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College Population

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INTRODUCTION

Mental health disorders affect 22.1% of the U.S. young adult population (ages 18-25), which is the highest of any age group [1]. Two common disorders in young adults are major depression and anxiety, occurring at 10.9% and 22.3%, respectively [1]. These disorders are often attributed to a serotonin deficiency and are treated with medications such as Selective Serotonin Reuptake Inhibitors (SSRIs). Medications are not always favored by patients, who report a three-fold preference for non-pharmacological forms of treatment [2]. Historically, nutrition has been overlooked as a contributor to poor mental health, but there is an increasing focus on this relationship, largely due to the central nervous system's need for key nutrients to maintain optimal function. The nutritional status of an individual is influenced by a variety of factors, including: life stage, environment, food access, and socioeconomic status [3]. In turn, each of these factors has an influence on mental health [4].

The relationship between nutrition and mental health has begun to be studied in a variety of settings, but the majority of research is focused on older adults. College-attending young adults face a variety of risk factors for poor mental health, including high stress and poor food access. Food insecurity is defined as the lack of consistent access to a sufficient quantity of healthy affordable foods, and on college campuses can be at rates as high as 59% of students [5]. Importantly, food insecurity has been shown to be associated with poor mental health [6-11]. Food insecurity rates can vary by region and are particularly high in the Appalachian area, with rates as high as 20.8%, much higher than the US average of 12.3% [12]. Due to the many risk factors for poor mental health faced by young adults on an Appalachian college campus, the prevalence of anxiety and depression and its relationship to dietary quality needs to be studied.

Research on the relationship between nutrition and mental health has focused on specific nutrients and found that omega-3 fatty acids are beneficial in improving mental health [13-21]. In addition to examining specific nutrients, research has shown the benefits of a dietary intervention in alleviating depression and anxiety symptoms [22-25]. These dietary interventions have used different approaches, including increased fruit and vegetable intake, following a Mediterranean diet, and nutrition education and counseling with a dietitian. However, the rates of mental health disorders in a population as well as the habitual dietary patterns of these individuals needs to be determined prior to describing dietary interventions.

This paper is intended to provide an overview of the literature on the relationship between nutrition and mental health, dietary intervention implementations for depression and anxiety, regional characteristics of dietary quality, and recommendations for future work.

LITERATURE REVIEW

I.   Relationship between dietary quality and mental health

Various cross-sectional studies have been conducted to determine if there is a relationship between nutrition and mental health [26-30]. Although specific nutrients have been studied for their effects on mental health, these are not representative of the daily diet's effects on mental health [28]. Thus, the goal of these studies was to assess the relationship between overall dietary quality and mental health disorders, mainly depression and anxiety. Depression has been linked to unhealthy behaviors and may make changing harmful behaviors more difficult [26]. Ohmori et al. studied associations between depression and unhealthy behaviors related to metabolic syndrome [26]. They aimed to do so because certain studies had found depression to be related to risk factors for metabolic syndrome, including high fasting plasma glucose (FPG), hypertension, and central adiposity, while others had not. Using a cross sectional design,

compared to 1135 of their non-depressed peers, women with depression exhibited higher rates of pre- and metabolic syndrome, blood pressure, serum insulin, and triglyceride levels. This cohort also had lower HDL, physical activity levels, and skipped breakfast more often. Men with depression exhibited fewer reports of eating a well-balanced diet and snacking between meals. For both genders, individuals with depression exhibited higher intakes of sodium and drank more alcohol compared with non-depressed controls. These results indicated that depression is associated with unhealthy behaviors in both genders, but more so in women than in men. However, this study was limited by a small sample size.

Another study by Stefanska et al. evaluated the dietary habits of depressed patients from an outpatient clinic and found differences among genders [27]. Researchers distributed a food frequency questionnaire (FFQ) to 150 patients aged 18-64, of which 75 were depressed. Female patients with depression were significantly more likely to consume wheat-rye bread, cheese, butter, cream, lard, coffee, and sugar compared to the non-depressed females. Male patients with depression had higher intakes of lard, but less frequent intake of vegetable oils, beer, and fast food than non-depressed males. This study again showed that habits of depressed individuals varies between genders.

Meegan et al. investigated the overall diet's effects on mental health using a cross-sectional design [28]. With a sample size of 2040 Caucasian adults, researchers investigated the physical and mental health of participants and their diet patterns using anthropometric measurements, multiple mental health screening tools, and a food frequency questionnaire to calculate a dietary score. Individuals with depression had greater BMI and physical measurements but there were not significant differences in these clinical measurements of anxious individuals. Individuals with anxiety had lower intakes of breads, cereals, rice and pasta, meat, fish, poultry, oils, and

confectionaries. They found no differences between groups in overall dietary compliance to food pyramid groups. However, those who had higher dietary quality reported higher well-being. When examining gender differences, females with higher dietary quality were nearly twice as likely to report well-being, and there were no differences among the male gender. The results of this study indicate the need for further investigation in the relationship between all lifestyle factors and mental health, and further confirms that there are differences between genders in these domains.

Another study by Nguyen et al. investigated diet and overall psychological well-being in addition to anxiety and depression [29]. Rather than overall dietary quality, this study specifically examined the relationship between fruit and vegetable consumption and psychological distress in a sample of 60,404 adults aged 45 years or older. After adjusting for lifestyle and sociodemographic characteristics, fruit and vegetable consumption was associated with a lower prevalence of psychological distress. The strongest relationship occurred at a medium intake, but this significance was lost at the highest levels of intake. These results show that increased fruit and vegetable intake may alleviate depression and anxiety symptoms, but optimal dosing requires further investigation.

A large-scale study by McMartin et al. conducted in Canada using data from five waves also analyzed fruit and vegetable intake's effects on the mental health status of adults (n=130,880) [30]. Researchers examined daily fruit and vegetable consumption of participants and the presence of a major depressive episode in the past year using a validated diagnostic tool. In addition, participants were asked whether they were diagnosed with a mood disorder by a professional and about their self-perceived mental health. In all 5 waves, higher intake of fruits and vegetables was associated with lower odds of depression, with a 27% reduction in odds of

depression if greater amounts were consumed compared to the lowest amounts. Perception of poor mental health, professional diagnosis of a mood disorder, and presence of an anxiety disorder were associated with low fruit and vegetable consumption in 4 of the 5 waves. This study offers further evidence that increased fruit and vegetable consumption is associated with better mental health.

The relationship between depression and anxiety and dietary quality are equivocal. A review article published in 2016 by Lim et al. summarizes the current research on the role of nutrients and dietary quality in mental health [31]. Omega-3 fatty acids, phospholipids, cholesterol, niacin, folate, vitamin B, and vitamin B12, show promising results in improving mental health. Saturated fats and sugars appear to worsen mental health and cognitive function. This review calls for more research into dietary quality's effect on mental health, in addition to timing of meals, and for a well-designed large-scale diet intervention study. Mental health and nutrition status have been shown to be related and certain foods, such as fruits and vegetables, can improve mental health. The effects of unhealthy foods on mental health requires further investigation.

II.   Poor diets and mental health

There has been little investigation into whether foods high in fats or sugars can be harmful to mental health and function. A study conducted in 2002 by Molteni et al. investigated the effects of consuming a diet that is high in saturated fat and refined sugar on cognitive function [32]. While this study focused on overall neuronal function by neuronal plasticity rather than mental health disorders, its implications are important for depression and anxiety. Neuronal plasticity is the ability to compensate for challenges, which includes behavioral adaptation [32]. Researchers examined the neuronal plasticity of rats by monitoring brain-derived neurotrophic factor

(BDNF). Using a standard low fat, complex-carbohydrate diet as a control, researchers compared rats' cognitive function over 2 years based on consumption of the control (standard rat chow) or the experimental diet which consisted of high saturated fat and refined sugar. Rats consuming the high saturated fat, high refined sugar diet had lower levels of BDNF and BDNF mRNA, which caused them to perform poorer in learning, maze tests, and overall cognitive function. This study is one of the few to examine the effects of high fat and high sugar on mental function and warrants further investigation. Certain foods have been shown to improve mental health, while others are associated with poorer mental function. The impact of interventions targeting these dietary factors on improving mental health is another area of study.

III.   Dietary interventions impact on mental health

A study conducted in 2016 by Conner et al. examined the effects of a fruit and vegetable intervention on the mental health of young adults [22]. Young adults (n=171, aged 18-25) with low fruit and vegetable consumption were assigned to three intervention groups: maintain usual diet (control), an ecological momentary intervention (EMI) group, and a fruit and vegetable intervention (FVI) group. The EMI group received reminders via text to increase their fruit and vegetable consumption, in addition to a voucher to purchase fruits and vegetables. The FVI group were distributed fresh fruit and vegetables equivalent to two servings to consume in addition to their normal diet. Participants were assessed on depression and anxiety pre- and post-intervention. In addition, participants responded to a daily survey on moods, vitality, flourishing, and flourishing behaviors. For further analysis, blood samples were taken to measure Vitamin C and carotenoids, and perceptions about fruit and vegetable benefits were measured to test for mediators of any psychological change. Participants in the FVI group were the only ones to show improvements in vitality, flourishing, and motivation. They found no changes in depression,

anxiety, and mood, and results were not mediated by Vitamin C, carotenoids, or perceptions. These results indicate that providing young adults with fresh fruits and vegetables can increase their well-being, however reminding them to do so does not have this effect. Therefore, having access to healthy foods plays a significant role in adherence to a diet and subsequently mental health. As this study was limited to 14 days, a longer intervention may be necessary to improve symptoms of depression and anxiety.

Rather than looking at specifically fruits and vegetables, Parletta et al. conducted another intervention examining whether adopting the Mediterranean diet can improve depression symptoms in adults [23]. The Mediterranean diet is bountiful in nutrients shown to be beneficial for brain function, specifically omega-3 fatty acids. This intervention used a randomized controlled trial design for a 6-month duration, using 152 participants with self-reported depression. The intervention group received 450mg DHA and 100mg EPA twice per day for 6 months. For the first 3 months, this group received Mediterranean diet staples, online resources, and nutrition education and culinary skill sessions. The control group attended social groups every 2 weeks for 3 months. The control group's purpose was to control for the social aspect of the cooking workshops that the intervention group attended. The intervention group showed a significantly greater increase in fruits, vegetables, whole grains, nuts and legumes, and significantly lower consumption of unhealthy foods. These changes remained consistent at 6-month follow-ups. Both groups showed improvement in their depression scores, but the intervention group showed significantly higher improvement than the control, with 1.68 times greater improvement in depression scores. Higher Mediterranean diet scores were significantly associated with lower depression and anxiety, better coping, and overall better quality of life. Increased EPA intake was associated with improve anxiety symptoms. This study shows that

providing the tools and skills to adhere to a Mediterranean diet can improve the symptoms of individuals with depression, again showing that providing access to healthy foods is a critical factor in improving mental health.

Jacka et al. conducted a randomized controlled trial dietary intervention that included nutrition education found improvements in depression symptoms in adults [24]. During this 3-month intervention, participants in the intervention group (n=31) received 7 nutritional education counseling sessions with a clinical dietitian. The control group (n=25) was a social support group. Individuals in the intervention group had much higher improvements in depression symptoms, with 10 entering remission, compared to only 2 in the control group. This study showed that a dietary intervention that includes professional nutrition education and counseling can be a viable therapy for individuals with major depression.

These interventions have shown a promising future for nutritional psychiatric interventions, creating a new field of nutritional psychiatry. A review article by Jacka summarizes where the field of nutritional psychiatry interventions stands to date [25]. Across various age groups, although mostly older adults, and across countries, a relationship between diet quality and mental health disorder risk has been established. Intervention studies have shown positive effects on treating mental health disorders. Newer studies examine biological pathways by which these improvements occur, including the immune system, neuronal plasticity, and the microbiome. However, this field is lacking in information on methodology, how to account for errors, how to enhance research control, and overall study design. Future studies need to refine study design and replicate in diverse populations. Due to the influence of environmental factors on mental health status, replication in diverse populations is required because the prevalence of mental

health symptoms may vary regionally. Interventions need to be tailored based on the population targeted, and the prevalence and causes of a problem in a population needs to first be determined.

IV.   Regional effects on mental health and dietary quality

The regional differences in dietary habits has been relatively overlooked, but a study conducted in 2017 by Stefanksa et al. examined this relationship [4]. Recruiting from a mental health outpatient clinic, researchers compared the dietary patterns of depressed patients living in rural areas and depressed patients living in urban areas. The study group contained 96 middle-aged women and 84 middle-aged men who had a diagnosis of depression for up to five years. Severity of depression was measured by the Hamilton Depression Rating Scale and the Beck Self-Esteem Scale. Nutritional status was measured by BMI, height, weight, blood cholesterol, and multiple 24-hour food recall interviews. Rural women had significantly higher intakes of fat, higher total cholesterol, higher blood glucose, and lower HDL cholesterol than urban women. Rural men had higher blood glucose and lower HDL cholesterol than urban men. Rural residents had significantly higher intakes of total energy, total fat, and saturated fat. These results show that individuals in rural areas may have more unhealthy eating patterns consisting of higher total energy and saturated fat intake, and therefore need a different targeted intervention.

The poorer dietary quality of depressed patients in rural areas could be due, in part, to lower food access. Although this was not considered in the previous study, another study by Davison et al. examined dietary quality of adults with mental health and status of food insecurity, or lack of access to a sufficient quantity of affordable, nutritious foods, is related to poor mental health [33]. Food insecurity has been linked to poor mental health [6-11]. However, few studies have incorporated both dietary quality and food insecurity when examining their relationship to mental health symptoms, rather they have looked at these variables singularly. A cross-sectional

study determined the differences in energy and nutrient intakes, macro and micronutrient intakes, and all of these factors combined in relation to perceived mental health and food insecurity status. Authors proposed that poor mental health and food insecurity worsen dietary quality, and that food insecurity and diet quality can independently predict mental health. To examine this, 20,498 respondents aged 19-70 answered questions on dietary intake via multiple 24-hour recalls, perceived mental health, and food security using the Household Food Security Survey Module. Sex, age, income, education, smoking, and relationship status were controlled for as these factors can influence dietary quality and food security status. Poorer dietary quality was found in those with poor mental health compared with those with good mental health. Food security, dietary quality, and mental health were significantly associated. Overall lower macronutrient and micronutrient intakes were found in those with poor mental health and those who were food insecure. When adjusting for covariates, individuals with poor mental health had increased odds of being food insecure, having poor dietary quality and low intakes of folate, iron, and protein. These results indicated that food insecurity and poor dietary quality independently predict poor mental health, and that individuals with poor mental health and who are food insecure have insufficient intakes of both macro and micronutrients.

The significant relationship between mental health, dietary quality, and food security suggest that individuals who are in areas of high food insecurity likely have a higher risk for poor mental health and dietary quality. Nationwide, the rate of food insecure households is 12.3% [12]. Areas such as the Appalachian region have high rates of food insecurity [12]. The Appalachian region is composed of parts of North Carolina, South Carolina, Virginia, Tennessee, Kentucky, Mississippi, Alabama, Georgia, Pennsylvania, Ohio, New York and the entire state of West Virginia. Of these 12 states, half have food insecurity rates higher than the US average,

with rates as high as 20.8% [12]. These rates can be even higher on college campuses, despite availability of meal plans. A study conducted in 2017 by McArthur et al. examined food insecurity rates on an Appalachian college campus [34]. More than 21% of students had low food security, and 24.3% had very low food security. For coping strategies, the most often used methods were purchasing cheap or processed foods, stretching food to make it last, and eating less healthy meals to have more food. This study showed that young adults on college campuses in the Appalachian region are at higher risks of food insecurity, and based on the literature discussed in this review, may be at higher risk for poor mental health and dietary quality as well.

V.   Conclusion of literature review

It is known that there is a strong relationship between nutrition and mental health as determined by cross-sectional studies in adults. It is also known that the dietary habits of depressed and anxious individuals differ, and that they also differ between genders. Among the studies and interventions that have been conducted, there is a wide-range of methods used to assess dietary quality and mental health symptoms. Future work needs to refine this study design by determining the best methods to capture this data. In addition, these interventions need to focus on providing food access to improve adherence to the recommended diet and examine the different dietary habits between genders and between depressed and anxious individuals.

The dietary habits of depressed or anxious individuals has been minimally studied but have shown to vary regionally. Because of these differences in dietary habits, the prevalence or severity of mental health symptoms may vary regionally as well. Overall, there is a limited amount of data available on the health of Appalachian individuals, who are at high risk of poor health due to low socioeconomic status, low food access, and low access to health services such as to counseling with registered dietitians. These and additional poor health risks, such as stress,

are present on college campuses. However, no studies have yet identified this relationship in a US young adult population in an Appalachian college setting. Young adults in this setting may face poor nutritional status due to low access to healthy food and high mental health symptoms attributed to high stress and the college environment. The aims of this study are to determine the prevalence of depression and anxiety symptoms in an Appalachian college-attending young adult population and the relationship between these symptoms and dietary quality. In addition, the role of food insecurity in relationship to these factors will be examined. It is hypothesized that 1) Individuals with poor mental health, classified as those with high depression and anxiety will show lower dietary quality characterized by lower fruit and vegetable intake and higher sugar intake, 2) individuals who are food insecure will show higher days of poor mental health and lower dietary quality, and 3) there will be differences in dietary patterns between genders, and between depressed and anxious individuals.

METHODS

Design:

This cross-sectional study investigated a sample of young adults attending a large, Appalachian university in fall 2017. To be eligible, participants had to be currently enrolled at the university ad at least 18 years of age. This study was approved by the university's Institutional Review Board.

Participants and Procedures:

Undergraduate and graduate students attending a large, Appalachian university in the fall 2017 semester were recruited. Using the university listserv, students were emailed an online survey link. Students who were interested clicked the link, which brought them to Qualtrics, an online survey platform. Participants were able to read the informed consent, and if accepted,

completed the survey. Students who denied consent were exited from the page. Students were incentivized to take the survey via the chance to win one of four $100 American Express gift cards. Contact information remained separate from the results of the survey to maintain confidentiality.

Survey Design:

The 116-item survey was developed by researchers from a multistate, collaborative university research group. The survey asked students to report their height, weight, number of days feeling depressed over the past 30 days, and number of days feeling anxious over the past 30 days. Students were screened for food insecurity using the US Household Food Security Survey Module, and for dietary quality using the Dietary Screener Questionnaire (DSQ). The DSQ groups responses into a dietary score for different food groups. Food groups examined for this study were Fruit and Vegetable intake and Added Sweeteners. For the Fruit and Vegetable domain, items included: fruit, fruit juice, salad, fried potatoes, other potatoes, dried beans, other vegetables, tomato sauce, salsa, and pizza. For the Added Sugars domain, items included: soda, fruit drinks, cookies, cakes, pie, donuts, ice cream, sugar/honey in coffee/tea, candy, and cereal. Scores indicate frequency of consumption on a daily basis, with a possible score of 20 servings for fruits and vegetables, and 16 servings for Added Sweeteners.

Statistical Analysis

Descriptive statistics were computed for all demographic and health questions. Students were placed into high or low mental health symptoms using cutoffs of greater than or equal to 10 days of poor depression or anxiety being designated as high. For DSQ scoring, students could receive a maximum score of 12 for fruit and vegetable intake due to exclusion of fried potatoes, pizza, tomato sauce, and salsa from the score based upon further review of nutritional adequacy.

Food security status was scored using the USDA's scoring system for the 10 questions. Scores with zero affirmative answers indicate high food security, scores of 1-2 marginal food security, 3-5 low food security, and 6-10 very low food security. Prevalence of food insecurity was determined by designating those in the high and marginal categories as food secure, and those in the low and very low categories as food insecure.

One-way ANOVA analysis was used to determine bivariate associations of students with high and low mental health symptoms with demographic variables, dietary quality, and BMI. Pearson Chi Squared analysis was used to determine bivariate associations of students with high and low mental health symptoms and food security status. All significant variables were placed into a full logistic regression model to determine the strongest predictor of poor mental health. Separate models were created for depression and anxiety and were stratified by gender due to the differences seen between the dietary habits of males and females with poor mental health.

RESULTS

The survey was completed by 1956 students. Respondents were predominantly aged 19-21 (59.4%), identified as female (67.5%), identified as being from Appalachia (57.1%), and lived off campus (80.9%). The mean BMI of this sample was $25.2 \pm .47$. Over a third (36.7%) of students were found to be food insecure. The mean fruit and vegetable intake was 1.80 ± 1.27 and the mean added sugars intake was 1.79 ± 1.26. The mean number of days feeling depressed was 9.67 ± 8.80, and the mean number of days feeling anxious was 14.1 ± 10.03.

Simple analysis of variables with number of depressed days showed significant associations with fruit and vegetable intake (p=.0096), gender identity (p=.0008), food security status (p=<.0001), added sugars intake (p=.0351), and BMI (p=.0091). Chi-squared analysis

showed significant associations with high days of depression and food insecurity, (p=<.0001),

and identification as male (p=.0002).

Simple analysis of variables with number of anxious days showed significant associations

with gender identity (p=<.0001), food security status (p=<.0001), added sugars intake (p=.0175),

and BMI (p=.0447). Chi-squared analysis showed significant associations with high days of

anxiety and food insecurity (p=<.0001), identification as female (p=<.0001). Tables 1 and 2

show sample characteristics by anxiety and depression status.

Table 1: Characteristics of respondents and correlations with depression status.

Variable	Low Depression		High Depression		p-value
	N	%	N	%	
Total Population					
	343	26.9	933	73.1	
Gender					
Male	228	21.2	503	46.7	.0002*
Female	71	6.59	276	25.6	
Housing					
On-Campus	128	11.9	77	7.2	0.0671
Off-Campus	601	55.9	269	25.0	
Food Security Status					
Food Secure	264	24.3	189	17.4	<.0001*
Food Insecure	473	43.6	159	14.7	
	Mean	**SD**	**Mean**	SD	
BMI	25.26	5.48	25.85	6.12	.1970

Demographic data presented in frequency and percentages. Pearson Chi-square frequency and one-way ANOVA analyses were performed. *P<.05.

Table 2: Characteristics of respondents and correlations with anxiety status.

Variable	Low Anxiety		High Anxiety		p-value
	N	%	N	%	
Total Population					
	343	26.9	933	73.1	
Gender					
Male	217	17.0	415	32.5	<.0001*
Female	126	9.87	518	40.6	
Living Status					
On-Campus	111	8.71	519	40.7	0.3720
Off-Campus	126	9.89	518	40.7	
Food Security Status					
Food Secure	426	33.1	353	27.4	<.0001*
Food Insecure	213	16.5	296	23.0	
	Mean	**SD**	**Mean**	SD	
BMI	24.92	5.04	25.55	5.99	.4438

Demographic data presented in frequency and percentages. Pearson Chi-square frequency and one-way ANOVA analyses were performed. *P<.05.

All variables significant in simple analyses with depression symptoms (food security status, fruit and vegetable intake, added sugars intake, and BMI) were entered into a full logistic regression model. All variables significant in simple analyses with anxiety symptoms (food security status, added sugars intake, ad BMI) were entered into another full logistic regression model. Both models were stratified by gender. For depression in males, fruit and vegetable intake remained a significant predictor of depressed days [odds ratio (OR)=.71 95% CI .54-.92], showing that for each unit increase in fruit and vegetable intake, the risk of higher days of depression decreased .71 times. For depression in females, food insecurity remained a significant predictor of depressed days [OR=2.19 95% CI 1.63-2.97], showing that food insecurity increased risk for high days of depression 2.19 times. For anxiety in males, food insecurity remained a significant predictor in number of anxious days [OR=2.12 95% CI 1.35-3.36], showing that food insecurity increased risks of higher days of anxiety 2.12 times. For anxiety in females, added sugars and food insecurity remained significant predictors of number of anxious days [OR=1.15 95% CI 1.02-1.29 and OR=1.52 95% CI 1.16-2.01, respectively]. For each unit increase in added sugars intake, risk for higher days of anxiety increased 1.15 times, and food insecurity increased risks for higher days of anxiety 1.15 times.

Table 3: Logistic Regression model predicting depression status in male students.

Variable	Odds Ratio	95% CI
Added Sugar Intake	1.10	.89-1.34
FV Intake	.71	.54-.92
Food Secure	.58	.33-1.0
Food Insecure	1.73	.99-3.0

Table 4: Logistic regression model predicting depression status in female students.

Variable	Odds Ratio	95% CI
Added Sugar Intake	1.10	0.97-1.25
FV Intake	.93	1.05-1.08
Food Secure	.46	.34-.61
Food Insecure	2.19	1.63-2.97

Table 5: Logistic regression model predicting anxiety status in male students.

Variable	Odds Ratio	95% CI
BMI	1.00	0.96-1.05
Added Sugar Intake	1.03	.86-1.22
Food Secure	.47	.30-.74
Food Insecure	2.12	1.35-3.36

Table 6: Logistic regression model predicting anxiety status in female students.

Variable	Odds Ratio	95% CI
BMI	1.02	.99-1.05
Added Sugar Intake	1.15	1.02-.1.29
Food Secure	.65	.50-.86
Food Insecure	1.52	1.16-2.01

DISCUSSION

To our knowledge, this is the first study to investigate the relationship between mental health, dietary quality, and food insecurity in a young adult population attending an Appalachian university while examining differences between genders. The mean number of days feeling depressed over the past 30 days was 9.67, and of feeling anxious, 14.1. These findings show that college students in the Appalachian environment face mental health problems for a third to half of the month, which may be hindering their academic progress and physical health. When looking at what determines these mental health symptoms, there were differences amongst genders. For males, the biggest predictor of depression was fruit and vegetable intake, and for anxiety, the biggest predictor was food insecurity. For females, the biggest predictor of depression was food insecurity, and for anxiety, the biggest predictors were food insecurity and

added sugar intake. These findings are consistent with previous studies showing differences in dietary patterns of males and females with mental health disorders [26-28]. These are also consistent with studies showing a linkage between dietary patterns and mental health [26-31], and food insecurity and mental health [6-11].

It was hypothesized that individuals with high days of depression or anxiety would show lower fruit and vegetable intake and higher added sugar intake. This was true for fruit and vegetable intake in males with high days of depression, and for added sugar intake in females with high days of anxiety. It was also hypothesized that food insecure individuals would have higher days of depression or anxiety. This was found to be true for anxiety in both males and females, and for depression in females. Finally, it was hypothesized that there would be a difference in dietary patterns of those with high days of depression and high days of anxiety and between genders. This was found to be true, as depressed males showed lower fruit and vegetable intake, and anxious females showed higher added sugar intake.

When looking at who is at risk of poor nutritional status and mental health in terms of these risk factors, young adults on college campuses face many of these risks. There are high rates of food insecurity and overall low access to healthy foods, high stress, and pressure to adapt and succeed in the college environment. These factors are increased when looking at college students on an Appalachian campus, a region plagued by poor health, low socioeconomic status, and poor access to health services. The present study found that individuals on an Appalachian college campus face food insecurity at 36.7%, much higher than the national average. This is consistent with previous studies showing rates of food insecurity on college campuses to be much higher than the national average [5, 34]. Dietary interventions have shown that providing

access to healthy foods can improve mental health symptoms, and thus interventions for this population should aim to provide healthy foods required for improved mental health [22-25].

Limitations of this study include self-reported mental health days rather than a diagnostic scale. In addition, the Dietary Screener Questionnaire includes items in the fruit and vegetable domain that are not healthy sources of fruits and vegetables, including fried potatoes and salsas. The data used in this study was collected from one university, and thus may not be applied to every college environment in Appalachia. Future work will include the use of a validated diagnostic tool, such as the Patient Health Questionnaire, and Beck Anxiety Inventory. In addition, the dietary quality will be better screened for using a tool that encompasses a variety of foods. Finally, data will be collected from multiple Appalachian college campuses.

To conclude, this study gathered data on a population that is understudied, despite their high risk for poor health due to low healthy food access, low socioeconomic status, and a high stress college environment. This study added data on the frequency and contributors to mental health symptoms in young adults on an Appalachian college campus. These individuals are at an important life-stage, where optimal physical and mental function is required to succeed. Identifying areas of need for this population is important to inform interventions. The results of this study are important to show that providing access to affordable healthy foods can improve the rates of mental health disorder symptoms in this environment. Access to healthy foods and dietary quality are associated with mental health, and these factors are modifiable. Improving these factors can improve the mental health of students, and thus may enhance their academic success.

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