

The association between nutrition education and knowledge of food high in added sugar, salt,
and saturated fat in college students

by

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Abstract

Background: College students have become more susceptible to increased risks of chronic diseases due to high intakes of problematic nutrients, such as added sugar, salt, and saturated fat, which are detrimental to their health. Moreover, busy student lifestyles and reliance on fast food consumption elevates the risk of prolonged consumption of unhealthy foods. This study's purpose was to assess the association between nutrition education and knowledge of food high in added sugar, salt, and saturated fat in college students.

Methods: This was a randomized controlled trial, from primary data collected through an online Qualtrics survey conducted in the Fall of 2017 at Kansas State University. However, it was used as a cross-sectional secondary data analysis in this study. Recruitment was conducted through emails and word of mouth. The research period was ten weeks, with a randomized control ($n=16$) and intervention ($n=16$) group. Demographic characteristics were captured for age, gender, race, year of school, residence, height measured in centimeters, weight measured in kilograms, and body mass index (BMI) for each college student. A Fisher's exact test with an alpha of 0.05 was used to evaluate the association between nutrition education and knowledge in the control and intervention group in college students.

Results: Findings from the analysis of demographic characteristics showed females (77.14%) responded greater than males (22.86%). Based on race, 85.29% of participants were White, 5.88% were Black or African-American, 2.88% were Asian, and others represented 5.88%. Height for men ($M=182.09$, $SD=6.18$) while females ($M=164.14$, $SD=5.63$) were shorter. Weight for male students was 86.25 Kg ($SD=19.83$) and for females 67.67 Kg

($SD=14.37$). The intervention group showed a significant difference in knowledge change related to food items under the fat category, such as pasta ($p= 0.03725$) and cheese ($p= 0.0000008551$). Salt or sodium, saturated fats, and added sugars had no significant difference in knowledge change.

Conclusion: Nutrition education influenced knowledge change about the fat content of plain pasta and cheese and the sodium content of pickles. However, there was no significant difference in knowledge change on added sugar, salt, and saturated fats in the intervention group compared to the control group. More research is needed to assess the impact nutrition education has on change in knowledge of foods high in added sugar, salt, and saturated fat among college students.

Key Words:

Healthy eating patterns, added sugar, salt, saturated fat, nutrition education, chronic diseases, college students

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Dedication

This master's report is dedicated to my mother, Dr. Phindile Alice Dlamini. She has been my pillar of strength through it all, such an incredible, educated, hardworking women, who has instilled the best a mother can for her daughter to approach this journey of life confidently independent.

Chapter 1 - Introduction

College students are more susceptible to chronic diseases because they consume unhealthy foods, engage in binge drinking behaviors, and are physically inactive (Kljajevic et al., 2021). These lifestyle behaviors increase the risk of high blood serum cholesterol, blood pressure, and a greater body mass index (Black et al., 2017). Busy lifestyles and the adoption of eating away from home have propelled individuals to rely heavily on fast foods for nutrition due to convenience, which influences the quality of dietary intake. This is associated with an increased intake of energy, fat, salt or sodium, and reduced intake of dietary fiber, vitamin C, and nutrients such as iron and calcium, which could have a negative impact on health (Matsumoto et al., 2021). Fast foods are known to be high in saturated fats, added sugars, and salt, which increases the risk of cardiovascular diseases. (Liang et al., 2009). Social changes and advancement of technology have increased intakes of foods high in added sugars, salt, and saturated fats with reduced energy expenditure and physical activity, which fuels the epidemic of chronic diseases, such as cardiovascular disease, as the main cause of mortality (Adel-Megeid et al., 2014). In addition, college students face transitioning to independent living, as they are away from home, which leads to dietary pattern changes, in most cases, resulting in unhealthy eating habits. Some of their unhealthy dietary patterns include consuming fast foods frequently, inadequate intake of fruits and vegetables, and dairy products (Brunt et al., 2008). This could result in outcomes that can further affect them during adulthood and transition into old age. For instance, losing significant nutrients impacts overall health, cardiovascular problems, and anorexia episodes (Moguel et al., 2019).

Moreover, an increased intake of these problematic nutrients such as added sugar, salt, and saturated fat, has been linked to inducing the epidemic of chronic diseases, obesity, hypertension, type 2 diabetes mellitus, cardiovascular diseases, and some cancers (Rippe et al., 2016). The freedom of food choices and financial resources indicates that most individuals purchase and consume unhealthy diets, that is, diets with elevated amounts of added sugars, salt, and saturated fats but fewer amounts of fresh fruits and vegetables, nuts, seeds, and whole grains, which are a major source of dietary fiber, and rich in proteins, vitamins and Phyto-chemicals (McKeown et al., 2013). Healthy diets consist of increased amounts of fresh fruits and vegetables, which are rich in vitamins, minerals, antioxidants, and fiber. However, it is vital to note that although unhealthy foods are cheaper when compared to healthy foods, they are detrimental to health, and treating those burdens of chronic diseases later becomes more expensive than the unhealthy cheaper foods college students invest in (Teleman et al., 2015).

This research assessed the association of nutrition education and knowledge of food high in added sugar, salt, and saturated fats commonly consumed by college students, which have been associated with increased risks of chronic diseases. These problematic nutrients have severe long-term consequences on healthcare cost for treatments and the overall burden of living with a chronic disease (Hardy et al., 2004). In addition, research has shown that increased consumption of added sugars, salt, and saturated fats is associated with depression symptoms (Vermeulen et al., 2017).

Therefore, nutrition education was used to help create awareness and change the student's dietary knowledge on nutrients such as added sugar, salt, and saturated fats that lead to the increase in chronic diseases. Furthermore, the intervention helped students differentiate

between foods high and low in nutrients so students can make wise decisions when purchasing and consuming unhealthy foods. Students received nutrition information with the intent to encourage them to spend their money on healthier food options despite considering that healthy foods are expensive compared to unhealthy foods, which tend to be cheaper but detrimental to their health. This helped increase knowledge change on their dietary behavior and food choices. Moreover, it was achieved through sharing weekly lessons on healthy dietary patterns, focusing on added sugar, salt, and saturated fat, which increases the risk of chronic diseases, to help students understand the health implications for their overall health.

Purpose

The purpose of this study was to answer the following research question:

1. Can nutrition education be associated with knowledge of food high in added sugar, salt, and saturated fat in college students?

Justification

Unhealthy eating habits practiced by college students increase the risk of chronic diseases, which have long-term consequences and healthcare cost implications that are burdensome. Chronic diseases, such as diabetes mellitus, have become burdens to individuals, thus affecting the healthcare system's experience in terms of health, outcomes, and costs. Previous studies have shown that chronic diseases decrease the quality of life of affected individuals, leading to mortality and morbidity (Kim et al., 2018). For example, a Medicare patient with one chronic disease sees four physicians a year, while those with more than one chronic condition account for 76% of Medicare expenditures (Bodenheimer et al., 2009).

College students who adopt new eating patterns that follow trends and groups of students who consume more unhealthy food led to an overabundance of calories. Late-night eating, eating on the go or while studying, and emotional eating linked to loneliness have been evident in the dietary changes of students when away from home. Further convenience, sugary and salty tastes of food readily available tend to be more affordable and what college students prefer, even though those foods are low in nutrition and detrimental to their health, which has severe consequences to their health as they grow older (Rana et al., 2021). In addition, socioeconomic status, education level, and exposure to nutrition education are crucial factors that can impact an individual's ability to make healthy dietary choices and sustain good long-term health. Addressing disparities in these factors and promoting access to nutrition education for all individuals can contribute to improving overall health outcomes and reducing health disparities related to diet-related diseases.

Therefore, using nutrition education may help college students gain more knowledge on making healthier food choices and be able to differentiate foods with excessive amounts of these nutrients, such as added sugar, salt, and saturated fat, that are detrimental to health and increase the risk of chronic diseases.

Chapter 2 - Literature review

Added sugars, salt, and saturated fat in food have been consumed in excess as they are energy-dense foods, easily accessible, inexpensive, highly advertised, and palatable. These attributes contribute to the unhealthy dietary trend among young adults, leading to obesity and cardiac diseases (Abdel-Megeid et al., 2014). Dietary intake plays a leading role in human health, contributing to many chronic diseases. Moreover, there are multiple leading causes based on dietary nutrients such as added sugars, salt, and saturated fats that cause increased mortality in the United States (US). Therefore, healthy eating patterns contribute to individuals' overall health, which has long-term health benefits (Arulogun et al., 2011). Over the past two decades, it has been seen that cardiovascular diseases and some cancers have been persistently the two leading causes of death, followed by cerebrovascular disease and diabetes mellitus, which also contribute to the increased rates of mortality in the US. Young adults around the age of 20 years are more susceptible to obesity due to unhealthy eating habits, which results in a body mass index in the obese range, hence increasing the risk of developing multiple chronic diseases, inclusive of type 2 diabetes mellitus, cardiovascular diseases, and some cancer (Hilderbrand et al., 2022).

Prevalence of chronic diseases

The Centers for Disease Control and Prevention states that according to chronic diseases in America, six in ten adults have a chronic disease, and four in ten adults have two or more chronic diseases. This is at an alarming rate as chronic diseases lead to deaths and disability, accounting for about \$4.1 Trillion in annual healthcare costs. Poor lifestyle habits increase the risks of chronic diseases such as tobacco use, poor nutrition, lack of physical activity, and excess

alcohol use (CDC, 2020). In addition, data from the CDC's analysis of the Behavioral Risk Factor Surveillance System (BRFSS) reveals concerning trends among adults aged 18-34 years with more than half of adults in this age group reported having at least one chronic condition, with almost a quarter reporting having multiple chronic conditions. The most prevalent chronic conditions among adults aged 18-34 were obesity (Watson et al., 2022), depression, and high blood pressure. Research has indicated that diet is the major contributor towards chronic diseases; thus, diets containing higher amounts of sugar, salt, and saturated fats have led to 11 million deaths in 2017 due to unhealthy diets, of which 10 million deaths were caused by CVDs (Dunford et al., 2019). Additionally, cancer was the second major cause of death related to poor diets, accounting for 913,000 people, and type 2 diabetes mellitus was the last major cause of death, accounting for 339,000 deaths (Rokeya et al., 2020).

Dietary factors affecting chronic diseases

Dietary factors propel the risk of chronic diseases in nutrients such as salt, added sugars, and saturated fats when consumed in excessive amounts. Generous portion sizes of foods and their daily consumption also increase the risks of chronic diseases. Added sugars and refined grains, which are often high in calories and have a high glycemic index, can contribute to postprandial (after-meal) glucose fluctuations, and stimulate hepatic (liver) triglyceride production. This can negatively affect overall health, particularly in a diet high in added sugars, which has been identified as a significant contributor to sugar intake in the US diet (Flock et al., 2011). Dietary fats and sugars are among the key nutrients that cause insulin resistance, which is the hallmark of type 2 diabetes mellitus, obesity, and metabolic syndrome. Obesity-related conditions include heart disease, stroke, type 2 diabetes, and certain cancers. These related conditions are among the leading causes of preventable and premature deaths, and young adults

aged 18 to 24 years are half as likely to suffer from obesity (CDC, 2023). The impact of excessive consumption of added sugars and refined grains on health is broad and significant. It can contribute to various metabolic, hormonal, and organ dysfunctions, increasing the risk of developing chronic diseases such as type 2 diabetes, cardiovascular disease, and kidney disease. It is essential to be mindful of the intake of added sugars and refined grains in the diet and prioritize a balanced, nutrient-rich diet for better long-term health outcomes. (Ramlagan et al., 2020). Excess intake of sugar has been shown to contribute to diabetes mellitus, leading to increased mortality (Uddin et al., 2020).

Sugar-sweetened beverages (SSBs) have contributed to obesity, such that one 16-ounce serving per day was linked to a weight gain of 0.22 kg in the random-effects model and 0.12 kg in the fixed-effect model over one year. Further, women who consumed excessive amounts of SSBs had an increased body weight gain of 8.0 kg over eight years, compared to women who had a lower intake of SSB, resulting in an average of 2.8 kg gained in the same period (Smith et al., 2020). Sugary foods, especially SSBs, have been correlated with an increased risk of diabetes mellitus because of the effects on adiposity and other metabolic outcomes. SSBs also increase the risks of CVD, thus contributing to the progression of high susceptibility to hypertension, stroke, coronary heart disease, inflammation, and dyslipidemia. Excessive salt intake has also been correlated to coronary heart disease, stroke, and non-cardiovascular diseases.

Therefore, reducing salt intake could reduce blood pressure complications and improve optimal levels in people, thus preventing premature deaths from stroke and cardiovascular diseases. Salt reduction is cost-effective and can minimize global burdens and healthcare costs from coronary heart diseases. As individuals increase their salt intake, certain vitamins, and

minerals such as calcium and potassium are reduced. Increasing salt intake increases calcium loss from the body excreted by urination. Research has shown that increased intake of salty foods is associated with stomach cancer which leads to more diseases for people who do not reduce their dietary intake of salt to the recommended amounts. Dietary fats also contribute to CVDs, from dietary fats such as polyunsaturated, monounsaturated, and saturated fats, lipoprotein metabolism, blood cholesterol, and coronary artery disease risks. In addition, high fat intake, especially from unhealthy sources such as saturated fats and trans-fatty acids, has been linked to an increased risk of certain types of cancer. Studies have shown that a diet high in fat, particularly from animal sources, can increase the risk of breast, prostate, ovarian, and colon cancers (Rokeya et al., 2020).

Although added sugars, salt, and saturated fats are widely consumed, there are always missing nutrients and benefits from those food items not consumed, such as a high intake of fruits and vegetables, legumes, and whole grains. Consuming a diet high in plant foods helps replace those missing nutrients not obtained when consuming unhealthy foods, such as dietary fiber, vitamin C, flavonoids, vitamin B1, folic acid, potassium, and magnesium. These nutrients are low in saturated fats, sugars, and salt, thus contain no cholesterol and are favorable towards health by improving the overall health of individuals. They better manage body weight and foster healthy blood lipid profiles (Bowman et al., 2020).

Foods commonly high in salt, sugar, and saturated fats

Based on the Dietary guideline for Americans, it is evident that current intakes of added sugars, salt, and saturated fats exceed the dietary guideline limits, which increases the risk of chronic diseases. The salt limit is 2,300 mg; however, males exceed this limit with 4,274 mg and

females with 3,142 mg average intakes. In addition, both males and females are consuming more than the recommended limit for saturated fat and added sugars. For saturated fat, the recommended limit is 10% of total energy intake, and both males and females are exceeding this limit (males at 76% and females at 71%). For added sugars, the recommended limit is also 10% of total energy intake, and both males and females are exceeding this limit (males at 62% and females at 66%) (Dietary Guidelines for Americans, 2020-2025). SSBs have been proven in the US as the largest and major source of added sugars, thus highly associated with risks of obesity, type 2 diabetes mellitus, metabolic syndrome, CVDs, and fatty liver as they are highly consumed. There is also a direct connection between SSBs and increased blood pressure. High saturated fat diets may contribute to excessive energy intake, thus linked to obesity (Teleman et al., 2015). Fast foods, such as pizza and hamburgers, have been shown to cost much less and are offered in larger portions. The appealing price range of these fast foods leads to frequent consumption. Highly saturated fatty foods include fried chicken, which increases weight gain and is hazardous to heart health and other illnesses. Excessive salt intake from commonly consumed foods such as bread, cereal, and biscuits damages health and contributes to strokes (Kamal et al., 2022).



Data Sources: Average Intakes and HEI-2015 Scores: Analysis of What We Eat in America, NHANES 2015-2016, day 1 dietary intake data, weighted. Recommended Intake Ranges: Healthy U.S.-Style Dietary Patterns (see [Appendix 3](#)). Percent Exceeding Limits: What We Eat in America, NHANES 2013-2016, 2 days dietary intake data, weighted.

Figure 1. Recommended limits for added sugar, salt, and saturated fat (Dietary Guidelines for Americans, 2020-2025)

Vending machines also offer access to energy-dense unhealthy foods and beverages such as potato chips, sugar-sweetened sodas, energy drinks, and snack bars high in added sugars. The accessibility and availability of unhealthy food options, such as those found in vending machines, can contribute to increased consumption of unhealthy foods, especially in settings where healthier food options are limited or not easily accessible. This can be particularly true for students or individuals who may have limited options for purchasing healthier foods due to factors such as location, transportation, and availability of healthier food options (Grech et al., 2017). Some kiosks and other fast-food vendors in colleges have been seen to sell food items such as meat-based wraps, croissants, pizzas, chips, soft drinks, processed meat products, and a variety of sandwiches, which have been characterized by high macronutrient density and degree of processing which has effects on health (Llanaj et al., 2018). Processed and restaurant foods tend to be exceedingly high in salt, sugar, and saturated fats. These food products have been seen to be extremely palatable, convenient, and sold in larger portion sizes, thus aggressively marketed to consumers, which cause detrimental health effects as they are nutritionally unbalanced. They have been linked with obesity and other chronic diseases (Rauber et al., 2018).

Saturated fatty acids (SFA) can be found in meat and dairy products as well as palm oil, which increases the risk of CVD, which is why people need to limit their consumption. The American Heart Association (AHA, 2023) recommends limiting the consumption of saturated fats to less than 6% of total daily calories for adults to reduce the risk of CVD. The Dietary Guidelines for Americans 2020-2025 also recommends that saturated fat intake be less than 10% of total daily calories. However, the average intake of saturated fats in the US is estimated to be

around 11-12% of total energy intake, which is higher than the recommended limits. (Hammad et al., 2015). Away-from-home foods have been evident in contributing increased energy, dietary fats, added sugar, and salt, thus huge portion sizes and overconsumption of these food items as they are more attractive to consumers (Urban et al., 2014). Diets characterized by high intakes of sugar and fats are based on highly processed foods, SSBs, red and processed meats, sweets, refined grains, and fried foods while low in fruit and vegetable intake in the diet, hence leading to type 2 diabetes mellitus due to increased intakes of sugar-sweetened beverages, especially in African American women (Huisman et al., 2018). Moreover, sugar, such as refined sugars from sugarcane and sugar beets, high fructose, and corn sweeteners have no nutritional value except for calories which leads to health effects such as being overweight (Willett et al., 2006).

Food choices and costs

Food choices and eating habits have been seen to be driven by concerns of nutrition and health, thus food economics, such that if there is a higher cost of healthy foods such as fruits and vegetables, it reduces and restricts the frequency of people purchasing those food items due to their limited resources. Further, it caused food prices and diet quality to increase social disparities in nutritional status across the socioeconomic strata (Rehm et al., 2011). Food marketing and advertising also play a role in shaping food choices, especially among children and adolescents. Unhealthy foods, such as sugary snacks, fast food, and sugary beverages, are often heavily marketed and promoted through various media channels, including television, social media, and other digital platforms. These marketing efforts can influence individuals' food preferences and consumption patterns, leading to an increased intake of less healthy foods. Based on the US diet, consumption of fats and sugars such as sweets has been associated with lower diet cost, such that the mean retail price of sucrose is much lower than in France, thus total

sugars double in consumption in the US than in France. Looking at energy costs of lean meats, fish, fruits, and vegetables, they have been viewed to be higher in energy costs than those of fats and sugars, which leads to higher dietary costs for consumers (Drewnowski et al., 2004). Food choices are also based on availability. For instance, in colleges, fast foods have been introduced such that, during celebrations, meetings and conferences, food is prepared by fast food chains with their choice of food options, leading college students and professors to base their food choice on what is readily available (Dunford et al., 2019) and cost-effective for them, besides the actual appeal of the food. This increases the number of times these fast foods high in added sugars, salt and saturated fats are consumed thus encouraging the sales, such that of these foods from vending machines in colleges, universities, and the workplace cafeteria (Arulogun et al., 2011). In restaurants, menu design also influences the food choice of individuals such that customers have been seen to choose the highest profit items. Research shows that 20% of males and 10% of females eat commercially prepared foods six or more times a week while about 55.9% of Americans eat out two or more times per week than the 24% that eat out less than once per week. All this is due to limited time, work, and parental duties, which makes it challenging for some people to plan their meals, cook at home, and opt for healthier food choices (Cohen et al., 2012).

As pricing is a crucial factor in making the right food choice, the pricing strategies also contribute, such as food taxes and subsidies, which have been seen as evidence to help improve the population's diets, thus reducing the increased risks of obesity and chronic diseases. Food taxes are also vital, especially for national and state governments, as they have revenue-raising potential (Mozzaffarian et al., 2014). The World Health Organization, in 2008, emphasized that policies should be used to trigger food prices and encourage healthy eating to improve the

overall health of humans. In addition, increasing the prices of foods that are high in nutrients associated with excess energy, salt, and saturated fats, such as sugary beverages, salty snacks, and foods high in unhealthy fats. This can be done through measures such as taxation, which increases the price of these foods, making them less affordable and potentially reducing their consumption. Higher prices can create an economic disincentive for individuals to purchase these less healthy foods, leading to reduced intake over time. On the other hand, reducing the prices of foods that are high in nutrients associated with health benefits, such as fiber and unsaturated fats found in fruits, vegetables, whole grains, nuts, seeds, and fish, can make these healthier options more affordable and accessible to consumers. Lower prices for these foods can encourage their consumption, potentially leading to improved dietary patterns and better health outcomes (Eyles et al., 2012).

Healthcare cost burden

Health insurance is key in allowing individuals to seek healthcare, such that when it comes to college students, health insurance coverage varies by age, race, workplace, and state of residence. Many college students depend on their parent's health insurance. However, if their family income is less than \$20,000 annually, students are more likely to be uninsured. This results in higher healthcare costs and a burden on young people with chronic diseases. In addition, there is a 10% to 25% increased risk of mortality, with 22000 deaths associated with the absence of insurance by 2006 (Prince et al., 2010). Unhealthy lifestyles of young Americans adults aged 18 to 25 years have been seen to have more than one chronic disease. In addition, chronic diseases such as cancer and diabetes are leading causes of death and disability in the US and are drivers of the nation's \$4.1 trillion in annual healthcare costs (CDC, 2022). This is influenced by poor dietary habits, sedentary lifestyles, and lack of informed decisions when

choosing food items because of a lack of nutritional knowledge and not prioritizing health. Three-quarters of healthcare expenditure in the US is on chronic disease bills, thus, 76% of Medicare expenditure goes to those beneficiaries with more than five chronic conditions, which cripples the health system. This has increased burdens for out-of-pocket pay or expenses for people with chronic diseases such as heart disease, diabetes, and certain types of cancer, are leading causes of morbidity, mortality, and healthcare costs in the United States. Taking proactive steps to prioritize health and follow evidence-based guidelines, such as the American Dietary Guidelines, can significantly reduce the risk of chronic diseases and associated healthcare costs. (The lancet, 2023). Some of these leading chronic diseases such as cancer, result in an increased constraint, thus unmet needs for effective treatments, thus early detection due to increased volumes of new cancer cases. This constrains the healthcare budget, leading to increasing pressure on payers to implement cost-saving strategies (Schlueter et al., 2020).

Healthy dietary patterns for chronic disease prevention

Chronic diseases are defined broadly as having a condition that lasts one year or more, requiring ongoing medical attention or limitation of activities of daily living or both (CDC, 2022). An unhealthy dietary pattern increases the risks of chronic diseases; however, prevention of most chronic diseases is possible through eating well, being physically active and avoiding tobacco, excessive drinking, and getting regular health screenings (CDC, 2023). The rank order of chronic diseases in the US is heart disease, cancer, cerebrovascular disease, and diabetes mellitus (Neuhouser et al., 2019). Although some chronic diseases cannot be prevented and cured, most chronic diseases can be prevented by reducing risk factors such as having high blood pressure, high low-density lipoprotein cholesterol, diabetes, smoking and secondhand smoke, exposure to obesity, unhealthy diets, and physical inactivity (CDC, 2023). Eating a healthy diet

has effects that are beneficial to the body and although food can be eaten in minimal portion sizes and the diversification of foods, maintaining a healthy weight is also vital as it reduces the risk of obesity and formulation of coronary artery disease (CAD), and hypertension. Replacing saturated fats and trans fats with unsaturated fats, such as sources of omega-3 fatty acids, help reduce the risk of CAD. Increased consumption of fruits and vegetables and folic acid intake also prevent the risks of CAD and stroke. Consuming high intakes of cereal products in their whole grain and high fiber form is also significant as they are less refined and lowers CAD and type 2 diabetes mellitus. Unrefined cereals contain fiber, vitamins, and minerals naturally present in whole grains when consumed as cereals; thus, the high fiber content helps facilitate weight control (Willett et al., 2006). Schulze et al., emphasize that consuming a Mediterranean diet is the most effective way of chronic disease prevention. This diet consists of encouraging an increased intake of fruits and vegetables, nuts, seeds, fish, legumes, and cereals, thus limiting the intake of meat and dairy products. Incorporating the Mediterranean diet as a dietary pattern, individuals can benefit from its health-promoting properties, including reduced risks of chronic diseases such as CVDs, certain cancers, diabetes mellitus, and neurodegenerative diseases. It can also help address the underconsumption of key nutrients, promoting overall health and well-being. However, it is important to note that individual dietary needs may vary, and consulting with a healthcare professional or registered dietitian is recommended before making significant changes to one's diet (Romagnolo et al., 2017).

Engaging in physical activity has other health benefits that reduce the risk of chronic diseases and increase long-term health benefits. The Dietary Guidelines for Americans emphasize that young adults should be physically active and at least have 150 to 300 minutes of moderate to intense aerobic activity, thus engaging in muscle-strengthening activities such as

weights at least two days each week (Dietary Guidelines for Americans, 2020-2025). Therefore, making it part of one's lifestyle to practice healthy behaviors, physical activity can help reduce the risk of chronic diseases, thus delaying the onset of diabetes mellitus. In addition, nutrition education and training play a crucial role in promoting health and preventing chronic diseases, and it can be particularly impactful when targeted towards college students, adults, and communities. By providing education and training on healthy eating habits, understanding food labels, cooking skills, and the importance of a balanced diet, individuals can make informed choices about their food consumption and improve their overall health (Staten et al., 2005).

Chapter 3 - Methods

Participants

Participants from Kansas State University were recruited using email and flyers on campus to participate in the study during the 2017 Fall semester. The initially targeted recruitment was for ($n=40$) college students; however, only ($n=39$) student responses were captured. The inclusion criteria required participants to be freshmen or sophomore year students, 18 years and older, and not be from a Nutrition, Dietetics, or Kinesiology Major, thus having not taken any nutrition-related courses. The Institutional Review Board reviewed and approved this study with approval number 8487 in 2017. Out of the ($n=39$) participants, only ($n=35$) completed the survey at baseline and at the end. One participant was below the required age (less than 18) to participate in the study, as the age range was from 18 to 24 years and above. The other four did not complete all the required responses to the survey.

Secondary data used in a cross-sectional study from the primary survey was used in this study. The focus was on four questions that will help assess the effectiveness of nutrition education intervention in monitoring dietary knowledge change in the intake of nutrients such as added sugar, salt, and saturated fat in college students. Overconsumption of these nutrients leads

to increased risks of chronic diseases. Demographics captured in this study included age (18 years to 24 years and above), gender (male and female), residence (on-campus, off-campus, and sorority or fraternity), year in school (freshmen or sophomore), race (White, Asian, and Black or African-American) and weight and height to calculate participants' BMI.

Study design

A randomized controlled trial (RCT) study design was used to conduct the research. Further, Qualtrics was used to administer the survey online. The RCT lasted ten weeks, during which participants were randomly assigned to the intervention and control groups, leading to a total of ($n=32$) participants. The intervention group consisted of ($n=16$) participants who attended four bi-weekly presentation sessions lasting 20 to 30 minutes that focused on fats, salt (sodium), added sugars, and physical activity. The control group ($n=16$) did not attend any presentation. Although the actual study was performed in 2017, the data has been used to assess the equivalent questions for this specific research study, focusing on assessing knowledge of four specific dietary nutrients: added sugar, fat, salt or sodium, and saturated fat. The original research questions asked were: 1) Do you think these are high or low in added sugars (flavored yogurt, ketchup, sweet potatoes, canned fruit in fruit juice, sport or energy drink, milk, and granola bar), 2) Do you think these are low or high in fat (plain pasta, regular salad dressing, luncheon meat, honey, cheese, and potato chips or corn chips), 3) Do you think these are high or low in salt or sodium (pickles, red meat, cottage cheese, prepackaged meals- frozen dinners or boxed macaroni and cheese, and canned soup), and 4) Do you think these are high or low in saturated fat (olive oil, beef or pork ribs, coconut oil, avocado, bacon or breakfast sausage and chocolate). The survey questions were validated, as they had been used in previous research of the National Cancer Institute (NCI) screener. The knowledge questions were taken from the

International Physical Activity questionnaire and articles including “General nutrition knowledge questionnaire for adults” (Parmenter et al., 1999).

Statistical analysis

Descriptive demographic analysis, using Microsoft Excel, was used to calculate the mean and standard deviation of variables such as age, weight, height, and BMI. Fisher’s exact test analysis was conducted using RStudio version 4.2.2 (2022.07.1, Build 554), and Alpha was set at 0.05, an alternative hypothesis: two-sided, was used for p-values to detect the differences between the control and intervention group, to analyze their responses toward the problematic nutrients being added sugar, salt, and saturated fat.

Nutrition education intervention

Nutrition education was offered to the intervention group ($n=16$), while the control group ($n=16$) had no nutrition information. This information was shared through four sessions every week, with information on added sugar, salt, fat, and saturated fat. Informational material such as flyers and handouts were given as other tools of nutrition education. These lessons were shared in-person at K-State with 20 to 30 minutes presentations. At the end of the 10-week period, both the control and intervention group were given information on food containing added sugar, salt, fat, saturated fat, and physical activity information was recommended to the students. Participants were taught on reducing the intake of foods high in added-sugar, salt, and saturated fat can promote a healthful, prolonged life and prevent premature deaths and health costs associated with chronic diseases. Chronic diseases increase the burden on the healthcare system as well as family members who must care for those impacted by the ongoing battles of living with an illness. In addition, participants learned about reading a food item's food label to identify

the amount of sodium, added sugars, and saturated fats contained in the product. This could also help them take caution when reading menus from fast food outlets and restaurants and to make wiser choices during meal selection in the dining halls or from vending machines. Moreover, students learned a monetary concept in the form of healthy bucks, to help them make healthier food choices while realizing that although healthy foods may seem expensive, it is more affordable than spending money on healthcare costs and treatments of chronic diseases due to unhealthy dietary choices made in the past.

Outcome

Short-term outcomes included broadening the participants' knowledge, understanding, and practice towards healthy dietary eating habits and creating awareness on sources of foods high in problem nutrients to increase their ability to make healthier food choices.

Chapter 4 - Results

Demographic characteristics

Anthropometric measures were taken for both male and female participants in the study. Height was measured in centimeters. Men were taller ($M=182.09$, $SD=6.18$) than females ($M=164.14$, $SD=5.63$). Weight was measured in kilograms, and the mean weight for males was 86.25 Kg ($SD= 19.83$) and 67.67Kg ($SD= 14.37$) for females. The average BMI for males was 25.87 and 25.25 for females. Moreover, 58.82% of the students were in their sophomore year, while only 41.18% were still freshmen. Based on race, 85.29% of the participants were White, followed by Black or African-American (5.88%), Asian (2.94%), and participants who selected Other (5.88%) as minority groups in K-State. As this study was conducted at Kansas State University, 55.88% of the students indicated they lived in an on-campus residence, 29.41% lived off-campus residence, 11.76% resided in a sorority or fraternity house, and 2.94% resided in another university or college. Table 1 below shows the demographic characteristics of all the participants in the research study.

Table 1. Demographic characteristics of the sample

Variables	Total number of participants (n)	Percentage (%)	Mean	Standard deviation (σ)
Age	35		19.1	1.22
Gender				
Male	8	22.86		
Female	27	77.14		
Height (cm)				
Male	8		182.09	6.18
Female	27		164.14	5.63
Weight (kg)				
Male	8		86.25	19.83
Female	27		67.67	14.39
Body mass index (BMI)				
Male	8		25.87	5.09
Female	27		25.25	5.84
Years in school				
Sophomore	20	58.82		
Freshmen	14	41.18		
Race				
White	29	85.29		
Black/American	2	5.88		
Asian	1	2.88		
Other	2	5.88		
Residence				
On-campus	19	55.88		
Off-campus	10	29.41		
Sorority/fraternity	4	11.76		
Other universities or college	1	2.94		

Added sugar

Question 56, shown in Table 2, indicates the results gathered from the responses of students, which assessed students' knowledge of added sugar by answering questions regarding added sugar content in the following foods: flavored yogurt ($p = 0.6851$), ketchup ($p = 0.1101$), sweet potatoes ($p = 1$), canned fruit in fruit juice ($p = 1$), sports drinks or energy drinks ($p = 1$), milk ($p = 0.22$) and granola bar ($p = 0.716$), for being high or low in added sugars. There was no

significant difference between the control and intervention group, as all p-values were greater than 0.05.

Table 2. Food items high or low in added sugar

Variables	Control group			Intervention group			Total	P-Value
	High	Low	Not sure	High	Low	Not sure		
Flavored yogurt	13	3	0	11	4	1	32	0.6851
Ketchup	13	0	3	14	2	0	32	0.1101
Sweet potatoes	2	13	1	1	14	1	32	1
Canned fruit in Fruit juice	15	1	0	15	1	0	32	1
Sports/energy drink	15	1	0	16	0	0	32	1
Milk	2	13	1	8	23	1	32	0.2200
Granola bar	10	5	1	9	7	0	32	0.7160

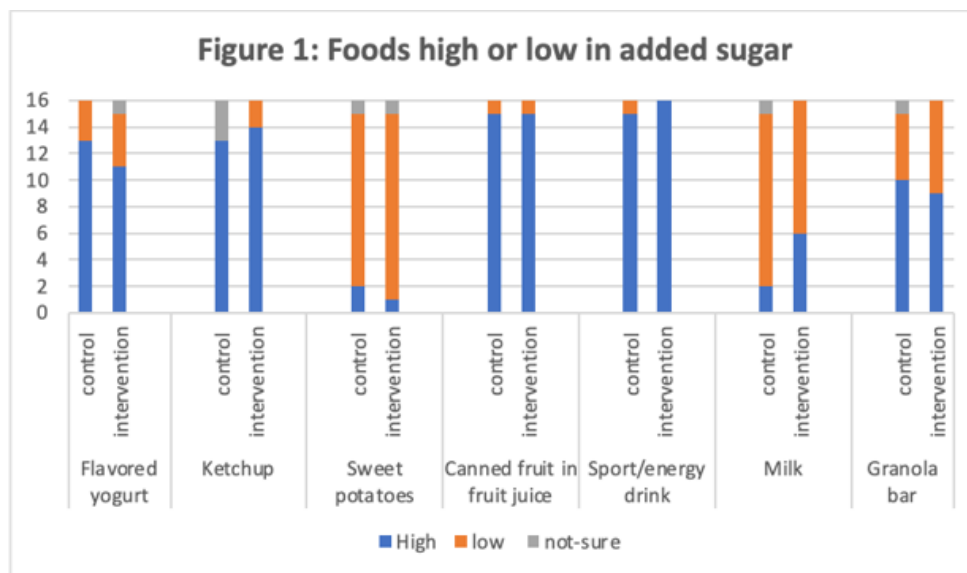


Figure 2. Food sources containing added sugar

Note: The control and intervention group consist of 16 participants each on the y-axis. X-axis shows the color category; blue color represents the category high, orange as low and grey as not sure for added sugar and variables in the control and intervention group

Fat

Question 57 asked students, “Do they think these foods such as plain pasta, regular salad dressing, luncheon meat, honey, cheese, and potato chips or corn chips are high or low in fat, are represented in Table 3. Plain pasta ($p = 0.03725$) was statistically significant between the control and intervention groups, indicating that nutrition education intervention was effective. Most students in the control group ($n=7$) categorized pasta as high in fat, while in the intervention group, all students (15) categorized it as low in fat. Cheese was statistically significant ($p=0.0000008551$), indicating an effect towards knowledge change as ($n=15$) students from the intervention group categorized it as high in fat. In contrast, ($n=15$) students in the control group indicated it was low in fat. Regular salad dressing ($p = 0.5996$), luncheon meat ($p = 0.08293$), honey ($p = 0.2274$), and potato chips or corn chips ($p = 0.2258$) were not statistically significant, indicating no effect on knowledge change on these food sources containing fat.

Table 3. Food items high or low in fat

Variable	Control group			Intervention group			Total	P-value
	High	Low	Not sure	High	Low	Not sure		
Plain pasta	7	9	0	1	15	0	32	0.03725*
Regular salad dressing	15	1	0	13	2	1	32	0.5996
Luncheon meat	15	1	0	10	5	1	32	0.08293
Honey	6	7	3	2	12	2	32	0.2274
Cheese	1	15	0	15	1	0	32	0.0000008551*
Potato chips or corn chips	13	2	1	16	0	0	32	0.2258

* p-value <0.05 is significantly different for the Fisher’s test when comparing plain pasta and cheese as high or low in fat intake between the control and the intervention group

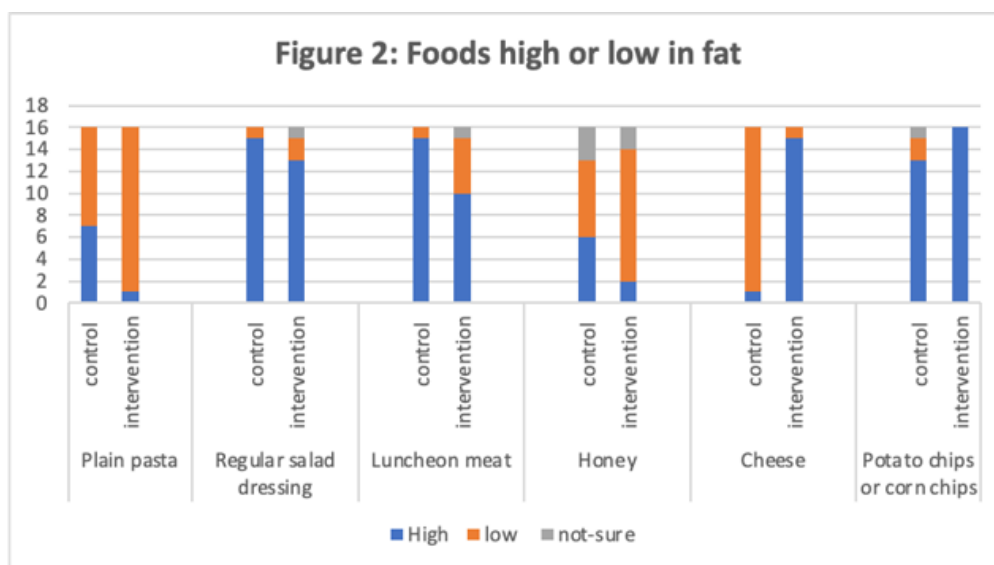


Figure 3. Food sources containing fat

Note: The control and intervention group consist of 16 participants each on the y-axis. X-axis shows the color category; blue color represents the category high, orange as low and grey as not sure for fat and variables in the control and intervention group

Salt or sodium

Question 58, from the Qualtrics survey, assessed participants' knowledge of the salt or sodium content of pickles, red meat, cottage cheese, prepackaged meals (frozen dinners or boxed macaroni and cheese), and canned soup. Pickles ($p = 0.1767$) had a high statistical significance, as all ($n=16$) students in the intervention group categorized it as high in salt or sodium; however, in the control group ($n=5$), students categorized it low in salt, and one student was unsure of it being high or low in salt. Red meat ($p = 0.3944$), cottage cheese ($p = 0.716$), prepackaged meals ($n = 10$ and canned soup ($n = 1$) were not statistically significant, showing no difference from nutrition education in the intervention group, when compared to the control group. Table 4 below shows all captured results from students' responses to the questions on sodium.

Table 4. Food items high or low in salt (sodium)

Variable	Control group			Intervention group			Total	P-value
	High	Low	Not sure	High	Low	Not sure		
Pickles	10	5	1	16	0	0	32	0.01767*
Red meat	11	5	0	14	2	0	32	0.2944
Cottage cheese	5	11	0	14	2	0	32	0.716
Prepackaged meals	16	0	0	16	0	0	32	1
Canned soup	14	2	0	13	2	1	32	1

* p-value <0.05 is significantly different for the Fisher's test when comparing pickles as high or low salt intake between the control and the intervention group.

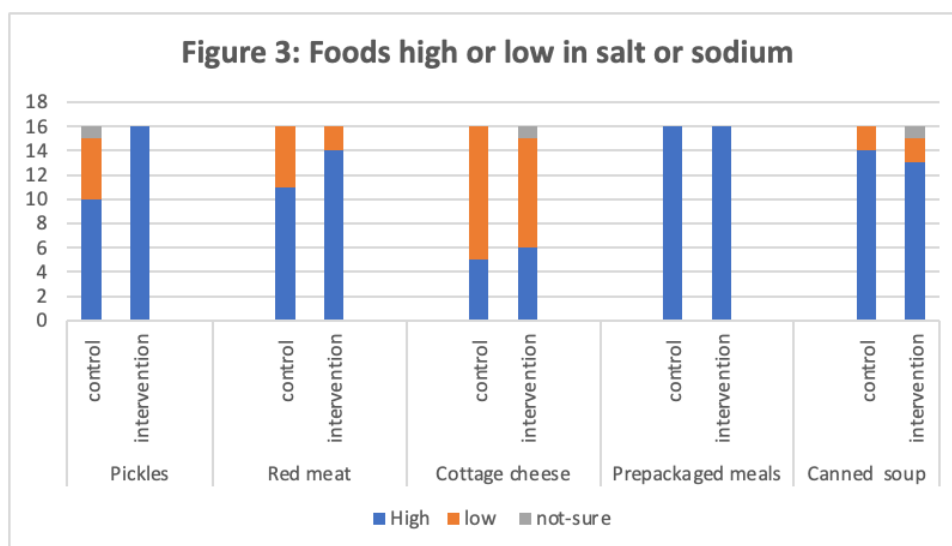


Figure 4. Food sources containing salt or sodium

Note: The control and intervention group consist of 16 participants each on the y-axis. X-axis shows the color category; blue color represents the category high, orange as low and grey as not sure for salt or sodium and variables in the control and intervention group

Saturated fats

Question 59 asked, “Do you think these foods such as olive oil, beef or pork ribs, coconut oil, avocado, bacon or breakfast sausage and chocolate are high or low in saturated fats?”

Students’ responses are shown in Table 5. These results from both the control and intervention groups showed no statistical significance, as there is no knowledge of a change in saturated fat on food sources such olive oil had ($p = 1$), beef, or pork ($p = 0.3029$), coconut oil ($p = 1$), avocado ($p = 1$), bacon or breakfast sausage ($p = 1$), and chocolate ($p = 1$).

Table 5. Food items high or low in saturated fats

Variable	Control group			Intervention group			Total	P-value
	High	Low	Not sure	High	Low	Not sure		
Olive oil	6	9	1	5	10	1	32	1
Beef or pork ribs	11	3	2	14	0	2	32	0.3029
Coconut oil	4	11	1	5	10	1	32	1
Avocado	4	12	0	4	11	1	32	1
Bacon or breakfast sausage	15	0	1	15	0	1	32	1
Chocolate	11	4	1	9	4	3	32	0.6831

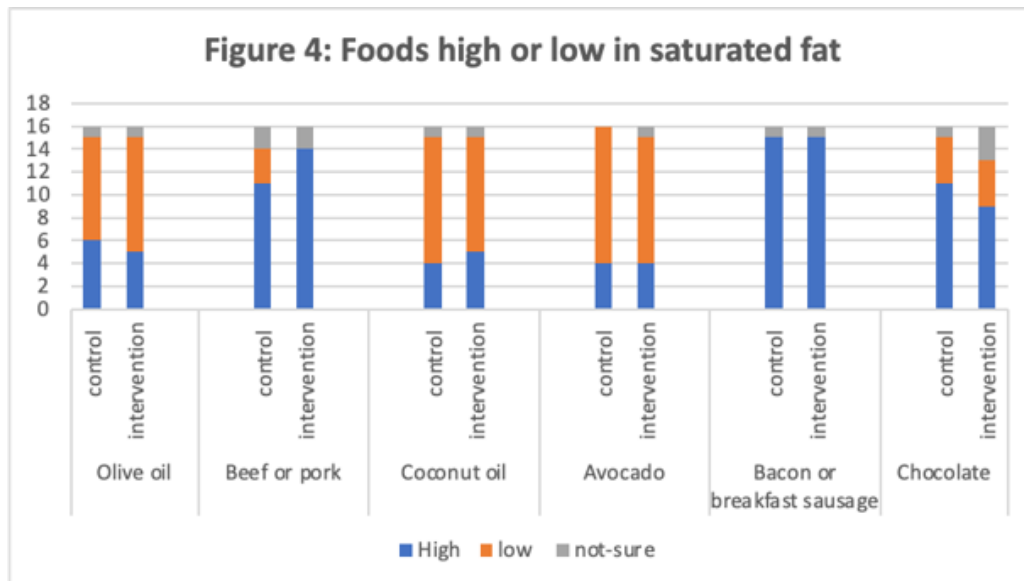


Figure 5. Food sources containing saturated fat

Note: The control and intervention group consist of 16 participants each on the y-axis. X-axis shows the color category; blue color represents the category high, orange as low and grey as not sure for saturated fat and variables in the control and intervention group

Chapter 5 - Discussion

Looking at the demographic variables, 77.14% of females responded to the survey questions compared to only 22.86% of male respondents. This could indicate that more females are prone to participate in surveys, sharing their knowledge and thoughts, especially as freshmen or sophomores (Smith et al., 2008). Furthermore, regarding nutrition and health, many females pay attention to their dietary patterns to maintain their physical appearance and manage their weight (Rolls et al., 1991). The average BMI of both males (25.87 kg/m) and females (25.25 kg/m) was within the same baseline, indicating that both males and females are categorized as overweight (BMI between 25.0 and 29.9). Moreover, BMI is a useful population-level measure of overweight and obesity, as it is for both sexes, and all age groups as it is a simple, inexpensive, and non-invasive way to estimate body fatness. (World Health Organization, 2021). However, although these students were classified as overweight, factors such as BMI not being a measure of fatness should be considered as BMI reflects height for weight than excess fat. Factors such as age, sex, ethnicity, and muscle mass have been shown to influence the relationship between BMI and body fat, hence does not distinguish between excess fat, muscle,

or bone mass such that BMI may not be a good measure of body fatness for athletes or people with very muscular builds, as muscle weighs more than fat. In addition, BMI does not consider other factors that can affect body fatness, such as bone density and body shape. (CDC, 2009). The mean height was 182.09 cm for males and 164 cm for females. Additionally, caution should be used when using BMI to classify someone as overweight and less healthy because it can be argued that some of these students, especially males, might be more muscular than fat, and different races represented in the study could have different bone densities. This leaves BMI as a limited measure to base students' overall health (Romero et al., 2005). However, the higher the BMI, the more increased risks of being unhealthy and prone to chronic diseases such as obesity, type 2 diabetes mellitus and cardiovascular diseases, and some cancers (NHANES, 2023).

Since ($n=20$) sophomore year students have been in the university, the survey questions suited them as they are familiar with foods consumed from local grocery shops, dining halls and nearby fast-food outlets. Further, they could have adapted to the unhealthy eating habits as college students based on the options of fast foods that are available and affordable, leading to some familiarity when identifying of those food items from the questionnaire. This could lead to bias as they could have previously known how those foods taste, which can be easily determined if it is too salty and sugary. However, determining saturated fat could need more nutrition education or gaining that knowledge from websites and friends who attend nutrition-related classes. Further, these are foods they frequently consume from fast food outlets and restaurants, and grocery shopping lists because of the transition of being a college student and the busy lifestyle, resulting in skipping meals, consuming larger quantities of fast foods and carbonated beverages, and high-fat foods, while consuming fewer amounts of fruits and vegetables

(Errisuriz et al., 2016). Further, although K-State is diverse in race, it was noted that many students taking part in the survey were White (85.29%), thus the minority groups being Asians (2.88%) and Black or African American (5.88%). This could be because K-State has a higher population of Whites than Blacks or African-Americans, and Asians in general. However, this does not give the overall generalization of the campus population based on the survey's small sample of student participants. According to Manhattan, Kansas, Data USA, 2020, Whites (non-Hispanic) account for 76.9%, while Asians (non-Hispanic) account for 5.72%. Black or African-American (non-Hispanic) also account for 5.53%. This indicates that the general population of Manhattan, Kansas, Riley County might be widely White populated, showing that it is relatable to the increased response rate from the White race, as Black or African American and Asian race are a minority race in Manhattan, Kansas.

Added sugars have been widely used in many food items in the US; thus, consumers will find a higher percentage of foods containing added sugars than natural sugars (American Heart Association, 2023). Some food items, such as yogurt and sauces, and snacks have added sugars to make the food items tastier. These can be from added sweeteners or fructose that increase the risk of having a higher intake of added sugars, resulting in an increased risk of chronic diseases (Ng et al., 2012). According to the findings in this study, the results indicated that there was no statistical difference in knowledge change in the sugar content of flavored yogurt, ketchup, sweet potatoes, canned fruits in fruit juice, sports or energy drinks, milk, and granola bars, as these foods are popularly consumed by students, between the control and intervention group. The nutrition education intervention was not as effective when compared to the control group, as all p-values were higher than 0.05 in all variables.

According to the results, nutrition education has less effect on changing students' perspectives regarding how familiar food items eaten daily, especially in excess, may contain added sugars, thus increasing risks of chronic diseases. Further, it is worth noting that the intervention group showed a gap in a clear understanding between sugars and added sugars. Therefore, it is vital to educate them more, especially on this difference, and help them focus on reading food labels on food items such as flavored yogurt or just ketchup, as some sauces like ketchup, for example, do contain added sugars that improve the taste of the tomatoes used in the sauce. Some of the students, for instance, may be into sports or athletics and stay up for longer hours due to studying, which increases their intake of energy drinks. Further, they skip breakfast and frequently consume energy bars such as granola bars. Although these food items are not as harmful, excess consumption leads to unhealthy dietary patterns as they could skip important meals containing fresh foods rich in fiber, vitamins, and minerals essential for the body, which students need. Therefore, nutrition education can increase students' knowledge and help them make informed decisions regarding food choices and their health (Lua et al., 2012).

Fats are essential for health, and healthy fats primarily come from plant-based sources (Ormiston et al., 2022). According to this study's results, the consumption of plain pasta and cheese in the intervention group showed a significant difference in knowledge change compared to the control group. The intervention group indicated that those foods were low in fat, and only one participant believed it was high. However, ($n=7$) participants thought it was high and only ($n=9$) participants believed it was low in the control group. This is significant as most people might tend to skip certain food items with the misconception that pasta is higher in fat, while they should consider what is added to the pasta, such as cheese, different sauces, and meats in the plain pasta dish. In addition, a dietary pattern consisting of pasta has been linked to greater daily

fiber and lower added sugar intake (Papanikolaou et al., 2020). Therefore, nutrition education has been evident or enlightened students on fat-containing food items; thus, those not considered higher in fat. One fascinating food item was cheese. All ($n=15$) of the intervention group indicated cheese was high in fat, while the control group had the majority ($n=15$) participants indicated it was low in fat. This shows that it is easy to classify foods high in fat as low because of a lack of knowledge and understanding of the basics of nutrition education. An individual's health could certainly be at risk if they consume high volumes of fatty foods without knowing the implications of how those foods negatively impact health. Although cheese may be frequently consumed by many Americans, especially on pizzas, it contains saturated fats and sodium; therefore, it should be consumed in moderation. Cheese is a dairy product and contains beneficial nutrients such as calcium, protein, and probiotics (The Harvard T.H. Chan School of Public Health in the public health school of Harvard University, 2023).

Salt or sodium is common in many food products, primarily as a flavor enhancer or preservative. All participants ($n=16$) in the intervention group indicated that pickles were high in sodium, whereas ten participants in the control group believed they were high in sodium. Although only five believed it was low and one was unsure, this could indicate that taste or preference could influence decisions about or evaluation of food items they may select, or the participants simply did not know and guessed. Regardless of why participants in the control group thought pickles were low in sodium, this lack of knowledge supports the need for nutrition education resources related to sodium in foods.

The results showed that the intervention and control groups' sodium knowledge about red meat, cottage cheese, prepackaged meals, and canned soups was not statistically significant.

However, these foods contain excessive amounts of salt since it is used as a preservative in these food items. School cafeterias and fast-food outlets often provide meals that are high in salt, which can lead to frequent intake of these foods by students. Busy lifestyles as students may limit their time for preparing fresh meals and may also result in a lack of cooking skills. This can push students towards consuming fast-food options that are readily available and convenient but may not always be the healthiest choice. In addition, during campus events or activities, students may be more likely to accept free meals or opt for fast food due to time constraints or limited financial resources. Preparing healthier meals may require more time and effort, such as washing and chopping vegetables, and cooking, which may not be feasible for students with busy schedules or limited access to kitchen facilities. These factors can contribute to unhealthy eating habits among college students, including frequent consumption of high-salt and fast foods, which can have negative impacts on their overall health and well-being. It is important for educational institutions to recognize these challenges and implement strategies to promote healthier food options on campus, provide education on nutrition and cooking skills, and support students in making healthier food choices despite their busy lifestyles and limited resources (CDC, 2022).

Nutrition education can inform students about the nutrient profile of foods to help them make healthier choices despite leading a busy lifestyle. Nutrition education can be viewed as an investment in their health by educating them on why eating and preparing healthy foods are vital for long-term health. Diets rich in fruits, vegetables, and whole grains provide key nutrients such as vitamins and minerals. This type of diet could also encourage foods low in sodium or moderate consumption of higher sodium foods. Sticking to 2,300 mg of salt intake as a daily limit recommended by the Dietary Guidelines for Americans 2020-2025, could be vital for their overall health. Moreover, some food items may not seem salty, however, reading the label could

help students understand the sodium content in different food items. Some labels do not directly call it salt, but namely sodium, therefore, that gives a clear indication of how much sodium or salt a food item contains. Even reading the ingredient list can be helpful in knowing what that item contains. Further, when purchasing groceries, students can read the food label as they may contain a nutritional health claim which is vital information on nutrition and health benefits of those food items, which communicates food value, thus can help make informed decisions in purchasing healthier food items (Ljubicic et al., 2022).

Saturated fats are common in food sources from animals and some plant products, and people tend to consume a lot of saturated fat, without realizing the excessive amount they consume. Sources of saturated fats include butter, and cow's milk, while some plant products such as chocolate, coconut and palm kernel oil contain saturated fats (de Souza et al., 2015). According to the study, the variables contained both plant and animal sources of fats, healthy fats included olive oil, coconut oil and avocado, and based on the results, most students, both in the control and intervention group, was able to indicate that these are lower in saturated fats. Beef or pork sausage and bacon or breakfast sausage was also seen as higher in saturated fats, in both the control and intervention group, however, when it came to chocolate, the control group indicated it as higher in saturated fat with ($n=11$) participants selecting high, and in the control group, ($n=9$) participants selected it as high in saturated fats, leading to ($n=3$) participants not being sure in the intervention group while only 1 participant was unsure in the control group. This shows a gap in the nutrition intervention group and could indicate that students did not grasp the concept of saturated fats well and may need more knowledge and understanding of foods containing saturated fats. In addition, these shows a gap in the knowledge of saturated fats which needs critical interventions that will be more effective to increase the understanding of foods that

contain saturated fats and an understanding of the difference between fats and saturated fats, thus their sources, such as being from plant and animal sources.

When it comes to chocolate intakes, it is possible that a smaller fraction of males may have viewed chocolate and been unsure if it is high in saturated fats due to less consumption of chocolate compared to females. This could potentially result in higher intakes of sugary foods, such as chocolate, among females compared to males. However, it is important to note that individual consumption patterns can vary widely, and not all females or males may fit into these generalizations. Factors such as cultural, personal, and individual preferences, as well as dietary habits, can also influence chocolate consumption and knowledge about its nutritional content. (Hallam et al., 2016). It is also important to educate the students on their intakes of breakfast, as some students, either in food outlets, may consume a full English breakfast, which contains high saturated fats from bacon or sausages, thus the breakfast from fast food outlets, containing pancakes, syrup, and sausages, increasing their intake of salt, added sugars and these saturated fats.

Limitations

The small sample size in this study could have resulted in limitations that may affect the external validity and overall conclusions of the research. A small sample size may not adequately represent the larger population on campus for K-state students, and findings from such a limited sample may not be generalizable to other populations. Moreover, the potential confounding effect of age could be a limitation if the study did not control age differences among participants (Faber et al., 2014). For example, if the study only included freshmen and sophomores, because there were no juniors, seniors, and graduate respondents towards the survey questionnaire, it may

not capture the full diversity of young adults in college, as older students who may have different dietary behaviors and nutritional awareness levels could be excluded. This could introduce bias and limit the generalizability of the findings. Another potential source of bias could be the exclusion of students based on their major, specifically only excluding students from Nutrition, Dietetics, and Kinesiology fields. This may result in a biased sample that does not accurately represent the overall student population. Additionally, not considering other factors such as nutrition awareness through social media or websites could also introduce confounding variables that were not controlled for, potentially impacting the validity of the study findings. Moreover, secondary data may not capture all the details needed to fully answer the research question, resulting in limitations in the conclusions that can be drawn from the data. For example, if the study only asked participants whether foods were high or low in added sugars, salt, and saturated fats without gathering more detailed information on the actual amounts or sources of these nutrients, it may result in incomplete or inaccurate findings. Without comprehensive data on the specific amounts of these nutrients in the foods consumed, it may be challenging to draw definitive conclusions or provide precise recommendations. Additionally, using secondary data may also present challenges in terms of data quality and reliability. The accuracy and consistency of the data may depend on the original data source and the methods used for data collection, which may not always align with the specific research questions or objectives of the current study (Cheng, et al., 2014).

Conclusion

Nutrition education was effective with knowledge change on plain pasta, cheese, and pickles in college students in the intervention group. However, gaps were identified in food sources containing added sugar, salt, and saturated fat. This results in the study not being conclusive towards overall knowledge change for college students. Future research should include interventions that will critically assess knowledge change on added sugar, salt, and saturated fat,

and include students to be able to identify those foods even in the local campus dining halls as a measure of understanding nutrition education to improve their eating habits and lifestyles towards health. In addition, emphasis should be directed towards college students eating for optimal health, chronic disease reduction in adulthood, and on the reduction of healthcare costs towards the healthcare government systems.

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Appendix A - Survey questions

2/2/23, 10:14 AM

Qualtrics Survey Software

Fruit and vegetable consumption

Thank you for participating in the survey! **You must be a Kansas State University freshman or sophomore student 18 years or older, cannot be a Nutrition, Dietetics or Kinesiology Major, and have not taken any nutrition related classes to participate in this research study.**

The purpose of this study is to help nutrition educators develop a way to assess the dietary intake and physical activity of non-health major freshmen and sophomore. This will help us develop programs and encourage students to make behavior changes of lifestyle to prevent chronic diseases in the long run.

This survey is part of research conducted by Kansas State University. If you have any questions, feel free to call Dr. Tandalayo Kidd, 785-532-0154 or you can call the University Research Compliance Office at Kansas State University – Rick Scheidt, Ph.D. at (785)532-3224. This study has been reviewed by the Institutional Review Board and has received approval No. 8487.

Be assured that all answers you provide will be kept confidential. This survey takes approximately 10-15 minutes to complete.
Click the next button to get started!

Please enter your participant ID

How old are you?

- ☐ Less than 18 years old
- ☐ 18
- ☐ 19
- ☐ 20

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2/2/23, 10:14 AM

Qualtrics Survey Software

- ☐ 21
- ☐ 22
- ☐ 23
- ☐ 24
- ☐ More than 24 years old

What is your year in school?

- ☐ Freshman
- ☐ Sophomore
- ☐ Junior
- ☐ Senior
- ☐ Graduate

What is your gender?

- ☐ Male
- ☐ Female
- ☐ Choose not to answer

Which one or more of the following would you say is your race?

- ☐ American Indian or Alaska Native
 - ☐ Asian
 - ☐ Black or African American
 - ☐ Hispanic, Latino, or Spanish origin
 - ☐ Native Hawaiian or Other Pacific Islander
 - ☐ White
 - ☐ Other
-

☐ Choose not to answer

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2/2/23, 10:14 AM

Qualtrics Survey Software

Where do you live?

- ☐ Campus residence hall
- ☐ Sorority or fraternity
- ☐ Other university/college housing
- ☐ Off-campus housing
- ☐ Parent or guardian's home
- ☐ Other

What is your height (in inches)?

******(If you choose *not to answer*, please type CNA in the box)

How much do you weigh (in pounds)?

** (If you choose *not to answer*, please type CNA in the box)

Are you an international student?

- ☐ Yes
- ☐ No
- ☐ Choose not to answer

Over the last month, how many times per month, week, or day did you drink **100% juice** such as orange, apple, grape, or grapefruit juice? ***Do not count fruit drinks*** like Kool-Aid, lemonade, Hi-C, cranberry juice drink, Tang, and Twister. Include juice you drank at all meal times and between meals.

- ☐ never
- ☐ 1-3 times last month
- ☐ 1-2 times per week

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Do you think these are high or low in **added** sugar?

	High	Low	Not sure
Flavored yogurt	☐	☐	☐
Ketchup	☐	☐	☐
Sweet potatoes	☐	☐	☐
Canned fruit in fruit juice	☐	☐	☐
Sports/Energy drink	☐	☐	☐
Milk	☐	☐	☐
Granola bar	☐	☐	☐

Do you think these are high or low in fat?

	High	Low	Not sure
Plain pasta	☐	☐	☐
Regular salad dressing	☐	☐	☐
Luncheon meat	☐	☐	☐
Honey	☐	☐	☐
Cheese	☐	☐	☐
Potato chips or corn chips	☐	☐	☐

Do you think these are high or low in salt/sodium?

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2/2/23, 10:14 AM

Qualtrics Survey Software

	High	Low	Not sure
Pickles	☐	☐	☐
Red meat	☐	☐	☐
Cottage cheese	☐	☐	☐
Prepackaged meals (frozen dinners or boxed macaroni and cheese)	☐	☐	☐
Canned soup	☐	☐	☐

Do you think these are high or low in saturated fat?

	High	Low	Not sure
Olive oil	☐	☐	☐
Beef or pork ribs	☐	☐	☐
Coconut oil	☐	☐	☐
Avocado	☐	☐	☐
Bacon or breakfast sausage	☐	☐	☐
chocolate	☐	☐	☐