5-2023

Barriers and facilitators of dairy consumption among individuals with metabolic syndrome.

Kofi Amoh-Mensah
University of Louisville

BARRIERS AND FACILITATORS OF DAIRY CONSUMPTION AMONG INDIVIDUALS WITH METABOLIC SYNDROME

By

Kofi Amoh-Mensah
RN, Nursing and Midwifery Training College-Kumasi, 2009
BSc (Hons) Nursing Science, Northumbria University, 2014
MPH, East Tennessee State University, 2017

A Dissertation
Submitted to the Faculty of the
School of Nursing of the University of Louisville
In Partial Fulfillment of the Requirements
For the Degree of

Doctor of Philosophy in Nursing

School of Nursing
University of Louisville
Louisville, Kentucky

May 2023

BARRIERS AND FACILITATORS OF DAIRY CONSUMPTION AMONG INDIVIDUALS WITH METABOLIC SYNDROME

By

Kofi Amoh-Mensah

RN, Nursing and Midwifery Training College-Kumasi, 2009

BSc (Hons) Nursing Science, Northumbria University, 2014

MPH, East Tennessee State University, 2017

A Dissertation Approved on

April 28, 2023

by the following Dissertation Committee:

____

Dissertation Director

Frances Hardin-Fanning, PhD, RN

____

Lynn Roser, PhD, RN

____

Sha Shuying, PhD

____

Shannon Shumaker, PhD, RN

____

Maria-Luz Fernandez, PhD

DEDICATION

I dedicate this dissertation to my wife, Cathy. You went through this journey with me and gave me your all to see me succeed. I love you.

And to Aseda and Ohemaa, daddy loves you.

ACKNOWLEDGEMENT

I want to thank my dissertation Co-Chair, Dr. Hardin-Fanning, for her direction and the personal and academic support she gave me during this period. Words cannot express how grateful I am to her. And to the members of the dissertation committee, Dr. Roser, Dr. Sha, Dr. Shumaker, and Dr. Fernandez. I am forever grateful to you all.

I acknowledge the tremendous support I received from the SON's office of research, especially Dr. Hall and Vickie Tencer. My stay at UofL would have been a challenge had I not been offered the Graduate Research Assistant position. And to my colleagues I worked with at the office of research throughout the years, you are appreciated. I appreciate the role of the Health and Social Justice Scholars program during my stay at UofL.

To Dr. Chlebowy, I appreciate your role as my academic advisor in the early stages of my PhD career, and to Dr. Ridner, thank you for bringing me to the UofL SON. You were the guide needed when I was lost.

To my parents and siblings, your prayers, support, and encouragement have held me through this PhD process. Finally, to my church, the Church of Pentecost-PIWC Louisville, thank you for the prayers and the social support you gave me, my wife, and my kids. You are appreciated, and I am forever indebted to you all.

ABSTRACT

BARRIERS AND FACILITATORS OF DAIRY CONSUMPTION AMONG INDIVIDUALS WITH METABOLIC SYNDROME

Kofi Amoh-Mensah

April 28, 2023

About 35% of the United States adult population meets the criteria for metabolic syndrome, representing about 85 million individuals. Consuming dairy products protects against the development of the metabolic syndrome and protects against the development of complications associated with it. However, approximately 10% of the U.S. population meets the daily recommendation for dairy products. Information about the use of dairy products among people living with metabolic syndrome is relatively unknown, even though it will benefit them the most.

Therefore, this dissertation aimed to assess dairy product consumption and explore the factors hindering or enhancing their consumption among individuals with metabolic syndrome. This dissertation has three manuscripts: (1) a systematic review to assess the effects of dairy consumption on the development of metabolic syndrome; (2) a review of literature comparing the dietary assessment methods, their strengths, and their limitations; (3) an assessment of the barriers and facilitators to consuming dairy products in individuals with metabolic syndrome.

The systematic review included 16 articles, of which seven (43.75%) were cross-sectional studies, five (31.25%) were randomized clinical trials, and four (25.00%) were

prospective cohort studies, with a total of 320,211 participants. The review concluded that dairy products exhibited protective effects against the risk of developing metabolic syndrome. The review compared four dietary assessment methods, including the 24-hour dietary recall, the food record, the food frequency questionnaire (F.F.Q.), and diet screeners. The outcome suggested that the dietary screener was the most appropriate instrument for the research because it measured dairy consumption over the past month without needing to analyze energy intake and the burden of responding to many questions.

The final manuscript assessed dairy consumption among people with metabolic syndrome using a survey and the barriers and facilitators to meeting the daily dairy recommendation. About 49% of respondents met the guidance of three cups per day, and the most common facilitator was access to dairy products. However, there were no differences between what respondents perceived as barriers and facilitators when they were related to the cups of dairy consumed in a day.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

About 35% of the United States adult population meet the criteria for metabolic syndrome, representing about 85 million individuals (Moore et al., 2017; Ramphal et al., 2014). No mortality statistics are directly attributable to metabolic syndrome, according to the National Vital Statistics Report of 2019 (Heron, 2021). However, metabolic syndrome increases the risk of developing other chronic diseases (Moore et al., 2017). Individuals who meet the criteria for metabolic syndrome have an increased risk of developing type 2 diabetes mellitus, cardiovascular diseases, and cancer (Lemieux & Després, 2020; Suliga et al., 2017; Moore et al., 2017). For instance, heart diseases, cancers, and diabetes mellitus were responsible for the demise of 659,041, 599,601, and 87,647 Americans, respectively. These three conditions caused about 47% of all deaths in the U.S in 2019 (Heron, 2021). Furthermore, individuals who meet the criteria for metabolic syndrome have a 16% to 18% increased risk of developing their first coronary event within a decade. This risk is similar to individuals who have experienced their first coronary event in the past (Sherling et al., 2017).

The economic cost associated with metabolic syndrome management and treatment is higher than for those living without the syndrome. Miller (2013) estimates the annual direct healthcare cost for metabolic syndrome patients at over $5,000 per person, which is about $2,061 more than those without metabolic syndrome. Kentucky's average health price is $7140 yearly (Dennis, 2021). Using the estimated excess healthcare cost for metabolic syndrome patients by Miller (2013), the Kentuckian diagnosed with metabolic syndrome will pay on average $9000, annually.

Consuming dairy products have shown to be protective against metabolic syndrome development. In those that have the syndrome, dairy consumption improved their health by reducing the parameters of the components of metabolic syndrome and their biomarkers (Babio et al., 2015; Martins et al., 2015). However, in the general population about 90% of Americans do not meet the daily dairy consumption recommendation in the U.S., according to the U.S. Department of Agriculture (USDA, 2020).

Previous studies attribute this decline to many factors, and lactose intolerance is the major contributor (Brown-Riggs, 2016; Mobley et al., 2014; Barr, 2013; Nicklas et al., 2011). Other barriers include cost, taste, the lack of knowledge about the recommended levels and the lack of knowledge about the dairy's health benefits. Another significant barrier to consuming dairy is the notion that milk products are fattening (Nicklas et al., 2013). Furthermore, some individuals do not consume dairy products because of their nutritional culture (Mobley et al., 2014). Such individuals did not grow up with dairy products as their food staple. Others believe there is no need for dairy products in old age because they are more beneficial to children. The taste of some dairy products was identified as a barrier, although this barrier is peculiar to low-fat milk (Mobley et al., 2014).

Conversely, among individuals who consume dairy products, the facilitators include the affordability, accessibility, and availability of dairy products (Nicklas et al., 2013). Another enabler of dairy product use is the health benefits such as good bone health. This health benefit caused some older adults to consume dairy products (Park et al., 2019; Mobley et al., 2014).

Studies about metabolic syndrome patients and their dairy consumption set them up as subjects who are given dairy as a form of an investigational product in randomized clinical trials (RCT; Vien et al., 2019; Schmidt et al., 2021a). This research approach makes the subjects put up good health behaviors to get the best outcomes since they know their activities and inactivities are monitored. Other study approaches assess the dairy consumption among individuals over a period of time in prospective and cross-sectional studies (Trichia et al., 2020; Jin & Je, 2021). The prevalence of metabolic syndrome is then assessed for differences in dairy consumption over the period of time.

However, there is scarcity of data about dairy consumption among individuals who have been diagnosed and living with metabolic syndrome. There is not enough information about this group meeting or not meeting the daily dairy consumption as recommended by the Dietary Guidelines for Americans 2020 (United States Department of America, USDA, 2020). Yet, it is this group of people that will most likely benefit from the protective effect of dairy consumption against metabolic syndrome and the health complications, such as heart diseases, cancers, and diabetes mellitus, that come with it.

Therefore, the purpose of this study was to assess dairy products consumption and the factors that hinder or enhance their consumption among individuals with metabolic syndrome. The concepts of the Health Promotion Model (HPM) were the guide of the study.

Theoretical Framework

The HPM has 11 concepts under three subheadings: individual characteristics and experiences, behavior-specific cognitions and affect, behavioral outcomes, and the direction of flow of the framework (McEwen, 2019). Concepts under the first category, individual characteristics, and experiences interact with the concepts in the second category, which subsequently affect those in the third category. However, the two concepts under the first category, the prior related behavior and personal factors, directly influence the behavioral outcome, which is the third category (McEwen, 2019). The personal factors concept describes the biological, socio-cultural, and psychological factors that influence the behavioral outcome.

A vital concept of the HPM is the perceived barriers to action (defined as "the perceptions of blocks, hurdles, and personal costs of undertaking a health behavior" (Pender, 2011, p. 4). This concept highlights the obstacles to espousing health-promoting behaviors. It assesses the ability of an individual to undertake a health-promoting behavior (Khoshnood et al., 2018; Peterson & Bredow, 2017). This concept falls under the second category, behavior-specific cognitions and affect, and interacts with other concepts from the same category, like activity-related affect, perceived self-efficacy, and perceived benefits of action. These concepts influence the health promoting behavior (Peterson & Bredow, 2017). Figure 2 shows the interactions between the concepts.

Using this theoretical framework as the research guide, the fundamental concept of interest, perceived barriers of action was used to assess the hindrances to consuming dairy products. The relationship between personal factors and daily dairy consumption was explored. Figure 3 shows a conceptual framework adapted from the HPM theoretical framework (in Figure 2) delineating the influence of perceived barriers and personal factors on behavioral outcomes.

Summary of Chapters

This dissertation comprises five chapters. Chapter One presents the background and the significance of the burden of metabolic syndrome on the individual diagnosed with it and the country at large economically and the complexities that arise when left unchecked. This chapter assesses the variables within Pender’s Health Promotion Model (HPM) that can help ascertain the study outcome, dairy consumption, among individuals with metabolic syndrome.

Chapter Two provides an in-depth systematic review of the effects of dairy consumption on metabolic syndrome. This chapter observes the protective effect of dairy consumption on metabolic syndrome. This observation makes a strong argument for why it is important to identify the factors that may hinder or enhance dairy consumption, to effectively advocate it to people with metabolic syndrome.

Chapter Three presents the review of literature of the measuring tools for collecting data and provides the reasons for selecting one over the others. It assesses the merits and demerits of the various dietary measuring tools that could have been utilized in collecting data on dairy consumption.

Chapter Four is the main study of the dissertation and describes the research design. It presents the main findings of this dissertation and the observations about the barriers and facilitators to consuming dairy products among the unique population of metabolic syndrome patients. This chapter also assesses the consumption of dairy products among this population. The final chapter is the synthesis of findings, significance to nursing, implications for future research, and conclusion.

CHAPTER II

THE EFFECTS OF DAIRY CONSUMPTION ON THE DEVELOPMENT OF METABOLIC SYNDROME: A SYSTEMATIC REVIEW

Background/Significance

Metabolic syndrome is a cluster of risk factors that increase an individual's risk of having type 2 diabetes mellitus, cardiovascular diseases, and cancer (Suliga et al., 2017). About 35% of the United States adult population meets the criteria for metabolic syndrome, representing about 85 million individuals (Moore et al., 2017; Ramphal et al., 2014).

According to the literature, dairy products reduce the risk of developing metabolic syndrome. When consumed, dairy products (i.e., food made from animal milk) possess protective abilities against the components of metabolic syndrome (Babio et al., 2015; Martins et al., 2015). Products may include but are not limited to milk, yogurt, cheese, custard, whipped cream, butter, and ice cream (Barrubés et al., 2018). Dairy products contain the following food nutrients: proteins, fats, oligosaccharides, and micronutrients, including vitamins like Retinol (vitamin A), calciferol (vitamin D), Tocopherol (vitamin E), Phytonadione (vitamin K), Calcium, Magnesium, Phosphorus, and Zinc (Timon et al., 2020).

Studies reveal the effects of these nutrients on the components of metabolic syndrome. For instance, dairy proteins (whey and casein) and calcium can aid in the weight reduction process (Fernandez et al., 2017; Dugan et al., 2016). Dairy calcium and saturated fatty acids (SFA) lower serum triglyceride levels and increase serum HDL levels (Jahreis & Dawczynski, 2020; Mena-Sánchez et al., 2019). Furthermore, dairy proteins, calcium, and SFAs possess antihypertension properties (Giromini et al., 2020; Jahreis & Dawczynski, 2020; Fernandez et al., 2017) and have glycemic control properties (Fernandez & Marette, 2020; Jahreis & Dawczynski, 2020).

These notwithstanding, evidence points to the fact that the dairy matrix, rather than the single nutrients, further enhances the health benefits attributed to dairy products (Givens & Lovegroove, 2020). While the various effects of metabolic syndrome can be associated with specific nutrients of dairy products, some of these effects overlap. Therefore, the modulating effects of these nutrients are greatly enhanced in the dairy matrix and may explain the findings that support the protective effects on metabolic syndrome (Mena-Sánchez et al., 2019).

However, the findings of the epidemiological, cross-sectional, and clinical trial studies on the effects of dairy product consumption on metabolic syndrome have been inconclusive (Fumeron et al., 2011; Louie et al., 2013). In this systematic review of the literature, the effectiveness of dairy product consumption in preventing the development of metabolic syndrome is assessed.

Methods

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used in the current analysis (Liberati et al., 2009).

Literature search strategy

A literature search was conducted for relevant articles published in English from three databases: CINAHL, PubMed, and EMBASE, from January 2017 to March 2022.

MeSH terms used included “dairy products” OR “milk” OR “cheese” AND “metabolic syndrome” OR “metabolic disease” OR “syndrome x”; “dairy products AND “metabolic syndrome”; “dairy products” OR “dairy” AND “metabolic syndrome x” OR “metabolic syndrome x.”

Eligibility criteria

Articles were included when they met the following criteria: a) an original/primary human study, b) either a randomized clinical trial, a cohort, epidemiologic, or cross-sectional study, c) published in English, d) include any of the metabolic syndrome, its components, or biomarkers as the outcome criteria, and e) had dairy products as interventions, not the micronutrients of dairy products, fortified products, or calcium. There were no non-database articles in the review.

Results

As shown in Figure 1, the search strategy identified 180 articles from CINAHL, 31 from PubMed, and 284 from EMBASE, summing up to 495 articles. After reviewing the titles, 444 articles were excluded for not including the search terms. About 51 articles initially met the criteria for abstract review. Out of these articles, 12 were identified as duplicates and removed accordingly. The abstracts of the remaining 39 papers were reviewed, and 19 studies were removed after the abstract review. Of the 19 articles not included, eight were reviews (systematic, narrative, literature, and meta-analysis); two were editorials; five studies used either a dairy nutrient or fortified dairy products as the intervention. Another two were non-human studies, and three did not have metabolic syndrome or any of its five components as the outcome criteria. Four of the 20 remaining articles in the full-text assessment were excluded from the review. One study was removed because it had dairy and legumes as the intervention diet (Baldeón et al., 2021). Another two were removed because they were abstracts from a conference (Mena-Sánchez & Babio Sánchez, 2017) & (Eelderink et al., 2017). Finally, the last study was not included because the outcome criteria were not a metabolic syndrome, its components, or its biomarkers (Bellikci-Koyu et al., 2019). Data extracted from the articles included in the review were author, year, study design, population, outcome criteria, intervention/assessment of interest, duration, and main findings.

Study Characteristics

Out of the 16 final articles included in this review, seven (43.75%) were cross-sectional studies. Five (31.25%) were randomized clinical trials, while four (25.00%) were prospective cohort studies. Three articles researched adolescent participants (11-18 years; Abreu et al., 2019; Fallah et al., 2018; Fallah et al., 2019), while 13 studies had adult participants (18 years and over). The 16 studies included in this review had a combined total of 320,211 participants. Other characteristics of the articles in this review are summarized in Table 1.

Quality of Articles

This review consists of 16 articles, including randomized clinical trials (RCTs), cross-sectional, and cohort studies assessing the effects of dairy product consumption on metabolic syndrome. The quality of each study was appraised using the Grading of recommendations, assessment, development, and evaluations (GRADE) system (Goldet & Howick, 2013; Guyattet al., 2011). The quality ranged from moderate to high. Most studies (11) were of moderate quality. Five articles (Fallah et al., 2018; Fallah et al., 2019; Schmidt et al., 2021a; Schmidt et al., 2021b; Vien et al., 2019) were of high quality. Where moderate quality suggests, there is moderate confidence that the actual effect is close to the estimated effect even though they may differ substantially. High quality means that there is high confidence that the actual impact is close to the estimated effect of the study outcome (Balshem et al., 2011).

Overall, 12 articles reveal a strong recommendation based on the quality of their evidence (moderate to high) and the strength of their outcomes that point to the protective effects of dairy consumption against metabolic syndrome, its components, or biomarkers (Guyatt et al., 2011; Balshem et al., 2011). These studies included Abreu et al. (2019); Bhavadharini et al. (2020); Jin & Je (2021); Kim & Kim (2017); Kyung Won & Wookyoun (2017); Lago-Sampedro et al. (2019); Mena-Sánchez et al., (2018); Sangah et al., (2017); Hedayat et al. (2020); Trichia et al., (2020); Beydoun et al., 2018; Vien et al. (2019).

Findings

Of the 16 articles, 10 provided either relative risk (RR), odds ratio (OR), or hazard ratio (HR) analyses. These studies observed a protective effect of dairy consumption against metabolic syndrome, its components, or biomarkers. Bhavadharini et al. (2020) observed that higher intakes of total dairy (OR 0.76; CI, 0.71-0.80, $p<0.0001$), whole fat dairy alone (OR 0.72; CI, 0.66-0.78, $p<0.0001$), and whole fat and low-fat dairy consumed jointly (OR 0.89; CI, 0.80 to 0.98, $p=0.0005$) were each associated with a lower prevalence of metabolic syndrome. Jin and Je (2021) saw a reduction in the prevalence of metabolic syndrome among dairy product consumers (≥1 serving/day) when stratified by age (OR 0.88; CI 0.78–0.998, $p=0.048$) for adults and (OR 0.80; CI 0.65–0.98, $p=0.020$) for the elderly compared to non-dairy consumers. In another study, dairy consumers (>7 servings/week) had a reduced risk of metabolic syndrome (HR 0.61; CI 0.52, 0.71, $p<0.0001$) compared to non-consumers (Kim & Kim, 2017). Kyung Won and Wookyoun (2017) observed a protective effect of dairy consumption against metabolic syndrome in women after adjusting for sex (AOR 0.67; CI: 0.56–0.80; $p<0.01$). Sangah et al. (2017) observed that higher milk consumption has a lower metabolic syndrome prevalence than those in the lowest consumption category. In men, ≥1 serving/day led to an 8% decrease in prevalence (OR: 0.92, CI: 0.86–0.99, $p=0.0160$). However, ≥2 servings/day in women caused about 32% less prevalence of metabolic syndrome (OR: 0.68, CI: 0.60–0.76, $p<0.0001$). Beydoun et al. (2018) report that fluid milk intake was inversely related to metabolic syndrome (HR: 0.86; CI: 0.78, 0.94; $p<0.05$).

Other studies revealed the inverse association between dairy consumption and some components of metabolic syndrome. For instance, Hidayat et al. (2020) found that milk consumers had lower odds of having elevated waist circumference (OR 0.78; CI, 0.67, 0.92), elevated triglyceridemia (OR 0.83; CI, 0.70, 0.99), and elevated blood pressure (OR 0.85; CI, 0.73, 0.99) than non-milk consumers. Lago-Sampedro et al. (2019) observed that consuming ≥3 servings/day of dairy reduced the risk of hypertension (OR, 0.743; CI, 0.57–0.95; $p=0.022$). Their study revealed that there was a dose-response association between dairy consumption and the odds of developing obesity, Once/day (OR, 0.758; CI, 0.60–0.95; p=0.02); twice/day (OR, 0.737; CI, 0.59–0.91; p=0.006); ≥3 times/day (OR, 0.641, CI, 0.51–0.80, p<0.001). These odds ratio values suggest about 24%, 26%, and 36% lower odds of developing obesity than non-dairy consumers (Lago-Sampedro et al., 2019). Mena-Sánchez et al. (2018) found that the higher the consumption of cheese, the lower prevalence of low HDL cholesterol (RR, 0.88; CI: 0.78-0.98; $p=0.02$) and hypertriglyceridemia (RR, 0.83; CI: 0.74-0.93; $p<0.01$). Abreu et al. (2019) observed that the non-overweight adolescents in the higher tertiles (2&3) of total dairy and milk consumption had a significant reduction in inflammatory biomarkers such as Interleukin-6 (IL-6). They observed that total dairy product consumption led to a 36% and 34% lower concentration of IL-6 than those in the first tertile (Tertile 2: AMR, arithmetic mean ratio; 0.64; 0.52, 0.80; $p<0.001$ & Tertile 3: AMR; 0.66; 0.53, 0.82; $p<0.001$). A similar observation was made for milk consumption, where there were 37% and 35% reductions in IL-6 concentration among tertiles 2&3 consumers (AMR; 0.63; 0.51; 0.78; $p<0.001$; AMR; 0.65; 0.51; 0.82; $p<0.001$) respectively (Abreu et al., 2019). The other articles' findings are in the synthesis table (Table 1).

Discussion

Several mechanisms may underly the impact of dairy products on metabolic syndrome, its components, and biomarkers. Chief among the explanations underscoring how dairy consumption benefits its users are the complex matrices of individual food nutrients and minerals interacting (Mena-Sánchez et al., 2019). Below are descriptions of some mechanisms of dairy nutrients and minerals and how they affect metabolic syndrome, its components, and biomarkers.

Evidence indicates dairy's role in reducing weight and waist circumference (Fernandez & Marette, 2020). Dairy products possess low carbohydrates and are high in protein. The protein components (whey and casein) enhance satiety and prevent excess energy intake, reducing the activities that result in adipocyte hypertrophy and inflammation. This effect is achieved by lowering inflammatory biomarkers such as interleukins, Il-1β, and IL-6 (Dugan et al., 2016). Therefore, satiety can reduce weight (Fernandez et al., 2017). Dairy calcium is involved in the weight reduction process. The calcium component of dairy enhances weight loss by preventing the adipocytes from storing fats (Chen et al., 2015). Dougkas et al. (2020) found a protective effect of dairy consumption against greater waist circumference, abdominal obesity, and the risk of obesity.

Dairy consumption reduces triglyceride levels and increases HDL levels using a similar calcium mechanism observed for weight reduction. Calcium in dairy promotes lipid metabolism, increasing the HDL-cholesterol level and lowering the plasma triglyceride levels (Mena-Sánchez et al., 2019). Calcium metabolites decrease fatty acid synthesis and increase lipolysis by slowing fat absorption and promoting fatty acid excretion through the feces. This process occurs by calcium interacting with fatty acids to form insoluble fatty acid soaps (Mena-Sánchez et al., 2019; Fernandez et al., 2017). Calcium increases the excretion of bile acids. The excess bile acid removal causes the liver to draw more cholesterol from the blood to synthesize more bile acids for use in the body. This digestive process reduces serum triglycerides (Givens & Lovegrove, 2020). Other studies point to the role of saturated fatty acids (SFA) in lowering serum triglyceride levels and increasing serum HDL levels (Jahreis & Dawczynski, 2020). Vaccenic acid, found in SFA of dairy products, suppresses the synthesis of triglycerides by the liver and the intestines leading to the lowering of serum triglycerides. Phospholipid *trans 9 palmitoleic* acids, a vaccenic acid derivative obtained after vaccenic acid oxidation, have been associated with lower serum triglyceride levels (Jahreis & Dawczynski, 2020).

In addition to weight reduction, triglyceride reduction, and HDL elevation, nutrients in dairy products possess antihypertension properties (Givens & Lovegrove, 2020). Vaccenic acid and its metabolite, *cis9, trans11* conjugated linoleic acid (CLA), are the dominant SFA in dairy products. The metabolites reduce cytokine effects (specifically interleukin, IL-8), thereby preventing the inflammatory process from starting. They achieve this anti-inflammatory ability through the nuclear receptor PPARγ, which decreases inflammatory response. This process prevents inflammation in the endothelial tissues, which are found in blood vessels, and prevents the hardening of the vasculature endothelium (Jahreis & Dawczynski, 2020). Studies reveal that dairy SFAs contain polar lipids (phospholipids and sphingolipids) in their membranes, which have anti-inflammatory effects (Mena-Sánchez et al., 2019). This process reduces arterial blood pressure as vessels can more easily expand to enhance blood flow.

The effect of dairy proteins and calcium on reducing blood pressure has been observed, and the mechanism of action has been reported. Dairy proteins possess angiotensin-converting enzyme (ACE) inhibitors and antioxidant properties (Giromini et al., 2020). The ACE increases blood pressure through the renin-angiotensin system by producing angiotensin II. Therefore, preventing the conversion of angiotensin I to angiotensin II through ACE inhibitors prevents blood pressure from rising (Kim & Je, 2016). Bioactive peptides released during digestion in the gastrointestinal tract influence these blood pressure-lowering effects. However, these bioactive peptides are more readily available in fermented dairy products before they are consumed (Fernandez & Marette, 2018). Giromini et al. (2020) posit that the effect of dairy proteins on the metabolism of serum triglycerides prevents the development of endothelial dysfunction and arterial stiffening.

The antioxidant properties of dairy proteins reduce serum glucose levels after consumption. This process inhibits oxidative stress and enhances the availability of nitric oxide (NO) in endothelial cells (Fernandez & Marette, 2020). NO enhances endothelial function by promoting vasodilation of blood vessels and mediating vascular tone, thereby reducing blood pressure (Giromini et al., 2020). Calcium indirectly reduces oxidative stress and hypertension by enhancing NO activity and promoting vasodilation (Fernandez et al., 2017). Dairy protects against metabolic syndrome and its components through these complex processes.

Dairy products possess the ability to enhance glycemic control by reducing postprandial hyperglycemia. Proteins, calcium, and SFA from dairy have been observed to have protective properties against type 2 diabetes (Fernandez & Marette, 2020; Jahreis & Dawczynski, 2020). Dairy proteins achieve hypoglycemic effects through several mechanisms: directly by modulating incretin hormones to stimulate the pancreatic β-cells to release insulin-specific amino acids like leucine trigger this mechanism, and indirectly by promoting satiety and preventing excess energy intake. These mechanisms cause blood glucose clearance and explain the attenuated postprandial hyperglycemia (Fernandez & Marette, 2020).

Calcium achieves hypoglycemic effects through three pathways: stimulation of β-cells to release insulin, improvement of insulin action, and reduction of inflammation (Fernandez et al., 2017). These mechanisms prevent insulin insensitivity. Dairy SFAs possess glucose homeostasis via two physiological pathways: vaccenic acid prevents the liver from accumulating triglycerides, enhancing insulin sensitivity, and *cis9,trans11* CLA stimulates insulin secretion and prevents insulin resistance (Jahreis & Dawczynski, 2020). The improvement in insulin sensitivity through dairy consumption reduces blood glucose levels and ultimately prevents the development of the metabolic syndrome.

Some RCTs in this review did not report dairy's statistically significant protective effect on metabolic syndrome, its components, or biomarkers (Schmidt et al., 2021a; Schmidt et al., 2021b; Fallah et al., 2019; Fallah et al., 2018). However, dairy consumption did not increase the risk of developing metabolic syndrome in these studies either. Schmidt et al. (2021a&b) did not observe an added risk of developing metabolic syndrome from consuming full-fat dairy products. Consuming diluted yogurt and fermented camel milk did not increase the risk of developing metabolic syndrome (Fallah et al., 2019; Fallah et al., 2018). Vien et al. (2019) observed that dairy consumption suppresses the sense of hunger and reduces blood glucose to the base levels after 60 minutes of consumption. This outcome underscores some of the mechanisms of dairy, as explained above. Schmidt et al. (2021a) observed a statistically significant reduction in the Matsuda insulin sensitivity index scores for full-fat and low-fat dairy products. Schmidt et al. (2021b) observed a statistically significant reduction of the systolic blood pressure scores for participants who consumed full-fat and low-fat dairy products.

However, in the RCTs, researchers emphasized the potential benefits of consuming the dairy products provided to participants. This stress on the importance of dairy can alter the normal lifestyles of participants, preventing them from engaging in other behaviors that may negatively or positively impact the study outcomes. This importance of dairy consumption alone was further evident in the analyses of these RCTs. None of the RCTs conducted inferential research to assess the effect of dairy when other factors were considered. All analyses were solely on the impact of dairy products on metabolic syndrome, and dairy was set as a supplement in a trial.

The RCTs were conducted over a shorter period and with smaller study participants. The longest follow-up period for the RCTs was 20 weeks (Fallah et al., 2019 and 2018), and the fewest was five days (Vien et al., 2019). The sum of all participants in the five RCTs was 151 (approximately 0.05%) of the total participants. RCT is the gold standard for clinical research since it leads to a causal effect conclusion. However, assessing the dietary behaviors of individuals over a longer time is clinically as significant (Beydoun et al., 2018).

The observational studies included in this review assessed dairy consumption while not modifying participants' lifestyles. Kim and Kim (2017) observed that participants who frequently consumed dairy were more likely to be younger, more active, educated, and less likely to be current smokers than those who consumed less dairy. Kyung, Won, and Wookyoun (2017) reveal that higher consumption of dairy was associated with higher consumption of flour and bread and lower consumption of refined foods, red meat, and alcoholic beverages. These observations suggest that nutrition, in general, and dairy consumption, is a way of life. Using an RCT study design may not be the most appropriate study design. The observations support the idea that dairy consumption consistently (not as a change during a trial) is the underlying protection.

Limitations

The main limitation of this review is that most of the articles included (11) were observational studies, which limits causal inference. However, these studies accounted for about 99.97% of the participants in the study. All but one of five RCTs, regarded as high quality by the GRADE a priori assessment, did not observe a significant association between dairy consumption and metabolic syndrome. This non-significant association may be due to the small sample sizes and the short follow-up period for the research. The intervention and control groups consumed dairy products, which may have accounted for their non-significant differences.

Implications

The implication of this review's findings may impact practice and research, especially on managing metabolic syndrome. Some individuals, from health professionals to the general population, tag dairy products, primarily whole-fat dairy products, as foods to avoid. This perception has become a barrier to dairy consumption among many people. With the findings of this review, healthcare providers can make a case for dairy products for their clients. On the other hand, researchers who want to conduct studies into the effects of dairy on chronic diseases should consider using epidemiological designs to prevent participants from assuming that the interventional dairy product used is therapeutic. Researchers can study the different barriers to dairy consumption and assess the consumption rate among metabolic syndrome patients. A follow-up study of the consumption rate could be the assessment of the barriers to or facilitators of dairy consumption among these individuals with metabolic syndrome.

Conclusion

This study is a systematic review of 16 articles, including five RCTs. The review's finding suggests dairy products likely exhibit protective effects against the risk of developing metabolic syndrome, as observed with the different studies realizing the different protecting effects against metabolic syndrome and its components. This finding may further indicate that the consumption of dairy products must be encouraged among the general population, especially individuals diagnosed with metabolic syndrome. However, further studies are warranted to assess the moderating effects of dairy against metabolic syndrome. In addition, studies are necessary to determine modifiable barriers to dairy consumption in individuals at risk for development of metabolic syndrome.

Figure 1

PRISMA Flow Diagram

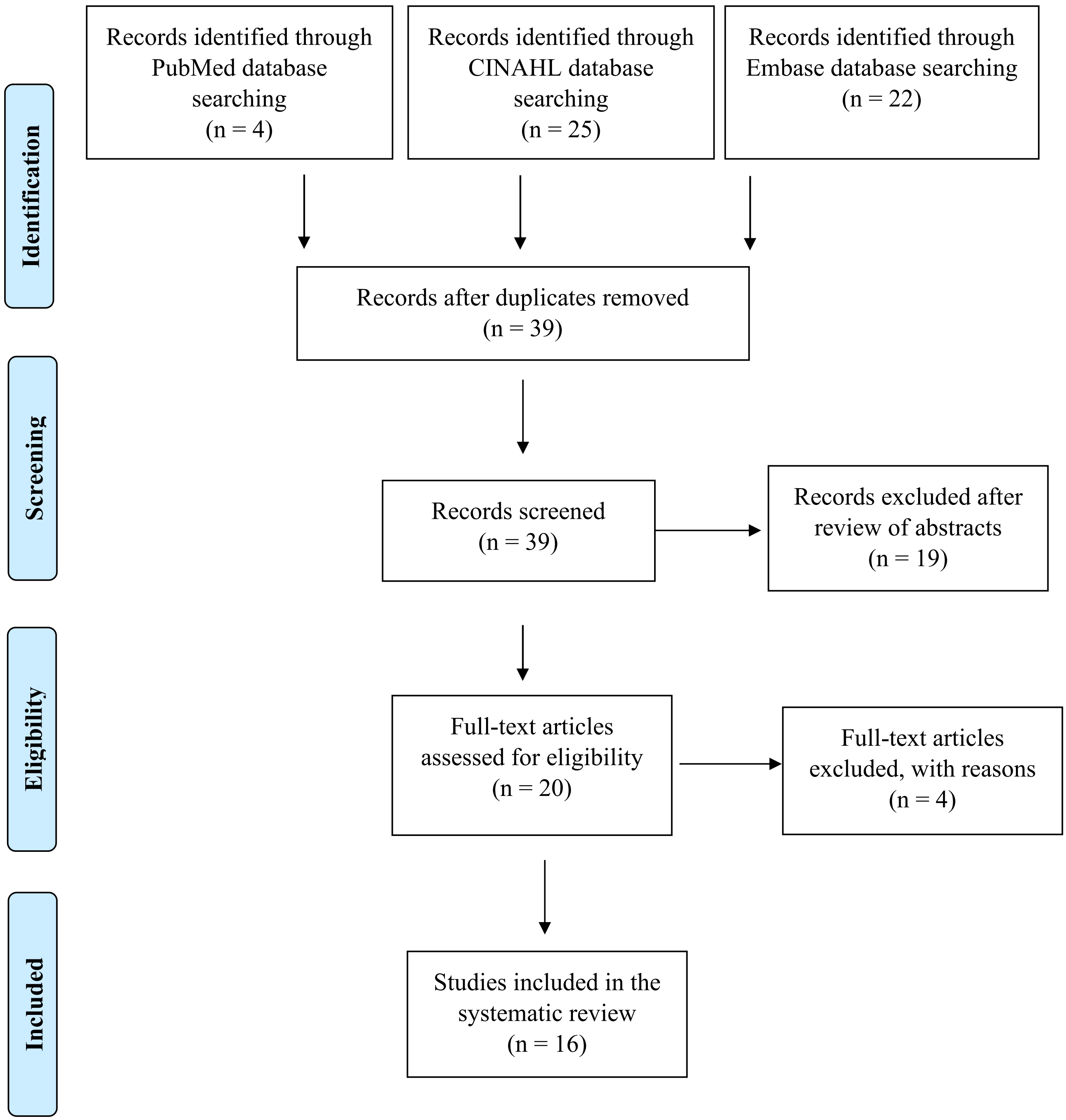


Table 1

Synthesis Table: The Effects of Dairy on Metabolic Syndrome and Components

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
Abreu et al. (2019)	Cross-sectional	7th graders and 10th graders (12-18 years)	Metabolic and inflammatory biomarkers (CRP, IL-6, adiponectin, and leptin)	Used FFQ to assess the consumption of milk (whole, reduced-fat, and fat-free), yogurt, and cheese (cottage and cream cheese) divided into tertiles: Total dairy products: tertile 1, ≤266.1 g/day; tertile 2, 266.1–506.9 g/day; tertile 3, ≥506.9 g/day; Milk: tertile 1, ≤192.5 g/day; tertile 2, 192.5–245.0 g/day; tertile 3, ≥245.0 g/day; Yogurt: tertile 1, ≤53.6 g/day; tertile 2, 53.6–125.0 g/day; tertile 3, ≥125.0 g/day; Cheese: tertile 1, ≤4.3 g/day; tertile 2, 4.3–12.9 g/day; tertile 3, ≥12.9 g/day	Not given	Inverse association between the total dairy product and milk intake (tertiles 2&3) and serum concentrations of IL-6 in non-overweight adolescents compared to tertile 1. Total dairy consumption (Tertile 2: AMR, arithmetic mean ratio; 0.64; 0.52, 0.80; *p* <0.001 & Tertile 3: AMR; 0.66; 0.53, 0.82; *p* <0.001); milk consumption (AMR; 0.63; 0.51; 0.78; *p* <0.001 & AMR; 0.65; 0.51; 0.82; *p* <0.001) respectively.

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
						No significant associations between serum concentrations of leptin and adiponectin and all dairy products
Beydoun et al. (2018)	Cohort	Urban adults aged from 30 to 64 years	Relationship between dairy products and MetS and components of MetS	Dietary exposures to dairy foods, namely, total dairy product intake (servings/d), total fluid milk intake (servings/d), total cheese intake (servings/d), and total yogurt intake (servings/d)	Visit 1: 2004 to 2009 Visit 2: 2009 to 2013	Milk intake was inversely related to the MetS (HR 0.86; CI 0.78, 0.94), triglyceride (HR 0.89; CI 0.81, 0.99), and HDL (HR 1.10; CI 1.01, 1.21). However, cheese and yogurt increased the risk for central obesity; fluid milk intake reduced the risk of MetS and reduced triglyceride levels; reduced HDL levels
Bhavadharini et al. (2020)	Prospective cohort/cross-sectional study	Adults aged from 35 to 70 years across 21 countries	Association between dairy consumption and MetS, and MetS components;	Total dairy, milk, yogurt, and cheese intake categories: zero, less than one serving/day, one to two servings/day, and	9.1 years of data collection	Higher intakes of total dairy (OR 0.76; CI, 0.71-0.80, *p*<0.0001), whole-fat dairy alone (OR 0.72; CI, 0.66-0.78,

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
			association between dairy consumption and incident hypertension and incident diabetes	more than two servings/day		*p*<0.0001), and whole-fat and low-fat dairy consumed jointly (OR 0.89; CI, 0.80 to 0.98, *p*=0.0005) were each associated with a lower prevalence of MetS.
Fallah et al. (2018)	Randomized clinical double-blind cross-over trial	Adolescents from ages 11-18 years with MetS	Homeostasis Model Assessment of Insulin Resistance (HOMA-IR) and inflammatory biomarkers	Control group: diluted cow's yogurt (DCY, 250 mls/day) for eight weeks Intervention group: fermented camel milk (FCM, 250 mls/day) for eight weeks. There was a washout period of 4 weeks and a cross-over for another eight weeks.	Between October 2016 and June 2017, with a follow-up period of 20 weeks per participant	No significant reduction of both FCM and DCY on the outcome. No significant differences between FCM and DCY on outcomes. HOMA-IR (0.25; CI -0.40, 0.91 *p*=0.42) Quantitative Insulin Sensitivity Check Index (QUICKI; -0.009; CI -0.029, 0.010; *p*=0.28) Fasting Blood Sugar (FBS; 0.79 mg/dL CI: -2.80; 4.38; *p*=0.65) Inflammatory markers:

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
						IL6 (-18.28pg/mL; CI -47.48, 10.90; *p*= 0.20) and TNF-α (7.08ng/L; CI -58.82; 73.00; *p*= 0.82)
Fallah et al. (2019)	Randomized clinical double-blind cross-over trial	Adolescents from ages 11-18 years with MetS	Obesity measures: weight, BMI, BMI z-score, waist circumference (WC), hip circumference, WHR, and blood pressure measures: SBP and DBP	Control group: diluted cow's yogurt (DCY, 250 mls/day) for eight weeks Intervention group: fermented camel milk (FCM, 250 mls/day) for eight weeks. There was a washout period of 4 weeks and a cross-over for another eight weeks.	Between October 2016 and June 2017, with a follow-up period of 20 weeks per participant	There were no significant differences in the effects of FCM and DCY on the following: Weight (-0.67 kg; CI: -1.97; 0.61; *p*=0.28). BMI (-0.10 kg/m^2; CI: -0.65; 0.45; *p*=0.70) WC (-1.10cm; CI: 3.22, 1.01; *p*=0.29) DBP (-4.45; CI: -10.04, 1.12; *p*=0.11)
Hidayat et al. (2020)	Cross-sectional	Adults aged 18 years and over	MetS and components of MetS	Milk consumers and non-milk consumers	Not given	There were no differences in the odds of developing MetS between the groups. However, milk consumers had lower odds of

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
						having elevated waist circumference (OR 0.78; CI, 0.67, 0.92), elevated triglyceride (OR 0.83; CI, 0.70, 0.99), and elevated blood pressure (OR 0.85; CI, 0.73, 0.99) than non-milk consumers
Jin & Je (2021)	Cross-sectional study	Adults aged from 19 to 64 years and the elderly from 65 years and over	Association between dairy consumption and MetS	24-hr dietary recall: total dairy consumption categorized into 0, <1 serving/day, & ≥ 1 serving/day	2013-2018 data	Compared with no dairy consumption in adults, high consumption (≥1 serving/day) was significantly associated with a lower prevalence of MetS (OR 0.88; CI 0.78–0.998, *p*=0.048); High dairy consumers among the elderly had 20% lower odds of MetS (OR 0.80; CI 0.65–0.98, *p*=0.020)
Kim & Kim (2017)	A prospective,	Adults aged 40–69 years	Association between total	FFQ assesses the previous year’s frequency	2001-2010	Frequent total dairy consumers (>7

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
	community-based cohort study		dairy consumption and incident MetS and its components	and portion size of dairy consumption, including milk, yogurt, and cheese. Categories for total dairy and milk: never, <1, 1≤ to <4, 4≤ to ≤7, >7 servings/week Categories for yogurt: never, <1, 1≤ to <4, ≥4 servings/week)	Ten years follow-up	servings/week) had a lower risk of MetS than non-dairy consumers (HR 0.61; CI 0.52, 0.71, $p<0{\cdot}0001$). Increased consumption of yogurt (≥4 servings/week) was associated with a lower incidence of MetS and its components
Kyung Won & Wookyoun (2017)	Cross-sectional	Adults aged 19–64 years	Obesity and MetS	24-h dietary for dairy products such as whole-fat milk, reduced fat (2%)/low-fat (1%), sweetened milk, yogurt, cheese/cheese products, and ice cream/dairy-based desserts. Frequencies: non-consumers, 0< to <1 serving/day, and ≥1 serving/day	2010–2013	Consuming ≥1 serving/day of dairy reduced the risk of MetS in women but not men (AOR: 0.67; CI: 0.56-0.80; $p<0.01$).
Lago-Sampedro et al. (2019)	Cross-sectional	18 years and over	Hypertension, obesity, and diabetes	Food Frequency Questionnaire (FFQ) past six months	2009-2010	Consuming ≥3 servings/day of dairy reduced the risk of hypertension

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
				Dairy products were classified into: -Milk, yogurt, cheese -Sugary dairy products (packaged milkshakes, pudding, custard, and ice cream) -Butter or cream Frequencies occur once per day, twice per day, and three or more times per day.		(OR, 0.743; CI, 0.57–0.95; *p*=0.022). Consuming dairy products at least once daily reduced the odds of obesity development: Once/day (OR, 0.758; CI, 0.60–0.95; *p*=0.02); twice/day (OR, 0.737; CI, 0.59–0.91; *p*=0.006); ≥3 times/day (OR, 0.641, CI, 0.51–0.80, *p*<0.001).
Mena-Sánchez et al. (2018)	Cross-sectional	Men aged 55-75 years and women aged 60-75 years, with BMI >27 to <40 kg/m^2 and MetS	MetS components	FFQ assessing fermented dairy products (low-fat yogurt, whole-fat yogurt, and all types of cheese) consumption. Consumption categorized into quartiles; lowest to highest (Q1, Q2, Q3, Q4).	September 2013-November 2016	Those in the higher quartiles of cheese consumption had a lower prevalence of low HDL-cholesterol (RR, 0.88; CI: 0.78-0.98; *p*=0.02) and hypertriglyceridemia (RR, 0.83; CI: 0.74-0.93; *p*<0.01).

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
						However, consumption of total fermented dairy products, yogurt (and its types) was not associated with any of the components of the MetS
Sangah et al. (2017)	Cross-sectional	Adults aged 40–69	Association between milk consumption and risk of MetS and its components	FFQ for milk consumption. Frequency of consumption- Women in five groups (none or rarely, <3 servings/week, 3 ≤ to < 7 servings/week, 1 serving/day, and ≥2 servings/day). Men four groups: (none or rarely, ≤2 servings/week, 3–6 servings/week, and ≥1 serving/day)	2004-2013	Higher milk consumption (≥1 serving/day in men & ≥2 servings/day in women) has a lower prevalence of MetS compared with those in the lowest category of consumption (OR: 0.92, CI: 0.86–0.99, *p*=0.0160 & OR: 0.68, CI: 0.60–0.76, *p*<0.0001) respectively.
Schmidt et al. (2021b, May)	Randomized Controlled Trial	18 to 75 years old with MetS	Fasting lipid profile (triglycerides, HDL cholesterol, LDL	Group 1: nonfat milk (“limited-dairy diet”) maximum of 3 servings/week Group 2: low-fat dairy diet (nonfat milk and	12 weeks	No significant difference between interventions on fasting blood lipids profiles:

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
			cholesterol, total cholesterol, free fatty acids, and LDL-Rf; the cholesterol content in 38 plasma lipoprotein fractions) and blood pressure	yogurt, low-fat cheese) 3.3 servings of dairy/day Group 3: Full-fat dairy diet (whole milk, full-fat yogurt, and cheese) 3.3 servings of dairy/day		Total cholesterol (*p*=0.328) Triglycerides (*p*=0.446) LDL cholesterol (*p*=0.975) HDL cholesterol (*p*=0.788) Blood pressure (BP): Significant differences between intervention groups on the systolic BP (*p*=0.048): Full-fat (mean, [±SD];-5.4[±16.1]) Low-fat (-1.6 [±8.6]) Limited (2.5 [±8.2])
Schmidt et al. (2021a)	Randomized Controlled Trial	18 to 75 years old, weight stable with MetS	Change in glucose tolerance, as assessed by measuring the glucose area under the curve (AUC) during a	Group 1: nonfat milk (“limited-dairy diet”) maximum of 3 servings/week Group 2: low-fat dairy diet (nonfat milk and yogurt, low-fat cheese) 3.3 servings of dairy/d Group 3: Full-fat dairy diet (whole milk, full-fat	12 weeks	The AUC presented no significant differences in glucose tolerance between limited, full-fat, and low-fat dairy (*p*=0.340). Matsuda insulin sensitivity index (ISI); significant

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
			3-hour frequently sampled Oral Glucose Tolerance Test (3-h FS-OGTT)	yogurt, and cheese) 3.3 servings of dairy/d		differences between intervention diets (*p*=0.012): Full-fat (mean, [±SD];-0.25[±0.91]) Low-fat (0.47[±1.07]); Limited dairy (0.00 [±0.92]). Body weight; significant differences between intervention diets (*p*=0.006): Full-fat (+1.0; CI, -0.2,1.8 kg) Low-fat (+0.3; CI -1.1,1.9 kg) Limited dairy (-0.4; CI, -2.5, 0.7 kg)
Trichia et al. (2020)	Prospective study	40 to 78 years	Changes in BMI, waist circumference, the ratio of the total to HDL cholesterol, glycated hemoglobin (HbA1c), and	Past year FFQ validated with a 7-day food diary on total and types of dairy products (low- and high-fat subtypes) consumed	An average follow-up period of 3.7 years	An increase in yogurt consumption led to a rise in HDL cholesterol (0.02 mmol/L; CI -0.04, -0.01) High-fat cheese: One serving/d increase leads to total cholesterol

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
			blood pressure (systolic and diastolic)			(0.12 mmol/L; CI: 0.04, 0.21), HDL cholesterol (0.04 mmol/L; CI 0.01, 0.07), and LDL cholesterol (0.09 mmol/L; CI: 0.02, 0.16) increase
Vien et al. (2019)	Non-blinded, within-subject, repeated-measures, RCT	Young adults: 20–30 years old with a BMI of 18.5–24.9 kg/m^2 and Adults: 60–70 years old with a BMI of 18.5–29.9 kg/m^2	Expression of the area under the curve (AUC) for: Satiety was measured at baseline and every 15-30 minutes over 3 hours postprandial. Blood glucose and insulin levels were measured at baseline and every 15-30 minutes for 2 hours postprandial	One serving of Reference or control food: skim milk (0.1% milk fat) Test foods: whole milk (3.25%), Greek yogurt (2%), and cheddar cheese (31%) Energy-free control: water	Five separate mornings, one week apart from each other	Appetite scores: reduced after all dairy treatment. Appetite tAUC was lower in females than males (11,529 ± 227 vs. 13,456 ± 230 mm*min, p=0.003); Postprandial glycemia: By 60 min, blood glucose (BG) returned to baseline after dairy treatment, but cheese and skim milk were lower than whole milk (p<0.04) Mean BG was higher in older than

Author (Year)	Study Design	Population	Outcome criteria	Intervention/Assessment of Interest	Duration	Main Findings
						young adults (5.20 ± 0.04 vs. 4.97 ± 0.03 mmol/L, *p*=0.0004) Mean BG lowest after cheese compared to both kinds of milk (*p*=0.0002) Serum Insulin: Insulin AUC is lower after cheese than milk and yogurt (*p*<0.001).

Table 2

Assessment of the Quality of each Article using the GRADE system.

Author (Year)	Study Design	GRADE Step 1 A priori ranking	GRADE Step 2a Downgrade	GRADE Step 2b Upgrade	STEP 3 Quality of Evidence
Abreu et al. (2019)	Cross-sectional	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*very large* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Beydoun et al. (2018)	Cohort	Low	Risk of bias---*no serious bias* Inconsistency---*serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*large* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Bhavadharini et al. (2020)	Prospective cohort/cross-sectional study	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency*	Large consistent effect---*large* Dose response---*not observed* Confounders only	+++ Moderate

Author (Year)	Study Design	GRADE Step 1 A priori ranking	GRADE Step 2a Downgrade	GRADE Step 2b Upgrade	STEP 3 Quality of Evidence
			Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	reducing size of effect---*not observed*	
Fallah et al. (2018)	Randomized clinical double-blind cross-over trial	High	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*serious (based on outcome)* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*not observed* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Fallah et al. (2019)	Randomized clinical double-blind cross-over trial	High	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*serious (based on outcome)* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*not observed* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Hidayat et al. (2020)	Cross-sectional	Low	Risk of bias---*no serious bias*	Large consistent effect---*not observed*	+++ Moderate

Author (Year)	Study Design	GRADE Step 1 A priori ranking	GRADE Step 2a Downgrade	GRADE Step 2b Upgrade	STEP 3 Quality of Evidence
			Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Dose response---*not observed* Confounders only reducing size of effect---*not observed*	
Jin & Je (2021)	Cross-sectional study	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*large* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Kim & Kim (2017)	A prospective, community-based cohort study	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*large* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate

Author (Year)	Study Design	GRADE Step 1 A priori ranking	GRADE Step 2a Downgrade	GRADE Step 2b Upgrade	STEP 3 Quality of Evidence
Kyung Won & Wookyoun (2017)	Cross-sectional	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*large* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Lago-Sampedro et al. (2019)	Cross-sectional	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*large* Dose response---*observed* Confounders only reducing size of effect---*observed*	+++ Moderate
Mena-Sánchez et al. (2018)	Cross-sectional	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision*	Large consistent effect---*not observed* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate

Author (Year)	Study Design	GRADE Step 1 A priori ranking	GRADE Step 2a Downgrade	GRADE Step 2b Upgrade	STEP 3 Quality of Evidence
			Publication bias---*undetected*		
Sangah et al. (2017)	Cross-sectional	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*not observed* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Schmidt et al. (2021b)	Randomized Controlled trial	High	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*not observed* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Schmidt et al. (2021a)	Randomized Controlled Trial	High	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness*	Large consistent effect---*not observed* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate

Author (Year)	Study Design	GRADE Step 1 A priori ranking	GRADE Step 2a Downgrade	GRADE Step 2b Upgrade	STEP 3 Quality of Evidence
			Imprecision---*serious imprecision (based on the outcome, use of area under the curve)* Publication bias---*undetected*		
Trichia et al. (2020)	Prospective study	Low	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*no serious imprecision* Publication bias---*undetected*	Large consistent effect---*not observed* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	+++ Moderate
Vien et al. (2019)	RCT	High	Risk of bias---*no serious bias* Inconsistency---*no serious inconsistency* Indirectness---*no serious indirectness* Imprecision---*serious imprecision (based on the outcome, use of area under the curve)* Publication bias---*undetected*	Large consistent effect---*not observed* Dose response---*not observed* Confounders only reducing size of effect---*not observed*	++++ High

CHAPTER III

COMPARISON OF DIETARY ASSESSMENT METHODS

Introduction

Dairy foods are animal milk-derived products (Barrubes et al., 2018), available as solids or liquids, and are fermented or non-fermented. Milk, cheese, and yogurt are the most frequently consumed dairy products (Soedama-Muthu & Guo, 2020). Like other foods, measuring the consumption of dairy products can be challenging during dietary assessments because individuals must document or recall their food in natural, unrestrained settings. In some instances, assessment requires the guidance of trained personnel to estimate the amount and frequency of the foods and nutrients consumed correctly (Martin et al., 2014). Estimating consumed food is more difficult for fluid-based foods than solid foods because fluids take the shape of containers (Amoutzopoulos et al., 2020). However, dietary intake measurement has become a crucial epidemiologic tool relevant to healthcare delivery. The relationships between food intake and health conditions have been established using dietary intake assessment instruments (Park et al., 2018).

There are multiple ways to measure dietary intake (Shim et al., 2014). This review considers the strengths and weaknesses of the different nutritional assessment instruments, such as the 24-hour dietary recall, the food record, the food frequency questionnaires (FFQ), and diet screeners. The author presents a rationale for the most appropriate measure for collecting data on dairy consumption in people diagnosed with metabolic syndrome. The selected measure is a diet screener used to assess the consumption of specific portions of diet over time.

The 24-hour Dietary Recall

The 24-hour dietary recall measures foods and drinks consumed in the past 24 hours of a given day (DeBiasse et al., 2018). This method of food assessment uses open-ended questions, which allow respondents to provide detailed information about what they have consumed, the time of day of consuming the food, and how they prepared food (Thompson et al., 2015). Since the recall is relatively short, responders can estimate the portion sizes of food consumed in absolute rather than relative terms (DeBiasse et al., 2018). For this reason, it is the "least biased of the self-report instruments, including the food record, the FFQ, and the screeners (Thompson et al., 2015; p. 1991)." However, to obtain representative dietary information from respondents, it is recommended that respondents provide more than one recall on different and non-successive days, with some scholars suggesting six to nine recall days, especially in the adolescent population (St. George et al., 2016). The multiple days' 24-hour recalls help to account for the changes in food consumed on different days, seasons, and occasions (Knüppel et al., 2019).

Typically, a trained interviewer administers the 24-hour dietary recall and guides respondents. This tool reduces the burden of reading through the questions, helping individuals with lower literacy levels provide food consumption information to the interviewer (Hughes et al., 2017). Another vital advantage the 24-hour dietary recall possesses over the other forms of measure is fewer measurement errors (Hewawitharana et al., 2018). Measurement error occurs when there is a discrepancy between the observed and the actual value (Thompson et al., 2015). It is somewhat prone to random errors (where there is an issue with measurement accuracy, but it does not necessarily alter the sample average,

However, some challenges come with using the 24-hour dietary recall measuring instrument. Chief among these challenges is cost (Subar et al., 2020). The cost of using the 24-hour dietary recall instrument comes from the training and use of interviewers to collect and code data. Nevertheless, this challenge has been mitigated with the advent of automated self-administered devices such as the National Cancer Institute's (NCI) automated self-administered 24-hour dietary assessment tool (Subar et al., 2012; Hughes et al., 2017). However, measures like the ASA24 do not eliminate the participant burden associated with repeating the data collection procedure on up to nine different days to obtain a representation of the food consumed (St. George et al., 2016). In addition, eliminating the role of interviewers results in excluding individuals with lower literacy levels who cannot use automated instruments like the ASA24 (Hughes et al., 2017). The 24-hour dietary recall depends on "episodic memory," where specific events are required to provide details of the food consumed (DeBiasse et al., 2018; p. 301).

The Food Record

The food record is a prospective dietary assessment tool that records food consumption in real time, including the time of the day and details about food preparation (Park et al., 2018). Data are collected over more than one day, with some studies suggesting three days while others suggest four days. Data can be collected on consecutive or nonconsecutive days (Subar et al., 2020; Akimoto et al., 2019). The reliance on real-time recording reduces the dependence on memory, which reduces the risk of recall bias. The amount of food consumed can be recorded by estimation based on portion size aides or by weighing using a weighing scale (NCI, 2020). This instrument possesses qualities similar to the 24-hour dietary recall measuring instrument (Subar et al., 2020). It has fewer measurement errors and is less prone to systematic bias (i.e., a measurement error where the observed value and the actual value are consistently broad, affecting the sample mean; NCI, n.d.). However, the food record is self-administered, unlike the 24-hour food measure (NCI, 2020).

The food record measure shares some common limitations with the 24-hour dietary recall. Cost of use is a significant drawback for the food record measuring tool, especially for the coding of data collected (Subar et al., 2020). The reason is that, for the most part, the measure is paper-based, open-ended, and handwritten (Park et al., 2018). For this reason, the food record measure is not practical for use in a larger sample size (Akimoto et al., 2019). A food record may not necessarily record an individual's "habitual" dietary intake (Takechi et al., 2018; p. 460; Akimoto et al., 2019). Respondents tend to change their dietary behavior during food record data collection because of the awareness that food intake is being monitored. This behavior change is known as reactivity bias (Ji et al., 2020). In weight reduction efforts, this bias can be positive.

The Food Frequency Questionnaire (FFQ)

The FFQ is a self-administered dietary assessment instrument that measures food consumed over a more extended period, typically a month or a year (Shim et al., 2014). With the ability to capture food consumed over a long period, the FFQ can characterize the regular diet of respondents (Takechi et al., 2018). In addition, the FFQ measures the frequency of food taken and sometimes collects information on the portion sizes of those foods (Thompson et al., 2015). It covers a wide range of food and drinks, typically including 100-200 food items (DeBiasse et al., 2018).

The FFQ is the preferred measure for epidemiological studies on chronic diseases compared to the 24-hour dietary recall and the food record. The FFQ helps assess long-term exposure to diets attributed to health conditions (Shim et al., 2014). The FFQ is the measure of choice for measuring dietary intake in a large sample size. However, it is not because it is the most accurate. Instead, it is challenging to use either food records or 24-hour dietary recall in terms of the cost and the coding of data (Subar et al., 2020). The challenge with measurement errors stems from its reliance on long-term memory (Shim et al., 2014). Respondents must calculate the frequency of food intake from the past month or year. Respondents are required to estimate portion sizes from the past. All these culminate in a measurement outcome of either a lower or higher estimate of the food consumed (Kirkpatrick et al., 2017). These cascading errors lead to a systematic error that causes a deviation from the actual value (Thompson et al., 2015). While these biases/errors are valid for the FFQ, studies regarding underestimating energy and proteins have revealed similar challenges with both the 24-hour dietary recall and the food record instruments. Evidence points to the underestimation of energy and protein intake when 24-hour dietary recall and food records were validated with the doubly labeled water (DLW) and urinary nitrogen, respectively. The 24-hour dietary recall underestimated energy by 3 to 34% and ranged from 11% to 28% for protein. Dietary data obtained with the food record underestimated protein and energy by 4 to 37% (Thompson et al., 2015).

A significant challenge in using FFQ is respondents not completing all the questions on the instrument (Shim et al., 2014). This challenge is attributed to the number of items on the FFQ, which takes significant time to complete (DeBiasse et al., 2018). Serra-Majem et al. (2009) term this challenge of not finishing the FFQ as a "fatigue response (p. S50)." Another weakness of the FFQ is the inability to assess seasonal foods consumption because respondents might not consistently consume some of the foods on the list. Seasonal foods are not readily available and, therefore, not consumed frequently (Shim et al., 2014). However, this challenge is its strength because the FFQ can capture episodically consumed foods (Thompson et al., 2015). Nevertheless, the issue with the number of items on the FFQ has led to the recommendation that FFQs with a shorter list, like the screeners, where items focus on a particular portion of the diet, be used in research (Thompson et al., 2015).

The Screeners

The screeners are short dietary measures that assess specific diet portions for a month or a year (Thompson et al., 2015). They are shorter adaptations of the FFQ (Bleiweiss-Sande et al., 2017). Screeners possess many of the characteristics of the FFQ, including some of the FFQ advantages and disadvantages (Thompson et al., 2015). Like the FFQ, the screeners face measurement errors and recall bias (Thompson et al., 2015). However, with limited items, screeners do not have challenges like the fatigue response associated with the FFQ (Serra-Majem et al., 2009). It can take less than 15 minutes to complete (Thompson et al., 2015). Screeners can be adapted to accommodate the eating habits of a particular group of people (Bleiweiss-Sande et al., 2017). Screeners can be used in every research method but are more appropriate for assessing food consumption in a cross-sectional study because they can provide a snapshot of food consumed among a population at a specific time (Thompson et al., 2015). Screeners are used as behavioral questionnaires to assess general dietary practices, sometimes presented as true or false questions. The other nutritional instruments do not offer these features (Thompson et al., 2015). A summary of the strengths and weaknesses of the dietary assessment is in Table 3.

Instrument Selection

Different dietary assessment measures and research methods can be used for various reasons. Akimoto et al. (2019) suggest food record may be used to assess actual food consumption because it measures food in real-time. They argue that the food record is appropriate for a randomized clinical trial (RCT) study. The data generated during the study period can be a reference during the analysis of components of investigational products (Akimoto et al., 2019). Studies point to the effect of the 24-hour dietary recall in describing the diet of a population. The 24-hour dietary recall is appropriate for evaluating the average consumption of a population (Thompson et al., 2015). Therefore, the 24-hour can estimate, on average, the food most consumed on a particular day which makes it appropriate for cross-sectional research (Thompson et al., 2015). The FFQ is the most appropriate measure to assess dietary consumption in the past, where specific details are hard to recall (Thompson et al., 2015). Thompson et al. (2015) suggest that the dietary screener can be used for all research methods when assessing frequency information for specific food consumption. However, the screener is most appropriate when the dietary assessment does not estimate energy consumption (Thompson et al., 2015).

One of the aims of this study was to assess the consumption of dairy products and whether adult metabolic syndrome patients met the daily dairy recommendation in the past month. To achieve the research aim, dairy products' frequency, and serving size had to be measured. A 24-hour dietary recall can be used to assess those who meet the daily dairy recommendation and will require respondents to give details of dairy consumed in the past 24 hours on a random day. However, assessing for recommendation on any day may not capture habitual dairy consumption (St. George et al., 2016). Individuals who did not consume dairy products in the past 24 hours would have missing data. Food records will produce similar data to 24-hour dietary recall and miss data for the days dairy products were not ingested. The food record will not provide enough data to capture habitual dairy consumers. The FFQ will include other items that may not be relevant to dairy products, increasing the burden on respondents (DeBiasse et al., 2018

The dietary screener is the most appropriate instrument for measuring dairy consumption among individuals diagnosed with metabolic syndrome. Because it provides respondents with the options of frequency and the serving size for a specific food type of interest, dairy products. The data required will not be used to estimate the energy consumed by respondents (Thompson et al., 2015). In addition, using the screener to assess the frequency and serving size of dairy product consumption was cost-effective compared to the other instruments. Screeners provide an avenue to collect data within the shortest possible time without burdening respondents, even without cash or material rewards.

Reviewing the Selected Measure for the Survey

The screener used in this study was adapted from the validated National Cancer Institute's (NCI) diet history questionnaire (DHQ) III. The DHQ III is a food frequency questionnaire released in 2018 to update the DHQ I & II and used for adults of ages 19 and above. The DHQ III is a 135-item food and beverages and 26 dietary supplement question. The validity and reliability of the DHQ III are based on the validity and reliability studies conducted on the DHQ I because they both have similar methods for collecting data on food consumption (Subar et al., 2001). In a study to assess the validity of the DHQ, Thompson et al. (2002) observed that it was more accurate than the NCI's Block Health Habits and History Questionnaire (HHHQ) because the DHQ asked about individual foods during the HHHQ nested foods together. Subar et al. (2001) compared the DHQ to the Block FFQ and the Willet purple form FFQ with 24-hour recall as a validation reference. They observed that the DHQ was as good as the Block FFQ and better than the Willet FFQ, measuring energy intake with correlations of 0.48, 0.45, and 0.18, respectively, for women and 0.49, respectively 0.45, and 0.21, respectively, for men.

The screener could collect a long-term retrospective diet history on specific diet portions from one to 12 months (Thompson et al., 2015). In this study, individuals with metabolic syndrome provided information about their previous dairy product consumption over the past month, adapting the components of the DHQ III that enquire about dairy consumption.

Table 3

Comparing the Different Dietary Measures

Measures	Strengths	Weaknesses
24-hour recall	• Short-term memory recall • Reduced chances of recall bias • Uses open-ended questions • Provides contextual details: quantities of food • The least biased of the self-report instruments • Few measurement errors	• Requires trained personnel to administer • Depends on episodic memory • Possible interviewer bias • Expensive and time-consuming • Multiple days are required to assess the usual intake
Dietary/food record	• Prospective: does not rely on the memory • No recall biases • Open-ended questions • Provides contextual details • provides accurate quantities • No interviewer required • Use for validating FFQ • Few measurement errors	• Costly: repeated measurement, data entry, and analysis • Time-consuming • Reactivity bias: change in dietary behavior • Multiple days are required to assess the usual intake
FFQ	• Low cost • Capability to characterize the	• Use of fixed lists of foods with closed-ended questions • The effect of memory (recall bias)

Measures	Strengths	Weaknesses
	usual diet in the past up to a year	
	• Captures episodically consumed foods	• difficulties in portion size estimation
	• Mostly be self-administered	• Measurement bias: under/over estimation of portion sizes
	• Minimize the risk of interviewer bias	• Systematic error: deviation from true values
	• Can be focused on both whole diet and nutrients	• Interpretation of questionnaires
	• Can be administered to a large population at a time	• Does not capture details of food
	•	• Fatigue response
Screeners	• Low cost	• Use of fixed lists of foods with closed-ended questions
	• A shorter list of items	• The effect of memory (recall bias)
	• Can be completed in a short time	• difficulties in portion size estimation
	• Mostly be self-administered	• Measurement bias: under/overestimation of portion sizes
	• Minimize the risk of interviewer bias	• Systematic error: deviation from actual values
	• Focusses on a portion of the diet	• Does not capture details of food
	• Can be administered to a large population at a time	•

Adapted from "Dietary Assessment Primer, Comparing dietary assessment instruments," by National Institutes of Health, National Cancer Institute. (https://dietassessmentprimer.cancer.gov/).

CHAPTER IV

BARRIERS AND FACILITATORS OF DAIRY CONSUMPTION AMONG INDIVIDUALS WITH METABOLIC SYNDROME

Background/Significance

About 35% of the United States adult population meets the criteria for metabolic syndrome, representing about 85 million individuals (Moore et al., 2017; Ramphal et al., 2014). Dairy product consumption has been shown to protect against metabolic syndrome development. In those with the syndrome, it reduces their risk of complications such as developing type 2 diabetes mellitus, cardiovascular diseases, and cancer (Babio et al., 2015; Martins et al., 2015).

However, in the general population, about 90% of Americans in the U.S. do not meet the daily dairy consumption recommendation (USDA, 2020). The recommended intake of dairy products is three cup-equivalents in a day. A cup equivalent is one cup (about 8 ounces) of milk or yogurt, one and a half ounces of natural cheese, or two ounces of processed cheese (USDA, 2020). Previous studies attribute low dairy consumption to many factors, with lactose intolerance being the major contributor (Brown-Riggs, 2016; Barr, 2013; Nicklas et al., 2011). Other barriers include cost, taste, the lack of knowledge about the recommended levels, and the lack of knowledge about dairy's health benefits. Another significant barrier to consuming dairy is the perception that all milk products are fattening (Mobley et al., 2014; Nicklas et al., 2013). Some individuals do not consume dairy products because of their nutritional culture (Mobley et al., 2014), and such individuals did not grow up with dairy products as their food staple. Others believe there is no need for dairy products in adulthood because dairy is more beneficial to children. The taste of some dairy products was identified as a barrier, although this barrier is peculiar to low-fat milk (Mobley et al., 2014).

Conversely, among individuals who consume dairy products, the facilitators include the affordability, accessibility, and availability of dairy products (Nicklas et al., 2013). Another enabler of dairy product use is the health benefits such as bone health, and this health benefit prompts some older adults to consume dairy products (Park et al., 2019; Mobley et al., 2014).

Studies about metabolic syndrome patients and dairy consumption are usually randomized clinical trials (RCT). Participants are given dairy or its derivatives as an investigational product (Vien et al., 2019; Schmidt et al., 2021a). This research approach likely results in the participants practicing good health behaviors to get the best outcomes since they know their activities are monitored. Other study approaches assess individuals' dairy consumption over time in prospective and cross-sectional studies (Trichia et al., 2020; Jin & Je, 2021). The prevalence of the metabolic syndrome is then assessed for differences in dairy consumption over a specific period.

However, data about dairy consumption among individuals diagnosed with metabolic syndrome is scarce. There is not enough information about whether these individuals meet the daily dairy consumption recommended by the Dietary Guidelines for Americans 2020 (United States Department of America, USDA, 2020). Yet, this group will most likely benefit from the protective effect of dairy consumption against metabolic syndrome and subsequent health complications, such as heart diseases, cancers, and diabetes mellitus.

Therefore, this study aims to assess dairy product consumption and explore the factors that hinder or enhance their consumption among individuals with metabolic syndrome. A vital concept of the Health Promotion Model is the perceived barriers to action (defined as “the perceptions of blocks, hurdles, and personal costs of undertaking a health behavior” Pender, 2011, p. 4). This concept, in part, can elucidate why individuals do not undertake specific health-promoting behaviors (Khoshnood et al., 2018).

Specific Aims:

1. To determine if individuals with metabolic syndrome meet the daily dairy consumption requirement;
2. To explore the relationship among biological or sociocultural factors and meeting the daily dairy consumption recommendation;
3. To determine the barriers to and facilitators of dairy consumption; and
4. Determine predictors of dairy consumption in people with metabolic syndrome.

Research Questions:

1. Do adults living with metabolic syndrome meet the daily recommendations for dairy consumption?
2. Do age, sex, race, income, and education level predict dairy consumption (ability to meet the recommendation) among individuals with metabolic syndrome?
3. What factors facilitate or hinder the consumption of dairy products among adult metabolic syndrome patients?

Using the HPM theoretical framework as the research guide, the fundamental concept of interest, perceived barriers of action was used to assess the hindrances to consuming dairy products. The relationship between personal factors and daily dairy consumption was explored. Figure 3 shows a conceptual framework adapted from the HPM theoretical framework (in Figure 2) delineating the influence of perceived barriers and personal factors on behavioral outcomes.

The concept of perceived barriers to and facilitators of dairy consumption was measured with an investigator-developed questionnaire reviewed and approved by the Dissertation Committee of the investigator. For each dairy product, respondents were required to respond to statements by selecting potential barriers and facilitators to determine the extent to which they agreed or disagreed they hindered or enhanced dairy consumption (Appendix A).

Methods

A cross-sectional survey design was used to assess respondents' dairy consumption in the past month and assess the perceived barriers to and facilitators of consuming dairy products.

Sample and Recruitment

A convenience sample (N=180, aged 18 years and above) diagnosed with metabolic syndrome or who met the criteria for metabolic syndrome. The required sample size was calculated from an online power analysis application (Statistic Kingdom, n.d.). With a power of 0.80, significance level $\alpha = 0.05$, and eight predictors, the study required a minimum sample size of 114 to detect a moderate effect size of 0.30 for multiple regression analysis. The estimations for the effect size, significance level, and power used in the sample size calculation were adapted from previous studies (Polit & Beck, 2021). Ten additional individuals were added to enhance the chances of obtaining the sample size (N =124) should they decide not to complete the entire questionnaire.

The online recruitment platform was necessary because the COVID-19 pandemic had significantly restricted participant recruitment via typical venues. The ResearchMatch online platform has over 157,000 volunteers and is accepted by the institutional review boards (IRB) of 187 institutions, including the University of Louisville (Harris et al., 2012). A feasibility study on the online platform revealed about 280 volunteers diagnosed with metabolic syndrome and about 1480 volunteers who met at least two of the five metabolic syndrome criteria.

Eligibility Criteria

Inclusion criteria for participants were (a) age 18 years and older; (b) being able to speak, read, and write English; and (c) meeting criteria for metabolic syndrome as defined by the joint scientific statement on metabolic syndrome:

> 1) elevated waist circumference (≥88 cm for women and ≥102 cm for men), 2) elevated triglycerides (≥150 mg/dL) or drug treatment for elevated triglycerides, 3) low HDL cholesterol (<40 mg/dL for men and <50 mg/dL for women) or drug treatment for low HDL cholesterol, 4) elevated blood pressure (systolic ≥130 mm Hg, or diastolic ≥85 mmHg, or both) or antihypertensive drug treatment for a history of hypertension, and 5) elevated fasting glucose (≥100 mg/dL) or drug treatment for elevated glucose. (Moore et al., 2017; p. 2)

Protection of Human Subjects

The University of Louisville's Human Subjects Protection Program (HSPP) officially approved the dissertation with IRB #22.0070 on March 8, 2022. ResearchMatch required proof of the Human Subjects Protection Program office's clearance to conduct the study and had research liaisons from the University of Louisville's HSPP corroborate this approval. Recruitment started after obtaining these ethical clearances.

Study Design

This study was conducted to answer the three questions as stated in Chapter 1. To answer Question #1, "How often do adult metabolic syndrome patients consume dairy products?" the questionnaire adapted from the DHQ III asked individuals living with metabolic syndrome to provide information about their dairy consumption in the past month. The survey included queries about the frequency and portion size of the dairy product consumed. (Appendix A). Data for Question #2, "Do age, sex, race, income, and education level predict dairy consumption (ability to meet recommendation) among individuals with metabolic syndrome?" were collected using variables adapted from the National Health and Nutrition Examination Survey (NHANES) 2017-2018 data documentation, codebook, and frequencies (2020). Question #3, "What factors facilitate or hinder the consumption of dairy products among adult metabolic syndrome patients?" was answered using an investigator-developed questionnaire (Appendix A).

Reviewing the Survey Content

The survey used for collecting data had three components, the demographic section, the dairy consumption section for each dairy product, and the barriers and facilitators section for each dairy product. The dietary screener was selected because it was appropriate for this cross-sectional study, providing respondents with options for selecting the relevant frequency and serving sizes for each dairy product they had consumed in the past month. And there was no need to estimate the energy consumed by respondents (Thompson et al., 2015). The short nature dietary screener made adding the other sections of the survey easier to help respondents answer the questionnaire without being overburdened by the number of items to respond to.

A self-reported demographic information questionnaire was adapted from the NHANES (2020) 2017-2018 data documentation, codebook, and frequencies. It included age, race, sex, educational level, and annual household income. Age was measured as a continuous variable in years. Race had five categories: Mexican American, Non-Hispanic Black, Non-Hispanic White, Other Hispanic, and Other races. Other races in this context meant non-Hispanic Asians and non-Hispanic multiracial groups. Education level had five categories: Less than 9th grade, 9th -11th grade, High School graduate/GED, some college or associate degree, and college graduate or above. There were seven categories for annual household income, including Less than $20,000; $20,000 to $29,999; $30,000 to $39,999; $40,000 to $49,999; $50,000 to $59,999; $60,000 to $69,999; and above $70,000 (NHANES, 2020). These demographic factors were selected because they measured the personal factors stated in the HPM theoretical framework underpinning this study. Inclusion in the survey was supported by previous evidence, which points to the influence of age, sex, race, education level, and income level on dairy consumption among the general population. Evidence in epidemiological studies suggests that age can influence the consumption of dairy products Kyung Won and Wookyoun (2017). Other studies observed that even among those who consumed dairy products, age determined the type of product to ingest (Lago-Sampredo et al., 2019). Nicklas et al. (2011) observed a more perceived lactose intolerance pattern in females than males. A similar observation was made for race, as more non-Whites perceived lactose intolerance than Whites, which became a barrier to consuming milk (Nicklas et al., 2011). Another study observed education level influenced people's choice of the fat contents of dairy products. Those with a college education chose low-fat dairy compared to those without a college education (Robb et al., 2007). In the same study, individuals with a lower income level were less likely to consume low-fat dairy products (Robb et al., 2007).

The final part of the survey measured perceived barriers to and facilitators of dairy consumption. An investigator-developed questionnaire was reviewed and approved by the Dissertation Committee. Reviewing the literature, the factors to measure perceived barriers and facilitators of dairy consumption were identified (Brown-Riggs, 2016; Mobley et al., 2014; Barr, 2013; Nicklas et al., 2013; Nicklas et al., 2011). But these factors were assessed in different populations and were included to be tested among metabolic syndrome patients.

The study participants were recruited from the ResearchMatch online platform. The platform provided respondents access to the survey. Participants had access to the survey on RedCap directly from ResearchMatch, and data were downloaded in Microsoft Excel and SPSS formats for analyses (Harris et al., 2012).

Data Analysis

Quantitative data were analyzed using the Statistical Package for the Social Sciences (SPSS) software version 29 (IBM Corp., Armonk, New York). The data included demographic information, the frequency and serving portion of dairy products consumption, and the barriers and facilitators to dairy consumption. The data provided descriptive statistics, which were then analyzed to answer each of the three research questions. The analysis included the demographic background (i.e., age, sex, education level, and household income) of respondents and the variable that confirms whether respondents met the daily dairy recommendation (Appendix A).

Finally, the third research question was analyzed using regression analysis. Multiple regression was conducted to explore the relationship between the factors that measured the perceived barriers and facilitators and the number of cup equivalents consumed per day for each dairy product. The factors that measured the perceived barriers were lactose intolerance (milk only), knowing the recommended amount, cost, and taste; dairy is fattening; dairy not an important part of the diet, and dairy is beneficial to kids. The factors that measured the perceived facilitators included affordability, difficult accessibility, availability, and awareness of health benefits. The full detail of these factors is in Appendix A.

Aim 1: Dairy Recommendations

The dairy products included in the analysis were milk, yogurt, and cheese. These are the products that fall within the recommendations from the United States Department of Agriculture (USDA). The recommended intake of dairy products is three cup-equivalents a day. A cup equivalent is one cup (8 ounces) of milk or yogurt, one and a half ounces of natural cheese, or two ounces of processed cheese (USDA, 2020). A series of analyses were conducted to check for respondents who met the recommendation. First, the number of times each product was consumed in the past month was calculated. The average of each answer option in the survey, requiring the number of times each product was consumed, was calculated. Then the amount of the product consumed was expressed in ounces. The amount of dairy consumed for each day was calculated by multiplying the number of times and the amount whenever consumed and dividing them by 30 days $\frac{(\# \; of \; times * \; amount)}{30}$ = Amount consumed per day. Secondly, the number of cups consumed per each dairy product was calculated by dividing the amount consumed per day by 8 ounces for milk and yogurt and 1.5 ounces for cheese: $\frac{amount \; consumed \; per \; day \; (oz)}{8 \; or \; 1.5 \; oz} * 1 \; cup$ = # of cups consumed per day. Finally, the number of cups consumed for each dairy product was summed up to check for respondents who met the recommendation: # of cups consumed per day (milk) + # of cups consumed per day (yogurt) + # of cups consumed per day (cheese) = Recommended amount. Respondents who had at least 3 cups of dairy consumed were considered as meeting the dairy recommendations per day. In contrast, those with fewer than three did not meet the daily dairy recommendation.

Aim 2: Biological or Sociocultural Factors and Dairy Recommendation

A simultaneous logistic regression analysis was conducted to test the model that predicted the outcome of meeting the daily dairy consumption recommendation. The demographic data (i.e., age, race, sex, educational background, and annual household income) were the predictor variables, with age, sex, and race constituting the biological variables and education and income representing the sociocultural variables. Race, educational background, and annual household income were each re-coded into two categories. The re-coding for each variable was necessary after the frequency analysis revealed the data were not evenly distributed and were negatively skewed. Therefore, race was categorized into Whites and non-Whites. The education level was categorized into those with no college education and those with a college education or above. The household income categories were those earning below $70,000 and those earning $70,000 and over annually, based on the U.S. median household income (Semega & Kollar, 2022). The outcome variable was the daily dairy recommendation, which had two categories: respondents who met the recommendation for daily dairy consumption and those who did not. Details of the creation of this variable are described above (Aim 1).

Aims 3 & 4: Perceived Barriers and Facilitators

The perceived barriers to and facilitators of dairy consumption were assessed by conducting a frequency analysis to determine the number of respondents who estimated to what extent they agreed or disagreed with a statement about each dairy product. Simultaneous multiple regression analyses were conducted to explore the relationships between the factors that measured the perceived barriers and facilitators and the number of cup equivalents consumed daily for each dairy product. The factors that measured the perceived barriers were lactose intolerance (milk only), knowing the recommended amount, cost, and taste, fattening, dairy not being an important part of diet, and dairy being beneficial to kids. The factors that measured the perceived facilitators included affordability, difficult accessibility, availability, and awareness of health benefits. The details of these factors can be found in Appendix A.

For each dairy product, the factors that measured the barriers and facilitators to consuming became the predictors, and the number of cups consumed for each product was the outcome. ANOVA was conducted to determine if there is a linear relationship between each set of factors measuring the barriers or the facilitators and the number of cups of their corresponding dairy product consumed in a day. The hypotheses for these were as follows:

Null hypothesis: hypothesized that the overall set of factors measuring the barriers and facilitators of each dairy product will be equal to zero.

i.e., H_0: $\beta_1 = \beta_2 = \cdot \cdot \cdot = \beta_k = 0$

Alternate hypothesis: hypothesized that at least one of the factors measuring the barriers to and facilitators of each dairy product will not be equal to zero.

H_1: $\beta_j \neq 0$ for at least one j, where j = each factor that measured perceived barriers or perceived facilitators.

Results

The total number of participants who responded to the online survey was 180, with an average age of 37.8 (SD±10.6) years. The majority of respondents were males (71.1%), identified as Whites (88.3%), and had some college education or an associate degree (83.3%). Most respondents (84.4%) reported living in a household with an income of at least $50,000 annually. The participants' average body mass index (BMI) was 25.3 (SD±10.23) kg/m^2. Most respondents (52%) had a normal BMI; 11.9% were underweight, 19.8% were overweight, and 16.4% were obese. Detailed demographic data and BMI categories of the participants are presented in Table 4.

Aim 1 - Dairy Recommendation

The mean milk intake among respondents was 2.38 (SD ± 2.67) cup equivalents per day. This amount suggests that if respondents consumed milk alone each day, they would be less than a cup away from meeting the daily dairy consumption recommendation. The average yogurt intake in this sample was 0.54 (SD ± 0.52) of a cup equivalent per day, and the respondents averaged about two (2.02; SD ± 1.98) cup equivalents/oz/slices of cheese per day. The average total amount of dairy consumed by respondents was 4.95 (SD $\pm$ 4.58) cups per day. About 48.9% of the respondents met the USDA dairy recommendation of three cups daily. Among participants who completed the daily dairy recommendation, about 78.4% were males, 86.4% were Whites, 97.7% had at least some college education, and 84.1% were from households with an annual income of less than $70,000 (Table 5).

Aim 2 - The relationship between Demographic Factors and Daily Dairy Recommendation.

Based on the demographic data obtained, a logistic regressional analysis was conducted to assess the likelihood of meeting the daily recommendation for dairy products. The demographic variables included age, sex, race, level of education, and annual household income. The analysis revealed the model containing all demographic variables was statistically significant and was able to distinguish between respondents who met the daily dairy recommendation and those who did not (χ^2 [5, N = 180] = 58.31, $p < 0.001$). The model explained between 27.7% (Cox and Snell R^2) and 36.9% (Nagelkerke R^2) of variance in meeting the daily dairy consumption recommendation, correctly classifying 71.1% of cases. The analysis revealed three of the five demographic variables made a unique statistically significant contribution to the model. These were age, level of education, and annual household income. Of these three variables, the level of education was the strongest predictor for meeting the daily dairy recommendation. Respondents who reported having at least a college degree were 15.32 times more likely to meet the daily dairy recommendation (OR: 15.32, CI [3.28, 71.54], $p < 0.001$). Respondents from households with an annual income of less than $70,000 were 2.1 times more likely to meet the daily dairy recommendation than those with more than $70000 yearly household income (OR: 3.10, CI [1.36, 7.09], $p = 0.007$). Finally, one year increase in age resulted in 7.7% lesser odds of meeting the daily dairy consumption recommendation (OR: 0.92, CI [0.88, 0.97], $p < 0.001$). Details of the findings are in Table 6.

Aims 3 & 4 - Perceived Barriers and Facilitators

The null hypotheses were rejected after ANOVA was conducted. The alternate hypotheses that at least one of the factors measuring the barriers to and facilitators of each dairy product will not be equal to zero were accepted. The *p*-values for each one of the analyses were less than 0.05 ($p<0.001$).

Milk consumption

The survey assessing the barriers to milk consumption among the participants with metabolic syndrome revealed that 126 (70%) respondents reported lactose intolerance. Respondents who did not know the recommended amount of milk to consume daily constituted 12.2%. About 33.3% responded, finding the milk cost relatively high, and 23.3% said they had difficulty with the milk taste. Participants who considered milk to be fattening constituted 30.6% of respondents. About 27.2% of participants noted milk was not essential to their diet. Finally, 25% of participants agreed with the statement that milk is beneficial to kids and not adults.

On the other hand, respondents provided answers to what they perceived to be the facilitators of milk consumption. There were 159 (88.3%) respondents who found milk affordable. But 27.3% agreed they have difficulties accessing milk, and 164 (91.1%) participants answered they have milk available whenever needed. Lastly, 161 (89.4%)

respondents revealed they knew about the health benefits associated with milk consumption (Table 7).

Relationship Between the Perceived Barriers and Facilitators, and Milk Consumption

A simultaneous multiple regression analysis revealed the factors measuring either the barriers to or the facilitators of consumption of each dairy product. The model, which included the seven factors measuring perceived barriers to consuming milk as the predictor variables, explained 31.8%, [$R^2 = 0.318$, $F\,(7, 172) = 12.91$, $p < 0.001$] of the variance in the number of cups of milk consumed in a day (the outcome variable). The R^2 represents the effect size of the model. The effect size of this model was 31.8% and suggests the factors measuring perceived barriers to consuming milk had a significant impact on milk consumption (Hatcher, 2013). The analyses revealed no multicollinearity (Pearson correlation > 0.80) among these seven predictors measuring the perceived barriers to consuming milk. The lack of multicollinearity suggested that the factors measuring perceived barriers to drinking milk independently predicted the daily cups consumed.

Both the Tolerance and Variance inflation factor (VIF) results revealed no predictor variable had values less than 0.10 (for Tolerance) or greater than 10 (for VIF), respectively. These results suggest how much of the variability of one predictor is explained by another predictor in the same model (Hatcher, 2013; Pallant, 2016). In this model, three of the seven factors were statistically significant, with the factor measuring "I know the recommended amount of milk to drink daily" making the highest significant unique contribution to explaining the number of cups of milk consumed in a day (standardized beta (β) = 0.27, $p < 0.001$). This significant unique contribution suggests the factor that measures the perceived barrier to consuming milk contributes about 27% in predicting the outcome, the number of cups consumed daily, at $p < 0.05$ significance level. And beta (β) equals 27%, the standardized coefficient of the factor. However, the unstandardized beta (b) for this factor was 2.231, meaning there was a positive relationship between this factor and the number of cups of milk consumed daily. This figure 2.231 suggests respondents who knew the recommended amount of milk were likely to drink 2.231 times more cups of milk in a day than those who did not (Hatcher, 2013; Pallant, 2016). The other two predictors that were statistically significant included the factors measured by "I find the cost of milk quite high" ($\beta = 0.24$, $p = 0.003$) and "I am lactose intolerant" ($\beta = 0.23$, $p < 0.001$). Both factors had positive relationships with the outcome with unstandardized beta b-values of 0.699 and 1.307, respectively. These values imply that those who strongly agreed that the cost of milk was relatively high consumed four times more cups of milk per day (4 * 0.699) than those who strongly disagreed with that statement. Those who were lactose intolerant drank 1.307 more cups of milk per day than those who did not.

The model that consisted of the factors measuring the facilitators for consuming milk predicted 34.3% of the variance in the number of cups of milk consumed in a day ($R^2 = 0.343$, $F(4, 175) = 24.38$, $p < 0.001$), representing a large effect size of the factors on the outcome. This model did not violate the multicollinearity assumption with no variable having a Pearson correlation above 0.80, Tolerance below 0.10, and VIF above 10. Out of the four predictors, three showed statistical significance at $\alpha = 0.05$. The factor measured by "I have difficulties accessing milk" had the highest unique contribution to explaining the number of cups of milk consumed in a day ($\beta = 0.53$, $p < 0.001$). The factor measuring "I find milk affordable" recorded a higher beta value ($\beta = 0.27$, $p < 0.001$) than "Milk is available whenever I need it" ($\beta = 0.22$, $p = 0.002$). The B-values for these three factors indicated a positive relationship between the factors and the number of cups of milk consumed daily. Respondents who perceived having difficulty accessing milk had 1.52 cups more milk than those who did not have that perception. Those who strongly agreed that milk is affordable had 1.015 cups more milk than those who only agreed to that perception and four times more than those who strongly disagreed. The rest of the factors measuring perceived barriers to consuming milk are in Table 8.

Yogurt Consumption

Participants provided feedback on the factors considered hindrances to their yogurt consumption. About 13.9% of respondents reportedly did not know the recommended amount of yogurt. Regarding the cost of yogurt, 35.5% found the price quite high. Those who responded having difficulties with the taste of yogurt constituted about 17.8% of the respondents. While 26.1% of participants thought yogurt was fattening. Other barriers to yogurt consumption included whether respondents found yogurt to form an essential part of their diet and whether yogurt benefited children but not adults. The participants who agreed or strongly agreed constituted 32.2% and 24.4% of participants, respectively. However, respondents agreed or strongly agreed to the following factors perceived as facilitators of consuming yogurt: the affordability of yogurt (86.7%), having difficulties accessing yogurt (25%), the availability of yogurt whenever they needed it (90%), and the awareness of the health benefits associated with yogurt consumption (88.3%). Further details of the results are in Table 9.

Relationship Between the Perceived Barriers and Facilitators, and Yogurt Consumption

The simultaneous multiple regression analysis was conducted to assess the relationship between the factors measuring the perceived barriers to consuming yogurt and the number of cups consumed daily. This analysis revealed the model comprising six-factor variables explained about 25.4% of the variance in the number of cups of yogurt consumed in a day ($R^2 = 0.254$, F (6, 173) = 11.18, $p < 0.001$). With this value, the R^2 predicts the model had a medium effect on the outcome. Two of the six factors revealed a statistically significant unique contribution to explaining the number of cups of yogurt consumed daily. These were factors measuring the perceived barriers to consuming yogurt and included “I know the recommended amount of yogurt to eat daily” ($\beta = 0.29$, $p < 0.001$) and “Yogurt is beneficial to children but not adults” ($\beta = 0.28$, $p = 0.002$). Therefore, with a total beta value of 0.57, these two factors correctly predicted about 57% of the cups of yogurt consumed daily at a $p < 0.05$ significance level. The two factors showed a positive relationship regarding the number of yogurt cups consumed daily. Those who knew the recommended amount of yogurt for a day consumed about half a cup more yogurt than those who did not. Those who perceived yogurt to benefit children and not adults appeared to eat about 1.3 ounces more than those who thought otherwise.

The model comprised four predictor variables that measured the perceived facilitators of yogurt consumption, explaining 14.4% of the variance in the number of cups of yogurt consumed in a day ($R^2 = 0.144$, F (4, 174) = 8.48, $p < 0.001$). With the R^2 value, the effect of the model on the outcome can be expressed as a medium effect. The factor measuring "I have difficulties accessing yogurt" was the variable in the model with a statistically significant and the strongest beta value ($\beta = 0.39$, $p < 0.001$). This factor that predicted the variance in the number of cups of yogurt consumed in a day did not violate the multicollinearity assumptions after the Pearson correlation values between predictors did not cross the threshold of 0.8, and no variable had a Tolerance and VIF value below 0.1 or above 10, respectively. Participants who agreed with this factor tended to consume 1.8 ounces more yogurt than those who disagreed. Details of the multiple regression results are in Table 10.

Cheese Consumption

Finally, 14.4% of respondents noted they did not know the recommended amount of cheese. Approximately 35% of the participants find the cost of cheese relatively high, and 22.8% encounter difficulties with the taste of cheese. About 30% of the respondents agreed or strongly agreed to find cheese fattening, and 27.3% reported cheese was not an essential part of their diet. Among the respondents, about 26.1% agreed or strongly agreed that cheese benefits children, not adults.

On the statements that sought to identify the enhancers of cheese consumption among participants, the responses revealed that 84.4% find cheese affordable. About 26.1% of respondents agreed or strongly agreed they have difficulties accessing cheese. Lastly, 86.7% had cheese available whenever needed, and 87.8% were aware of the health benefits of cheese consumption (Table 11).

Relationship Between the Perceived Barriers and Facilitators, and Cheese Consumption

A simultaneous regression analysis for both the sets of models for barriers and facilitators and the number of slices of cheese consumed in a day was conducted. The investigation revealed the six-factor variables explained about 14.8% (medium effect) of the variance in the number of slices of cheese consumed in a day ($R^2 = 0.148$, F (6, 173) = 6.18, $p < 0.001$). The model had two of six variables with statistically significant unique contributions to explaining the number of cheese slices consumed daily. The factor measuring "I find cheese fattening" had the strongest unique contribution (β = 0.36, $p < 0.001$), and the factor measuring "I know the recommended amount of cheese to eat daily" (β = 0.17, p = 0.026) was the other factor that showed statistical significance. The unstandardized beta *b*-values for the factors showed positive relationships with the outcome with 0.757 and 0.928 for the factor measuring "I find cheese fattening" and the factor measuring "I know the recommended amount of cheese to eat daily," respectively. A *b*-value of 0.754 implies that those strongly perceiving cheese to be fattening consumed four times more (4*0.754=3.016) cheese slices than those who strongly disagreed. Those who knew the recommended amount of cheese to eat daily had about a slice of cheese more than those who did not know.

The factors that formed the variables assessing the facilitators to consuming cheese revealed the model explained 23.3% (medium effect) of the variance in the number of slices of cheese consumed in a day ($R^2 = 0.233$, F (4, 175) = 14.60, $p < 0.001$). The model had four variables, with three showing statistically significant unique contributions to explaining the number of cheese slices consumed daily. The factor measuring “I have difficulties in accessing cheese” showed the strongest unique contribution ($\beta = 0.43$, $p < 0.001$). This factor showed a positive relationship with the outcome, with a B-value of 1.004. This value suggests those who agreed to have difficulties accessing cheese one more slice of cheese in a day than those who disagreed. The factor with the next highest beta value was “I find cheese affordable” ($\beta = 0.23$, $p = 0.004$), and the factor measuring “Cheese is available whenever I need it” became the third with a statistically significant beta value ($\beta = 0.19$, $p = 0.033$). The two factors revealed a positive relationship with the outcome, the number of cheese slices consumed daily, with B-values 0.559 and 0.497, respectively. These indicate that those who find cheese affordable and available whenever they need it consumed about half a slice of cheese more than those who did not. The rest of the results from the simultaneous multiple regression can be found in Table 12.

Discussion

This research was based on Pender’s health promotion model theory (HPM). This theory posits that perceived barriers to action can influence health-promoting behavior (McEwen, 2019). Another concept is that personal factors such as biological, psychological, and sociocultural factors appear to influence the outcome of health-promoting behavior, according to the model (Peterson & Bredow, 2017). In this case, the health-promoting behavior is the consumption of dairy products. Chapter 2 of this dissertation established that consuming dairy products was a health-promoting behavior since it protects against the risk of metabolic syndrome. Therefore, this study aimed to assess if individuals living with metabolic syndrome met the USDA’s daily dairy recommendation in the 2020 Dietary Guidelines for Americans (DGA); and if there were any relationship between perceived barriers, facilitators, or personal factors and their consumption of dairy products.

Dairy Recommendation

The consumption of dairy products has been declining in developed countries (Park et al., 2019). The USDA estimates approximately 10% of the U.S. population meets the recommendation for dairy consumption in a day (USDA, 2020). However, this research did not observe this trend among individuals with metabolic syndrome. Instead, about 49% of the convenience sample of individuals living with metabolic syndrome met the daily dairy consumption recommendation of three cups per day, according to the 2020 Dietary Guidelines for Americans (USDA, 2020).

The demographic makeup of the participants and the relatively small sample size in this study may explain the difference in estimates of people who meet the dairy recommendation for a day. Dairy consumption was positively associated with higher education levels. Participants with at least some college education or an associate degree were 15 times more likely to meet the daily dairy recommendation than those with a high or lower education level. A similar observation was made by Kyung Won and Wookyoun (2017), where individuals who met the daily dairy recommendation for Korea were more likely to be highly educated. Individuals at higher income levels tend to consume more dairy than those at lower income levels (Petherick, 2016). However, this statement was not consistent with the findings of this study sample. Instead, those with an annual household income of less than $70,000 were about three times more likely to meet the recommendation than those from households earning more than $70,000.

Meeting the dairy consumption recommendation has been associated with increasing age (Lago-Sampredo et al., 2019; Mena-Sanchez et al., 2018). Younger people tend to have competing meals, while older people do not have that challenge (Park et al., 2019). However, in this group, an increase in age reduced the possibility of meeting the recommendation by about 7.7%. While this finding contrasts with some studies, other studies had similar results. Kyung Won and Wookyoun (2017) observed that individuals who met the daily dairy recommendation in their sample were younger than those who did not.

Barriers and Facilitators to Dairy Consumption

In this study, factors that measured perceived barriers determined milk, yogurt, and cheese consumption. The participants of this study knew the recommended amount to consume for all three dairy products, manifested in the number of cups of milk consumed in a day. Those who knew the amount to drink a day consumed over two cups more milk than those who did not. Similarly, those who knew the recommended amount of yogurt and cheese consumed more than those who did not. For yogurt, they consumed over three ounces more and almost a slice of cheese more than those who did not. In effect, most of the study participants did not find this factor as a barrier, but rather it facilitated their consumption of dairy products. This outcome contrasts with the findings of Nicklas et al. (2013), that observed that not knowing the recommendation hindered dairy consumption. The higher education level of respondents may explain this finding, as over 80% had at least an associate degree.

The cost of milk and lactose intolerance were significant perceived barriers to consuming milk. However, these factors did not appear to be barriers when the number of cups of milk per day was assessed. For instance, lactose intolerance was reported as a barrier by 70% of the respondents. But most participants who had this as a barrier had at least 1.3 cups more milk in a day than those who were not lactose intolerant. This observation contrasts with the findings that identified individuals who perceived lactose intolerance had lower calcium levels in their blood than those who did not (Nicklas et al., 2011). Lactose intolerance is the most common hindrance and exclusively to milk consumption affecting about 65% of the global population (Walsh & Gunn, 2020). There are options for lactose intolerance, such as lactose-free and A2 milk (Mobley et al., 2014; Walsh & Gunn, 2020), but these options cost much more than others (Hess et al., 2020). However, the high cost of milk may not necessarily prevent milk consumption in adults (Mobley et al., 2014), and this was evident in this convenience sample where those who perceived the cost of milk to be relatively high had over half a cup more milk in a day than those who did not. Individuals can consume yogurt or cheese to meet their daily dairy recommendation as they have low to no lactose (Nicklas et al., 2011).

The other perceived barriers related to yogurt and cheese consumption included the perception that yogurt was beneficial to children but not adults and the perception that cheese was fattening. However, most participants did not perceive them as barriers to consuming yogurt and cheese. When their responses were analyzed with how much they consumed, those who perceived yogurt was not beneficial to them consumed over an ounce more yogurt than those who perceived yogurt to be helpful. Similarly, those who thought cheese was fattening consumed almost a slice more cheese than those who did not. In contrast, Allen et al. (2017) found that those who believed there were fats in a dairy product were more likely to avoid consuming the product.

The most common facilitator of all three products was access to dairy products. For each product, most respondents noted they had no difficulty accessing them. However, when the number of cups consumed for each product was assessed, those who disagreed they had access consumed about a cup, a slice, or about two ounces more milk, cheese, or yogurt, respectively than those who had access to them. Respondents pointed to the affordability and availability of dairy products as the facilitators to consuming them, in this case, milk and cheese. All three factors were identified as enabling dairy product consumption (Nicklas et al., 2013). These assertions were manifested in their milk and cheese consumption, especially for affordability and availability. Those who thought milk was affordable and available consumed about a cup of milk more than those who did not. A similar observation was made for cheese, with respondents who found it affordable and available consuming about half a slice more than those who did not.

Limitations

This study had some limitations, the first being the cross-sectional study design. Therefore, a cause-and-effect inference cannot be drawn from the outcome. Respondents were recruited online, and their claim of having the diagnosis of metabolic syndrome or meeting three of the five components of metabolic syndrome could not be independently authenticated. However, in-person recruitment would have been more challenging, given the contract restrictions of the COVID-19 pandemic. Other clinics and offices had most of their clients online via telemedicine and accessing them was difficult. However, ResearchMatch was an effective recruitment platform for reaching out to the participants of this study (Harris et al., 2012).

Using the online platform led to the limitation of having a non-representative group of participants. Respondents were disproportionately White, young, well-educated, and had higher household incomes. A national survey on internet users found that 98% and 97% of adults in the U.S. with internet access have college degrees and associate degrees, respectively, compared to 86% of adults with high school or lower-level education (Pew Research Center, 2021).

Another limitation is access to ResearchMatch by the general population. Individuals join the platform by their own volition. However even among individuals with internet access, not everyone knows what it is and the purpose it serves. There were challenges with bots and fraudulent individuals who were in for the incentives associated with participating in the study. These were corrected when emails that were provided as a part of receiving the incentives were required to provide their zip codes. The emails associated with the bots did not respond and those that were associated with the fraudulent individuals appeared to be the same. The respondents to associated with these emails were not included in the analyses of this research. However, the access to internet and to ResearchMatch, and the elimination of the responses associated with the bots and fraud may have resulted in a selection bias. Therefore, the findings of this study cannot be representative of the general population.

This study did not consider the many different dairy products participants consumed. Such differentiation could have guided respondents to respond appropriately to their perceived barriers or facilitators to specific dairy products. For instance, lactose intolerance was identified as a barrier, but respondents who had that as a barrier consumed more milk. They may have consumed other milk products, such as lactose-free or A2. But they could not differentiate their experiences from their current state since they had no option for selecting the type of dairy product consumed. Finally, the survey used to collect data on dairy consumption had biases that may have affected the outcome. Recall and measurement biases are the major ones associated with the dietary screener, which can lead to deviation from the actual values. Therefore, the investigator used approximations to assess participants who met the recommendation for dairy consumption.

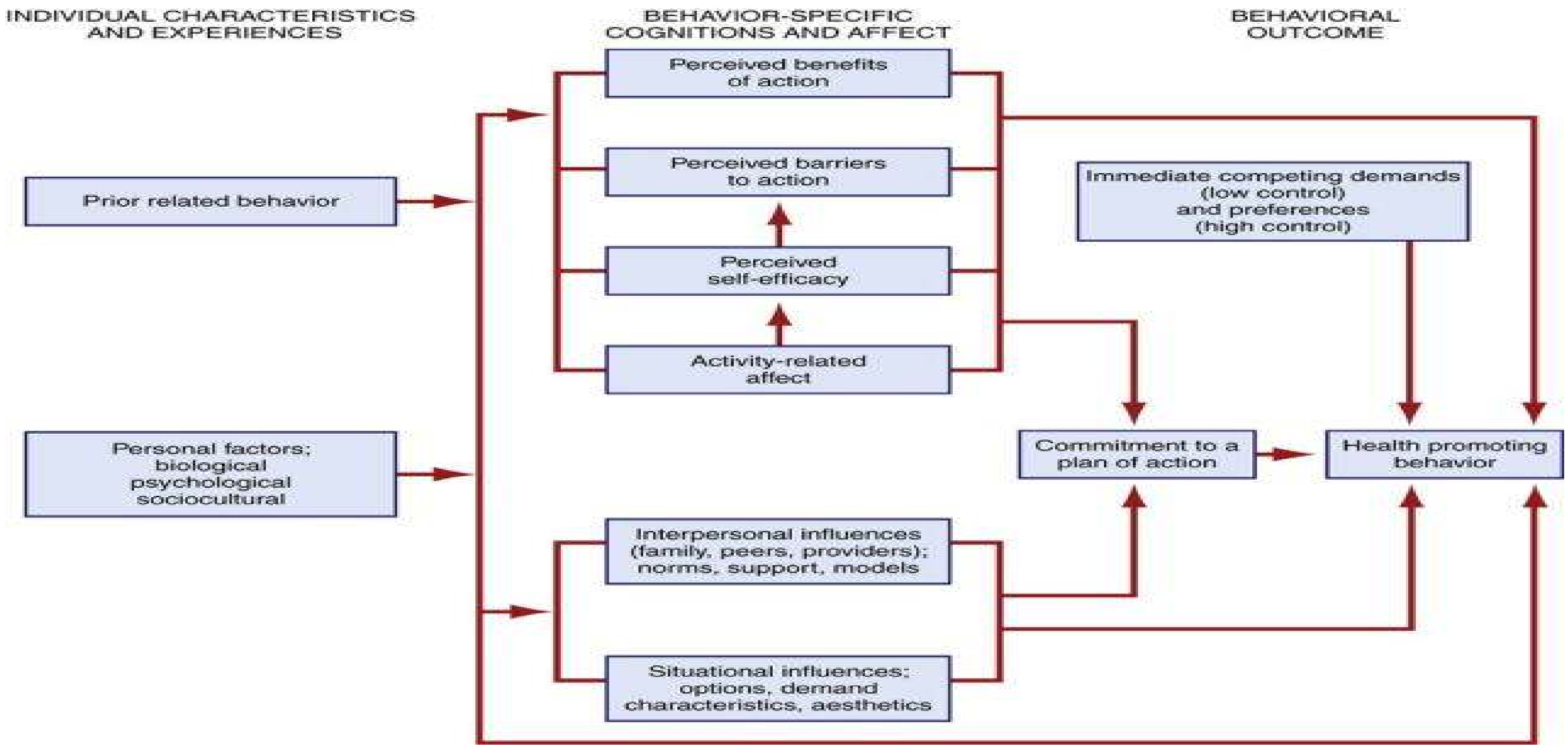
Conclusion

Perceived barriers, perceived facilitators, and personal factors can predict the consumption of dairy products. Knowing the recommended amount of dairy products to eat and the availability of dairy products facilitates dairy consumption, and these factors must be considered for the promotion of dairy consumption.

However, this study identified some challenges that may need further investigation. There were no differences between the perceived barriers and facilitators when they were related to the cups of dairy consumed in a day. Therefore, further analyses of the data are warranted to differentiate between the barriers from the facilitators to dairy consumption. Another study using other food measuring tools to assess previous dairy consumption is needed. Further research should be conducted to evaluate the reliability of the survey that measured the perceived barriers and facilitators. The findings of that study can identify the redundant factors to better measure the barriers and facilitators.

Figure 2

Pender's Health Promoting Model



Adapted from *Nola Pender Health Promotion Model,* by Psych-Mental health hub: Essential resources, learning and support, n.d. (https://pmhealthnp.com/nola-pender-health-promotion-model/). In the public domain.

Figure 3

Variables of Interest as Conceptualized within HPM

Individual Characteristics   Behavior Specific Cognitive Affect Behavioral Outcome

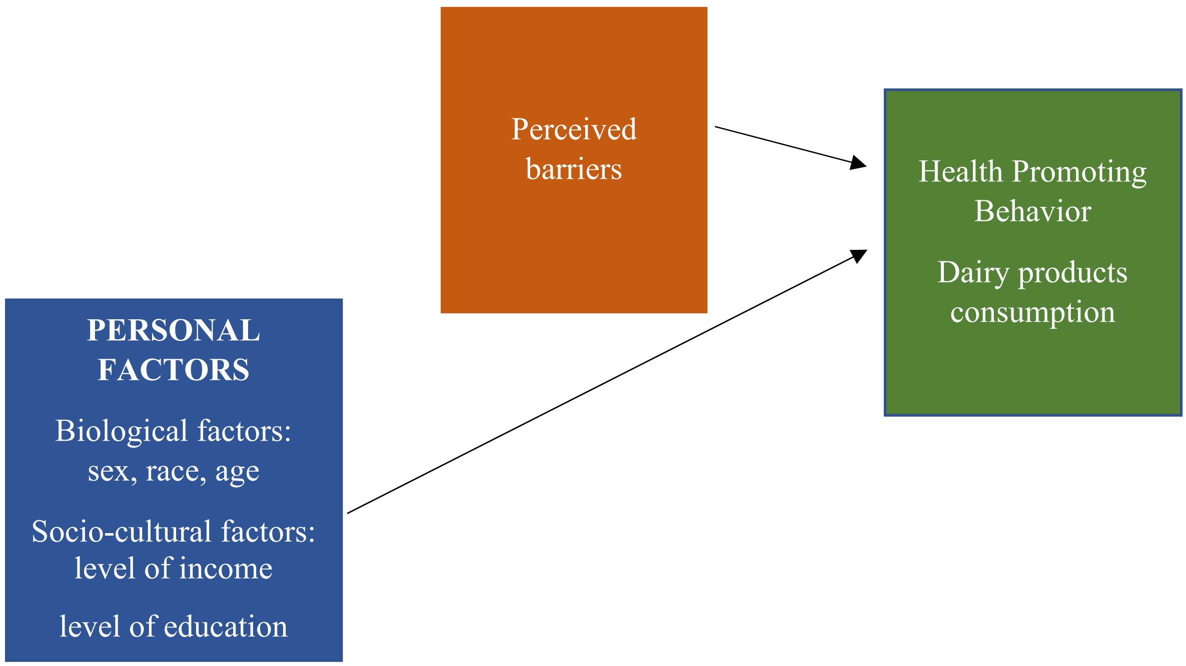


Table 4

Description of Participants and Their BMI (N = 180)

Variables	*n*	%
Age	Mean (SD) 37.8 (±10.6)	
Sex		
Male	128	71.1
Female	52	28.9
Race		
Mexican American	2	1.1
Other Hispanic	1	1.1
Non-Hispanic White	159	88.3
Non-Hispanic Black	16	8.9
Other Race	2	0.6
Education		
9-11th Grade	10	5.6
High School/GED Grad	20	11.1
Some college or AA degree	52	28.9
College Grad or Above	98	44.4
Annual Household Income		
<$20,000	3	1.7
$20,000 – 29,999	3	1.7
$30,000 – 39,999	8	4.4
$40,000 – 49,999	14	7.8
$50,000 – 59,999	45	25.0
$60,000 – 69,999	67	37.2
≥$70,000	40	22.2
Body Mass Index (BMI)	Mean (SD) 25.3 (± 10.23) kg/m^2	
Underweight	21	11.9
Normal Weight	92	52.0
Overweight	35	19.7
Obese	29	16.4

Table 5

Description of Daily Dairy Consumption

Dairy Product	Mean Number of Cups Consumed per Day (SD)
Milk	2.38 (±2.67)
Yogurt	0.54 (±0.52)
Cheese	2.02 (±1.98)
Total Dairy Consumed per Day	4.95 (±4.58)

Meeting Recommendation (3 cups/day)		
	Meets Recommendation N (%)	Does Not N (%)
Sex		
Male	69 (78.4)	59 (64.1)
Female	19 (21.6)	33 (35.9)
Race		
White	76 (86.4)	83 (90.2)
Non-White	12 (13.6)	9 (9.8)
Education Level		
High School/GED Grad and below	2 (2.3)	28 (30.4)
Some college or AA degree and above	86 (97.7)	64 (69.6)
Household Income		
≥$70000	14 (15.9)	26 (28.3)
<$70000	74 (84.1)	66 (71.7)
Total	88 (48.9)	92 (51.1)

Table 6

Simultaneous Logistic Regression Results: Predicting Meeting the Daily Dairy Recommendation from Personal Factors (N = 180)

Predictors	*B*	*SE*	*Wald* χ^2	*p*	Adjusted odds ratio	
					OR	*[95% CI]*
Age	-.08	.023	11.827	<.001	.923	.881, .966
Sex						
Male (Ref)						
Female	-.005	.428	.00	.991	.995	.430, 2.300
Race						
White (Ref)						
Non-White	.365	.528	.477	.490	1.440	.511, 4.058
Education Level						
≥Some College Education (Ref)						
< Some College Education	2.729	.786	12.048	<.001	15.320	3.281, 71.542
Household Income						
≥$70,000(Ref)						
<$70,000	1.132	.421	7.225	.007	3.103	1.359, 7.087
Constant	-.666	1.450	.211	.646	.514	

Note. *N* = 180. For the model containing constant plus all predictors: -2LL = 191.13. Model χ^2 (8, *N* = 180) = 34.098, $p < .001$. Cox & Snell R^2 = .277. Nagelkerke R^2 = .369. *B* = Logistic coefficients. *SE* = Standard errors for logistic coefficients. Wald χ^2 = Test of null hypothesis that *B* = 0 (for each test *df* = 1). *p* = Probability value for Wald χ^2. *OR* = Adjusted odds ratio. *95% CI* = 95% Confidence interval for the adjusted odds ratio.

Table 7

Multiple Regression Results: Predicting the Number of cups of Milk Consumed Daily from the Factors Measuring Perceived Barriers to Drinking Milk.

Predictor Variables	*b*	*SE*	*β*	*p*	*95%CI*
Constant	-3.839	.736		<.001	
Lactose Intolerance	1.307	.385	.225	<.001	.548, 2.067
Know the recommended amount	2.231	.558	.274	<.001	1.130, 3.332
Cost	.669	.230	.241	.003	.245, 1.152
Taste	.151	.266	.054	.571	-.374, .676
Milk is fattening	-.027	.260	-.009	.916	-.541, .486
Milk not important part of diet	.385	.259	.141	.085	-.126, .896
Milk is beneficial to kids	.448	.259	.155	.085	-.063, .960

Note. N = 180. Model R = .587, Model R^2 = .344, F (7, 172) = 12.908, p < .001. Adjusted R^2 = .318. b = unstandardized multiple regression coefficient. SE = standard error. *95% CI* = 95% confidence interval. p = probability value. β = standardized multiple regression coefficient.

Table 8

Multiple Regression Results: Predicting the Number of Cups of Milk Consumed Daily from the Factors Measuring Perceived Facilitators to Drinking Milk.

Predictor Variables	*b*	*SE*	*β*	*p*	*95%CI*
Constant	-7.926	1.231		<.001	-10.356, -5.496
Affordability	1.015	.254	.272	<.001	.513, 1.516
Difficulty having access	1.520	.190	.525	<.001	1.146, 1.894
Availability	.885	.287	.224	.002	.319, 1.451
Awareness of health benefits	.320	.257	.083	.213	-.186, .827

Note. N = 180. Model R = .598, Model R^2 = .358, F (4, 175) = 114.338, p < .001. Adjusted R^2 = .343. *b* = unstandardized multiple regression coefficient. *SE* = standard error. *95% CI* = 95% confidence interval. *p* = probability value. *β* = standardized multiple regression coefficient.

Table 9

Multiple Regression Results: Predicting the Number of Cups of Yogurt Consumed Daily from the Factors Measuring Perceived Barriers to Consuming Yogurt.

Predictor Variables	*b*	*SE*	*β*	*p*	*95%CI*
Constant	-426	.152		.006	-.726, -.127
Know the recommended amount	.430	.104	.289	<.001	.224, .636
Cost	-.006	.046	-.011	.889	-.098, .085
Taste	.106	.063	.167	.096	-.019, .230
Yogurt is fattening	-.010	.053	-.017	.851	.095, .296
Yogurt not important part of diet	.068	.052	.122	.193	-.034, .170
Yogurt is beneficial to kids	.158	.051	.281	.002	.056, .260

Note. N = 180. Model R = .529, Model R^2 = .279, F (6, 173) = 11.183, p < .001. Adjusted R^2 = .254. b = unstandardized multiple regression coefficient. SE = standard error. *95% CI* = 95% confidence interval. p = probability value. β = standardized multiple regression coefficient.

Table 10

Multiple Regression Results: Predicting the Number of Cups of Yogurt Consumed Daily from the Factors Measuring Perceived Facilitators to Consuming Yogurt.

Predictor Variables	*b*	*SE*	*β*	*p*	*95%CI*
Constant	-.460	.229		.046	-913, -.008
Affordability	.013	.056	.020	.820	-.098, .124
Difficulty having access	.221	.041	.386	<.001	.140, .303
Availability	.085	.065	.117	.192	-.043, .214
Awareness of health benefits	.080	.059	.112	.177	-.037, .197

Note. N = 179. Model R = .404, Model R^2 = .163, F (4, 174) = 8.482, p < .001. Adjusted R^2 = .144. b = unstandardized multiple regression coefficient. SE = standard error. *95% CI* = 95% confidence interval. p = probability value. β = standardized multiple regression coefficient.

Table 11

Multiple Regression Results: Predicting the Number of Slices of Cheese Consumed Daily from the Factors Measuring Perceived Barriers to Consuming Cheese.

Predictor Variables	*b*	*SE*	*β*	*p*	*95%CI*
Constant	-.504	.588		.392	-1.664, .656
Know the recommended amount	.928	.413	.166	.026	.113, 1.742
Cost	.066	.213	.028	.757	-.355, .488
Taste	-.182	.261	-.079	.487	-.697, .333
Cheese is fattening	.757	.208	.363	<.001	.347, 1.167
Cheese not important part of diet	-.259	.222	-.121	.246	-.698, .180
Cheese is beneficial to kids	.465	.261	.205	.076	-.050, .980

Note. N = 180. Model R = .420, Model R^2 = .176, F (6, 173) = 6.179, p < .001. Adjusted R^2 = .148. *b* = unstandardized multiple regression coefficient. *SE* = standard error. *95% CI* = 95% confidence interval. *p* = probability value. *β* = standardized multiple regression coefficient.

Table 12

Multiple Regression Results: Predicting the Number of Slices of Cheese Consumed Daily from the Factors Measuring Perceived Facilitators to Consuming Cheese.

Predictor Variables	*b*	*SE*	*β*	*p*	*95%CI*
Constant	-3.739	.852		<.001	-5.421, -2.057
Affordability	.559	.193	.227	.004	.178, .940
Difficulty having access	1.004	.162	.431	<.001	.685, 1.323
Availability	.497	.231	.189	.033	.042, .952
Awareness of health benefits	.132	.215	.049	.541	-.293, .556

Note. N = 180. Model R = .500, Model R^2 = .250, F (4, 175) = 14.597, p < .001. Adjusted R^2 = .233. b = unstandardized multiple regression coefficient. SE = standard error. *95% CI* = 95% confidence interval. p = probability value. β = standardized multiple regression coefficient.

CHAPTER V

SYNTHESIS AND CONCLUSION

This dissertation had three main purposes: (1) to systematically review the literature on the effect of dairy product consumption on metabolic syndrome, (2) to explore the dietary measuring instruments and select the appropriate measure for collecting data on dairy consumption, and (3) to assess the dairy consumption and the barriers to and facilitators of dairy consumption among individuals with metabolic syndrome.

Synthesis of Findings and Implications

Metabolic syndrome affects about a third of the U.S. adult population (Moore et al., 2017). The syndrome has not been attributed directly to the mortality rate in the U.S. (Heron, 2021). However, metabolic syndrome when left untreated, is a known precursor of chronic diseases including type 2 diabetes mellitus, cardiovascular diseases, and cancer (Moore et al., 2017). These three conditions were attributed to about 47% of all deaths in the U.S. in 2019 (Heron, 2021). Dairy products are protective against the components of metabolic syndrome (Babio et al., 2015; Martins et al., 2015).

A systematic review of the literature was conducted to assess the effect of dairy consumption on metabolic syndrome (Chapter Two). The review included 16 articles, of which five were RCTs. The finding suggested dairy products had protective effects against the risk of developing metabolic syndrome and its components. This finding indicated that the encouraging dairy consumption was warranted, especially individuals diagnosed with metabolic syndrome. The USDA reports about 10% of the population meet the daily dairy consumption recommendation (USDA, 2020). However, there was no data on dairy consumption among people living with metabolic syndrome. The main limitation of this review is that most of the articles included (11) were observational studies. This limitation prevented a cause-and-effect association between dairy consumption and metabolic syndrome.

In order to assess the consumption of dairy products among the metabolic syndrome patient population, an appropriate dietary measure was required. A review comparing the dietary assessment methods, their strengths, and their limitations was conducted. Four dietary measures were reviewed: the 24-hour dietary recall, the food record, the FFQ, and the dietary screeners (Chapter Three). The dietary screener was the most appropriate instrument for measuring dairy consumption among individuals diagnosed with metabolic syndrome. It was easy to adapt to measure only dairy products and provided options of frequency and serving sizes for each dairy product. The study did not need to estimate the energy consumed by respondents but rather estimate the frequency and serving size dairy was consumed (Thompson et al., 2015). However, the screener has recall and measurement biases that can lead to deviation from the actual values.

Chapter Four is a cross-sectional study conducted to determine if individuals with metabolic syndrome meet the daily dairy recommendation, explore the relationship among biological or sociocultural factors and meeting the daily dairy consumption recommendation, and determine the barriers to, facilitators of, and predictors dairy consumption.

Almost 49% of the respondents met the USDA dairy recommendation of three cups daily. For the relationship between the personal factors and meeting daily dairy recommendation, it was observed there was a relationship between the biological factor (age) and socio-cultural factors (education level and household income). Perceived barriers, perceived facilitators, and personal factors predicted the consumption of dairy products. Knowing the recommended servings of dairy products to eat and the availability of dairy products facilitated dairy consumption.

However, this study identified some challenges that may need further investigation. There were no differences between the perceived barriers and facilitators when they were related to the cups of dairy consumed in a day. Therefore, further analyses are warranted to differentiate between the barriers from the facilitators to dairy consumption using other food measuring tools to assess previous consumption. Further research should be conducted to evaluate the reliability of the survey that measured the perceived barriers and facilitators. The findings of that study can identify the redundant factors to better measure the barriers and facilitators.

Recommendations for Future Research and Practice

Some recommendations are suggested based on the results of the studies. The systematic review of the literature suggests studies are necessary to determine modifiable barriers to dairy consumption in individuals at risk for development of metabolic syndrome. This recommendation was considered in conducting the Chapter Four study of this dissertation. This study recommends further analyses of the data to differentiate between the barriers from the facilitators to dairy consumption. It also recommends that other food measuring tools be used to assess previous dairy consumption. Further research should be conducted to evaluate the reliability of the survey that measured the perceived barriers and facilitators.

A study to assess the perception of healthcare providers (medical doctors, Nurse Practitioners, Nurses, and Nutritionists) on dairy products and whether they would recommend them to their metabolic syndrome patients is necessary. These are professionals who have influence on what their patients consume, and their thoughts may determine whether they would recommend dairy products to their patients.

REFERENCES

Abreu, S., Agostinis-Sobrinho, C., Santos, R., Moreira, C., Lopes, L., Gonçalves, C., Oliveira-Santos, J., Sousa-Sá, E., Rodrigues, B., Mota, J., & Rosário, R. (2019). Association of dairy product consumption with metabolic and inflammatory biomarkers in adolescents: A cross-sectional analysis from the LabMed study. *Nutrients*, *11*(10), 2268-2268. https://doi.org/10.3390/nu11102268

Akimoto, S., Goto, C., & Kuriki, K. (2019). Relationship between ethanol consumption and TBL2 rs17145738 on LDL-C concentration in Japanese adults: A four-season 3-day weighed diet record study. *BMC Nutrition*, *5*, 61. https://doi.org/10.1186/s40795-019-0315-6

Allen, S., Goddard, E., & Farmer, A. (2018). How knowledge, attitudes, and beliefs impact dairy anti-consumption. *British Food Journal. 120*(10), 2304-2316. https://doi.org/10.1108/BFJ-12-2017-0733

Amoutzopoulos, B., Page, P., Roberts, C., Roe, M., Cade, J., Steer, T., Baker, R., Hawes, T., Galloway, C., Yu, D., & Almiron-Roig, E. (2020). Portion size estimation in dietary assessment: a systematic review of existing tools, their strengths, and limitations. *Nutrition Reviews*, *78*(11), 885-900. https://doi.org/10.1093/nutrit/nuz107

Babio, N., Becerra-Tomas, N., Martinez-Gonzalez, M. A., Corella, D., Estruch, R., Ros, E., Sayon-Orea, C., Fito, M., Serra-Majem, L., Aros, F., Lamuela-Raventos, R. M., Lapetra, J., Gomez-Gracia, E., Fiol, M., Diaz-Lopez, A., Sorli, J. V., Martinez, J. A., & Salas-Salvado, J. (2015). Consumption of yogurt, low-fat milk, and other low-fat dairy products is associated with lower risk of metabolic syndrome incidence in an elderly Mediterranean population. *The Journal of Nutrition* 145, no. 10. 2308-2316. https://doi.org/10.3945/jn.115.214593

Baldeón, M. E., Felix, C., Fornasini, M., Zertuche, F., Largo, C., Paucar, M. J., Ponce, L., Rangarajan, S., Yusuf, S., & López-Jaramillo, P. (2021). Prevalence of metabolic syndrome and diabetes mellitus type-2 and their association with intake of dairy and legume in Andean communities of Ecuador. *PLoS One*, *16*(7 July). https://doi.org/10.1371/journal.pone.0254812

Balshem, H., Helfand, M., Schünemann, H. J., Oxman, A. D., Kunz, R., Brozek, J., Falck-Ytter, Y., Meerpohl, J., Norris, S., & Guyatt, G. H. (2011). GRADE guidelines: 3. Rating the quality of evidence. *Journal of Clinical Epidemiology*, *64*(4), 401-406. http://dx.doi.org/10.1016/j.jclinepi.2010.07.015

Barrubes, L., Babio, N., Mena-Sánchez, G., Toledo, E., Ramírez-Sabio, J. B., Estruch, R., Ros, E., Fito, M., Aros, F., Fiol, M., Santos-Lozano, J. M., Serra-Majem, L., Pinto, X., Martınez-Gonzalez, M. A., Sorli, J. V., Basora, J., & Salas-Salvado, J. (2018). Dairy product consumption and risk of colorectal cancer in an older Mediterranean population at high cardiovascular risk. *International Journal of Cancer*, *143*(6), 1356-1366. https://doi.org/10.1002/ijc.31540

Bellikci-Koyu, E., Sarer-Yurekli, B. P., Akyon, Y., Aydin-Kose, F., Karagozlu, C., Ozgen, A. G., Brinkmann, A., Nitsche, A., Ergunay, K., Yilmaz, E., & Buyuktuncer, Z. (2019). Effects of regular kefir consumption on gut microbiota in patients with metabolic syndrome: A parallel-group, randomized, controlled study. *Nutrients*, *11*(9), 2089. https://doi.org/10.3390/nu11092089

Beydoun, M. A., Fanelli-Kuczmarski, M. T., Beydoun, H. A., Dore, G. A., Canas, J. A., Evans, M. K., & Zonderman, A. B. (2018). Dairy product consumption and its association with metabolic disturbance in a prospective study of urban adults. *British Journal of Nutrition*, *119*(6), 706-719. https://doi.org/10.1017/S0007114518000028

Bhavadharini, B., Dehghan, M., Mente, A., Rangarajan, S., Sheridan, P., Mohan, V., Iqbal, R., Gupta, R., Lear, S., Wentzel-Viljoen, E., Avezum, A., Lopez-Jaramillo, P., Mony, P., Varma, R. P., Kumar, R., Chifamba, J., Alhabib, K. F., Mohammadifard, N., Oguz, A., Yusuf, S. (2020). Association of dairy consumption with metabolic syndrome, hypertension and diabetes in 147 812 individuals from 21 countries. *BMJ Open Diabetes Research and Care*, *8*(1). https://doi.org/10.1136/bmjdrc-2019-000826

Bleiweiss-Sande, R., Kranz, S., Bakun, P., Tanskey, L., Wright, C., & Sacheck, J. (2017). Comparative study of a new dietary screener to assess food groups of concern in children. *Food and Nutrition Bulletin*, *38*(4), 585-593. https://doi.org/10.1177/0379572117733400

Brown-Riggs, C. (2016). Nutrition and health disparities: the role of dairy in improving minority health outcomes. *International Journal of Environmental Research and Public Health*, *13*(1), 28. https://doi.org/10.3390/ijerph13010028

Chen, G. C., Szeto, I. M., Chen, L. H., Han, S. F., Li, Y. J., Van Hekezen, R., & Qin, L. Q. (2015). Dairy products consumption and metabolic syndrome in adults: systematic review and meta-analysis of observational studies. *Scientific Reports*, *5*(1), 1-10. https://doi.org/10.1038/srep14606

DeBiasse, M. A., Bowen, D. J., Quatromoni, P. A., Quinn, E., & Quintiliani, L. M. (2018). Feasibility and acceptability of dietary intake assessment via 24-hour recall and food frequency questionnaire among women with low socioeconomic status. *Journal of the Academy of Nutrition and Dietetics*, *118*(2), 301-307. https://doi.org/10.1016/j.jand.2017.08.011

Dennis, L. (July 1, 2020). Kentucky health insurance. https://healthcareinsider.com/kentucky-health-insurance-19508

Dugan, C. E., Aguilar, D., Park, Y. K., Lee, J. Y., & Fernandez, M. L. (2016). Dairy consumption lowers systemic inflammation and liver enzymes in typically low-dairy consumers with clinical characteristics of metabolic syndrome. *Journal of the American College of Nutrition*, 35(3), 255-261. http://dx.doi.org/10.1080/07315724.2015.1022637

Eelderink, C., Rietsema, S., Van Vliet, I. M. Y., Boer, T., Singh-Povel, C. M., Geurts, J., Corpeleijn, E., & Bakker, S. J. L. (2017). The effect of high and low dairy consumption on cardio-metabolic risk factors in overweight adults [Conference

Abstract]. *Annals of Nutrition and Metabolism*, *71*, 986-987. https://doi.org/10.1159/000480486

Fallah, Z., Feizi, A., Hashemipour, M., & Kelishadi, R. (2018). Effect of fermented camel milk on glucose metabolism, insulin resistance, and inflammatory biomarkers of adolescents with metabolic syndrome: A double-blind, randomized, cross-over trial. *Journal of Research in Medical Sciences*, *23*, 1-9. https://doi.org/10.4103/jrms.JRMS_1191_17

Fallah, Z., Feizi, A., Hashemipour, M., Namazi, N., Azarbayejani, L., & Kelishadi, R. (2019). Effect of fermented camel milk on obesity measures and blood pressure of adolescents with metabolic syndrome. *Journal of Pediatrics Review*, *7*(3), 181-189. https://doi.org/10.32598/jpr.7.3.181

Fernandez, M. A., & Marette, A. (2018). Novel perspectives on fermented milks and cardiometabolic health with a focus on type 2 diabetes. *Nutrition Reviews*, *76*(Supplement_1), 16-28. https://doi.org/10.1093/nutrit/nuy060

Fernandez, M. A., & Marette, A. (2020). Dairy products and diabetes: Role of protein on glycaemic control. In D. I. Givens (Ed.), *Milk and dairy foods: Their functionality in human health and disease* (pp. 173-196). Academic Press.

Fernandez, M. A., Panahi, S., Daniel, N., Tremblay, A., & Marette, A. (2017). Yogurt and cardiometabolic diseases: a critical review of potential mechanisms. *Advances in Nutrition*, *8*(6), 812-829. https://doi.org/10.3945/an.116.013946

Fumeron, F. L., A.; Abi Khalil, C.; Jaziri, R.; Porchay-Baldérelli, I.; Lantieri, O.; Vol, S.; Balkau, B.; Marre, M. (2011). Dairy consumption and the incidence of hyperglycemia and the metabolic syndrome: results from a French prospective study, data from the epidemiological study on the insulin resistance syndrome (DESIR). *Diabetes Care* 34(4): 813-817. https://doi.org/10.2337/dc10-1772

Giromini, C., Fekete, A. A., Pinotti, L., & Baldi, A. (2020). Milk proteins: Their role in cardiovascular health. In D. I. Givens (Ed.), *Milk and dairy foods: Their functionality in human health and disease* (pp. 145-167). Academic Press.

Givens, D. I., & Lovegrove, J. A. (2020). Dairy fats and health. In D. I. Givens (Ed.), *Milk and dairy foods: Their functionality in human health and disease* (pp. 29-49). Academic Press.

Goldet, G., & Howick, J. (2013). Understanding GRADE: an introduction. *Journal of Evidence-Based Medicine*, *6*(1), 50-54. https://doi.org/10.1111/jebm.12018

Guyatt, G., Oxman, A. D., Akl, E. A., Kunz, R., Vist, G., Brozek, J., Norris, S., Falck-Ytter, Y., Glasziou, P., deBeer, H., Jaeschke, R., Rind, D., Meerpohl, J., Dahm, P., & Schünemann, H. J. (2011). GRADE guidelines: 1. Introduction—GRADE evidence profiles and summary of findings tables. *Journal of Clinical Epidemiology*, *64*(4), 383-394. https://doi.org/10.1016/j.jclinepi.2010.04.026

Harris, P. A., Scott, K. W., Lebo, L., Hassan, N., Lighter, C., & Pulley, J. (2012). ResearchMatch: A national registry to recruit volunteers for clinical research. *Academic Medicine Journal of the Association of American Medical Colleges, 87*(1), 66. https://doi.org/10.1097/ACM.0b013e31823ab7d2

Hatcher, L. (2013). *Advanced statistics in research: Reading, understanding, and writing up data analysis results.* Shadow Finch Media, Saginaw, Michigan. ISBN-13: 978-0-9858670-0-3.

Heron, M. (2021, July 26). *Deaths: Leading Causes for 2019.* https://www.cdc.gov/nchs/data/nvsr/nvsr70/nvsr70-09-508.pdf

Hess, J. M., Cifelli, C. J., & Fulgoni III, V. L. (2020). Energy and nutrient intake of Americans according to meeting current dairy recommendations. *Nutrients*, *12*(10), 3006. https://doi.org/10.3390/nu12103006

Hewawitharana, S. C., Thompson, F. E., Loria, C. M., Strauss, W., Nagaraja, J., Ritchie, L., & Webb, K. L. (2018). Comparison of the NHANES dietary screener questionnaire to the automated self-administered 24-hour recall for children in the healthy communities study. *Nutrition Journal*, *17*(1), 111. https://doi.org/10.1186/s12937-018-0415-1

Hidayat, K., Yu, L. G., Yang, J. R., Zhang, X. Y., Zhou, H., Shi, Y. J., Liu, B., & Qin, L. Q. (2020). The association between milk consumption and the metabolic syndrome: A cross-sectional study of the residents of Suzhou, China and a meta-analysis [Article]. *British Journal of Nutrition*, *123*(9), 1013-1023. https://doi.org/10.1017/S0007114520000227

Hughes, A. R., Summer, S. S., Ollberding, N. J., Benken, L. A., & Kalkwarf, H. J. (2017). Comparison of an interviewer-administered with an automated self-administered 24 h (ASA24) dietary recall in adolescents. *Public Health Nutrition*, *20*(17), 3060-3067. https://doi.org/10.1017/s1368980017002269

Human Subject Protection Program. (n.d.). *Expedited review regulations 45 CFR 46.110 and 21 CFR 56.110.* https://louisville.edu/research/humansubjects/policies/011ExpeditedReviewprocedures.pdf

Jahreis, G., & Dawczynski, C. (2020). Trans and conjugated fatty acids in dairy products: Cause for concern? In D. I. Givens (Ed.), *Milk and dairy foods: Their functionality in human health and disease* (pp. 87-120). Academic Press.

Ji, Y., Plourde, H., Bouzo, V., Kilgour, R. D., & Cohen, T. R. (2020). Validity and usability of a smartphone image-based dietary assessment app compared to 3-day food diaries in assessing dietary intake among Canadian adults: Randomized controlled trial. *Journal of Medical Internet Research mHealth uHealth*, *8*(9), e16953. https://doi.org/10.2196/16953

Jin, S., & Je, Y. (2021). Dairy consumption and risk of metabolic syndrome in Korean adults and elderly people. *Metabolic Syndrome and Related Disorders*, *19*(5), 272-280. https://doi.org/10.1089/met.2020.0122

Khoshnood, Z., Rayyani, M., & Tirgari, B. (2018). Theory analysis for Pender's health promotion model (HPM) by Barnum's criteria: A critical perspective. *International Journal of Adolescent Medicine and Health*, 20170160, 1-9**.** https://doi.org/10.1515/ijamh-2017-0160

Kim, D., & Kim, J. (2017). Dairy consumption is associated with a lower incidence of the metabolic syndrome in middle-aged and older Korean adults: the Korean genome and epidemiology study (KoGES). *British Journal of Nutrition*, *117*(1), 148-160. https://doi.org/10.1017/S000711451600444X

Kirkpatrick, S. I., Vanderlee, L., Raffoul, A., Stapleton, J., Csizmadi, I., Boucher, B. A., Massarelli, I., Rondeau, I., & Robson, P. J. (2017). Self-report dietary assessment tools used in Canadian research: A scoping review. *Advances in Nutrition*, *8*(2), 276-289. https://doi.org/10.3945/an.116.014027

Knüppel, S., Norman, K., & Boeing, H. (2019). Is a single 24-hour dietary recall per person sufficient to estimate the population distribution of usual dietary intake? *Journal of Nutrition*, *149*(9), 1491-1492. https://doi.org/10.1093/jn/nxz118

Kyung Won, L., & Wookyoun, C. (2017). The consumption of dairy products is associated with reduced risks of obesity and metabolic syndrome in Korean women but not in men. *Nutrients*, *9*(6), 1-17. https://doi.org/10.3390/nu9060630
Kyung Won, L., & Wookyoun, C. (2017). The consumption of dairy products is associated with reduced risks of obesity and metabolic syndrome in Korean women but not in men. *Nutrients*, *9*(6), 1-17. https://doi.org/10.3390/nu9060630
Lago-Sampedro, A., García-Escobar, E., Rubio-Martín, E., Pascual-Aguirre, N., Valdés, S., Soriguer, F., Goday, A., Calle-Pascual, A., Castell, C., Menéndez, E., Delgado, E., Bordiú, E., Castaño, L., Franch-Nadal, J., Girbés, J., Chaves, F. J., Gaztambide, S., Rojo-Martínez, G., & Olveira, G. (2019). Dairy product consumption and metabolic diseases in the diabetes study. *Nutrients*, *11*(2). https://doi.org/10.3390/nu11020262

Lemieux, I., & Després, J. P. (2020). Metabolic syndrome: Past, present and future. *Nutrients.* 12 (11), 3501. https://doi.org/10.3390/nu12113501

Liberati, A., Altman, D. G., Tetzlaff, J., Mulrow, C., Gøtzsche, P. C., Ioannidis, J. P., Clarke, M., Devereaux, P. J., Kleijnen, J., & Moher, D. (2009). The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. *Journal of Clinical Epidemiology*, 62(10), e1-e34. https://doi.org/10.1016/j.jclinepi.2009.06.006

Louie, J. C. Y., Flood, V. M., Rangan, A. M., Burlutsky, G., Gill, T. P., Gopinath, B., & Mitchell, P. (2013). Higher regular fat dairy consumption is associated with lower incidence of metabolic syndrome but not type 2 diabetes. *Nutrition, Metabolism and Cardiovascular Diseases*, *23*(9), 816-821. http://dx.doi.org/10.1016/j.numecd.2012.08.004

Martin, C. K., Nicklas, T., Gunturk, B., Correa, J. B., Allen, H. R., & Champagne, C. (2014). Measuring food intake with digital photography. *Journal of Human Nutrition and Dietetics*, *27*, 72-81. https://doi.org/10.1111/jhn.12014

McEwen, M. (2019). Overview of selected middle range nursing theories. In M. McEwen & E. M. Wills (Eds.), *Theoretical basis for nursing* (5th ed. pp. 223-252). Wolters Kluwer.

Mena-Sánchez, G., & Babio Sánchez, N. E. (2017). Fermented dairy, diet quality diet and cardio-metabolic profile in a Mediterranean cohort at high cardiovascular risk (CVR) [Conference Abstract]. *Annals of Nutrition and Metabolism*, *71*, 476. https://doi.org/10.1159/000480486

Mena-Sánchez, G., Babio, N., Martínez-González, M. Á., Corella, D., Schröder, H., Vioque, J., Romaguera, D., Martínez, J. A., Lopez-Miranda, J., Estruch, R., Wärnberg, J., Bueno-Cavanillas, A., Serra-Majem, L., Tur, J. A., Arós, F., Tinahones, F. J., Sánchez, V. M., Lapetra, J., Pintó, X., & Vidal, J. (2018). Fermented dairy products, diet quality, and cardio-metabolic profile of a Mediterranean cohort at high cardiovascular risk. *Nutrition, Metabolism & Cardiovascular Diseases*, *28*(10), 1002-1011. https://doi.org/10.1016/j.numecd.2018.05.006

Mena-Sánchez, G., Becerra-Tomás, N., Babio, N., & Salas-Salvadó, J. (2019). Dairy Product Consumption in the Prevention of Metabolic Syndrome: A Systematic Review and Meta-Analysis of Prospective Cohort Studies. *Advances in Nutrition*, *10*(suppl_2), S144-s153. https://doi.org/10.1093/advances/nmy083

Miller, R. M. (2013). The controversial question of metabolic syndrome. *The American Journal of Managed Care*, *19*, E1-E1. https://www.ajmc.com/journals/evidence-based-diabetes-management/2013/2013-1-vol19-sp2/the-controversial-question-of-metabolic-syndrome?p=1

Mobley, A. R., Jensen, J. D., & Maulding, M. K. (2014). Attitudes, beliefs, and barriers related to milk consumption in older, low-income women. *Journal of Nutrition Education and Behavior*, 46(6), 554-559. http://dx.doi.org/10.1016/j.jneb.2013.11.018

Moore, J. X., Chaudhary, N., & Akinyemiju, T. (2017). Metabolic syndrome prevalence by race/ethnicity and sex in the United States, national health and nutrition examination survey, 1988–2012. *Preventing Chronic Disease,* 14, E24. https://doi.org/10.5888/pcd14.160287

National Cancer Institute (2020, September 25). *Diet history questionnaire (DHQ III)*. https://epi.grants.cancer.gov/dhq3/

National Cancer Institute. (2020, July 24). *NCS dietary assessment literature review - List of abbreviations.* https://epi.grants.cancer.gov/past-initiatives/assess_wc/review/appendix/abbreviations_list.html

National Cancer Institute. (n.d.). *Dietary assessment instruments profiles.* www.dietassessmentprimer.cancer.gov/profiles/

National Health and Nutrition Examination Survey 2017-2018 Data Documentation, Codebook, and Frequencies (February 2020). Demographic variables and sample weights (Demo_J). https://wwwn.cdc.gov/Nchs/Nhanes/2017-2018/DEMO_J.htm

Nicklas, T. A., Jahns, L., Bogle, M. L., Chester, D. N., Giovanni, M., Klurfeld, D. M., Laugero, K., Liu, Y., Lopez, S., & Tucker, K. L. (2013). Barriers and facilitators for consumer adherence to the dietary guidelines for Americans: the HEALTH study. *Journal of the Academy of Nutrition and Dietetics*, *113*(10), 1317-1331. http://dx.doi.org/10.1016/j.jand.2013.05.004

Nicklas, T. A., Qu, H., Hughes, S. O., He, M., Wagner, S. E., Foushee, H. R., & Shewchuk, R. M. (2011). Self-perceived lactose intolerance results in lower intakes of calcium and dairy foods and is associated with hypertension and diabetes in adults. *The American Journal of Clinical Nutrition*, *94*(1), 191-198. https://doi.org/10.3945/ajcn.110.009860

Pallant, J. (2016). *SPSS survival manual* (6th Edition). Open University Press, Berkshire England. ISBN-13: 978-0-33-526154-3.

Park, J., Lee, H. S., Lee, C., & Lee, H. J. (2019). Milk consumption patterns and perceptions in Korean adolescents, adults, and the elderly. *International Dairy Journal*, *95*, 78-85. https://doi.org/10.1016/j.idairyj.2019.03.011

Park, Y., Dodd, K. W., Kipnis, V., Thompson, F. E., Potischman, N., Schoeller, D. A., Baer, D. J., Midthune, D., Troiano, R. P., Bowles, H., & Subar, A. F. (2018). Comparison of self-reported dietary intakes from the Automated Self-Administered 24-h recall, 4-d food records, and food-frequency questionnaires against recovery biomarkers. *American Journal of Clinical Nutrition*, *107*(1), 80-93. https://doi.org/10.1093/ajcn/nqx002

Pender (2011). *Heath promotion model manual.* University of Michigan www.https://deepblue.lib.umich.edu/bitstream/handle/2027.42/85350/HEALTH_PROMOTION_MANUAL_Rev_5-2011.pdf

Peterson, S.J., & Bredow, T.S. (2017). *Middle range theories: Application to nursing research* (4th ed.). Lippincott.

Petherick, A. (January 2016). *Milk consumption around the world.* International Milk Genomics Consortium. https://milkgenomics.org/article/milk-consumption-around-the-world/

Pew Research Center (April 7, 2021). *Internet/broadband fact sheet.* https://www.pewresearch.org/internet/fact-sheet/internet-broadband/#panel-e60540d5-6342-47eb-835d-21b1c0a5e37b

Polit, D.F. & Beck, C.T. (2021). *Nursing research: Generating and assessing evidence for nursing practice* (11th ed.). Wolters Kluwer.

Robb, C. A., Reynolds, L. M., & Abdel-Ghany, M. (2007). Consumer preference among fluid milks: low-fat vs. high-fat milk consumption in the United States. *International Journal of Consumer Studies, 31*(1), 90-94. https://doi.org/10.1111/j.1470-6431.2006.00492.x

Sangah, S., Jiyeon, L., Hwi-Won, L., Kim, C. E., Daehee, K., & Jong-koo, L. (2017). Association between milk consumption and metabolic syndrome among Korean adults: results from the health examinees study. *Nutrients*, *9*(10), 1102. https://doi.org/10.3390/nu9101102

Schmidt, K. A., Cromer, G., Burhans, M. S., Kuzma, J. N., Hagman, D. K., Fernando, I., Murray, M., Utzschneider, K. M., Holte, S., Kraft, J., & Kratz, M. (2021a). The impact of diets rich in low-fat or full-fat dairy on glucose tolerance and its determinants: a randomized controlled trial. *American Journal of Clinical Nutrition*, *113*(3), 534-547. https://doi.org/10.1093/ajcn/nqaa301

Schmidt, K. A., Cromer, G., Burhans, M. S., Kuzma, J. N., Hagman, D. K., Fernando, I., Murray, M., Utzschneider, K. M., Holte, S., Kraft, J., & Kratz, M. (2021b, May). Impact of low-fat and full-fat dairy foods on fasting lipid profile and blood pressure: exploratory endpoints of a randomized controlled trial. *American Journal of Clinical Nutrition*, *114*(3), 882-892. https://doi.org/10.1093/ajcn/nqab131

Semega, J., & Kollar, M. (2022, September 13). *Income in the United States: 2021.* https://www.census.gov/library/publications/2022/demo/p60-276.html#:~:text=Real%20median%20household%20income%20was,and%20Table%20A%2sD1

Serra-Majem, L., Pfrimer, K., Doreste-Alonso, J., Ribas-Barba, L., Sánchez-Villegas, A., Ortiz-Andrellucchi, A., & Henríquez-Sánchez, P. (2009). Dietary assessment methods for intakes of iron, calcium, selenium, zinc and iodine. *British Journal of Nutrition*, *102*(S1), S38-S55. https://doi.org/10.1017/S0007114509993138

Sherling, D. H., Perumareddi, P., & Hennekens, C. H. (2017). Metabolic syndrome: Clinical and policy implications of the new silent killer. *Journal of Cardiovascular Pharmacology and Therapeutics*, *22*(4), 365-367. https://doi.org/10.1177%2F1074248416686187

Shim, J. S., Oh, K., & Kim, H. C. (2014). Dietary assessment methods in epidemiologic studies. *Epidemiology and Health*, *36*. http://dx.doi.org/10.4178/epih/e2014009

Shin, S., Lee, H. W., Kim, C. E., Lim, J., Lee, J. K., & Kang, D. (2017). Association between milk consumption and metabolic syndrome among Korean adults: Results from the health examinees study. *Nutrients*, *9*(10), 1102. https://doi.org/10.3390/nu9101102

Soedamah-Muthu, S. S., & Guo, J. (2020). Dairy consumption and cardiometabolic diseases: Evidence from prospective studies. In D. I. Givens (Ed.), *Milk and dairy foods: Their functionality in human health and disease.* (pp. 1-29). Academic Press.

St. George, S. M., Van Horn, M. L., Lawman, H. G., & Wilson, D. K. (2016). Reliability of 24-hour dietary recalls as a measure of diet in African-American youth. *Journal of the Academy of Nutrition and Dietetics*, *116*(10), 1551-1559. https://doi.org/10.1016/j.jand.2016.05.011

Statistics Kingdom (n.d.). *Sample size calculators.* https://www.statskingdom.com/sample_size_all.html

Subar, A. F., Kirkpatrick, S. I., Mittl, B., Zimmerman, T. P., Thompson, F. E., Bingley, C., Willis, Islam, N. G., Tom Baranowski, T., McNutt, S., & Potischman, N. (2012). The Automated Self-Administered 24-hour Dietary Recall (ASA24): A resource for researchers, clinicians, and educators from the National Cancer Institute. *Journal of the Academy of Nutrition and Dietetics, 112*(8), 1134. https://doi.org/10.1016/j.jand.2012.04.016

Subar, A. F., Potischman, N., Dodd, K. W., Thompson, F. E., Baer, D. J., Schoeller, D. A., Midthune, D., Kipnis, V., Kirkpatrick, S. I., Mittl, B., Zimmerman, T. P., Douglass, D., Bowles, H. R., & Park, Y. (2020). Performance and feasibility of recalls completed using the automated self-administered 24-hour dietary assessment tool in relation to other self-report tools and biomarkers in the interactive diet and activity tracking in AARP (IDATA) study. *Journal of the Academy of Nutrition and Dietetics*, *120*(11), 1805-1820. https://doi.org/10.1016/j.jand.2020.06.015

Subar, A. F., Thompson, F. E., Kipnis, V., Midthune, D., Hurwitz, P., McNutt, S., McIntosh, A., & Rosenfeld, S. (2001). Comparative validation of the Block, Willett, and National Cancer Institute food frequency questionnaires: The eating at America's table study. *American Journal of Epidemiology*, *154*(12), 1089-1099. https://doi.org/10.1093/aje/154.12.1089

Takechi, R., Alfonso, H., Harrison, A., Hiramatsu, N., Ishisaka, A., Tanaka, A., Tan, L., & Lee, A. H. (2018). Assessing self-reported green tea and coffee consumption by food frequency questionnaire and food record and their association with polyphenol biomarkers in Japanese women. *Asia Pacific Journal of Clinical Nutrition*, *27*(2), 460-465. https://doi.org/10.6133/apjcn.052017.06

Thompson, F. E., Kirkpatrick, S. I., Subar, A. F., Reedy, J., Schap, T. E., Wilson, M. M., & Krebs-Smith, S. M. (2015). The national cancer institute's dietary assessment primer: A resource for diet research. *Journal of the Academy of Nutrition and Dietetics*, 115(12), 1986-1995. http://dx.doi.org/10.1016/j.jand.2015.08.016

Thompson, F. E., Subar, A. F., Brown, C. C., Smith, A. F., Sharbaugh, C. O., Jobe, J. B., Mittl, B., Gibson, J. T., & Ziegler, R. G. (2002). Cognitive research enhances accuracy of food frequency questionnaire reports: results of an experimental validation study. *Journal of the American Dietetic Association*, *102*(2), 212-225. https://doi.org/10.1016/S0002-8223(02)90050-7

Timon, C. M., O'Connor, A., Bhargava, N., Gibney, E. R., & Feeney, E. L. (2020). Dairy Consumption and Metabolic Health. *Nutrients*, *12*(10), 3040. https://doi.org/10.3390/nu12103040

Trichia, E., Luben, R., Khaw, K.-T., Wareham, N. J., Imamura, F., & Forouhi, N. G. (2020). The associations of longitudinal changes in consumption of total and types of dairy products and markers of metabolic risk and adiposity: findings from the European investigation into cancer and nutrition (EPIC)–Norfolk study, United Kingdom. *American Journal of Clinical Nutrition*, *111*(5), 1018-1026. https://doi.org/10.1093/ajcn/nqz335

U.S. Department of Agriculture and U.S. Department of Health and Human Services (December 2020). *Dietary Guidelines for Americans, 2020-2025.* (9th Edition). Available at https://www.dietaryguidelines.gov/

U.S. Department of Agriculture and U.S. Department of Health and Human Services (December 2020). *Dietary Guidelines for Americans, 2020-2025.* (9th Edition). Available at https://www.dietaryguidelines.gov/

Vien, S., Fabek, H., Yamagishi, Y., Lee, Y. T., Luhovyy, B. L., & Anderson, G. H. (2019). Role of single serving form of dairy on satiety and postprandial glycaemia in young and older healthy adults. *Applied Physiology, Nutrition & Metabolism*, *44*(12), 1289-1296. https://doi.org/10.1139/apnm-2018-0887

Walsh, M. C., & Gunn, C (2020). Non-dairy milk substitutes: Are they of adequate nutritional composition? In D. I. Givens (Ed.), *Milk and dairy foods: Their functionality in human health and disease* (pp. 347-364). Academic Press.

Appendix A

Questionnaire for Collecting Data for the Study

1. Age ____________________________

2. Race
   - Mexican American
   - Non-Hispanic Black
   - Non-Hispanic White
   - Other Hispanic
   - Other Race

3. Sex
   - Female
   - Male

4. Education Level
   - Less than 9th grade
   - 9th -11th grade
   - High School graduate/GED
   - Some College or Associate Degree
   - College graduate or Above

5. Annual Household Income
   - Less than $20,000
   - $20,000 to $29,999
   - $30,000 to $39,999
   - $40,000 to $49,999
   - $50,000 to $59,999
   - $60,000 to $69,999
   - Above $70,000

6. Estimate how much you weigh (in pounds) ____________________________
7. How tall are you? ____________________________
8. Over the past month, how often did you drink milk as a beverage (NOT in coffee, tea, or cereal; NOT including milkshake)?
   - 1 time in the past month
   - 2-3 times in the past month
   - 1-2 times per week
   - 3-4 times per week
   - 5-6 times per week
   - 1 time per day
   - 2-3 times per day
   - 4-5 times per day
   - 6 or more times per day

9. Each time you drank milk as a beverage, how much did you usually drink?
   - Less than 3⁄4 cup (6 ounces)
   - 3⁄4 to 11⁄2 cups (6 to 12 ounces)
   - More than 11⁄2 cups (12 ounces)

- I don't drink milk

10. Over the past month, how often did you eat yogurt (NOT including frozen yogurt)?
    - 1 time in the past month
    - 2-3 times in the past month
    - 1 time per week
    - 2 times per week
    - 3-4 times per week
    - 5-6 times per week
    - 1 time per day
    - 2 or more times per day
11. Each time you ate yogurt, how much did you usually eat?
    - Less than ½ cup or less than 1 container
    - ½ to ¾ cup or 1 container
    - More than ¾ cup or more than 1 container
    - I don't eat yogurt
12. Over the past month, how often did you eat cheese (including low-fat, on cheeseburgers, or in sandwiches or subs)?
    - 1 time in the past month
    - 2-3 times in the past month
    - 1 time per week
    - 2 times per week
    - 3-4 times per week
    - 5-6 times per week
    - 1 time per day
    - 2 or more times per day
13. Each time you ate cheese, how much did you usually eat?
    - Less than ½ ounce or less than 1 slice
    - ½ to 1½ ounces or 1 slice
    - More than 1½ ounces or more than 1 slice
    - I don't eat cheese
14. Over the past month, how often did you eat ice cream?
    - 1 time in the past month
    - 2-3 times in the past month
    - 1 time per week
    - 2 times per week
    - 3-4 times per week
    - 5-6 times per week
    - 1 time per day
    - 2 or more times per day
15. Each time you ate ice cream, how much did you usually eat?
    - Less than 1 cup or 135g
    - 1 cup to 1 medium size cup or 240g
    - More than 1 medium size cup or 240g
    - I don't eat ice cream

16. Over the past month, how often did you eat cream cheese?
    - 1 time in the past month
    - 2-3 times in the past month
    - 1 time per week
    - 2 times per week
    - 3-4 times per week
    - 5-6 times per week
    - 1 time per day
    - 2 or more times per day
17. Each time you ate cream cheese, how much did you usually eat?
    - Less than 1⁄4 cup or 2 ounces/4 tablespoons/60 grams/2 servings
    - 1⁄4 to 3⁄4 cup or 6 ounces/12 tablespoons/170 grams/6 servings
    - More than 3⁄4 cup
    - I don't eat cream cheese
18. I am lactose intolerant
    - Yes
    - No
19. I know the recommended amount of milk to drink daily
    - Yes
    - No
20. I find the cost of milk quite high
    - strongly disagree
    - disagree
    - agree
    - strongly agree
21. I have difficulties with the taste of milk
    - strongly disagree
    - disagree
    - agree
    - strongly agree
22. I find milk fattening
    - strongly disagree
    - disagree
    - agree
    - strongly agree
23. Milk is not an important part of my diet
    - strongly disagree
    - disagree
    - agree
    - strongly agree
24. Milk is beneficial to children but not adults
    - strongly disagree
    - disagree
    - agree
    - strongly agree
25. What are some of the factors that hinder your milk consumption not mentioned above?
    ____
26. I find milk affordable
    - strongly disagree
    - disagree

- agree
- strongly agree

27. I have difficulties accessing milk
- strongly disagree
- disagree
- agree
- strongly agree

28. Milk is available whenever I need it
- strongly disagree
- disagree
- agree
- strongly agree

29. I am aware of the health benefits associated with drinking milk
- strongly disagree
- disagree
- agree
- strongly agree

30. What are some of the factors that facilitate your milk consumption not mentioned above?

____

31. I know the recommended amount of yogurt to eat daily
- Yes
- No

32. I find the cost of yogurt quite high
- strongly disagree
- disagree
- agree
- strongly agree

33. I have difficulties with the taste of yogurt
- strongly disagree
- disagree
- agree
- strongly agree

34. I find yogurt fattening
- strongly disagree
- disagree
- agree
- strongly agree

35. Yogurt is not an important part of my diet
- strongly disagree
- disagree
- agree
- strongly agree

36. Yogurt is beneficial to children but not adults
- strongly disagree
- disagree
- agree
- strongly agree

37. What are some of the factors that hinder your yogurt consumption not mentioned above?

____

38. I find yogurt affordable
- strongly disagree

- disagree
- agree
- strongly agree

39. I have difficulties accessing yogurt
    - strongly disagree
    - disagree
    - agree
    - strongly agree

40. Yogurt is available whenever I need it
    - strongly disagree
    - disagree
    - agree
    - strongly agree

41. I am aware of the health benefits associated with drinking yogurt
    - strongly disagree
    - disagree
    - agree
    - strongly agree

42. What are some of the factors that facilitate your yogurt consumption not mentioned above?
    ____

43. I know the recommended amount of cheese to eat daily
    - Yes
    - No

44. I find the cost of cheese quite high
    - strongly disagree
    - disagree
    - agree
    - strongly agree

45. I have difficulties with the taste of cheese
    - strongly disagree
    - disagree
    - agree
    - strongly agree

46. I find cheese fattening
    - strongly disagree
    - disagree
    - agree
    - strongly agree

47. Cheese is not an important part of my diet
    - strongly disagree
    - disagree
    - agree
    - strongly agree

48. Cheese is beneficial to children but not adults
    - strongly disagree
    - disagree
    - agree
    - strongly agree

49. What are some of the factors that hinder your cheese consumption not mentioned above?
    ____

50. I find cheese affordable
- strongly disagree
- disagree
- agree
- strongly agree

51. I have difficulties accessing cheese
- strongly disagree
- disagree
- agree
- strongly agree

52. Cheese is available whenever I need it
- strongly disagree
- disagree
- agree
- strongly agree

53. I am aware of the health benefits associated with drinking cheese
- strongly disagree
- disagree
- agree
- strongly agree

54. What are some of the factors that facilitate your cheese consumption not mentioned above?

____

55. I know the recommended amount of ice cream to drink daily
- Yes
- No

56. I find the cost of ice cream quite high
- strongly disagree
- disagree
- agree
- strongly agree

57. I have difficulties with the taste of ice cream
- strongly disagree
- disagree
- agree
- strongly agree

58. I find ice cream fattening
- strongly disagree
- disagree
- agree
- strongly agree

59. Ice cream is not an important part of my diet
- strongly disagree
- disagree
- agree
- strongly agree

60. Ice cream is beneficial to children but not adults
- strongly disagree
- disagree
- agree
- strongly agree

61. What are some of the factors that hinder your ice cream consumption not mentioned above? ______________________________

62. I find ice cream affordable
- strongly disagree
- disagree
- agree
- strongly agree

63. I have difficulties accessing ice cream
- strongly disagree
- disagree
- agree
- strongly agree

64. Ice cream is available whenever I need it
- strongly disagree
- disagree
- agree
- strongly agree

65. I am aware of the health benefits associated with drinking ice cream
- strongly disagree
- disagree
- agree
- strongly agree

66. What are some of the factors that facilitate your ice cream consumption not mentioned above? ______________________________

67. I know the recommended amount of cream cheese to drink daily
- Yes
- No

68. I find the cost of cream cheese quite high
- strongly disagree
- disagree
- agree
- strongly agree

69. I have difficulties with the taste of cream cheese
- strongly disagree
- disagree
- agree
- strongly agree

70. I find cream cheese fattening
- strongly disagree
- disagree
- agree
- strongly agree

71. Cream cheese is not an important part of my diet
- strongly disagree
- disagree
- agree
- strongly agree

72. Cream cheese is beneficial to children but not adults
- strongly disagree
- disagree
- agree

- strongly agree

73. What are some of the factors that hinder your cream cheese consumption not mentioned above?

____

74. I find cream cheese affordable
    - strongly disagree
    - disagree
    - agree
    - strongly agree

75. I have difficulties accessing cream cheese
    - strongly disagree
    - disagree
    - agree
    - strongly agree

76. Cream cheese is available whenever I need it
    - strongly disagree
    - disagree
    - agree
    - strongly agree

77. I am aware of the health benefits associated with drinking cream cheese
    - strongly disagree
    - disagree
    - agree
    - strongly agree

78. What are some of the factors that facilitate your cream cheese consumption not mentioned above?

____

CURRICULUM VITAE

NAME: Kofi Amoh-Mensah

ADDRESS: 6044 Taylor Drive
Burlington, KY 41005
kofam2004@yahoo.com

EDUCATION:

PhD Candidate, Nursing
University of Louisville, School of Nursing
November 9, 2021 – Present

PhD Student, Nursing
University of Louisville, School of Nursing
2019-2021

Health Professions Education Certificate
University of Louisville
2020-2021

Master of Public Health
East Tennessee State University
2017-2019

Graduate Certificate in Biostatistics
East Tennessee State University
2017-2019

BSC (Hons) Nursing Science
Northumbria University
2013-2014

Diploma in General Nursing
Nursing and Midwifery Training College-Kumasi
2006-2009

SCHOLARSHIPS & AWARDS:

Health and Social Justice Scholarship - $5000
Sigma Theta Tau Iota Zeta Chapter Dissertation award - $500
Ruth Craddock Fund Dissertation award - $500
Ruth Craddock Fund - $125

PROFESSIONAL SOCIETIES:

Sigma Theta Tau Iota Zeta Chapter
Sigma Theta Tau International

PUBLICATION:

Amoh-Mensah, K., Ankomah, S. E., Kusiwaa-Karikari, A., & Arthur, J. A. (2017). Prevention of hypertension: A critical review of the health benefits of salt, garlic, fish oil, chocolate and vitamin D. *International Journal of Medical Sciences and Technology*, *7*(7):38-46.

INVITED PRESENTATIONS:

Hardin-Fanning, F., Baxter, M., & **Amoh-Mensah, K.** (2022). Factors associated with the likelihood of perceiving food assistance as socially acceptable. *Council for the Advancement of Nursing Science (CANS) State of the Science Congress on Nursing Research.* Washington D.C.

Amoh-Mensah, K., & Sha, S. (2022). Factors associated with the development of metabolic syndrome: A NHANES 2017-2018 analysis. *Spring Research Assembly, UofL SON.* Louisville, Kentucky.

Amoh-Mensah, K., & Sha, S. (2021). Factors associated with the development of metabolic syndrome: A NHANES 2017-2018 analysis. *Research!Louisville Nursing Symposium.* Louisville, Kentucky.

Amoh-Mensah, K., & Sha, S. (2021). Factors associated with the development of metabolic syndrome: A NHANES 2017-2018 analysis. *Research!Louisville.* Louisville, Kentucky.

Amoh-Mensah, K., & Chlebowy, D. (2021). The effects of diet in the prevention of metabolic syndrome: A systematic review. *Midwest Nursing Research Society (MNRS) 45th Annual Research Virtual Conference.*

Amoh-Mensah, K., & Chlebowy, D. (2021). The effects of dairy products consumption on metabolic syndrome prevention: A systematic review. *Graduate Student*

Regional Research Conference (GSRRC). Louisville, Kentucky.

Amoh-Mensah, K. (2020). The effects of diet in the prevention of metabolic syndrome: A systematic review. *Graduate Student Regional Research Conference (GSRRC).* Louisville, Kentucky.