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Dairy Consumption and its Influence on Body Composition a Cross-Sectional Analysis of College-Aged Students in Mississippi

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Dairy consumption and its influence on body composition: A cross-sectional analysis of college-aged students in Mississippi

By

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Regular consumption of dairy is thought to aid in preserving lean body mass while decreasing body fat, however, studies have reported inconsistent results. The overall aim of this cross-sectional study was to examine the influence of dairy consumption on body composition, specifically body fat percentage, among college-aged individuals in Mississippi. Total dairy consumption, type of dairy, and the relationship between race and sex were examined in 580 participants aged 18-26 years. Two-tailed correlation tests revealed a nonsignificant relationship between frequency of dairy consumption and body fat percentage among males, (r = .02, p = .68, n = 98) and females, (r = .06, p = .17, n = 469). There was also a nonsignificant interaction among race categories and dairy consumption. Future studies examining college-aged individuals should be performed with a more diverse sample to see if a relationship exists.

DEDICATION

To my mother, father, and sister. I could not have completed this without your love, patience, and encouragement. Thank you for always keeping me sane.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

Dairy is a staple food group within the American diet that provides a variety of essential nutrients such as protein, calcium, riboflavin, and vitamin D. In fact, 58 % of Americans select dairy as a choice for quality protein, with the average American consuming roughly 643 pounds (292.3 kilograms) of dairy every year, with 199 pounds (90.5 kilograms) stemming from the consumption of fluid milk alone (Statista, 2018 & United States Department of Agriculture (USDA), 2018). Even though dairy consumption has steadily decreased since the 1980s, America remains the second largest dairy producer behind India with an annual yield of 97.8 million metric tons, with California and Wisconsin being the top two state producers (Statista, 2018). Last year, the United States exported 2,187,722 metric tons of dairy, and imported 157,450 metric tons of dairy (United States Dairy Export Council, 2018 & USDA, 2019). Despite these volumes, dairy is not ranked in the top 50 of America's import and export items, but it is an industry valued at $38.1 billion (Statista, 2018 & USDA, 2019). When analyzing consumer behavior patterns, reduced-fat (2% milkfat) dairy remains the most popular choice for Americans while whole-fat dairy options have drastically declined (Statista, 2018). Lower fat dairy options remain popular due to national recommendations, such as the 2015 Dietary Guidelines for Americans and current research articles stating that full-fat dairy products increase the risk for cardiovascular disease and other chronic illnesses (Department of Health and Human Services (DHHS) & USDA, 2015).

The Dietary Guidelines for Americans are a series of recommendations to aid Americans in the selection and intake of key food groups to achieve and maintain an optimal eating pattern (DHHS & USDA, 2015). Currently, the Dietary Guidelines advise Americans to consume two to three servings of dairy per day since the food group contains nutrients of concern: including protein, calcium, vitamin D, and potassium. A serving varies depending on the type of dairy consumed. For example, one serving of milk or yogurt is typically one cup or eight fluid ounces. For cheese, it can range from one and a half to two ounces, depending on the amount of processing the product has had (USDA, 2018). Additionally, the Dietary Guidelines for Americans advocate for fat-free or low-fat dairy which helps account for their popularity among consumers.

Dietary guidelines can be reflective of other countries' cultures and evolving eating patterns. For example, consuming dairy is not common within Asian countries, and is not discussed with addressing national dietary recommendations (Food and Agriculture Organization of the United Nations (FAO), 2019). This is largely due to a majority of Asians having a deficiency in lactase, the enzyme predominantly found in milk (FAO, 2019 & Prentice, 2014). Other countries, especially Nordic nations, have strong recommendations on dairy. Denmark advocates for at least 500 grams/day of dairy, with most coming from low-fat products whereas western European countries like Ireland recommend three servings per day where one serving constitutes 1/3 pint of milk, one ounce of cheese, or one carton of yogurt. Other European countries like the Czech Republic advocate for two to three servings per day where one serving is equal to 300 mg of calcium (i.e. 300 mL of milk, 200 mL of yogurt, or 55 grams of cheese) (World Health Organization (WHO), 2019). Currently, only seven African nations have designated dietary guidelines, which mainly focus on preventing malnutrition. Most African countries consume below the recommended 200 liters per capita annually (WHO, 2019).Latin American countries, like Colombia, have dietary guidelines that have dairy recommendations specified for certain age ranges (FAO, 2019). Canada is one of the newest countries to drastically alter the national recommendations from past models. Canada's Food Guide (Health Canada, 2019) has removed the entire "Milk" and "Milk Products" categories and corresponding recommendations, and instead, has leaned towards a more plant-based approach for the complete guide (Health Canada, 2019). The overhaul stems from reports that the majority of Canadians are not consuming enough vegetables, fruits, and whole grains, and while there are concerns, the proponents of the new guide believe it will help the public make easier healthy choices.

Since this study focuses on individuals from Mississippi, it is important to note the overweight and obesity epidemic, especially within the rural South. Mississippi currently ranks second in adult obesity behind West Virginia. (Centers for Disease Control and Prevention, 2018). In 2015 alone, over 50% of Mississippians were classified as overweight (BMI = 25.0 - 29.9 kg/m^2), and 37.3% of Mississippians even met obese ranges (BMI > 30 kg/m^2), with the highest percentage of obese individuals centered in the Mississippi Delta, which has an annual obesity increase of 3.5% (State of Obesity, 2017). The overall prevalence of obesity and extreme obesity in Mississippi increased among both males and females, aged 26-44 years old, and Caucasian and African-American populations from 2001-2010 (State of Obesity, 2017). The fastest growing rates of obesity were seen among children and young adults. Despite efforts such as mandatory gym classes in public schools, revisions to the National School Lunch Program and Supplemental Nutrition Assessment Program, and growing health promotion initiatives developed to help combat the obesity rates in the state, it is expected to cost $3.9 billion in healthcare costs by the end of 2018 (Mendy et al., 2017).

The purpose of this study was to investigate the relationship between dairy consumption and body composition, specifically body fat percentage, since that increases the risk for a multitude of chronic diseases like cardiovascular disease (CVD), type 2 diabetes, and hypertension (Thorning et al., 2016). Additionally, the influences of race, gender, type of dairy consumed, and total dairy consumption on body fat percentage were also examined. The primary goal was to determine if a significant relationship existed among dairy consumption and body fat percentage in earlier age ranges than older age groups that have been previously researched. Significant findings could contribute to the literature and help identify those who might be at greatest risk for increased body fat with consumption or underconsumption of dairy.

CHAPTER II

LITERATURE REVIEW

Consumption Patterns

The current consumption pattern of dairy for Americans has steadily decreased since the 1980s, which many researchers believe might play a role in the obesity epidemic of the nation. In a study conducted by Rice et al. (2013), the team analyzed data obtained through a National Institutes of Health (NIH) food frequency questionnaire which revealed that the average American population was not meeting the minimum intake requirements of two to three cups of dairy per day, which many scientists hypothesized to be correlated to increased body fat and obesity since the overconsumption of refined carbohydrates takes precedent among foods commonly consumed among the American diet (USDA, 2018). In fact, 42% of Americans over the age of one consume below the Estimated Average Requirement (EAR) for calcium and 92% for vitamin D, two key nutrients found in dairy foods (Office of Disease Prevention and Health Promotion, 2019).

For adults under the age of 50, the recommended daily allowance (RDA) for calcium and vitamin D is 1000 milligrams (mg) and 400-800 International Units (IU) each day, respectively (National Institute of Medicine, 2010). As mentioned in the 2015 Dietary Guidelines for Americans, regularly consuming two to three servings of dairy per day is recommended to ensure adequate intake of calcium and vitamin D (DHHS, &

USDA, 2015). The average calcium content for one cup of milk is 300 mg., and a six-ounce serving of yogurt can contain 200-300 mg. of calcium depending on the type and flavor. Cheese typically ranges lower for calcium content (100-300 mg.) which is a direct result from the type of milk used and the amount of processing undergone in production (Midwest Dairy, 2019).

When discussing the calcium content of dairy, it is important to understand the bioavailability of the food group. Calcium absorption is affected by oxalates and phylates because they inhibit absorption. Low oxalate foods such as kale, broccoli, and bok choy have higher calcium absorption rates as opposed to high oxalate foods like spinach, rhubarb, and almonds (Weaver et al., 2006). While dairy contains neither of these two compounds, only 30 % of calcium found in milk, cheese, or yogurt is actually absorbed (Guèguen & Pointillart, 2000). However, this does not imply that dairy is not a good source of calcium. In actuality, dairy is able to supply the same amount of calcium in fewer serving sizes when compared to vegetable sources (Fulgoni et al., 2011).

Additionally, Mirmiran et al. (2015) reported that most obese individuals avoided the consumption of dairy products due to the misconceptions about the fattening results these products may have, even though research has found beneficial outcomes on body weight with regularly consuming dairy (Zemel et al., 2005). There is still skepticism among consumers about what dairy choice is the healthier option, but researchers are beginning to understand the full results of dairy and its relationship, if there is one present at all, on overall health (Thorning et al., 2016).

It is also important to understand the distinctions as to which dairy products are classified and regulated. The U.S. Food and Drug Administration (FDA) is the regulatory agency for nutritional labeling of a variety of food products, including dairy. Presently, there are specific requirements for products to be labeled in a certain manner. For example, for a product to be labeled "fat-free," it must have less than half a gram of fat such as skim milk whereas "low-fat" products must contain three grams or less (CFR 101.62(b)) than the regular product. This is commonly seen in 2% milk products. Additionally, for a food to be considered "reduced/less," it must have at least 25% fewer calories or fat content, depending on what the nutrient claim is specifying (CFR 101.60(b)). Other nutrient content claims regarding whether a product is a "excellent source" or "good source" has certain legal requirements as well. Excellent sources must contain 20% or more and good sources contain 10-19% of the daily value of the nutrient specified (21 CFR 101.54(b & e)) (FDA, 2018). Comprehending what these nutrient claims mean would help consumers make a well-informed decision that keeps their health in mind when food shopping.

Biological Mechanisms of Dairy

From a biological perspective, there is evidence to suggest that increased calcium intake from dairy products is associated with alterations in energy metabolism, specifically in regard to lipid oxidation. Dairy and dietary calcium are thought to change the body's available energy and energy utilization (Zemel, 2009). Dietary calcium is thought to suppress calcitriol levels, which lowers intracellular calcium levels, and in turn, affects adipocyte lipid metabolism by inhibiting lipid synthesis (Philips & Zemel, 2011). Additionally, dairy in itself is thought to reduce energy availability by decreasing the absorption of fatty acids through the formation of calcium/fatty acid soaps in the intestine (Zemel, 2005). This is what helps classify dairy as a high satiety product which controls appetite. Also, increased lipolysis from adipocytes to release free fatty acid from their storage sites may help provide a substrate for enhanced lipid oxidation in both fasting or fed states, however, research in this area is still ongoing (Morigny, 2009 & Teegarden, 2005). Lastly, Tremblay et al. (2015) reported evidence to suggest that the high calcium and varied molecular protein structure found in yogurt and other dairy foods may influence appetite and energy intake due to different absorption rates and post-absorptive responses in the gastrointestinal tract, creating a greater sense of fullness and satiety when compared to carbohydrate sources.

The amount of fat in dairy products has also been investigated for potential health benefits regarding certain chronic ailments. Findings from previous research studies have indicated that full-fat milk, cheese, yogurt, and other cultured milk products may provide a protective outcome for cardiovascular disease (CVD) whereas other studies have found a positive relationship between full-fat dairy consumption and chronic disease (Lorden et al, 2018, Liang et al., 2016, & Soltanti & Vefa, 2017). One study of 600,000 adults from different ethnicities reported no significant relationship between full-fat or low-fat dairy consumption and risk of CVD, despite the saturated fat content found in whole or full-fat products (Soedamah et al., 2011). Additionally, another study following Swedish women observed a twenty-one percent decreased risk of CVD with every five grams per day increase of dairy saturated fat (de Oliveria et al., 2012). These findings seem to contradict what researchers have previously thought to be true regarding saturated fat and cardiovascular disease, however, future research is needed to confirm these findings.

One issue regarding the inconsistencies of many research findings regarding dairy is that dairy can be consumed alone or mixed within other foods. Additionally, the differences in what is considered as high or low amounts of servings varies greatly among studies which makes the possibility of drawing a comparative analysis difficult and even inaccurate (Abargouei et al., 2012). Differences in certain ethnic genomic makeup may also explain some discrepancies with dairy consumption among various racial groups, however, future studies in the field of nutritional genomics are needed (Comferford &. Pasin, 2017). Differences among how males and females metabolically respond to dairy consumption should be investigated as well (Rice, 2014).

Dairy consumption may increase the risk of certain adverse health conditions, including prostate and breast cancer. The danger of dairy product consumption as it relates to prostate and breast cancers is most likely related to increases in insulin-like growth factor (IGF-1), which is found in cow's milk (Rosenblatt et al, 2015). In the Physicians Health Study, tracking 21,660 participants for 28 years, researchers observed an increased risk of prostate cancer for those who consumed ≥ 2.5 servings of dairy products per day as compared with those who consumed ≤ 0.5 servings a day. Prostate cancer risk was elevated with increased consumption of low-fat milk, suggesting that too much dairy calcium, and not just the fat associated with dairy products, could be a potential threat to prostate health (Rosenblatt et al., 2015). However, it is still unclear if certain dairy products elevate the risk of prostate cancer more so than others, and many researchers speculate that the item in question is not calcium nor fat, but rather a different bioactive component such as a certain fatty acid found in dairy (Aune et al., 2015).

New Dairy Research findings

As research and technology have progressed, new research findings surrounding dairy have been published to better explain the relationship dairy has on body composition. New research seems to be showing reduced incidence of chronic disease, reduced body fat percentages, and positive obesity treatment options in certain populations (Sotlanti & Vafa, 2017). These findings help better categorize the proposed benefits dairy may have on public health.

One recent publication regarding dairy consumption could affect the current nutrition dairy recommendations. In the PURE study (Deghana et al., 2018), which followed 136,000 adults in twenty-one countries over the course of nine years, researchers found that eating dairy of all types was associated with an overall lower incidence of premature death, CVD, and stroke. Consumption of greater than three servings per day was associated with a reduced risk of mortality as well. Additionally, subjects who consumed greater than two servings of full-fat dairy per day had lower mortality, CVD, and stroke rates compared to those who did not consume any dairy products. The findings of this study help broaden the potential consequences when avoiding a single nutrient or food group within the diet. For instance, it is common knowledge that saturated fat increases low-density lipoprotein cholesterol which increases the risk for heart disease, but dairy also has additional nutrients like calcium, magnesium, vitamin K, and probiotics (if product is fermented) which can combat the negative effects of one specific nutrient.

In a meta-analysis consisting of 37 randomized control trials in adults, Geng et al. (2017) reported high dairy consumption was significantly associated with increased body weight and lean mass but decreased body fat and waist circumference. When studying obese adolescents and effective weight treatments, Wrotniak et al. (2018) reported that intakes of reduced-fat, low-fat, or fat-free dairy products were significantly associated with improved obesity treatment outcomes among adolescents.

When investigating the association between dairy consumption and plasma inflammatory biomarkers, Gadotti et al. (2018) discovered that yogurt consumption could act as a protectant on inflammatory status whereas cheese consumption seems to act as proinflammatory agent. These findings seem to juxtapose results from the Caerphilly Prospective Cohort Study (CAPS) which stated that increased cheese consumption was associated with lower BMI. There was also no evidence to suggest that total dairy, milk, cream, and butter were significantly associated with BMI (Guo et al. 2018). New findings are still unable to remain consistent, but scientists are continuing their quest to better understand the multifaceted relationship of dairy consumption on body composition.

Now, research is centering towards other components of milk rather than fat content. Since milk composition is complex, researchers theorize that potential benefits might lie in certain fatty acids found only in milk or in certain minerals that are predominantly found in milk such as calcium, potassium, or vitamin D (Liang et al., 2018 & Parm & Nam, 2015). However, these studies are still ongoing or have limited results to support the findings. In the future, it may be possible to have a clearer picture of how dairy influences health.

Body Composition and Dairy Intake

Body composition can be calculated in a multitude of ways, with some methods being more accurate than others. The current gold standard is using dual x-ray absorptiometry (DEXA) (Branski et al., 2010). However, certain assessment techniques like skinfold thickness and bioelectrical impedance analysis (BIA) have become commonplace when determining body composition due to ease of use and low financial costs even though their standard error can be high (Bohn & Heitmann, 2013, Etchison et al., 2011, & von Hurst et al., 2015) . For example, BMI does not distinguish between fat mass and lean (fat-free) mass which can lead to misleading results, especially for children and adolescents since they are still growing, but it is still the most popular method of measurement in many clinical and community settings (Wells & Fewtrell, 2006). The measure of body fat percentage is a more useful predictor of morbidity and mortality risk unlike BMI (Bohm & Heitmann, 2013; von Hurst et al., 2015).

Body composition can be affected by many factors. The most important factors are diet, physical activity, and genetics. Since diet and physical activity are modifiable factors, numerous research studies are being conducted to better explain the effects of these factors and their influence on many chronic diseases and illnesses(de Oliverira et al., 2012, Soedamah-Muthu et al., 2011, & Teegarden, 2005). Abargouei et al. (2012) conducted a meta-analysis and found that the majority of cross-sectional studies regarding the relationship between dairy consumption and body weight, composition, or abdominal fat accumulation in adults possessed a significant inverse association. Additionally, the findings of the Coronary Artery Risk Development in Young Adults (CARDIA) study found that dairy consumption was inversely associated with the incidence of all insulin resistance syndrome components (dyslipidemia, hypertension, and elevated BMI) among men but not overweight women and not among leaner individuals. The study discovered that each daily occurrence of dairy consumption was associated with a twenty-one percent lower odds of insulin resistance syndrome (Pereira et al., 2002). However, not all studies have concluded such positive benefits. In a cohort study, a group of males were followed for twelve years, and the results showed that low-fat dairy fat intake was associated with a higher risk of central obesity, especially if the male participants did not have central obesity before the baseline readings at the beginning of the study (Dougkas et al. (2011). This inconsistency among research studies has still not been resolved, but scientists hope that better explanations lie in future research findings.

Body fat percentage calculations tend to be more accurate in assessing overall health status. One of the pioneering articles advocating for body fat percentages as a method of measurement was Gallagher et al. (2000), and they developed body fat ranges by BMI guidelines with predicted body fat percentage equations. Ping et al. (2017) suggested combining both BIA and BMI when screening young adults for obesity for better accuracy. They also detected that in young, Asian females, obesity prevalence would be underestimated by BMI criteria (Table 2.1). Furthermore, they disclosed that young males tended to have a more accurate BMI and BIA correlation when compared to females.

Another benefit for body fat percentage when compared to BMI is the distinction between male and female classifications. Women are destined to have higher body fat due to biological design whereas men can have lower amounts and still be considered healthy. Table 2.2 and Table 2.3 present the categories between men and women, respectively. Overall, body fat percentage tends to be a better indicator of identifying individuals who are overweight or obese when compared to other measurements such as BMI (Etchison et al., 2011)

Table 2.1 Body mass index (BMI) classification

Category	BMI (kg/m^2)
Underweight	< 18.50
Normal	18.51 - 24.99
Overweight	25.00 – 29.99
Obesity (Class I)	30.00 – 34.99
Obesity (Class II)	35.50 – 39.99
Extreme Obesity (Class III)	40.00 +

Source: National Heart, Lung, and Blood Institute; National Institutes of Health; U.S. Department of Health and Human Services, 2019

Table 2.2 Body fat percentage categories for men

	Age				
Classification	20-29	30-39	40-49	50-59	60+
Low	7.1 – 11.7	11.3 – 15.8	13.6 – 18	15.3 – 19.7	15.3 – 20.7
Borderline Low	11.8 – 15.8	15.9 – 18.9	18.1 – 21	19.8 – 22.6	20.8 – 23.4
Average	15.9 – 19.4	19 – 22.2	21.1 – 24	22.7 – 25.6	23.5 – 26.6
Borderline High	19.5 – 25.8	22.3 – 27.2	24.1 – 28.8	25.7- 30.2	26.7 – 31.1
High	25.9 +	27.3 +	28.9 +	30.3 +	31.2 +

Source: American College of Sports Medicine (ACSM), 2012

Table 2.3 Body fat percentage categories for women

	Age				
Category	20-29	30-39	40-49	50-59	60+
Low	14.5 – 18.9	15.5 – 19.9	18.5 – 23.4	21.6 – 26.5	21.1 – 27.4
Borderline Low	19 – 22	20 – 23	23.5 – 26.3	26.6 – 30	27.5 – 30.8
Average	22.1 – 25.3	23.1 – 26.9	26.4 – 30	30.1 – 33.4	30.9 – 34.2
Borderline High	25.4 – 32	27 – 32.7	31.1 – 34.9	33.5 – 37.8	34.3 – 39.2
High	32.1 +	32.8 +	35 +	37.9 +	39.3 +

Source: American College of Sports Medicine (ACSM), 2012

CHAPTER III

METHODOLOGY

Research Design

For this study, participants were college students ranging from 18 to 26 years of age, currently enrolled at Mississippi State University. Eligibility criteria for inclusion in the study included falling into designated age range, ability to complete an online diet history questionnaire, and complete a body composition assessment. Additionally, participants were also asked to complete a consent form prior to any data collection. Exclusions were made for any individual who was not currently enrolled within the university, not within the study age range, pregnant (self-reported), or inability to complete either the diet history questionnaire or body composition assessment. The eligible age range for this study was based on The Institute of Medicine and National Research Council (2015) stating that this particular age range is a critical period of development where the actions and behaviors of this age group could strongly affect the trajectory of their later adult life. It is important to note that this study used retrospective data collected from an ongoing study at the university, and separate Institutional Review Board (IRB) approval was not required. An addendum to the ongoing study's IRB approval (IRB: 17-025) was added for this cross-sectional study.

Data Collection

Participants were first asked to complete the Diet History Questionnaire II (DHQ II), which is a food frequency questionnaire that has been validated (National Institutes of Health, 2018). The questionnaire is designed to assess a participant's dietary intake through self-reporting the quantity, size, and frequency of consumption of 134 food items consumed during the prior twelve months. The link to the questionnaire was sent via email prior to the body composition assessment appointment to encourage completion beforehand. After the questionnaire was completed, participants made appointments to have their body composition analyzed with the TBF-300A TANITA® (TANITA, Arlington Heights, Illinois), a foot-to-foot bioelectrical impedance scale. The mechanics behind the TBF-300A TANITA® is based around imperceptible single frequency electrical currents being sent throughout the body once the participant has stepped on the scale with bare feet. In accordance with the instruction manual, heels were planted directly on top of the posterior electrodes while the front part of the foot had direct contact with the anterior electrodes of the machine. If the participant had calloused feet or nylon stockings present, 0.5 cc of saline or water was placed in the center of each electrode to act as a conductive material and allow the electrical current to still pass freely. The electrical current is affected by the amount of water within an individual's body; bodily tissues that contain large amounts of fluids have high conductivity rates for the electrical current while fat and bone slow down the signal. As the TBF-300A TANITA® determines the resistance to the electrical current, it provides impedance measurements. Then, body fat and lean body mass measurements will be calculated with variables such as sex, body type (standard or athlete), and age considered. Each participant had their assessment measurement in compliance with the TANITA TBF-300A® instructional manual protocol (TANITA, Arlington Heights, Illinois). One pound was used for clothing allowance, and participants were asked to remove any excess clothing such as shoes and jackets. Height was taken using the 235 Heightronic Digital Stadiometer (QuickMedical®, Issaquah, Washington). Participants were asked not to drink any liquids, eat any food, nor engage in vigorous physical activity for at least four hours prior to their appointment since such activities interfere with accurate readings. Data from both the dietary history questionnaire and body composition measurements were compiled into one database. Data from the DHQ II focused solely on participants' dairy intake.

Statistical Analysis

Statistical analysis was performed using Statistical Package for Social Sciences (IBM Corp. 2016. IBM SPSS Statistics for Windows, Version 24.0. Armonk, NY: IBM Corp.). Two-tailed Pearson correlation tests were conducted when analyzing whether the type of dairy and total dairy consumption had an effect on body composition, specifically body fat percentages among both sex and race categories. Table 3.1 classifies what was considered a serving for each dairy category assessed. Categories that possessed 20 or below participants were omitted due to the low sample size diminishing statistical power (Bonett & Wright, 2000). Outliers were identified and omitted for each category and identified as follows: > 8 servings per day for total dairy consumption and milk consumption, > 3 servings per day for yogurt consumption, and > 6 servings per day for cheese consumption. There was a total of four outliers for total dairy consumption, three outliers for milk consumption, one outlier for cheese consumption, and none for yogurt consumption. Descriptive analyses were also determined. Continuous variables are reported as mean ± standard deviation (M ± SD). A significance level of $p \leq .05$ was used for all statistical testing.

Table 3.1 Classification of dairy servings

1 milk serving	8 fl. oz. (1 cup)
1 yogurt serving	1 cup
1 cheese serving	1.5 oz. for natural cheeses 2.0 oz. for processed cheese

Source: DHHS & USDA, 2018

CHAPTER IV

RESULTS AND DISCUSSION

Demographics

A total of 580 participants completed the DHQ II in its entirety as well as completing the body composition assessment. There were 478 female and 102 male participants (Table 4.1). The majority classified themselves as Caucasian (71.1%), and the second largest race group was African-American (25.4%). Additionally, only 538 of the 580 participants disclosed race information within the questionnaire. Subsequently, the unclassified participants were discarded when completing analyses (Table 4.2).

Overall, men consumed more dairy than women counterparts. Caucasian men (n = 57) held the highest rank of total dairy consumption with an average of 1.93 ± 1.41 servings per day (Table 4.2). Interestingly, Caucasian females (n = 330) were the dominant race within the study but had the lowest yogurt and cheese consumption rates with an average of .13 ± .18 servings per day and .51 ± .50 servings per day, respectively. These daily consumption values were significantly lower than what the 2015 Dietary Guidelines for Americans recommends, however, when examining body fat percentages and corresponding dairy consumption values among sex categories, there was no statistical significance; this suggests that regardless of much dairy underconsumption was present among sexes, it had no effect on a participant's body fat percentage (r = .02, p = .72, n = 580). In regard to race and dairy consumption patterns, Hispanic women had the lowest milk consumption values with an average of .33 ± .11 servings per day. Yogurt was among the lowest consumed dairy product among both men and women, however, it did possess an inverse correlation for body fat percentage among Caucasian and African-American males. Milk consumption was the most popular choice among both sex and race categories which coincides with national consumer patterns.

Total Dairy Consumption and Type of Dairy Consumed and Its Relationship to Body Composition Among Men and Women:

Correlation tests revealed a nonsignificant relationship between the frequency of dairy consumption and body fat percentage among males, (r = .02, p = .68, n = 98), and females, (r = .06, p = .17, n = 469) (Figure 4.1). Additionally, when examining each type of dairy consumed, there were similar nonsignificant findings. Milk consumption and body fat percentage among males revealed a nonsignificant correlation (r = .09, p = .37, n = 98) and (r = .04, p = .37, n = 468) for females (Figure 4.2). Yogurt consumption and body fat percentage among males revealed an inverse negative correlation (r = -.07, p = .52, n = 98) and a slight positive correlation (r = .01, p = .76, n = 466) for females (Figure 4.3). Lastly, cheese consumption and body fat percentage among males was calculated as (r = .20, p = .05, n = 98) and (r = .07, p = .14, n = 468) for females (Figure 4.4).

Total Dairy Consumption and Type of Dairy Consumed and Its Relationship to Body Composition Among Race Categories:

Correlation tests revealed a nonsignificant relationship among total dairy consumption and body fat percentage among race groups. Total dairy consumption and body fat percentage for white/Caucasians was calculated as (r = -.02, p = .64, n = 388) (Table 4.3 & 4.5) (Figure 4.5) which revealed an inverse relationship but was still statistically nonsignificant. Total dairy consumption and body fat percentage for blacks/African-Americans was (r = .08, p = .33, n = 138) (Table 4.4 & 4.6) (Figure 4.5). Since Asian participants only constituted of nine subjects, correlation tests were not completed since the small sample size would have greatly diminished statistical power. This was repeated with the Hispanic participants as well due to their corresponding small sample size of three participants. Milk consumption and body fat percentage for white/Caucasians was analyzed at (r = -.07, p = .18, n = 387) while black/African-Americans possessed a relationship of (r = .05, p = .55, n = 138) (Figure 4.6). Yogurt consumption and its influence on body fat for white/Caucasians was measured as (r = .02, p = .66, n = 387); black/African-Americans were measured at (r = .06, p = .50, n = 136) (Figure 4.7). Lastly, cheese consumption and its relationship on body fat held a relationship as follows: (r = .05, p = .30, n = 387) for white/Caucasians; (r = .07, p = .40, n = 138) for black/African-Americans (Figure 4.8).

Implication of Results

Overall, the study did not support the belief that dairy consumption influences body composition in college-aged individuals in Mississippi, even when examining factors such as sex, race, total dairy consumption, and type of dairy consumed. In a similar study conducted by Abreu et al. (2012), they reported an inverse relationship between milk intake and both BMI and body fat percentage only in girls in the study of 1001 adolescents, ranging 15 to 18 years of age. Similar results were found analyzing dairy consumption patterns and body composition from the National Adult Nutrition Survey in Ireland. Feeney et al. (2017) found that higher total dairy consumption was associated with lower BMI, body fat percentage, waist circumference, and waist-to-hip ratio among participants which helps lower the risk of developing chronic diseases that are linked to higher levels of body fat. However, Kauvelioti et al. (2017) reported nonsignificant findings among dairy consumption influencing body composition and body size in youths. Additionally, in a cohort study assessing changes in anthropometric variables when consuming dairy, Schwingshacki et al. (2016) reported that yogurt, in particular, was inversely related with a decreased risk of obesity, changes in waist circumference, or body weight. With inconsistent results among studies, it is difficult to establish a definitive relationship.

Body Mass Index vs. Body Fat Percentage

Comparing sex and race classes, the average age for Caucasian males (n = 57) was 20.6 ± 2.1 years of age and Caucasian females (n = 330) was 20.2 ± 2.7 years. The fat percentage for males was 18.30 ± .75 while females had 27.00 ± 8.49 %. The average BMI value for Caucasian males (n = 57) was 25.71 ± 4.57 kg/m² whereas females (n = 330) had an average of 23.45 ± 5.23 kg/m². Based on these descriptive statistics, Caucasian females exhibited borderline high body fat percentage classification, but the BMI classification was within a healthy classification. Additionally, for Caucasian males, the body fat percentage corresponded to the borderline low category while their BMI classification landed into the overweight class. In African- American males (n = 28), the average age was 20.6 ± 1.9 years with body fat percentage at 20.89 ± 8.88 % (average category) and BMI at 26.88 ± 6.17 kg/m² (overweight category). For African-American females (n = 110), the mean age was 20.0 ± 1.4 years with body fat percentage ranking at 32.62 ± 10.58 percent (high category) and BMI at 27.07 ± 7.73 kg/m² (overweight classification). Asian males (n = 4) had a mean age of 21.6 ± 3.5 years and body fat percentage of 15.80 ± 1.33 (borderline low) and BMI value of 24.18 ± .71 kg/m² (normal classification) whereas Asian females (n = 5) had an average age of 26.5 ± 8.6 and body fat percentage of 18.22 ± 9.54 (low category) and BMI of 19.23 ± 2.63 kg/m² (normal classification). This aids the argument of BMI not being a leading indicator when determining body composition since it tends to either overestimate or underestimate. There were only two instances where both body fat % and BMI aligned within the same category and that was with the Hispanic male (n = 1) who exhibited a body fat percentage of 19.60 (borderline high) and BMI of 29.0 (overweight) and Hispanic females (n = 2) who have body fat percentages of 31.05 ± 11.95 (borderline high) and BMI of 25.10 ± 6.22 (overweight classification).

Limitations

There were several limitations regarding the sample pool which could have interfered with the results of the study. Firstly, the sample size was not equally distributed among males and females. Out of the 580 total participants, 478 were female, which constituted 82.4% of the entire sample size. The sample was also not evenly distributed among race categories. The majority of the participants classified themselves as Caucasian (n=398, 71.1%). Since the information regarding race was self-reported, some participants did not disclose any information, and subsequently were not included in the data analysis. Another limitation within the study was the duration of the DHQ II. The length varied depending on the variety of food within each participant's diet. For example, the more varied the participant's diet, the longer the survey would be. This deterred many participants to complete the DHQ II in its entirety. Additionally, data for the DHQ II was self-reported which could have impacted analysis since some participants could have not accurately reported serving size, frequency of consumption, or even omitting foods that were consumed within the time frame of the study. The body composition assessment also had limitations. The use of diuretics or alcohol were not checked prior to testing which could have affected the results. The time of assessment was another factor to consider when interpreting results. Ideally, all participants would be measured in the morning before any food was consumed, however, scheduling was left to the participant's convenience.

Future Research

While past research studies focused on older populations such as middle-aged adults or much younger populations like pediatrics, college-aged individuals have not been extensively studied as much as their respective age counterparts in regard to dairy consumption altering body composition (Berkey et al., 2005 & Zemel et al., 2012). This particular age range may help identify a potential relationship between dairy consumption and body composition which could lead to more primary health-based interventions rather than secondary interventions which are more commonplace in middle-adulthood (Institute of Medicine and National Research Council, 2015). Additionally, more recent publications have provoked the thought of investigating the effects of bovine feeding practices, particularly the use of antibiotics, to see if there is any association between dairy consumption and increased body fat accumulation (Cox & Blaser, 2014). Lastly, the comparison between dairy and nondairy milk substitutes (i.e. almond, soy, or coconut milk) in relation to body fat percentage should be investigated as well since their popularity has drastically increased over the last few years, with even some companies marketing their nondairy products as a healthier alternative to regular dairy.

Table 4.1 Demographics of sample (M ± SD)

	Men (n = 102)	Women (n = 478)	All Participants (n = 580)
Age (years)	21.0 ± 2.2	20.6 ± 2.8	20.4 ± 2.8
Weight (kilograms)	81.82 ± 20.46	64.82 ± 19.37	68.61 ± 18.61
Body Mass Index (BMI) kg/m²	26.39 ± 6.21	24.04 ± 7.68	24.64 ± 5.98
Body Fat %	20.05 ± 7.96	28.04 ± 9.25	26.70 ± 9.81
Fat Mass (kilogram)	17.45 ± 14.33	22.16 ± 13.66	19.57 ± 12.98
Total Dairy Consumption (# of servings per day)	1.83 ± 1.35	1.31 ± 1.24	1.45 ± 1.43

Table 4.2 Body mass index (BMI) classification among sex and race categories

Category	Sex	Race
Underweight (< 18.5 kg/m²)	4 males 6 females	5 African -American 12 White
Normal (18.51- 24.99 kg/m²)	76 males 347 females	84 African -American 376 White 9 Asian
Overweight (25.00- 29.99 kg/m²)	12 males 56 females	23 African -American 62 White 3 Hispanic
Obese (Class I) (30.00 – 34.99 kg/m²)	6 males 46 females	40 African -American 32 White
Obese (Class II) (35.50- 39.99 kg/m²)	3 males 20 females	21 African -American 36 White
Extreme Obesity (Class III) (40 > kg/ m²)	1 male 3 females	2 White 3 African -American

Table 4.3 Body fat percentages for men among race categories

Classification	Race
Low 7.1-11.7 %	3 African -American 5 White
Borderline Low 11.8-15.8 %	8 African -American 7White 4 Asian
Average 15.9- 19.4%	13 African -American 32 White
Borderline High 19.5-25.8%	1 Hispanic 15 White 4 African -American
High 25.9 + %	None

Table 4.4 Body fat percentages for women among race categories

Classification	Race
Low 14.5-18.9%	None
Borderline Low %	1 African -American 5 White 2 Asian
Average %	78 African -American 298 White 2 Asian
Borderline High %	2 Hispanic 54 White 25 African -American
High 32.1 +%	12 White 10 African -American

Table 4.5 Average dairy consumption per serving among sex and races (M ± SD)

	Total Dairy Consumption	Milk Consumption	Yogurt Consumption	Cheese Consumption
All Women (n = 478)	.99 ± 1.12	.50 ± .82	.14 ± .21	.34 ± .25
All Men (n = 102)	2.78 ± 2.79	1.74 ± 1.86	.33 ± .63	.69 ± .46
African-American Women (n = 110)	1.39 ± 1.59	.68 ± 1.01	.11 ± .29	.59 ± .84
African-American Men (n = 28)	1.56 ± 1.95	.95 ± 1.87	.06 ± .17	.54 ± .63
Caucasian Women (n = 330)	1.30 ± 1.13	.65 ± .80	.13 ± .18	.51 ± .50
Caucasian Men (n = 57)	1.93 ± 1.41	1.18 ± 1.14	.09 ± .15	.64 ± .66
Hispanic Women (n = 2)	1.30 ± .47	.33 ± .11	.23 ± .02	.73 ± .57
Hispanic Men (n = 1)	.71	.13	0	.58
Asian Men (n = 4)	1.40 ± .69	.89 ± .61	.11 ± .18	.39 ± .12
Asian Women (n = 5)	1.71 ± .89	.83 ± .34	.47 ± .56	.39 ± .34

1 serving of milk = 1 cup (8 fl. oz.)
1 serving of yogurt = 1 cup
1 serving of cheese = 1.5 -2.0 oz.

Table 4.6 Correlation matrix for white/Caucasian males (n = 57)

Body Fat %	Body Fat %	Total Dairy Consumption (servings/day)	Milk Consumption (servings/day)	Yogurt Consumption (servings/day)	Cheese Consumption (servings/day)
Total Dairy Consumption (servings/day)	.01	-	-	-	-
Milk Consumption (servings/day)	-.09	.89	-	-	-
Yogurt Consumption (servings/day)	-.18	.03	-.09	-	-
Cheese Consumption (servings/day)	.21	.61	.17	-.01	-

Table 4.7 Correlation matrix for black/African-American males (n = 28)

Body Fat %	Body Fat %	Total Dairy Consumption (servings/day)	Milk Consumption (servings/day)	Yogurt Consumption (servings/day)	Cheese Consumption (servings/day)
Total Dairy Consumption (servings/day)	.33	-	-	-	-
Milk Consumption (servings/day)	.28	.95	-	-	-
Yogurt Consumption (servings/day)	-.10	.02	-.03	-	-
Cheese Consumption (servings/day)	.20	.28	-.03	-.13	-

Table 4.8 Correlation matrix for white/Caucasian females (n = 330)

Body Fat %	Body Fat %	Total Dairy Consumption (servings/day)	Milk Consumption (servings/day)	Yogurt Consumption (servings/day)	Cheese Consumption (servings/day)
Total Dairy Consumption (servings/day)	.05	-	-	-	-
Milk Consumption (servings/day)	.03	.88	-	-	-
Yogurt Consumption (servings/day)	.02	.41	.23	-	-
Cheese Consumption (servings/day)	.06	.69	.28	.20	-

Table 4.9 Correlation matrix for black/African-American females (n = 110)

Body Fat %	Body Fat %	Total Dairy Consumption (servings/day)	Milk Consumption (servings/day)	Yogurt Consumption (servings/day)	Cheese Consumption (servings/day)
Total Dairy Consumption (servings/day)	.06	-	-	-	-
Milk Consumption (servings/day)	.04	.83	-	-	-
Yogurt Consumption (servings/day)	.05	.43	.24	-	-
Cheese Consumption (servings/day)	.05	.75	.28	.19	-

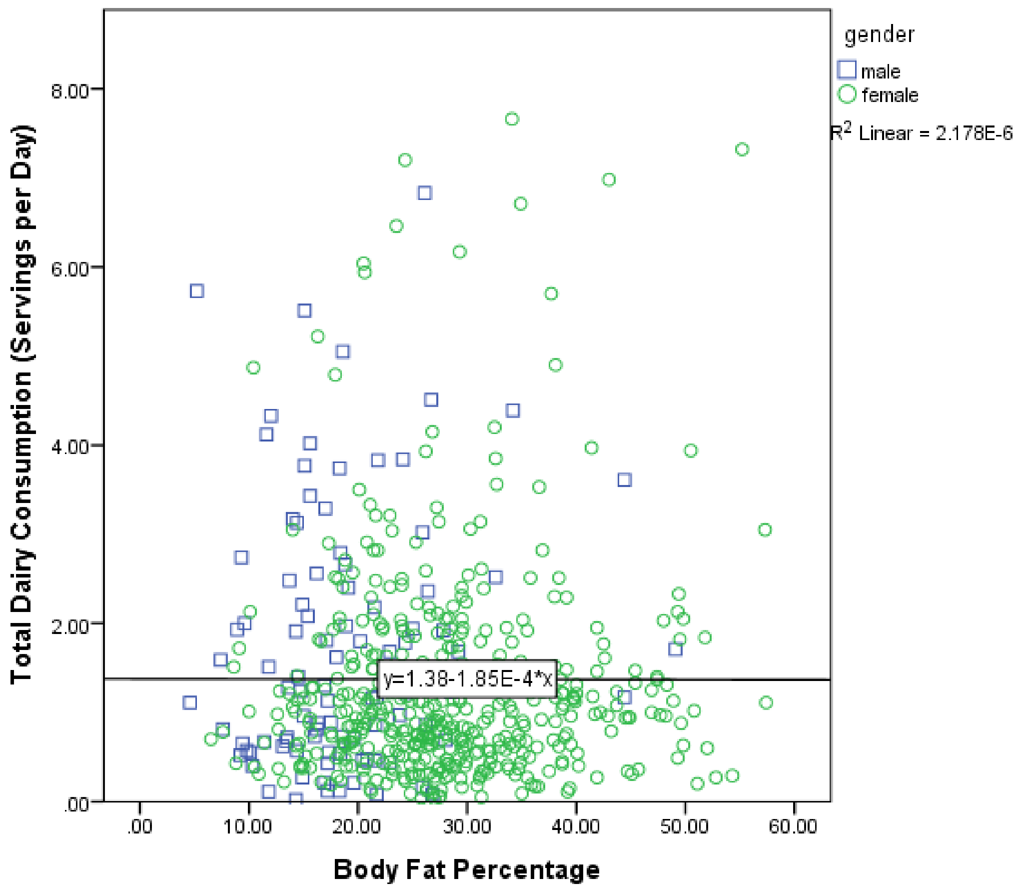

Figure 4.1 Total dairy consumption and body fat percentage among sex categories

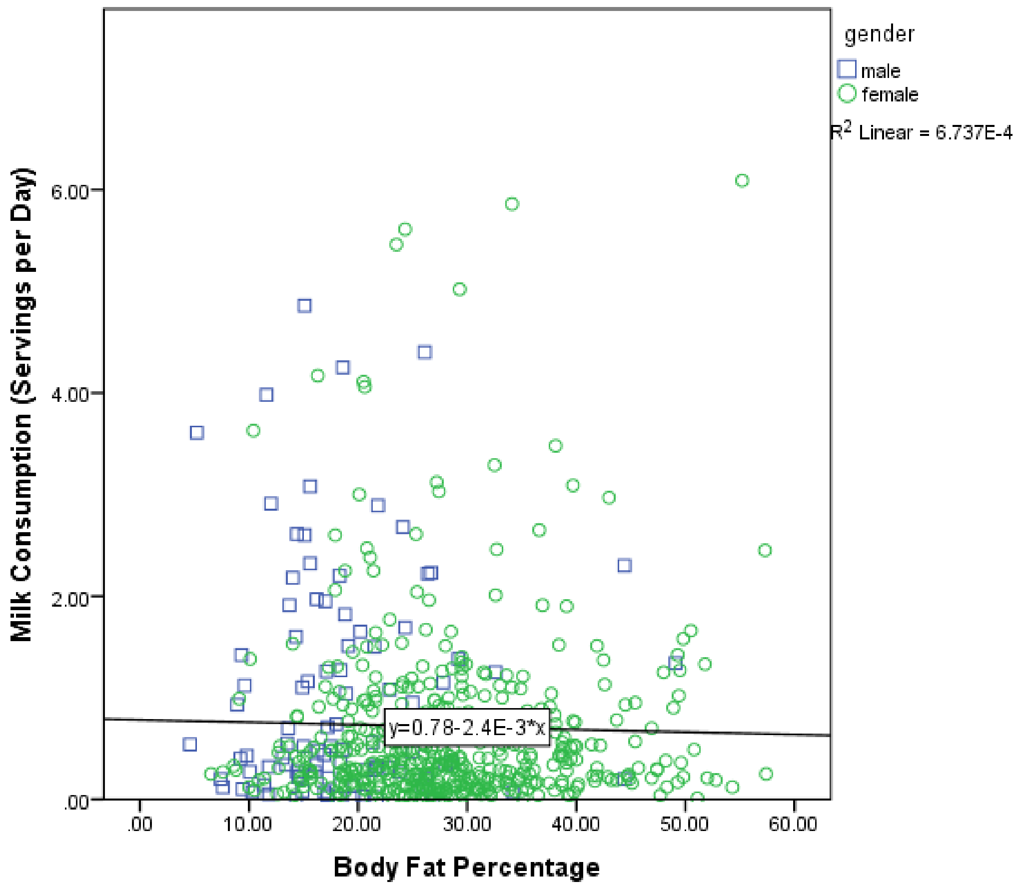

Figure 4.2 Milk consumption and body fat percentage among sex categories

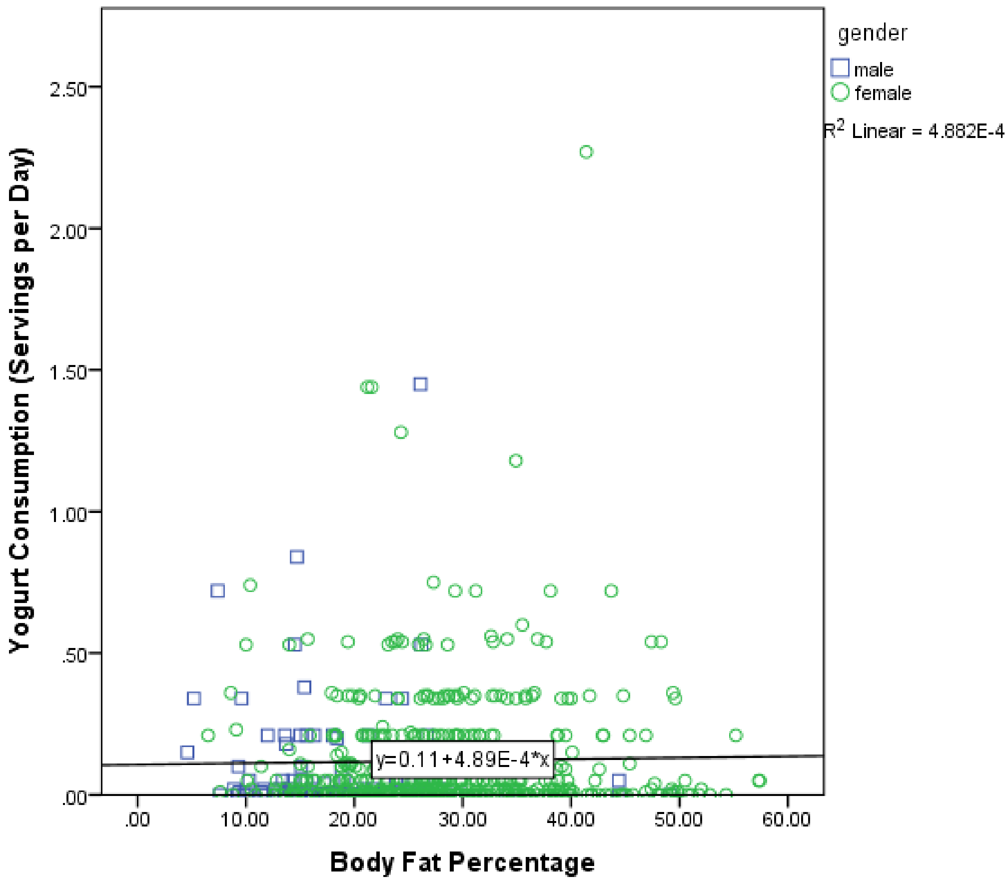

Figure 4.3 Yogurt consumption and body fat percentage among sex categories

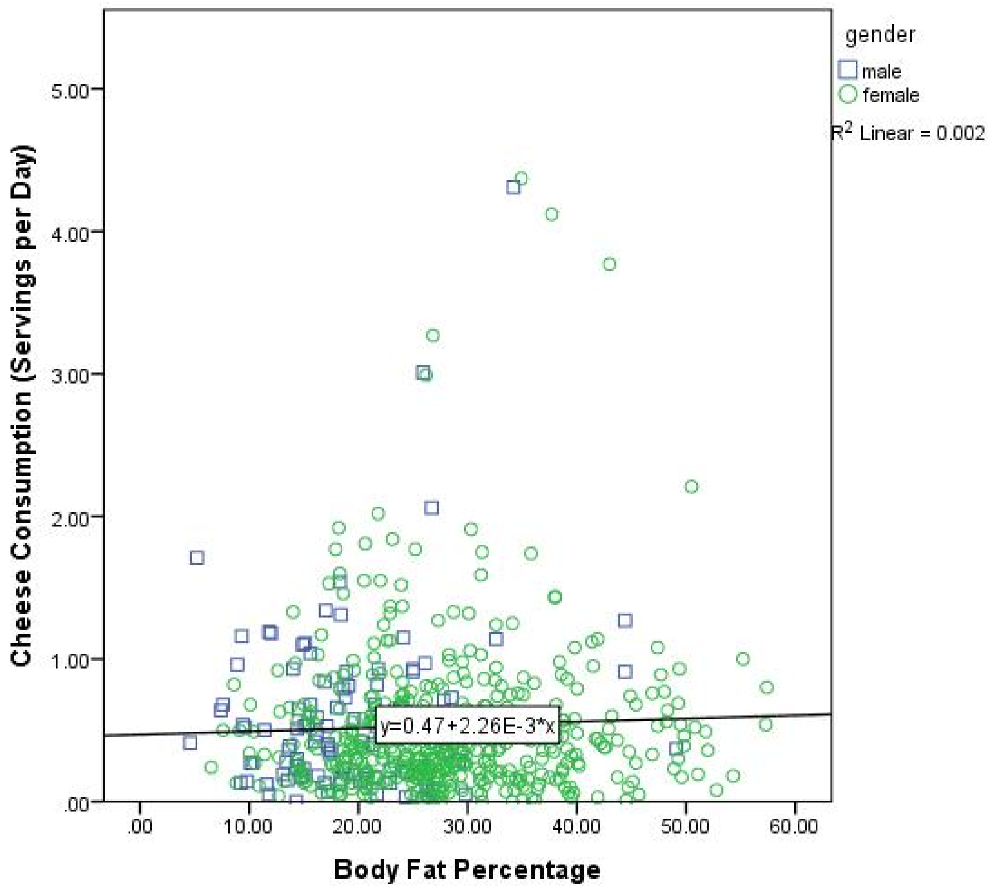

Figure 4.4 Cheese consumption and body fat percentage among sex categories

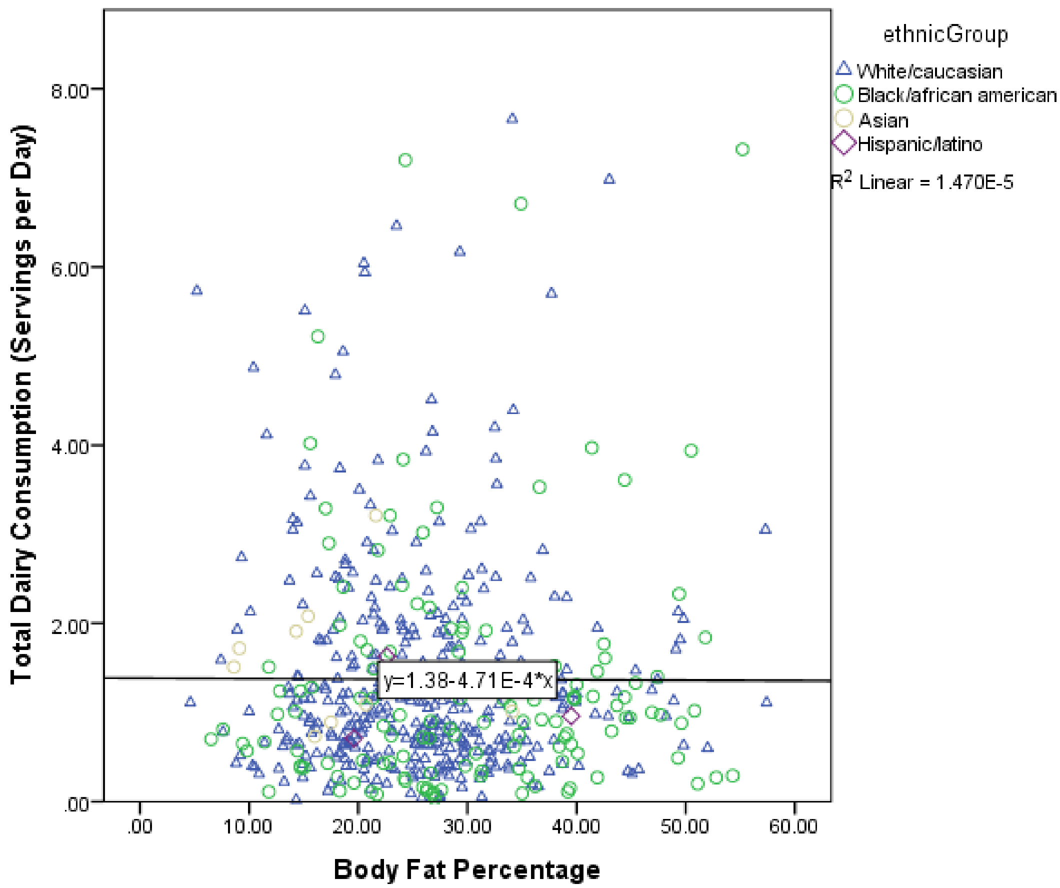

Figure 4.5 Total dairy consumption and body fat percentage among different race categories

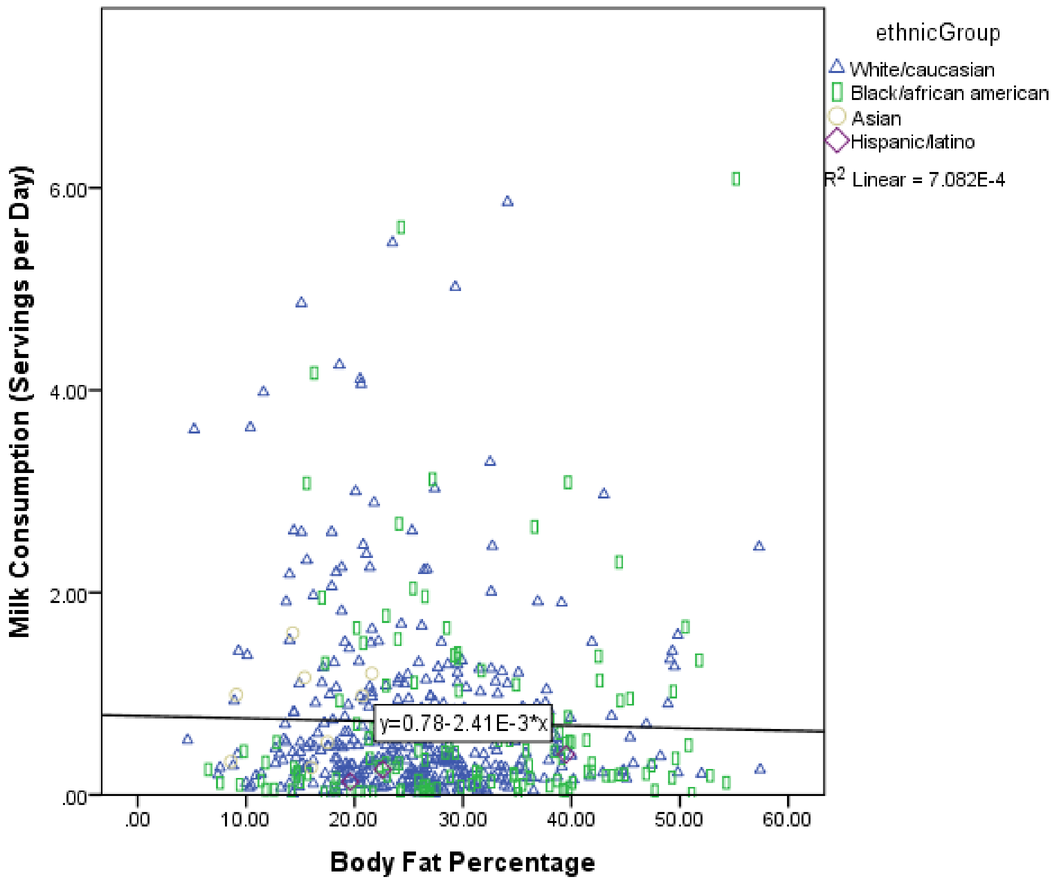

Figure 4.6 Milk consumption and body fat percentage among different race categories

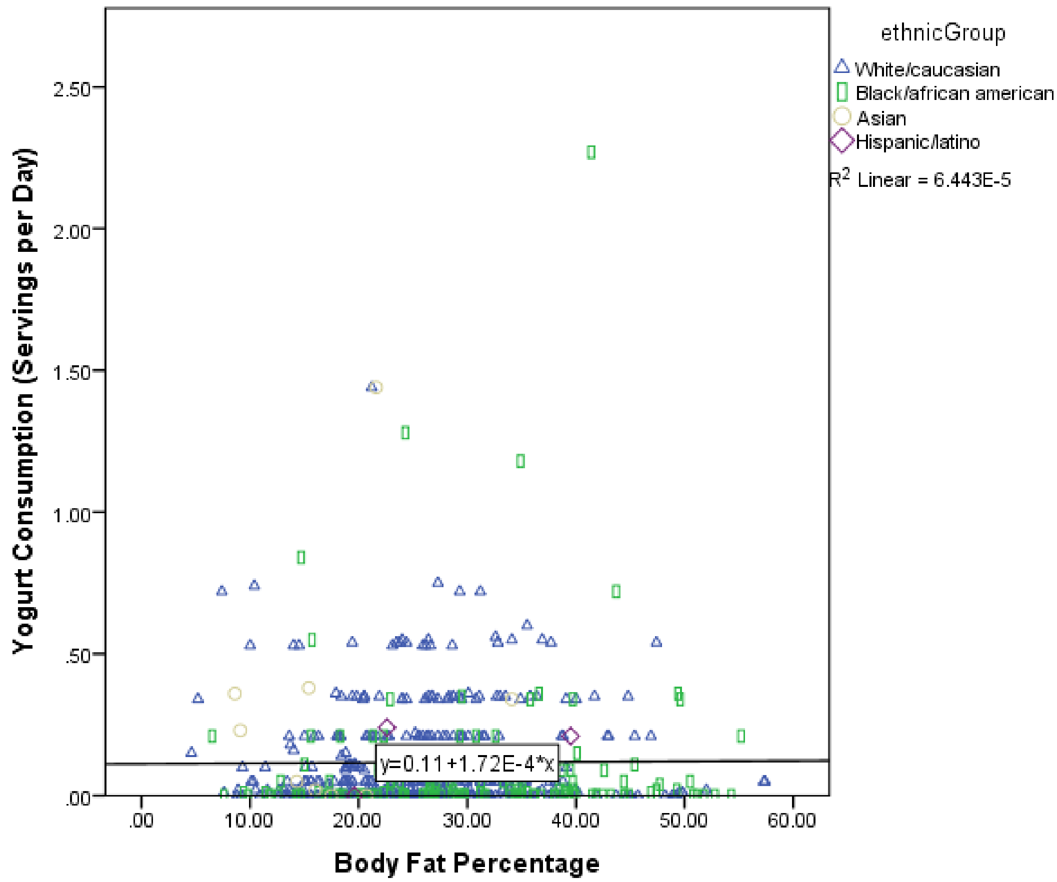

Figure 4.7 Yogurt consumption and body fat percentage among different race categories

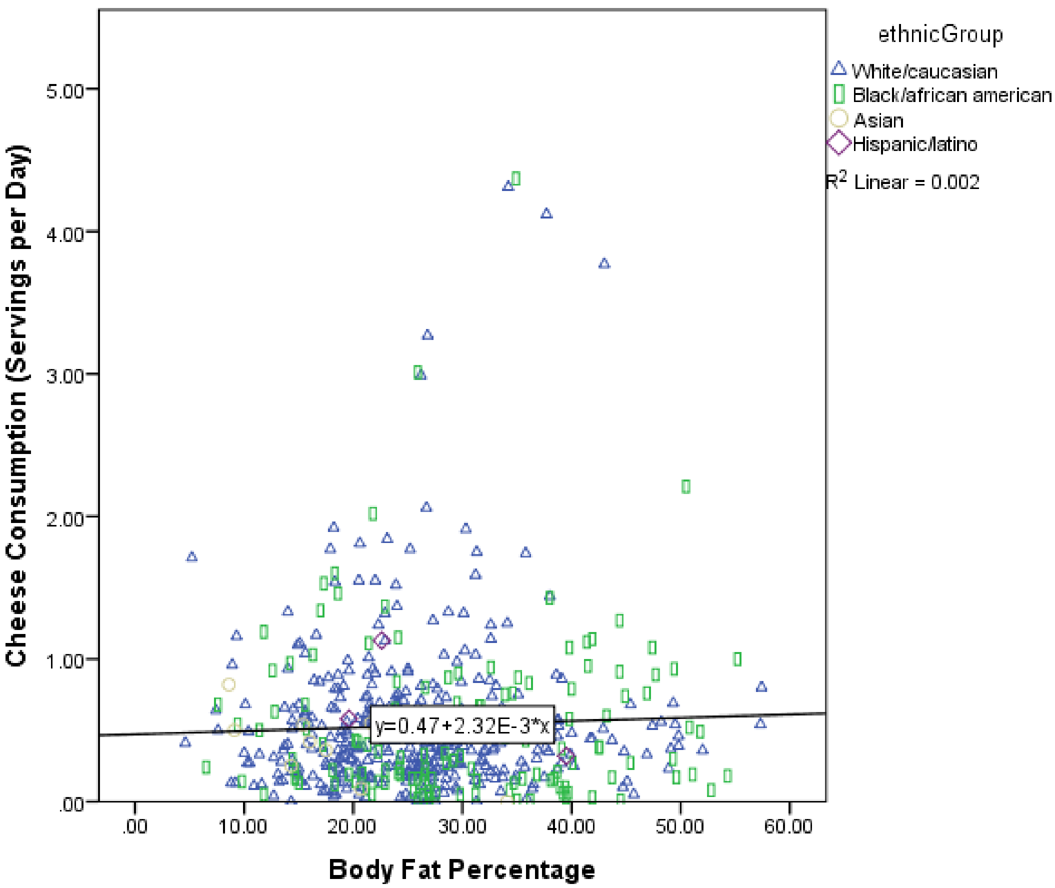

Figure 4.8 Cheese consumption and body fat percentage among different race categories

CHAPTER V

CONCLUSION

According to the Centers for Disease Control and Prevention (CDC) (2018), obesity affects 93.3 million Americans. In Mississippi, over half of the state's population is classified as either overweight or obese. This classification increases the risk of developing certain chronic disease such as heart disease, type 2 diabetes, and hypertension as well as premature death. Despite efforts to combat the obesity epidemic, rates continue to rise nationally and even globally. Therefore, it is vital to apply and deliver more primary-based health interventions to younger audiences to help alleviate this issue.

Diet is one of the most modifiable factors when fighting the obesity epidemic within America. As a food group, dairy has been inconclusive regarding its overall influence on body composition, especially in regard to body fat. A major reason behind this elusive relationship is the variety of research designs in past research. Diversity among study duration, sample pool, and classification of dairy products creates accounts for difficulty when establishing a relationship.

The results of this study suggest that the consumption of dairy does not have a significant impact on body fat. Furthermore, the frequency and type of dairy consumed did not impact body fat percentages. When comparing the relationship of dairy consumption influencing body fat between different sex and race categories, there was also no significant impact. Based on these findings, dairy consumption does not contribute to overall increased body fat in college-aged individuals.

This study did present some limitations which could have impacted findings, mainly stemming from the non-diverse sample pool. Over 50% of the participants were Caucasian females. Additionally, the DHQ II was self-reported which could lead to inaccuracy when examining consumption patterns. Lastly, this study only analyzed data from one point in time. Participants were not followed past the initial data collection, so statistical significance among each of the investigated variables could have potentially shown influence later in time.

Future research in this area is much needed since past studies have yet to establish a definite link between regular dairy consumption and overall body composition. Examining earlier age ranges, particularly 18-26 years old, is important because the lifestyle patterns in this age bracket help determine the trajectory of these individuals in their later adult life. Future research investigating other components of dairy such as certain fatty acids and vitamin and mineral content may help better illustrate the overall picture. Also, bovine feedings practices (i.e. use of antibiotics) as well as the relationship of non-dairy milk alternatives on body composition should be investigated due to changes in consumer preferences over the last ten years

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