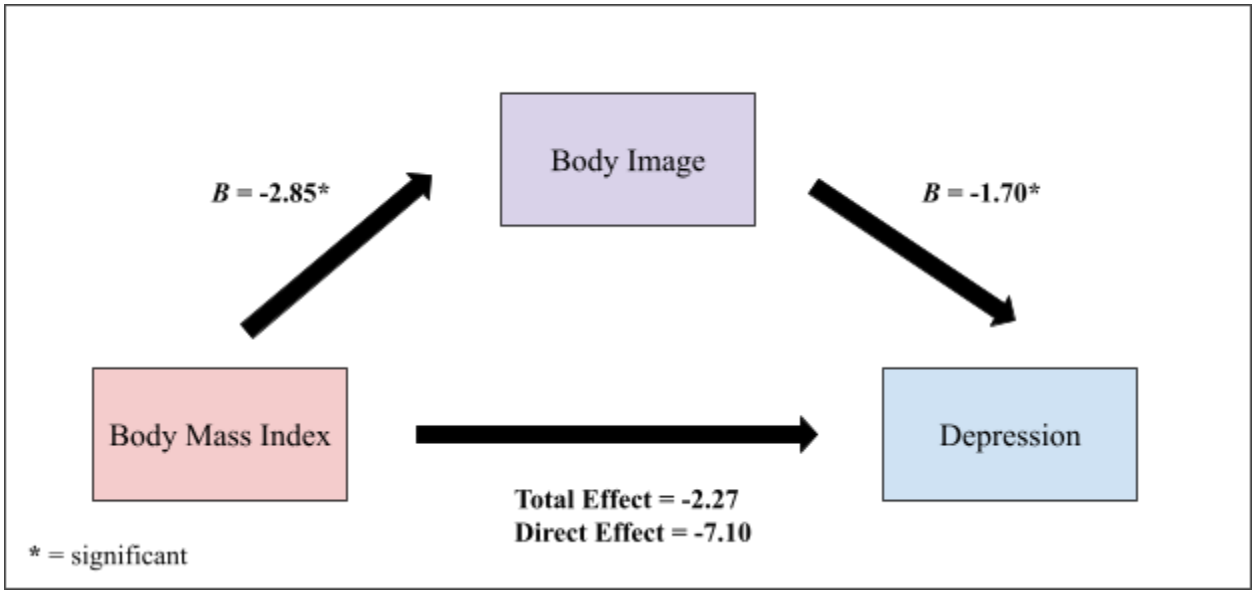

Figure 2: The Results of a Mediation Analysis showing Body Image as a Full Mediator between BMI and Depression

A third model that was tested used gender as the moderator between BMI and BDI. Gender is a potential moderating variable because the relationship could be different depending on if the participant identifies as a man or woman. Covariates in the model were race, parental education, and parental income. The overall model was significant ($F(6, 379) = 2.98$, $p = .007$), explaining 4.5% of the variance. Additionally, the increase in R-squared due to the interaction term was significant ($F(1, 379) = 4.71$, $p = .031$). Despite the interaction term being significant, simple slope analyses did not reach significance. Higher BMI was approaching a significant association with lower depression in males ($B = -8.9$, $SE = 4.7$, $p = 0.06$), and higher BMI had an insignificant association with higher depression in females ($B = 4.6$, $SE = 4.1$, $p = 0.26$) (**Figure 3**).

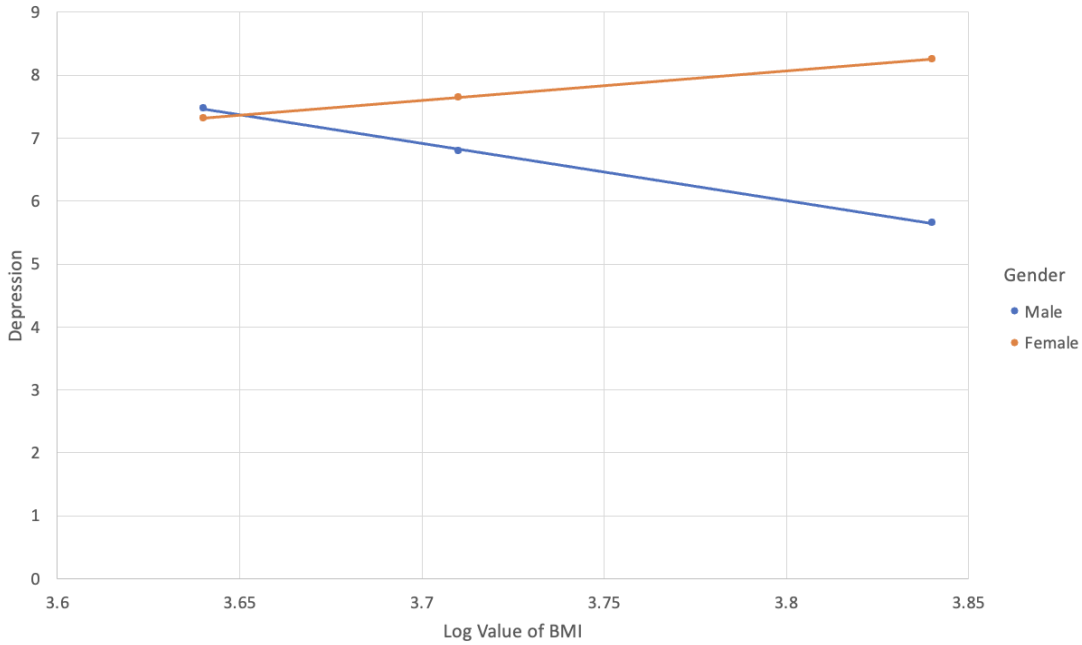

Figure 3: The Effects of BMI on BDI Dependent on Gender.

Discussion

In the current study, I investigated the relationship between BMI and depression, as well as potential mediators of the relationship. I also explored the moderating role of gender. The main finding of this study is that body image is a mechanism that explains the relationship between BMI and depression since as BMI increases, it causes body image to decrease, and with a decrease in body image, depression increases. Additionally, gender moderates the relationship between BMI and depression in that it is different in men and women. Finally, I found that cortisol could not explain the relationship between BMI and depression.

The results of the study are somewhat inconsistent with the existing literature. Firstly, unlike many previous studies, there was no correlation nor quadratic relationship between BMI and depression by itself (Badillo et al., 2022; Simon et al., 2008; de Wit et al., 2009). Additionally, when using race, gender, parental income, parental education, body image, and cortisol as covariates in the relationship between BMI and depression, the overall regression model was significant, but BMI was not a significant predictor in the model.

Secondly, the sample did not have the expected correlations based on existing literature between BMI and cortisol (Abraham et al., 2013; Wester et al., 2014) or between cortisol and depression (Dienes et al., 2013; Nandam et al., 2020). This lack of correlations made it unsurprising when the first mediation model, using cortisol as a mediator in the relationship between BMI and depression, was insignificant. Within the context of this sample, this means that cortisol levels did not explain the relationship between BMI and depression.

Thirdly, body image was correlated with both BMI and depression, as seen in previous studies (Ahadzadeh et al., 2018; Manaf et al., 2016; Soares Filho et al., 2021). Additionally, the

mediation model with body image was significant. For the mediation model, it was a full mediation as there was no total or direct effect, meaning that body image explains the relationship between BMI and depression, and there is no relationship without body image.

Finally, once again opposing existing literature, in this sample, gender was not correlated with depression (Mayo Clinic, 2019). However, the moderation model with gender as the moderator was significant, meaning that the relationship between BMI and depression does depend on gender. This finding is consistent with previous literature that men and women may have different relationships between BMI and depression, and more specifically, may have inverse relationships in that men have higher depression at lower BMI and women have higher depression at higher BMI (Carpenter et al., 2000). The results of these four models show that for this sample, it is the societal impacts of gender and body image that are explanatory in the relationship between BMI and depression rather than the physical impacts of higher BMI such as cortisol.

There are a few limitations of this study that could explain why my sample did not follow the expected trends. First, mediation models usually need data with three time points. This study only had one time point, so this could've led to problems with the validity of the mediation analyses. A second limitation of this study is that the sample is only from two colleges and thus has a higher likelihood of being homogenous and not representative of college students as a whole. Additionally, college student samples are not generalizable to all populations given that college students tend to be a very homogenous population and are unrepresentative of the general population, particularly when using personal and attitudinal variables (Hanel & Vione, 2016). The college student population tends to be healthier than most populations, which could particularly affect a study like this that considers weight health. A third limitation is that many of

the variables that were used such as the Beck Depression Inventory were self-reported. Self-report variables are non-clinical, so even if the variables used in the study have high validity, they may not be accurate representations of the individual.

More specific to this sample, there were a few characteristics that I believe could have affected the results of the study. Firstly, there was a lack of variance in the depression variable. Only 15% of the participants met the cutoff for some form of depression, which is significantly lower than national estimates of the prevalence of depression in college students (Elflein, 2022). If there was not much variation in the outcome variable, then it would be hard to find trends with predictor variables. Similarly, there was only 2.5% of the sample with an underweight BMI, which makes sense why a quadratic relationship between BMI and depression was not present. Secondly, based on anecdotal knowledge of one of the colleges used in the sample, this population could have an unusually high proportion of athletes (College Factual, 2022). With a higher-than-average proportion of athletes, there could be unexpected trends as athletes tend to have more muscle mass and higher BMIs that are less indicative of being overweight (CDC, 2022). This is a potential explanation for why in individuals with high body confidence, having a higher BMI was related to lower depression if many of these individuals were athletes. Finally, based on post-hoc analysis, the sample of participants in this study may have had slightly different views of bodies as a whole. In addition to the question asking about one's own body, participants were asked to pick the male and female body from an image (**Figure 4**) that represented the healthiest and most attractive body sizes.

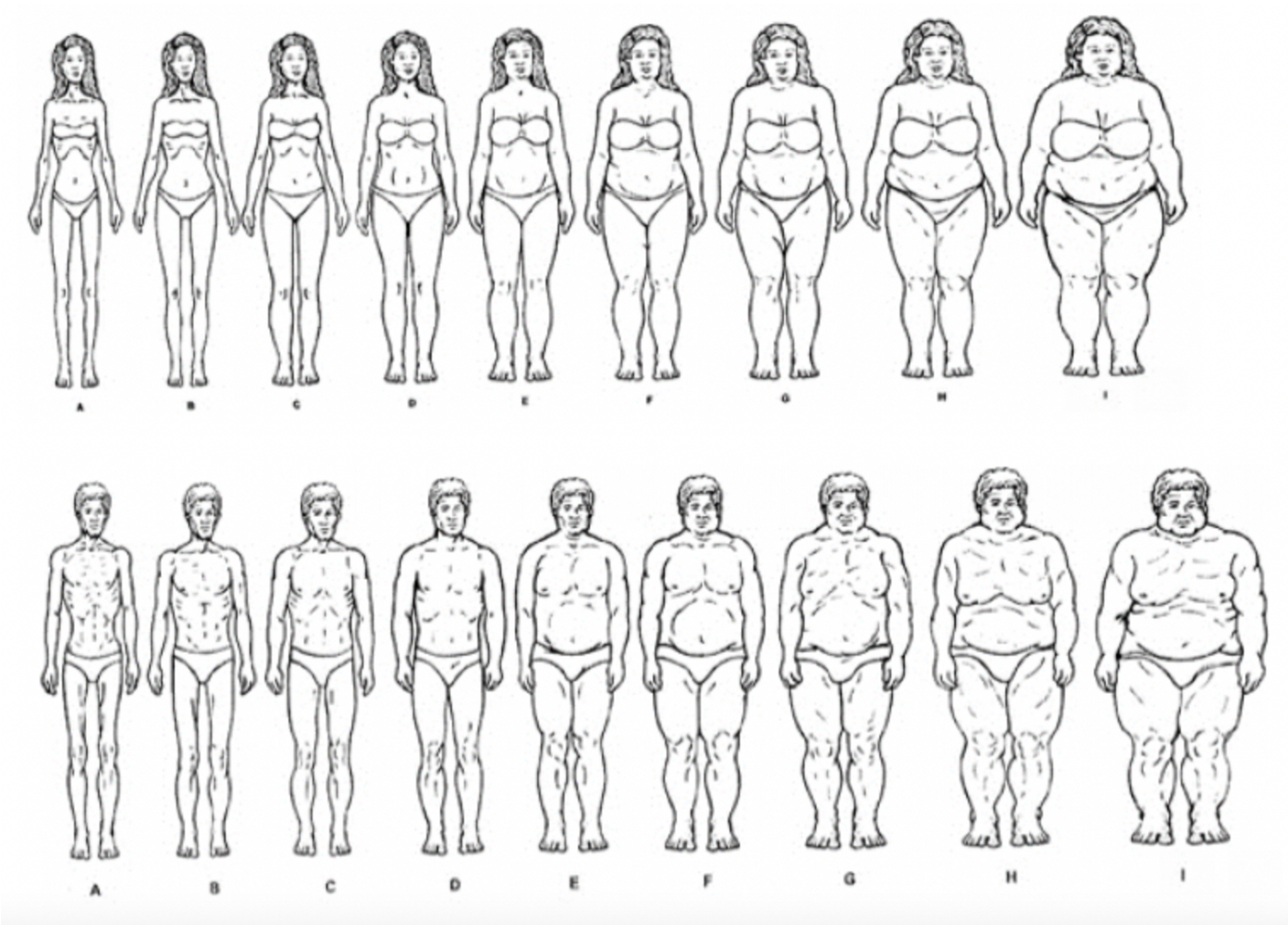

Figure 4: Image of Bodies Used to Assess Participant Ideal Male and Female Body Size for Health and Attractiveness

The mean body picked for females to represent the healthiest and most attractive body was between C and D, closer to C, and the mean body picked for males was between C and D but closer to D. In a large sample, of individuals 18-30, the average for women was between B and C, and for men was between D and E (Bulik et al., 2001). This means that my sample idealized skinner male bodies than a general sample, and my sample idealized bigger female bodies than a general sample. If the difference was big enough, this could affect any analyses

done on body image given the expected influence of "ideal" figures on oneself would be different.

While there were many limitations to my study, there were also a few strengths. First of all, the self-report variables used, particularly the Beck Depression Inventory, have been found to have high reliability and validity, which mitigates the risk that the variable is incorrectly measuring what it should be (Reynolds & Gould, 1981; Storch et al., 2004). The second strength of this study is the biological variables that were collected. Rather than just comparing self-report variables, being able to include biologically measured cortisol reactivity in response to the TSST adds to the validity of the study as a whole.

In conclusion, my data provides evidence that in this sample it is the psychological/societal factors that explain and impact the relationship between BMI and depression, particularly gender and body confidence. More specifically, body image explains the relationship between BMI and depression, in that individuals with higher BMI have lower body image and a low body image leads to higher levels of depression. Additionally, gender changed the relationship as well, and even though the role of gender could be societal or biological, the other biological variable of cortisol reactivity was insignificant in the relationship. Future research could look at doing longitudinal studies with these variables to get three time points for more accurate mediation analyses. This study could also be replicated in a larger and more heterogeneous sample to see if the trends found here hold true. Finally, future research should continue to try to replicate and uncover the mechanisms of the relationship between BMI and depression, as obesity and mental health are both prevalent and detrimental problems in society today.

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