NUTRITION KNOWLEDGE, MOTIVATION FOR HEALTHY EATING, AND DIET QUALITY IN ARMY ROTC CADETS AT TWO MIDWESTERN UNIVERSITIES

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ABSTRACT

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Background: Army ROTC cadets and service members are required to meet body composition and physical fitness test standards that are dependent on dietary behaviors. The associations of nutrition knowledge on diet quality through motivation for healthy eating of ROTC cadets are yet unknown.

Objectives: To examine the associations among nutrition knowledge and diet quality through motivation for healthy eating in Army ROTC cadets

Design: Cross-sectional study with convenience sampling scheme

Participants/setting: Army ROTC cadets (n=205) from two Midwestern universities

Main outcome measures: The associations between nutrition knowledge, motivation for healthy eating, and diet quality

Statistical analyses: Frequencies, means, multivariate analysis, and mediation modeling were used to study the associations among the variables.

Results: Cadets demonstrated inadequate nutrition knowledge and consumption of the majority of food groups compared to recommendations. Autonomous motivation for healthy eating was a significant, positive predictor of diet quality ($\beta=1.071$, SE=0.178, $p<0.001$) and controlled motivation for healthy eating predicted negatively diet quality ($\beta=-1.093$, SE=0.241, $p<0.001$). Motivation for healthy eating did not mediate the association between nutrition knowledge and diet quality.

Conclusion: Nutrition knowledge was not associated with motivation for healthy eating nor diet quality. However, motivation for healthy eating was a significant predictor of diet quality.

To America’s most honorable service members, thank you

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I am a strong proponent that "it takes a village" and the following pages truly took the effort of a strong and enduring village. No village would be possible without our Creator and Savior, Jesus Christ. He has been the thread throughout my life providing me the grace and motivation through it all.

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CHAPTER ONE: INTRODUCTION

BACKGROUND

Reserve Officer Training Corps (ROTC) is a program to train future officers for the United States military (Dept of Army, 2018b). ROTC cadets are individuals who enroll in college and officer training to prepare to serve as officers in the military after their training is done (Dept of Army, 2018b). ROTC cadets complete academic coursework while simultaneously receiving military and leadership training through drills and military science courses (Dept of Army, 2018b). In turn, they may have part, or all, of their education paid for by their military branch through scholarships in exchange for service in the military after graduation (Dept of Army, 2016b).

Commissioned ROTC cadets make up to 40% of all officers in the Army and are in transition from civilian college students to military officers (Dept of Army, 2018b). The ROTC program prepares cadets to become professional military officers, and thus, holds the cadets to the same body composition and physical fitness test standards as those for the commissioned officers are held to (Dept of Army, 2018b). The physical fitness test requires a two-mile run, two-minutes of push-ups, and two-minutes of sit-ups with a score calculated based on age- and sex-specific criteria every six months. Additionally, cadets must meet age- and sex-specific weight-for-height criteria every six months. Cadets exceeding these criteria are tape measured to estimate body fat percentage. Cadets who exceed the body composition criteria face repercussions including being reprimanded, losing their scholarships, or risking being dismissed from service (US Army Cadet Command, 2016).

In addition to body composition and physical fitness standards, the Army puts a focus on performance to maintain the well-being of its service members through the Performance Triad, focusing on nutrition, sleep, and physical activity (Dept of Army, 2018a). According to Army Regulation 40-25, "all Services will provide Service members with a fundamental knowledge of nutrition during initial military training" and there will also be consistent, nutrition messaging to help maximize performance throughout one's profession (Dept of Army, Navy, and Air Force, 2017). ROTC programs are recommended to include the topic of nutrition on the curriculum (Dept of Army, 2018b). However, ROTC cadets and service members have demonstrated inadequate nutrition knowledge in topics including basic nutrition, dietary recommendations, sports nutrition, and performance (Bovill, Tharion, & Lieberman, 2003; Connell, Torres-McGehee, Emerson, Jenson, & Ferland, 2017; Valentine, Schumacher, Murphy, & Ma, 2018). Additionally, there is no military-wide standardized execution plans or monitoring process to ensure all service members possess nutrition knowledge and skills that are needed to fulfill the military requirements.

Despite the Army's emphasis on performance, active duty military personnel have demonstrated suboptimal intake, knowledge, attitudes, and behaviors related to nutrition (Dept of Defense, 2013; Piche, Stankorb, & Salgueiro, 2014; Purvis, Lentino, Jackson, Murphy, & Deuster, 2013; Ramsey, Hostetler, & Andrews, 2013). To help service members' meeting body composition and physical fitness standards, researchers developed a number of interventions with a combination of nutrition and physical activity programs (Piche et al., 2014; Purvis et al., 2013). Some of the interventions have been targeted to select sub-populations in the military but demonstrated limited efficacy and sustainability (Murray, Aboul-Enein, Bernstein, & Kruk, 2017; Piche et al., 2014). Furthermore, there is no current diet assessment tool that is universally adopted Army-wide or ROTC-wide to examine the diet quality of service members. Many military-specific studies vary in their approach to assess dietary intake (Dept of Defense, 2013;

Piche et al., 2014; Purvis et al., 2013). The lack of military-wide, standardized dietary assessment tools makes it difficult to generalize the findings to all service members.

Adequate preparation of ROTC cadets is important for the success of US military and also the cadets' long-term lives in many aspects. ROTC cadets are in young adulthood transitioning from university life into military life, meeting the military requirements while forming healthy eating behaviors that will last throughout their military career and meeting all academic achievements demanded by their programs in colleges and universities. Importantly, ROTC cadets need to form healthy eating behaviors that ensure meeting increased nutritional needs to fuel their bodies in response to increased physical demands. The cadets face unusual challenges by receiving full-time college education and military life training simultaneously (US Army Cadet Command, 2011).

Dietary intake and nutrition is important in performance (Academy of Nutrition and Dietetics, Dietitians of Canada, & College of Sports Medicine, 2016; Rash, Malinauskas, Duffrin, Barber-Heidal, & Overton, 2008). ROTC can be a critically important opportunity to introduce any educational interventions to prevent several nutrition and eating behavior challenges reported among officers including obesity, cardiovascular disease, and diabetes (Jackson et al., 2013). Obesity and unhealthy eating behavior can increase the risk of chronic diseases, such as heart disease, mortality and healthcare costs (Eilerman et al., 2014; Shams-White & Deuster, 2017). In 2011, 51.2% and 12.4% of military service members were considered overweight and obese, respectively per the CDC guidelines (Dept of Defense, 2013). Problematic eating behaviors have been reported in service members as they try to meet body composition and physical fitness test standards (Clark, Heileson, DeMay, & Cole, 2017; Cole, Clark, Heileson, DeMay, & Smith, 2016; Piche et al., 2014).

Traditionally, efforts have been focused on decreasing obesity and promoting diet quality through increasing nutrition knowledge. However, whether nutrition knowledge is the primary determinant on dietary intake is controversial (Abbey, Wright, & Kirkpatrick, 2017; Andrews, Wojcik, Boyd, & Bowers, 2016; Heaney, O'Connor, Michael, Gifford, & Naughton, 2011; Rash et al., 2008; Wardle, Parmenter, & Waller, 2000). A newer approach to improve diet quality through nutrition knowledge is by enhancing psychological determinants (Tabbakh & Freeland-Graves, 2016). One psychological that may be important in Army ROTC cadets is motivation for healthy eating. Individuals vary in how motivated they are to regulate their eating in terms of the types and amount of food they consume (Guertin, Rocchi, Pelletier, Émond, & Lalande, 2015; Pelletier & Dion, 2007; Pelletier, Dion, Slovinec-D'Angelo, & Reid, 2004). Eating regulation has been evaluated in the context of motivation utilizing the Self-Determination Theory, which gauges type of motivation on a spectrum from amotivation to intrinsic motivation (Guertin et al., 2015; Pelletier et al., 2004; Verstuyf, Patrick, Vansteenkiste, & Teixeira, 2012). Cadets tend to be self-motivated individuals in the context of public service motivation compared to civilian college students (Ngaruiya, Knox Velez, Clerkin, & Taylor, 2014). When engaging in dietary restriction or overconsumption, cadets are demonstrating controlled eating regulation (Pelletier & Dion, 2007). Individuals with higher autonomous motivation for healthy eating have been reported to have healthier eating habits (Guertin et al., 2015; Pelletier et al., 2004). Since motivation for healthy eating has shown to affect diet quality in other studies, motivation for healthy eating may be an important determinant mediating the relationship between nutrition knowledge and diet quality (Guertin et al., 2015; Pelletier et al., 2004). No studies to our knowledge have examined the role of motivation for healthy eating in explaining the relation between nutrition knowledge and diet quality in Army ROTC cadets.

PROBLEM STATEMENT

Diet quality directly affects health and performance (Academy of Nutrition and Dietetics et al., 2016; Rash et al., 2008). ROTC cadets are at a transitional period from civilian college students to officers in the military and have increased performance demands compared to traditional college students (Connell et al., 2017; Dept of Army, 2018b). Cadets are required to meet the same body composition and physical fitness test standards as officers are. Prior to becoming leaders in the military, ROTC offers a unique opportunity to prepare cadets for a successful military career and sustainable lifestyle for long-term health. Nutrition is part of the recommended curriculum for ROTC cadets and required as part of military training once they become officers (Dept of Army, 2013, 2018b).

Despite the Army's ongoing efforts to promote health, inadequate nutrition knowledge, suboptimal diet quality, and problematic eating behaviors have been reported in ROTC cadets and service members (Connell et al., 2017; Dept of Defense, 2013; Piche et al., 2014; Purvis et al., 2013). One study examined nutrition knowledge in ROTC cadets through a series of questions on sports nutrition, basic nutrition concepts, and dietary recommendations (Connell et al., 2017). The mean nutrition knowledge score was 55.3% $\pm$ 13.1, which researchers concluded was insufficient, compared to an adequate nutrition knowledge cut-off of 75% (Connell et al., 2017). ROTC cadets have also reported binge eating and using diet pills, among other tactics to control weight (Connell et al., 2017). It appears that there may be areas for improvement with the reported lack of nutrition knowledge and problematic eating behaviors in ROTC cadets (Connell et al., 2017). Other researchers have also found that nutrition knowledge was deemed inadequate in Army soldiers using sports nutrition questions and that service members also have less than optimal diet quality and abnormal eating behaviors (Bovill et al., 2003; Dept of Defense, 2013; Purvis et al., 2013). In non-military studies, nutrition knowledge has been shown to predict dietary intake, but results are inconsistent with some researchers suggesting that there is more to the equation than solely knowledge (Ilich, Vollono, & Brownbill, 1999; Rash et al., 2008; Spronk, Kullen, Burdon, & O'Connor, 2014; Spronk et al., 2014; Wardle et al., 2000).

Other factors such as cost and availability of foods have been reported to influence intake in ROTC cadets (Nevarez, 2018). However, the current body of literature presents conflicting results on the effect of nutrition knowledge on dietary intake, or if psychological determinants mediate the relationship. It is possible that diet quality, nutrition knowledge, and motivation for healthy eating impact ROTC cadets' ability to meet military required body composition and physical fitness test standards. The environment of the ROTC program poses unique challenges in assessing nutrition knowledge, motivation for healthy eating, and diet quality. Service members are oftentimes in and out of training and the field and there are no universally used diet assessment methods currently with surveillance and monitoring in place.

Although nutrition knowledge may be one factor influencing dietary intake, there has been a shift in focus to how psychological determinants may mediate the pathway between nutrition knowledge and diet quality (Tabbakh & Freeland-Graves, 2016). One psychological element that may serve as an important mediator between nutrition knowledge and diet quality is motivation for healthy eating (Guertin et al., 2015; Pelletier et al., 2004). Individuals may vary in how motivated they are to regulate their eating, which translates into how much they consume and the types of food they choose to eat (Guertin et al., 2015; Pelletier & Dion, 2007; Pelletier et al., 2004). Researchers have examined how nutrition knowledge affects diet quality through psychological determinants in college females, but no studies able to be sourced have examined this pathway in ROTC cadets (Tabbakh & Freeland-Graves, 2016). This study intends to explore the underlying mechanisms of how nutrition knowledge and motivation for healthy eating are related to diet quality in ROTC cadets.

RESEARCH AIMS

Aim 1. To assess nutrition knowledge, motivation for healthy eating, and diet quality in Army ROTC cadets

Aim 2. To examine how nutrition knowledge and motivation for healthy eating are associated with diet quality in Army ROTC cadets

Hypothesis 2a. Nutrition knowledge will be indirectly and positively associated with diet quality through autonomous motivation for healthy eating

Hypothesis 2b. Nutrition knowledge will be positively associated with autonomous motivation for healthy eating in Army ROTC cadets

Hypothesis 2c. Nutrition knowledge will be negatively associated with controlled motivation for healthy eating in Army ROTC cadets

Hypothesis 2d. Autonomous motivation for healthy eating will be positively associated with diet quality in Army ROTC cadets

Hypothesis 2e. Controlled motivation for healthy eating will be negatively associated with diet quality in Army ROTC cadets

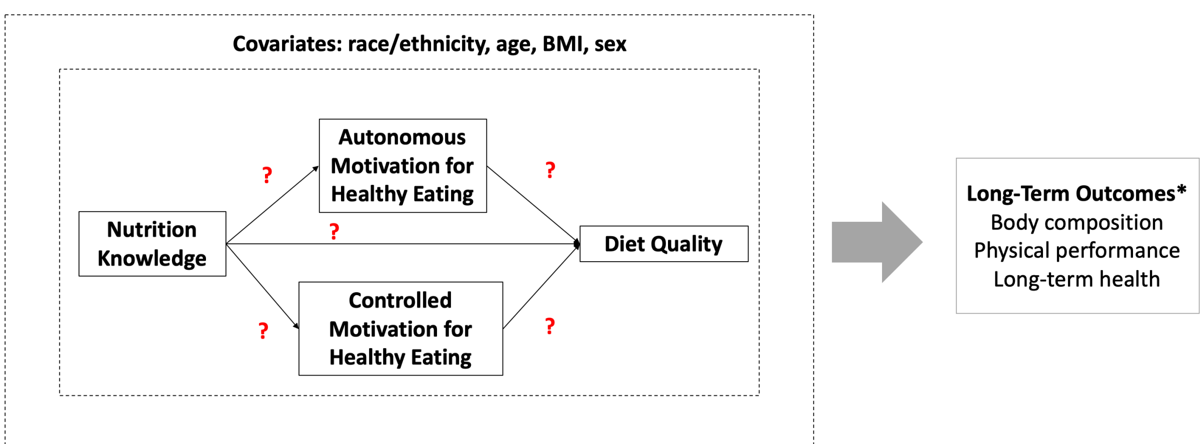

Figure 1. Conceptual model of research aims, covariates, and long-term outcomes
*Long-term outcomes not measured in current study

SIGNIFICANCE

Diet quality is a key component in performance (Academy of Nutrition and Dietetics et al., 2016; Rash et al., 2008). As future leaders in the military, ROTC cadets need to be well-equipped to model healthful behaviors and meet the body composition and physical fitness test requirements set by the Department of Defense for both officers and enlisted service personnel. Military service members, including ROTC cadets, have pressure to meet body composition and physical fitness test standards in order to keep scholarships and their careers. ROTC cadets and service members have reported inadequate nutrition knowledge, intake, and eating behaviors (Connell et al., 2017; Purvis et al., 2013). There is conflicting research on if nutrition knowledge directly affects diet quality or if psychological determinants, such as motivation for healthy eating, mediate the pathway (Spronk et al., 2014; Tabbakh & Freeland-Graves, 2016; Wardle et al., 2000). The significance of this study is to understand how motivation for healthy eating and nutrition knowledge are associated with achieving diet quality in ROTC cadets to maximize performance and health, which can go on to inform Department of Defense future interventions.

Prior to being able to design interventions, it is important to identify ROTC cadets' nutrition knowledge and motivation for healthy eating and their impact on diet quality. This study serves as a preliminary investigation to understand the associations of nutrition knowledge, motivation for healthy eating, and diet quality to have a better sense of ROTC cadets' baseline. Due to the increased risk of complications and healthcare costs associated with both overweight/obesity, it is essential to examine factors impacting diet quality in ROTC cadets.

The findings of this study can be used in planning future nutrition assessment, education, training, and nutrition counseling strategies for ROTC cadets to help them to achieve and maintain the body composition and physical activity test standards and engage in healthful eating behaviors. ROTC cadets are an important target population for future interventions as they will be in leadership roles and can impact others in the military and themselves through the rest of adulthood.

DEFINITIONS

- ***Army ROTC cadets:*** individuals who enroll in university classes and military training to prepare to become officers in the US Army after they finish the program, must meet body composition and physical fitness test standards every six months (Dept of Army, 2016b, 2018b).
- ***Body composition standards:*** Age- and sex-specific weight-for-height criteria that must be met by cadets and service members every six months. The cadets who do not meet the criteria are subjected to tape measurements of neck, waist, and hips (women only) for estimation of body fat percentage. Cadets risk loss of scholarship or may be required to lose weight if they exceed criteria (Dept of Army, 2013).
- ***Physical fitness test standards:*** Age- and sex-specific score calculated using cadets' and service members' two-mile run time, number of sit-ups in two minutes, and number of push-ups in two minutes. Physical fitness test standards are taken every six months along with the test for body composition standards (Dept of Army, 2013).
- ***Diet quality:*** Measure of healthful eating through food groups consisting primarily of whole grains, fruits, vegetables, fish, and dairy foods. Diet quality in this study is measured with a validated Healthy Eating Score-5 utilized by the US Army in the Comprehensive Soldier and Family Fitness Global Assessment Tool (Purvis et al., 2013).
- ***Psychological determinants:*** factors related to the mental and emotional condition of an individual that affect intake and eating, such as motivation for healthy eating, stress, and eating attitudes (Brug, 2008; Pelletier et al., 2004).

- ***Motivation for healthy eating:*** Impetus and drive towards healthful eating to regulate eating behavior with two forms including autonomous, a positive form of motivation consisting of intrinsic, integrated and identified regulation, and controlled, a negative form or lack-of motivation consisting of introjected, external, and non-regulation. Motivation for healthy eating is measured in this study by utilizing 24 motivation and eating regulation questions developed and validated by Pelletier and colleagues and validated in college females in Canada (Brug, 2008; Pelletier et al., 2004).
- ***Self-regulation:*** An essential ability and capacity to control behavior and attention based on long-term goals and well-being (Ridder & Wit, 2008).
- ***Autonomous motivation for healthy eating:*** Self-determined and positive drive to choose healthful foods and self-regulate eating behavior. Autonomous motivation for healthy eating is measured with the Regulation of Eating Behaviors Survey with the three subscales of identified, integrated, and intrinsic regulation (Pelletier et al., 2004).
- ***Controlled motivation for healthy eating:*** Regulating eating and choosing foods based on self-control and influences of external forces. Controlled motivation for healthy eating is less self-determined than autonomous motivation for healthy eating and measured with the Regulation of Eating Behaviors Survey with three subscales of amotivation, external regulation, and introjected regulation (Pelletier et al., 2004).
- ***Intrinsic regulation:*** Autonomous engagement in self-regulation based on own personal commitment for long-term well-being (Pelletier et al., 2004).
- ***Integrated regulation:*** Autonomous engagement in self-regulation based on feeling that it is essential for their individual life and they easily choose to do it (Pelletier et al., 2004).

- ***Identified regulation:*** Autonomous engagement in self-regulation based on thinking it is the right thing to do for their long-term well-being (Pelletier et al., 2004).
- ***Introjected regulation:*** Controlled engagement in self-regulation based on feeling guilty or shameful if they did not (Pelletier et al., 2004).
- ***External regulation:*** Controlled engagement in self-regulation based on exterior forces and pressure to do so (Pelletier et al., 2004).
- ***Amotivation:*** No engagement in self-regulation as they do not see the benefits or risks of doing so (Pelletier et al., 2004).
- ***Nutrition knowledge:*** Assessment of one's understanding of nutrition including energy, macronutrients, hydration, and vitamins/minerals. Nutrition knowledge in the present study was measured utilizing 24 true/false questions developed by the US Army Research Institute for Environmental Medicine and currently in the validation stage (Cole, 2016; Tabbakh & Freeland-Graves, 2016).

CHAPTER TWO: LITERATURE REVIEW

ROTC IN THE US MILITARY

Department of Defense Overview. The Department of Defense is tasked with protecting the security of the American people (Dept of Defense, n.d.). The Department of Defense classifies the military into two categories: active duty and reserves. Active duty consists of all service members in the Air Force, Army, Marine Corps, and Navy. The Reserves consist of all service members in the Air Force Reserve, Air National Guard, Army National Guard, Army Reserve, Coast Guard Reserve, Marine Corps Reserve, and Navy Reserve. In the United States, there are over 2.1 million service members in the military with over 1.3 million active duty service members (Dept of Defense, 2017).

The largest branch of the military is the Army with over 465,800 active duty service members (Dept of Defense, 2017). In 2016, 43% of Army service members were active duty, 30% were in the Army National Guard, and 47% were in the Army reserves. Of active duty Army, 17% were females, 23% were black, 17% were Hispanic, and 96% had a high school diploma. Enlisted soldiers were primarily between the ages of 20-29 (57%) and active duty officers were between 20-29 years old (34%), 30-39 years old (37%) and 40 years and older (29%) (Dept of Army, 2016a).

Individuals recruited to become enlisted in the military start by attending basic training on introduction to military life to get ready mentally, physically, and emotionally for their career. All service members attend basic training, but the training length and physical fitness requirements vary depending on military branch. For example, Army basic training is typically ten weeks long and occurs at four different bases in the United States. During this time, they live in dormitories and eat meals in dining facilities (garrisons) on base. After basic training, they can move on to become candidates to be leaders in the military. Individuals can qualify to become officer candidates if they have: 1) graduated from a four-year university, such as an ROTC program or military school; 2) previously been enlisted and are moving up in the rankings; or 3) a specialized skill or professional degree to be directly commissioned from civilians to officers. Length and location of officer candidate training depends on the military branch (Today's Military, 2017).

ROTC Program Overview. In 2018, more than 40% of Army Officers in the United States were commissioned through the ROTC program (Dept of Army, 2018b). Individuals can become officer candidates through the Reserve Officers' Training Corps (ROTC) program. ROTC cadets receive military training during the four-year program while simultaneously completing college degree-earning coursework. There are hundreds of Army ROTC programs around the country (Dept of Army, 2018b). The military training includes basic training and drills to prepare the cadets for warfighter readiness.

ROTC serves all branches, but the largest branch is the Army ROTC program (Dept of Army, 2018b). There are currently over 32,000 Army ROTC cadets throughout the United States broken up into eight different brigades, or regions, of programs (US Cadet Command, 2018). In order to qualify for AROTC, students must be US citizens, have a high school diploma or equivalent, be between the ages of 17 to 27 years old, have a college GPA of at least 2.5, and must meet body composition and physical fitness test standards (Dept of Army, 2018b). Army ROTC cadet training includes opportunities to attend summer training camps to gain skills and hands-on experience to prepare them for their roles as the future leaders in the Army (Dept of Army, 2018b).

ROTC Program Recruitment, Enrollment, and Commitment. After being recruited and enrolling in an ROTC program, cadets may receive financial assistance or full tuition vouchers for school during their ROTC program when contracted, but not all cadets receive scholarships or money (US Army Cadet Command, 2016). Another way that ROTC cadets are funded is through the Green to Gold program, which provides enlisted soldiers with scholarships to go from active duty to ROTC to then becoming an officer (Dept of Army, 2018b). Cadets are able to contract, or commit to serve in the Army, at any point in their program, but many opt to become contracted around their junior year. Once ROTC cadets sign their contracts, they can receive scholarships, which covers tuition, room and board, sustenance, and travel for the duration of their college career. In turn, they are required to serve in the military for up to eight years and can do so either in active duty or in the reserves, depending on their assignment (Dept of Army, 2018b). Following college graduation, ROTC cadets assume military responsibilities and are commissioned as Second Lieutenants with terms and conditions outlined on their contracts (Dept of Army, 2018b).

ROTC Curriculum. In addition to ROTC cadets' college coursework, they learn the skills to prepare them successfully for their military endeavors, including through basic training, drills, and physical training sessions. The ROTC cadets are required to partake in ROTC training, Cadet Initial Entry Training, and military science classes to prepare them for their military service. Cadet Initial Entry Training (CIET) is an intense summer training that is four weeks long that provides an abbreviated version of the first two years of the ROTC program for cadets who decide to later, such as when they are entering their junior year of college (Dept of Army, 2018b). In the summer between junior and senior years, ROTC cadets attend a five-week Cadet Leadership Course at Fort Knox to receive further leadership training prior to transitioning to become officers (Dept of Army, 2018b). Each Army ROTC program determines their own curriculum. The Army's recommended topics covered during a cadet's four-year program can be found in Table 1.

Table 1. ROTC curriculum

Army ROTC Basic Course	
Year	*Topics Covered*
Freshman (Role of the Army)	• Introduction to Army Leadership • Army Customs and Traditions • Military Operations and Tactics • Goal Setting and Accomplishment • Health and Physical Fitness
Sophomore (Role of Officer)	• Applied Leadership Theory • Communications • Principles of War • Military Operations and Tactics
Cadet Initial Entry Training (optional)	
Army ROTC Advanced Course	
Junior (Small Unit Training)	• Command and Staff Functions • Law of War • Weapons • Team Dynamics and Peer Leadership • Military Operations and Tactics
Cadet Leadership Course	
Senior (Transition to Becoming an Officer)	• Training the Force • Military Justice • Ethical Decision Making • Personnel Management • Cultural Awareness • Post and Installation Support • Military Operations and Tactics

(Adapted from Dept of Army, 2015)

One of the topics to be covered in the ROTC program is health and physical fitness (Dept of Army, 2018b). As previously mentioned, the ROTC program curriculum varies from institution to institution. Although ROTC program leadership is provided with some guidance on the nutrition topics to be covered, delivery and curriculum may vary depending on institution (Dept of Army, 2018b). Additionally, to our knowledge, there is no surveillance and monitoring on the efficacy of the nutrition education topics covered in ROTC training.

ROTC Standards. All ROTC cadets, regardless of scholarship status, are held to the same body composition outlined and physical fitness standards (US Army Cadet Command, 2016). If ROTC cadets do not meet body composition or physical fitness test standards, they may receive informal coaching from ROTC program leadership as well as additional time for PT, but at no time do they meet with a nutrition professional for nutrition counseling to help meet occupational standards. ROTC cadets may have access to a university sports dietitian or the dietitian at the student health center, but this may vary depending on institution.

Unique Challenges in the ROTC Program Environment. ROTC cadets are at a transitional period between civilian life and transitioning to become Army officers. It may be ROTC cadets' first time living away from home as college freshmen. They may be adjusting to college life, including navigating on- and off-campus dining options and social pressures while also balancing rigorous responsibilities of ROTC training. Cadets are typically very busy running between classes, extracurriculars, ROTC responsibilities, and social life.

Cadets have an increasing amount of pressure on them to succeed in their classes, body composition and physical fitness test standards, and the ROTC program, in general. They may feel pressured by the leadership and may be exhausted from early morning physical training sessions. Despite these pressures, one study on motivation in ROTC cadets found that cadets were more motivated for to work in public service compared to civilian undergraduate students (Ngaruiya et al., 2014). The self-drive and motivation in cadets may be why cadets choose to enroll in ROTC programs and commit themselves to serve in the United States Army.

BODY COMPOSITION AND PHYSICAL FITNESS STANDARDS IN MILITARY PERSONNEL AND ROTC CADETS

The Department of Defense expects officers and enlisted service members to meet body composition and physical fitness test standards and also promotes performance and nutrition through the Performance Triad and Army regulations (Dept of Army, 2013, 2018a).

The Department of Defense has specific physical requirements, including physical performance tests and body composition regulations, to ensure that members are equipped and ready physically for combat (Dept of Defense, 2002). Each military branch is tasked with executing and implementing their own policies in order to meet each branch's own standards set by the Department of Defense (Dept of Defense, 2002).

Body Composition Standards. The Army's standards are outlined in Army Regulation 600-9, which delineates that all Army service members must meet age-specific weight-for-height criteria (Appendix B) at least every six months (Dept of Army, 2013). The original purpose for the body composition standards was to prevent malnourished individuals from enlisting to protect America. However, as obesity rates have increased in the United States, the purpose of this criteria has moved to an obesity prevention emphasis (Pierce et al., 2017).

Those who do not meet the criteria proceed to have percent body fat estimated from circumference tape measurements adjusted for sex (Dept of Army, 2013). For men, circumference measurements are taken at the neck and waist three times in inches. Then body fat percentage is estimated with the equation: % body fat (men) = [86.010 x Log10 (waist – neck)] – [70.041 x Log10 (height)] + 36.76. For women, measurements are taken at the neck, waist, and hips and body fat percentage is estimated utilizing the equation: % body fat (women) = [163.205 x Log10 (waist + hip – neck)] – [97.684 x Log10 (height)] – 78.387. There are age-specific and sex-specific maximum acceptable body fat percentages (Table 2) before facing repercussions (Dept of Army, 2013).

The standards set by the Army allow some flexibility in meeting weight-for-height criteria compared to CDC's BMI categories. For example, a 23-year-old male who is 70 inches tall and weighs 185 pounds would have a BMI of 26.5 (overweight), but would still be considered weight-for-height compliant according to the Army (Dept of Army, 2013). This flexibility may adjust for the limitations of utilizing BMI since it does not account for percent of muscle mass and is only one indicator of overall health of an individual (Pierce et al., 2017).

Table 2. Army maximum acceptable body fat percentages

Age group	Male	Female
17-20 years	20%	30%
21-27 years	22%	32%
28-39 years	24%	34%
40 years and older	26%	36%

(Adapted from Dept of Army Regulation 600-9, 2006)

Those in the Army who fail the percent body fat criteria are required to lose a certain number of pounds per month, subject to mandatory nutrition counseling with a registered dietitian, and risk being dismissed from the Army as part of the US Body Composition Program in Figure 2 (Dept of Army, 2013; Murray et al., 2017). ROTC cadets who fail to meet body composition standards are required to meet the standards within a certain amount of time and may receive weight loss tips from ROTC leadership instead of from a registered dietitian nutritionist (Nevarez, 2018).

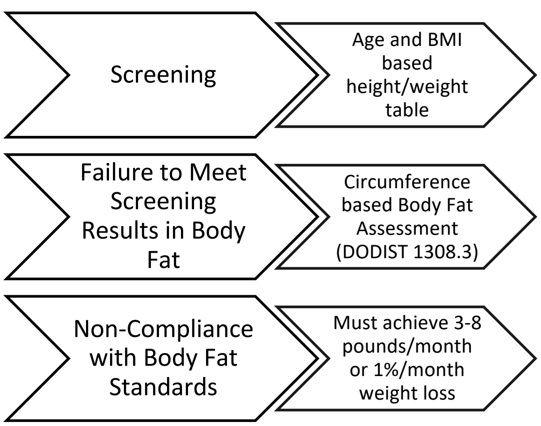

Figure 2. US Army Body Composition Program enrollment procedure
(Adapted from Murray, Abdoul-Enein, Bernstein, and Kruk, 2017)

Researchers have examined the relationship among different methods to measure body fat composition in Army ROTC cadets and found that body fat estimated through circumference measurements did not differ significantly from other body composition assessment methods, such as bioelectrical impedance and underwater weighing (Steed, Krull, Morgan, Tucker, & Ludy, 2016). Body fat composition was not associated with physical fitness test score in the cadets (Steed et al., 2016).

Physical Fitness Test Standards. With some variations among branches, all service members' physical fitness must be assessed by aerobic vigor (endurance) and muscular power and stamina (strength) (Dept of Army, 2013; Dept of Defense, 2002). The US Army's physical fitness test is assessed by scores calculated from a two-mile run, number of push-ups in two minutes, and number of sit-ups in two minutes and adjusted based on sex and age. The service members are expected to obtain a passing score not only during their ROTC Program and Basic Training, but also regularly during their service (Dept of Army, 2013, 2018b).

Congruence Between Body Composition Standards and Physical Fitness Standards. Military members have not been immune to the health risks that the rest of America faces (Dept of Defense, 2013; McCarthy, Elshaw, Szekely, & Pflugeisen, 2017; Piche et al., 2014). Due to the increased concern for military obesity, Eilerman et al. (2014) examined electronic health records of 2.2 million Military Health System (MHS) members from 2009-2012 and compared to the obesity rates to the general United States population. The authors adjusted for age and found that military active duty obesity rates were lower than the general United States population (18.3% vs. 34.9%), although the overweight rate increased in active duty from 52.7% to 53.4% from 2009 to 2012. Weight-for-height criteria is still utilized by the military as a way of monitoring and controlling for obesity rates in the service (Eilerman et al., 2014).

A pilot program to preserve military members who might otherwise be dismissed due to their weight status has been tested (Bowles, Picano, Epperly, & Myer, 2006). The pilot program focused on nutrition, physical activity, lifestyle modifications, and personal willingness to make changes utilizing the cognitive-behavioral theory. Military participants took part in a five-day nutrition group program and then followed-up over the next twelve months. Of 93 subjects who participated in the pilot intervention, 57% (n=53) completed the follow-up program and showed significant changes in weight (Bowles et al., 2006). Participants improved in more favorable self-control over eating behavior from beginning of intervention to one-year follow-up (Bowles et al., 2006). Motivators to lose weight included physical activity, the support of the group members, and feeling towards themselves amongst other things. This study demonstrated how a multi-disciplinary, group-centered approach to nutrition could possibly result in long-term behavior change (Bowles et al., 2006). However, nutrition was only one component of this intervention, so it is difficult to say which changes were caused by which components of this approach.

Moreover, other researchers conducted a secondary analysis of the Assessment of Recruit Motivation and Strength (ARMS) study to see if Army recruits that exceeded the weight-for-height and/or percent body fat criteria had increased risk for illness or being dismissed from the Army (Niebuhr et al., 2013). The study aimed to see if it was economically favorable to continue to train soldiers who do not meet body standards in the hopes that they can perform just as well as their colleagues. The authors found that the military's healthcare cost expenditure was higher on individuals who did not meet body standards compared to those who did meet body standards (Niebuhr et al., 2013). Utilizing the ARMS study data, a different set of researchers investigated if recruits with excessive body fat had increased risk of injury (Cowan, Bedno, Urban, Yi, & Niebuhr, 2011). The authors reported that those individuals with excess body fat were at a 47% higher risk for injury compared to those within a normal weight-for-height range (Cowan et al., 2011). Excess body fat can lead to increased healthcare costs and health risks, which is a reason why the military has body composition standards in place to ensure service members are warfighter ready (Cowan et al., 2011).

Health Promotion in the US Military. Each branch of the military is tasked with developing their respective tools for health promotion to ensure their service members are in prime condition (Dept of Defense, 2013). The Army utilizes the Army Surgeon General's tool called the Performance Triad, which aims to promote being prepared and healthy through sleep, physical activity, and nutrition (Dept of Army, 2018a).

One of the ways that the Department of Defense is promoting health throughout the branches is with the Go for Green program to provide tools and resources so that service members are able to make healthy food choices in the dining halls (Arsenault, Singleton, & Funderburk, 2014). Food items in the cafeteria have nutrition information and labels corresponding with the colors of the stoplight – green for healthiest options, yellow for sometimes-foods, and red for foods to limit. The focus of this effort is on function with green foods having a benefit and red foods having a negative influence on performance. In addition to providing this visual nutrition information, they also promote strategically placing food items to make the healthy choice the easy choice. For example, having whole fruit (a green item) in the high-traffic area and having fried chicken (a red item) at the serving line in the lower-traffic area. Not only is the focus on providing nutrition information and strategic food placement, there are also marketing and nutrition education components to encourage familiarity with the Go for Green system (Arsenault et al., 2014). It is up to the individual military dining facilities if they choose to implement the Go for Green system and the execution process can take about six months (Arsenault et al., 2014). The registered dietitian can assist in assigning which food falls into which category and the nutrition education piece. This provides an opportunity for Army service members to apply their nutrition knowledge and behavior with the goals of increased performance and meeting body composition standards (Arsenault et al., 2014).

There have been ongoing, multi-level efforts to prevent obesity in the military. There have been teaching kitchens installed, web-based training, and clinical trials to focus on where the gaps are in military obesity prevention programs (McCarthy et al., 2017). Additionally, there have been environmental obesity prevention efforts including Go for Green focused on the foodservice environment (Arsenault et al., 2014). Some of the limitations of the military programs are that there is not a lot of published data and research quantifying the programs' efficacies. There is also a need for buy-in from military leaders on the ground so that health behaviors can be modeled and implemented by the rest of service members (Shams-White & Deuster, 2017).

Murray et al. (2017) conducted a narrative review of weight management interventions in the military and found that most of the interventions did not result in a significant weight loss past six months after the interventions took place. Moreover, most of the programs did not have data to support the interventions' efficacies and standardization across interventions was lacking (Murray et al., 2017). Although some strides have been made to prevent and treat obesity in the military, there is no data to back their efficacy. It is difficult to justify implementing programs military-wide without having data to support them and more research and documentation is needed in the future.

Meeting one's nutritional needs is a balancing act as overconsumption and under consumption can have severe consequences on the health and well-being of service members. If service members are not eating enough, they may be cutting out food groups completely and not getting the nutrients that they need along with putting their psychological health at risk (French & Jeffery, 1994). If service members are overconsuming, they may be choosing less healthful foods over healthful foods and not getting the nutrients that they need (Drewnowski, 2004). Despite the current nutrition-related military regulations, service members continue to have lower than desired nutritional intake and higher than desired rates of overweight/obesity, even if lower than the national average (Dept of Defense, 2013). There have been problems and challenges in conforming to nutrition-related regulations in military personnel that need to be addressed in order to promote warfighter readiness.

NUTRITION-RELATED PROBLEMS IN COLLEGE STUDENTS, COLLEGE ATHLETES, AND THE MILITARY

In order to promote nutrition and well-being, Healthy People 2020 nutrition-related objectives focus on decreasing overweight and obesity and increasing the number of United States adults who are in the normal weight category (Dept of Health and Human Services, 2018). In addition, Healthy People 2020 aims to increase intake of healthful foods, like fruit (NWS-14), vegetables, and whole grains with reduced intake of foods high in saturated fats and added sugars (Dept of Health and Human Services, 2018). Despite these objectives being in place, college students, ROTC cadets, college athletes, and military service members face a host of nutrition-related problems (Beals & Hill, 2006; de Vos et al., 2015; Eilerman et al., 2014; Haberman & Luffey, 1998).

Nutrition-Related Problems in College Students. College may be the first-time students are away from home and students face many nutrition-related problems, including food insecurity and external pressure from peers (Gropper et al., 2014). This may be compounded with the unique stresses of the college environment, such as navigating university dining facilities and possibly living away from home for the first time, which can cause additional stress (Ross, Neibling, & Heckert, 1999). It is important that college students consume nutrient-dense, high quality foods for optimal function, perform well academically and establish healthful and sustainable habits to carry on into adulthood and beyond (Kelly, Mazzeo, & Bean, 2013).

In addition to the Healthy People 2020 objectives, there is also Healthy Campus 2020, an initiative by the American College Health Association to increase the health on university campuses throughout the United States (American College Health Association, 2018). Healthy College 2020 nutrition-related objectives include increasing the number of students who are at a healthy weight status, decreasing obesity prevalence on campuses, increasing the proportion of students who are eating at least five servings of fruits and vegetables per day, and increasing the number of students who are receiving nutrition information from their college institution (American College Health Association, 2018). These objectives are set partially because of the prevalence of reported inadequate diet quality in college students as well as them being at such a crucial time in their lives to establish healthy habits that they will carry on for the rest of their lives (American College Health Association, 2018; Haberman & Luffey, 1998; Nelson, Story, Larson, Neumark-Sztainer, & Lytle, 2008).

A common conviction about the "Freshman 15" is about freshman year's weight gain with the increased freedom of living away from home and having access to the residential dining halls (Crombie, Ilich, Dutton, Panton, & Abood, 2009). Studies vary widely on if the "Freshman 15" truly exists. In one study, researchers concluded from a review of literature that used various methodologies that weight gain in college students was moderate, but less than the 15 pounds (Crombie et al., 2009). The authors reported that factors influencing one's predisposition to freshmen weight gain included BMI when entering college, eating behaviors, eating patterns, sex, ethnicity, residency, and physical activity (Crombie et al., 2009). A meta-analysis examining 5549 students in 22 studies confirmed that 60.9% of freshman students gained weight with an average weight gain of 7.5 pounds during the freshman year (Vadeboncoeur, Townsend, & Foster, 2015). Although both of these studies disproved that weight gain during freshman year is around 15 pounds, college remains a high-risk period for potential weight gain due to the stress and physiological changes that accompany moving into adulthood (de Vos et al., 2015). Weight gain in college can lead to sustained weight gain and obesity later on in life (Nelson et al., 2008).

Excessive weight gain can lead to obesity, a national health concern. The prevalence of US obesity was approximately 39.8% from 2015-2016 (Hales, Carroll, Fryar, & Ogden, 2017). Obesity increases one's risk of a series of complications including increased cardiovascular disease, stroke, diabetes, and mortality (Ogden, Carroll, Fryar, & Flegal, 2015; Shams-White & Deuster, 2017). Furthermore, obesity has societal implications including increased healthcare costs and public health burdens (CDC, 2018). Although there has been a slowdown in the trajectory of obesity in the United States, it remains a top priority to public health professionals (CDC, 2018).

With the emphasis around obesity and weight gain during college comes a fear of weight gain and eating restriction for some individuals (Lowe et al., 2006; Pelletier et al., 2004; Pliner & Saunders, 2008). It has been reported that female students who restricted eating, lived on campus, and had a history of dieting had higher weight gain in freshman year than their counterparts (Lowe et al., 2006; Pliner & Saunders, 2008). Researchers who examined eating behaviors of the underclassmen and upperclassmen, and showed no differences by college year demonstrated the need for interventions throughout the college (Driskell, Kim, & Goebel, 2005).

College students report that barriers of time and their lifestyle impact their dietary intake and physical activity (Martinez, Harmon, Nigg, Bantum, & Strayhorn, 2016). There have been an increasing number of interventions aimed to help college students with their nutrition-related problems. For instance, there have been social media interventions aimed at utilizing technology to increase awareness of nutrition in young adults (Klassen, Douglass, Brennan, Truby, & Lim, 2018). Additionally, college cafeterias try to help diners navigate their food choices by using the stoplight system with healthiest foods labeled with green signs and foods to eat in moderation labeled with red signs (Seward, Block, & Chatterjee, 2016). In a systematic review of nutrition-related interventions in college students, researchers found that intervention methodologies varied greatly and no particular intervention worked better than others (Kelly et al., 2013). The authors concluded that individuals' abilities to engage in autonomous eating self-regulation and set goals are important components in college students being able to maximize nutritional intake (Kelly et al., 2013).

Nutrition-Related Problems in ROTC Cadets. ROTC cadets have a double burden of adjusting to college life and transitioning into military life. In one study, researchers assessed weight and body composition changes during their freshman year as they were concurrently in the ROTC program (Crombie, Liu, Ormsbee, & Ilich, 2012). They examined body composition, physical activity, and diet at baseline and 6-month follow-up and found no significant relationship between nutritional intake and body composition. However, the authors did find that physical activity was an important predictor in meeting body composition standards (Crombie et al., 2012). Another study aimed to look at dietary supplement use in college students and college athletes compared to ROTC cadets and found that ROTC cadets were consuming similar amounts of dietary supplements as the other two groups of students (Valentine et al., 2018). ROTC cadets also face nutrition-related problems such as being at increased risk for eating disorders, going to extremes to control weight, and consuming dietary supplements (Connell et al., 2017; Lauder & Campbell, 2001; Nevarez, 2018).

There are a lot of factors influencing nutrition including the stressful environment, social pressures, and autonomy that comes with being an adult. In both civilian college students and ROTC cadets, establishing healthy and sustainable habits is important, as these are primarily the habits they will carry into adulthood with, regardless if they are continuing on with their military career or not (Nelson et al., 2008).

Nutrition-Related Problems in College Athletes. College athletes, particularly wrestlers and gymnasts, have body composition and/or performance standards as ROTC cadets have (Beals & Hill, 2006; Manore, 2015). These athletes facing the challenge of balancing their demands for sport and academic life need to fuel their bodies to perform well while maintaining body composition and function. In order for college athletes to be well-equipped to fuel their bodies, it is the responsibility of the university to be able to provide resources to maintain the health and well-being of their athletes (Andrews et al., 2016). Sports that put an extra emphasis on body composition, such as wrestling and ballet, or endurance, such as long-distance running, can lead to disordered eating (Beals & Hill, 2006). The college athletes under the pressure to maximize performance while maintaining body composition may develop disordered eating habits, such as skipping meals, binge eating, abusing laxatives, and wearing plastic wrap around their stomach in the sauna to lose weight (Beals & Hill, 2006; Petrie, Greenleaf, Reel, & Carter, 2008; Wells, Chin, Tacke, & Bunn, 2015). Similar to college athletes, ROTC cadets are under an immense amount of pressure trying to balance maintaining body composition, performance, and also academic and social lives (Nevarez, 2018).

Nutrition-Related Problems in the Military. Army Regulation 40-25 outlines that each service is required to provide service members with nutrition education both during preliminary military training and throughout their careers (Dept of Army, Navy, and Air Force, 2017). This includes topics such as My Plate, the Dietary Guidelines for Americans, and other basic nutrition concepts (Dept of Army, Navy, and Air Force, 2017). Army Regulation 40-25 also outlines that nutrition education shall be provided for managing weight, navigating military dining facilities, and rationing food while out in the field (Dept of Army, Navy, and Air Force, 2017). Specific nutrition guidelines for service members, called the Military Dietary Reference Intakes (MDRIs, Appendix C) adjust to increased physical activity and demands of labor-intensive military work

(Dept of Army, Navy, and Air Force, 2017). The MDRIs are formulated for healthy, active military service members from 17 to 50 years of age who are not pregnant or lactating and can be found in the Appendices (Dept of Army, Navy, and Air Force, 2017). Calorie recommendations range from 35-51kcal/kg/day for women and 38-58kcal/kg/day for men, depending on level of physical activity compared to lower calorie recommendations for the general population (Baker-Fulco, Bathalon, Bovill, & Liberman, 2001). Nutrient needs vary based on the individual and can be dependent on a variety of factors, including military assignment. For ROTC cadets, they are participating in physical training and drill exercises and may need additional nutrients due to their increased activity levels. It is crucial to promote military members properly fueling themselves to meet their needs without overconsuming to put their health, career, or the security of the United States at risk (Ramsey et al., 2013). No national data or studies could be sourced to quantify population-level in-depth nutritional intake compared to the MDRIs in service members.

The Department of Defense assesses the health status of active duty military service members through the Health-Related Behaviors Survey (HRBS) that takes place approximately every three years on a stratified sample of Army, Navy, Marine Corps, and Air Force service members (Dept of Defense, 2013). The survey consists of an array of topics related to the well-being of service members including stress, coping mechanisms, weight management, physical activity, nutrition, sleep, and substance abuse among other health components (Dept of Defense, 2013). The nutrition part of HRBS examines dietary intake, including consumption of healthful foods and foods to eat in moderation, and weight status. In 2011, the survey had a response rate of 20% (n=39877) and results showed that 30.8% of service members older than 20 years old were in the healthy weight category compared to 34.7% of all service members being in the normal weight category (Dept of Defense, 2013). These rates were determined by the CDC's

BMI guidelines for overweight (25.0 to 29.9) and obesity (30.0 and up) (CDC, 2018). It is important to recognize that the body weight standards required in the Army differ from the CDC's classification for overweight and obesity (Dept of Army, 2013). For example, an 28 year-old male in the Army who weighs 179 pounds and is 68 inches tall would have a BMI of 27.2, which would be acceptable weight-for-height criteria according to the Army even though it is considered overweight according to CDC guidelines (CDC, 2018; Dept of Army, 2013). Furthermore, Army service members exceeding weight status then have percentage body fat estimation with body circumference measurement before any disciplinary actions are taken (Dept of Army, 2013). Service members with high muscle mass may have high BMI but relatively low body fat percentage. Therefore, BMI may not be the best indicator of health status in this population. However, BMI can still be looked at along with other health behaviors to get an overall picture of the well-being in service members.

The HRBS contained questions about habitual frequency of consumption of fruits, vegetables, whole grains, dairy, lean protein, snack foods, sweets, sugary beverages, caffeinated drinks, and fried food (Dept of Defense, 2013). The survey results showed that only 11.2% of service members (10.8% for Army) consumed three or more servings of fruit per day and 12.9% (12.9% for Army) consumed vegetables three or more times per day. Sugary drinks, fried foods, sweets, and snack foods were consumed more than once a day by 35.8%, 15.2%, 24.0%, and 24.1% of service members, respectively (Dept of Defense, 2013). Strengths of this study included the large sample size and inclusion of healthy, like vegetables, and less healthy foods, like fried foods, on the survey. Weaknesses of the study include lack of quantification of serving sizes and it would be useful to examine the dietary intake. Additionally, the Department of Defense's report does not provide nutrition-specific suggestions based on the findings of the report and instead focused their discussion on other health-related behaviors, such as substance abuse and mental health (Dept of Defense, 2013). While these non-nutrition-related issues are also important, a key shortcoming of further maximizing service members' performance is poor nutritional intake.

The physical activity portion of HRBS examined if individuals were adhering to physical activity recommendations of at least 150 minutes of moderate or 75 minutes of vigorous exercise each week (Dept of Defense, 2013). Results on the physical activity portion of the survey indicated that 36.8% (31.3% for Army) of service members engaged in less than 150 minutes of moderate physical activity per week and 46.3% (42.9% for Army) engaged in less than 75 minutes per week of vigorous physical activity (Dept of Defense, 2013). Barriers identified for engaging in physical activity included lack of time and demand of current assignment. Furthermore, 95.7% of active Army service members had passed their most recent physical fitness test (Dept of Defense, 2013). The Department of Defense's HRBS data suggests that higher percentage of service members meet weight standards and physical activity recommendations compared to the general US population (Dept of Defense, 2013). The military has invested time and resources into programs to ensure that members are able to perform accordingly. While the survey did address physical activity barriers, it did not address potential barriers to following nutrition recommendations. Through addressing nutritional intake and maximizing performance, it may be possible to further improve health outcomes and enhance the Department of Defense's ability to do their job.

A secondary data analysis of participants in the 2005 HRBS examined the dietary habits and physical activity of active duty service members in reference to the Healthy People 2010 objectives (Smith et al., 2013). Similar to the 2011 survey results, the majority of service members surveyed in 2005 did not meet Dietary Guidelines for Americans with only 3% of participants eating fruit one time per day, vegetables three times per day, and whole grains three times per day (Smith et al., 2013). Service members lack of intake of nutritious food and eating habits of skipping breakfast and eating out at restaurants frequently can potentially impact performance and overall health, even after service is complete (Smith et al., 2013).

In addition to the US Army service members being at risk due to poor nutrition, other countries have also been focusing on examining dietary intake and adiposity in their service members (Mullie, Deliens, & Clarys, 2016). In a 2014 online survey with 26,566 Belgian Army service members, researchers examined their nutrition behaviors in relation to demographics, rank, physical activity (Mullie et al., 2016). In addition, the survey inquired about typical portion of meat consumed in grams, number of breakfast meals consumed each week, servings of daily fruits and vegetables, and frequency of consumption of sugar-sweetened beverages. Average BMI of participants was 26.6 kg/m^2 and 24.5k g/m^2 for males and females, respectively. When it came to rank, 20.0% of men and 25.7% of women were officers, 57.2% of men and 42.0% of women were non-commissioned, and 22.8% of males and 32.2% of females were enlisted (Mullie et al., 2016). A non-commissioned officer is someone who moves up the ranks from enlisted to become a leader in the military (Merriam-Webster, 2018). Females were more likely to consume breakfast and less likely to consume sugar-sweetened beverages compared to their male counterparts. Furthermore, females also performed less physical activity compared to men participants (Mullie et al., 2016). Surprisingly, sugar-sweetened beverage intake was inversely associated with the rate of obesity ($p<0.05$). In this study, there was no significant relationship between physical activity and sugar-sweetened beverage intake. Although researchers found that sugar-sweetened beverage consumption was associated with a lower BMI, individuals who consumed sugar-sweetened beverages were engaged in less healthy behaviors, which could potentially impact their military performance (Mullie et al., 2016).

In the US Army, due to the pressure of meeting body composition and physical fitness test standards, a significant number of service members inaccurately perceive their weight status (Clark et al., 2017). In one study, 81% of normal weight military service members had an inaccurate perception of their weight status and were trying to lose weight. Furthermore, 38% of female service members who were normal weight and 21% of male service members who were overweight had inaccurate perceptions of their weight and were dieting (Clark et al., 2017). Weight misperception can cause individuals to go to extremes with diet and physical activity even if they do not need to lose weight (Clark et al., 2017).

As weight loss efforts are not unique to the military population, civilians and military alike engage in potentially dangerous cycles of prolonged dieting that can have long-lasting physiological and mental consequences (French & Jeffery, 1994). Rate estimates of disordered eating in the military disordered vacillate from 0.1 to 16% with many service members not wanting to report eating problems with the fear that they will be dismissed from service (Bodell, Forney, Keel, Gutierrez, & Joiner, 2014; Cole et al., 2016). One cross-sectional descriptive study sought to see if intuitive eating and eating motivation examining physical, emotional, and environmental social determinations for eating, were related with weight status in the military (Cole et al., 2016). Participants (n=295) were active duty service members and had anthropometrics taken and completed a demographic questionnaire and validated Intuitive Eating Scale (IES) and Motivation for Eating Scale (MFES) surveys. Out of all of the participants, 64.4% had a BMI in the overweight classification and 33.3% of the subjects self-reported that they completed at least 30 minutes of physical activity five days per week (Cole et al., 2016). The majority (52%) of the participants reported making efforts to lose weight and 30% reported skipping meals. There was a significant difference between overweight and non-obese patients when it came to frequency of skipping meals ($p<0.001$). Military rank and education levels were inversely associated with BMIs and frequency of skipping meals ($p<0.001$). Normal weight participants reported physical factors, such as being hungry, influencing eating motivation more so than emotional reasons, like being sad (Cole et al., 2016). Individuals in the normal weight category were more likely to be intuitive eaters compared to overweight participants. Participants in the normal weight category were more likely to rely on their intuitive eating cues and have physical reasons for eating compared to overweight participants (Cole et al., 2016). This can be taken into consideration when planning and implementing nutrition intervention in military service members of different weight classifications.

NUTRITION KNOWLEDGE

Nutrition knowledge is an assessment of one's understanding of healthful and nutritious food and eating behaviors. It is one of the many factors that may influence engaging in healthy eating. Nutrition knowledge has been shown to mediate consumption of fruit and vegetables in a sample of adult participants (Wardle et al., 2000). In college students, nutrition knowledge has been positively associated with healthful dietary intake (Ilich et al., 1999). A systematic review on 29 studies on nutrition knowledge and dietary intake reported that the majority (n=19) of studies had a positive, but weak association with nutrition knowledge (Spronk et al., 2014). There has been an increasing focus on factors mediating the association between nutrition knowledge and dietary intake, such as psychological determinants (Tabbkah & Graves, 2016).

There are many different tools and ways to assess nutrition knowledge in participants. In a study on nutrition knowledge in ROTC cadets, sports nutrition questions including on weight management, maximizing nutrition for performance, and dietary supplements were used (Connell et al., 2017). The researchers determined that participants had adequate nutrition knowledge if they scored a 75% or better on the survey (Connell et al., 2017). The mean nutrition knowledge score was $55.3 \pm 13.1\%$ (Connell et al., 2017). Another study also found that nutrition knowledge scores were inadequate in 157 Army soldiers using sports nutrition questions on basic nutrition concepts, performance, and dietary supplements with a mean nutrition knowledge score of 48.5 $\pm$ 15.2% (Bovill et al., 2003). Similar nutrition knowledge assessments were also utilized in college athletes to survey their understanding in domains such as macronutrients, micronutrients, properly fueling, and hydration (Abbey et al., 2017; Andrews et al., 2016). Studies on college athletes have also found that there is an opportunity to improve nutrition knowledge with participants demonstrating suboptimal nutrition knowledge (Abbey et al., 2017; Andrews et al., 2016).

DIET QUALITY ASSESSMENT

Diet quality is key to performance and health (Academy of Nutrition and Dietetics et al., 2016). It is recommended that individuals consume a variety of foods in order to get balanced nutrition to sustain overall health and functioning (Shim, Oh, & Kim, 2014). Nutrition-related consumption information can be collected by a variety of dietary assessment methods described below dependent on the such settings as global and/or national levels, and community and individual levels (Shim et al., 2014). There are many different indices to assess the quality of one's diet, including diet records, 24-hour recalls, food frequency questionnaires, and Healthy Eating Score-5.

Diet Records. Diet records generally involve an individual keeping a food log of everything consumed for three consecutive days or two weekdays and a weekend day (Ortega, Pérez-Rodrigo, & López-Sobaler, 2015). Individuals are usually asked to keep track of the type and amount of food they consumed, when, where and environmental settings when they consumed the food. This way to collect a comprehensive view of food consumption has been used in a variety of interventions to initiate behavior change through self-monitoring. However, it can be overwhelming for a participant to track what they ate for three days (Ortega et al., 2015). Individuals may not accurately record food consumed and sometimes change their eating behaviors knowing that they are taking part in the diet record (Ortega et al., 2015).

24-Hour Recall. 24-hour recalls consist of asking an individual everything consumed within the past 24-hours (Shim et al., 2014). These can be conducted over the phone or in-person. The USDA's Multiple-Pass Approach Method is a thorough and comprehensive way to conduct 24-hour recalls (USDA, 2016). Using the Multiple-Pass Approach Method includes asking a quick list of foods and beverages that the individual consumed, forgotten food list probes, time and occasion, detailed food descriptions, amounts, and a final probe. Although quick and cheap to administer, 24-hour recalls require a participant to remember details of food consumption the day before and do not depict day-to-day variations in food consumption (Shim et al., 2014). While 24-hour recalls can provide quality information, they do have their limitations and provide only a glimpse into one's eating behavior (Shim et al., 2014).

Food Frequency Questionnaires. Food frequency questionnaires aim to capture food patterns and trends over a longer period of time to demonstrate long-term eating behaviors (Shim et al., 2014). Semi-quantitative food frequency questionnaires ask participants about portion sizes, but not all food frequency questionnaires have a portion size component. Individuals may have a hard time recalling what they ate over the past year and are time consuming to complete lengthy food frequency questionnaires (Shim et al., 2014).

With the National Institutes of Health's NIH's food frequency questionnaire that is utilized in NHANES, usual intake is assessed (NIH National Cancer Institute, 2004). Usual intake provides an overall picture over time of someone's diet (NIH National Cancer Institute, 2004). They are oftentimes used to assess dietary patterns in relation towards health and providing policy recommendations (NIH National Cancer Institute, 2004).

Healthy Eating Score-5. The Healthy Eating Score-5 questionnaire is a military-specific dietary assessment tool that was developed to assess diet quality in the military (Golenbock, Kazman, Moylan, Kupchak, & Deuster, 2016). Researchers validated the use of Healthy Eating Score-5 against food frequency questionnaires and nutrition-related laboratory values in 221 Army soldiers (Golenbock et al., 2016). Researchers found correlations between Healthy Eating Score-5 and Healthy Eating Index-2010 Scores ($r=0.48$, $p<.001$) (Golenbock et al., 2016). The Healthy Eating Score-5 was also tested for its reliability in a 2012 study utilizing the Army's Global Assessment Tool (GAT) that assesses health and wellness in service members. Researchers added nutrition questions, including the Healthy Eating Score-5 (Purvis et al., 2013). A total of 13,858 Army service members completed the nutrition questions. Cronbach alpha-analysis measuring the internal consistency of the tool was 0.81 in this pilot (Purvis et al., 2013). The Healthy Eating Score-5 is currently used by the Army in their Global Assessment Tool (GAT) to assess diet quality in service members (Purvis et al., 2013). Healthy Eating Score-5 can potentially serve as an indicator of diet quality compared to the recommendations provided in the Military Dietary Reference Intakes (Golenbock et al., 2016; Purvis et al., 2013).

While the Healthy Eating Score-5 measures fruit, vegetable, dairy, whole grain, and fish consumption over the last 30 days, it does have some similarities with Healthy Eating Index-2010 (Golenbock et al., 2016; Guenther et al., 2013; Purvis et al., 2013). The Healthy Eating Index-2010 measures diet quality based on dietary intake of total fruit, whole fruit, total vegetables, green beans, whole grains, dairy, total protein foods, seafood and plant proteins, fatty acids, refined grains, sodium, and empty calories (Guenther et al., 2013). The Healthy Eating Score-5 food groups were chosen to be a part of the measure of diet quality in the Army population as they were reported problematic food groups in military members (Purvis, et al., 2013). Fruits and vegetables provide essential vitamins and minerals that service members need, whole grains provide a healthy source of energy to fuel service members' labor-intensive work, dairy provides calcium to keep bones strong and prevent injury, and fish is an anti-inflammatory and can assist with brain health (Purvis et al., 2013; USDA, 2018). Each of the five categories is scored on a five-point scale for a total possible HES-5 score ranging from 0 to 25 (Purvis, et al., 2013). Healthy Eating Index-2015 is the updated version of Healthy Eating Index-2010 that has saturated fat and added sugars instead of empty calories (Krebs-Smith et al., 2018). Unlike Healthy Eating Index-2010 and Healthy Eating Index-2015, Healthy Eating Score-5 only adds positive scores whereas HEI-2010 and HEI-2015 both have negative moderation indices that are computed into the HEI score (Purvis et al., 2013).

MyPlate Method. The MyPlate method is a widely used public health tool that encourages healthy eating in the general US population (USDA, 2018). The USDA uses a visual MyPlate tool and encourages consumers to fill half their plate with fruits and vegetables, one-quarter of the plate with protein, one-quarter of the plate with grains, and to also have a little bit of dairy present (USDA, 2018). MyPlate recommends two cups of fruit, three cups of vegetables, three cups of dairy, six ounces of protein, and six ounces of grains per day for healthy adults (USDA, 2018). It is similar to Healthy Eating Score-5 in assessing fruits, vegetables, and dairy. However, the two tools differ because Healthy Eating Score-5 examines fish and whole grain consumption whereas MyPlate promotes protein and general grain intake while encouraging half of the grains to be whole (Purvis et al., 2013; USDA, 2018). MyPlate has been proven to be an effective tool to encourage healthy dietary intake by nutrition educators (Levine, Abbatangelo-Gray, Mobley, McLaughlin, & Herzog, 2012; Uruakpa, Moeckly, Fulford, Hollister, & Kim, 2013).

NUTRITION-RELATED THEORETICAL FRAMEWORK

Multiple learning behavior change theories have been hypothesized and applied to nutrition and eating behaviors changes through different approaches and frameworks. Nutrition professionals can apply psychological theories to nutrition intervention to guide behavior change and provide theoretical framework (Spahn et al., 2010). The theoretical framework is used throughout the nutrition care process to maximize the likelihood of initiating and sustaining a change in an individual (Spahn et al., 2010). For example, the Social Learning Theory aims to change behavior by promoting support from one's social circle whereas the Transtheoretical Model aims to gauge where somone is in their readiness to change (Spahn et al., 2010).

Social Cognitive Theory. The social cognitive theory was created by Albert Bandura (1971) and proposes that behavior change can be prompted with a social framework and one's own cognition, the environment, and behaviors (Bandura, 1971). This theory has been widely used in behavior change strategies as a conceptual model to guide interventions (Contento, 2008). There are many components that affect one's behavior and the social cognitive theory states that reciprocal determinism cause cognition, the environment, and behavior to all impact one another (Dewar, Lubans, Plotnikoff, & Morgan, 2012). The components of the social cognitive theory include outcome expectations, outcome expectancies, behavioral capability, observational learning/modeling, self-efficacy, reinforcements, and self-regulation/self-control (Contento, 2008).

Outcome Expectations. Outcome expectations include one's anticipations for the results of their behavior. It includes physical or material, social, and self-evaluative outcomes (Contento, 2008). These outcome expectations may include perceived benefits and perceived barriers, such as the benefits to ensuring adequate nutrition post-exercise, barriers inhibiting one from being able to fuel after exercise, social norms regarding consuming a snack post-exercise, and gauging one's dignity for if they decide to fuel their body after exercise.

Outcomes Expectancies. This includes the amount of motivation one has towards behavior change and the consequences of the behavior change (Contento, 2008) such as fueling post-workout and expecting it to increase physical fitness performance.

Behavioral Capability. This construct includes the knowledge and skills to be able to initiate behavior change (Contento, 2008). For example, providing nutrition education and handouts on timing and snack ideas for post-workout fueling.

Observational Learning/Modeling. This includes witnessing and learning from skills and behavior from others (Contento, 2008). For example, it may include a dietitian providing a walk-through of the dining facility and modeling what a balanced plate looks like.

Self-Efficacy. This involves how self-assured individuals feel to overcome barriers and initiate behavior change (Contento, 2008). For example, how confident an athlete feels to choose and time a post-workout snack appropriately.

Reinforcements. Reinforcements are reactions that sway the chance of engaging in that behavior again (Contento, 2008). They can be internal, such as feeling nourished after consuming a post-workout snack, or external, such as performing well on a physical fitness test after properly nourishing one's body.

Self-Regulation/Self-Control. This consists of how individuals are able to guide and control their behavior, including observing a behavior and then directing oneself to incorporate that health behavior change (Contento, 2008). For example, an athlete may see their teammate fueling with a specific snack and the associated benefits and then might engage in that same behavior himself.

Dewar et al. conducted a study to create and validate a tool on dietary behaviors in adolescents utilizing social cognitive measures. There was a total of 173 students (mean age = 13.72 ± 1.24) who completed the validated survey. Through this study, researchers were able to validate the questionnaire as a way to measure dietary patterns and behavior change with a psychological and theory-driven backing. Through this study, researchers demonstrated a reliable and valid tool to use to guide behavior change and healthy eating in adolescents (Dewar, et al., 2012). Although Dewar and colleagues did not validate this study on college-aged students, other researchers have examined what barriers may inhibit college students from being able to engage in behavior change. Greaney et al. conducted a qualitative study to look at barriers and facilitators of weight management in college-aged students through sixteen online focus groups. There was a total of 115 students amongst the focus groups with 54.8% of participants being female and 72.2% being within the normal weight range. Barriers to weight management included absence of restraint, stress, boredom, social situations, time restrictions, cafeteria food, and financial restrictions. Motivators to weight management included having a high metabolism, being mindful about food intake, having social support, and utilizing the University's resources to make healthful food choices and to engage in physical activity. This study went to point out that interventions should target both the individual level as well as environmental level (Greaney et al., 2009). For instance, students must have the self-efficacy and motivation to engage in healthful behaviors, but the social context and environment also plays a huge role in one's capacity to initiate behavior change (Greaney et al., 2009).

Another study aimed to look at the nutrition knowledge, aims, and self-efficacy of college students with an online survey (Matthews, Doerr, & Dworatzek, 2015). A total of 6638 university students completed the survey. Students demonstrated lower than desired nutrition knowledge and self-efficacy but have the intentions to consume more vegetables and less energy dense items. Although this study was cross-sectional and self-administered online, students demonstrated desire and intent to modify dietary behavior, but did not have the tools to do so (Matthews, Doerr, & Dworatzek, 2015).

Transtheoretical Model. Another theory that may be utilized to initiate behavior change is the transtheoretical model (Prochaska & Velicer, 1997). The transtheoretical model was created on the basis that individuals are at different stages of readiness to change a behavior (Prochaska & Velicer, 1997). Some may be in pre-contemplation, where they are not even thinking about changing their behavior. Others are in contemplation, where they are considering making a change, but are not quite ready (Prochaska & Velicer, 1997). Those in the preparation stage of change are getting ready to initiate the change, such as creating a healthy food grocery list (Prochaska & Velicer, 1997). Those in action are engaging in behavior change, such as exercising at the gym or actively eating more servings of vegetables each day (Prochaska & Velicer, 1997). The maintenance stage of change occurs approximately six months after the individual has continued to engage in the behavior that they changed (Prochaska & Velicer, 1997). This theory modifies the nutrition intervention technique based on where an individual is at in their readiness to change (Prochaska & Velicer, 1997). Currently, research is limited on if this is an effective strategy to use to achieve nutrition behavior change in patients (Spahn et al., 2010).

Self-Determination Theory. Although there are dimensions of these theories which prove to be effective, the majority of this research has not demonstrated long-term behavior change (Pelletier et al., 2004; Spahn et al., 2010). Deci and Ryan (1985) suggested a theory that one's inclination to change behavior depends on their motivation to self-regulate, or to control their behavior and attention based on their long-term goals and well-being (Deci & Ryan, 1985; Ridder & Wit, 2008). They hypothesized that one must feel autonomous, competent, and a sense of relatedness in order to become more autonomously motivated to regulate behavior for long-term wellness (Deci & Ryan, 1985). Autonomy occurs when someone feels in control of their situation to regulate their behavior (Deci & Ryan, 1985). Competence transpires when one feels like they have the ability needed to regulate their behavior (Deci & Ryan, 1985). Lastly, a sense of relatedness provides social support needed for behavior change (Deci & Ryan, 1985).

Pelletier (2004) applied this theory to the regulation of eating behavior based on the premise that humans are naturally wired to regulate eating (Pelletier et al., 2004). Although eating regulation usually occurs for homeostasis, in which people are eating for physical needs, individuals may override eating regulation for hedonic pleasure and reward (Lutter & Nestler, 2009). With both of these forms of eating regulation in mind, individuals vary in how motivated they are to regulate their eating (Pelletier et al., 2004). Those who are not motivated to regulate their eating may not listen to their internal cues and may be more likely to engage in periods of dietary restriction and overconsumption (Pelletier et al., 2004). Other individuals may feel pressure from external forces and attempt control their eating behavior due to those extrinsic forces (Pelletier et al., 2004). Others may feel intrinsically and autonomously motivated to engage in healthy eating because they feel a personal commitment and feel that it will benefit their long-term health (Pelletier et al., 2004). Motivation for healthy eating aligns with the concept of intuitive eating, in which people listen to their hunger and fullness cues while trusting their bodies to get the nutrition that they need (Avalos & Tylka, 2006; Cadena-Schlam & López-Guimerà, 2014; Tribole & Resch, 2007). Both intuitive eating and motivation for healthy eating contain the idea of a biological basis for being natural wired to regulate eating (Avalos & Tylka, 2006; Cadena-Schlam & López-Guimerà, 2014; Tribole & Resch, 2007). Intuitive eating may be a strategy used to help individuals to feel motivated to engage in healthy eating (Tribole &

Resch, 2007). Motivation for healthy eating is important as an imbalance of nutrients can lead to complications (Pelletier et al., 2004).

Self-regulation can be explained by the Self-Determination Theory, which focuses on types of motivation, or determination, that influence one's decisions through the concepts of autonomy, relatedness, and competence (Deci & Ryan, 1985; Pelletier et al., 2004). Three major types of motivation that influence one's ability to self-regulate are intrinsic motivation, extrinsic motivation, and amotivation. An individual who is intrinsically motivated participates in a behavior for oneself without any external reward. Intrinsically motivated people are more likely to autonomously engage in self-regulation based on their own personal commitment for their long-term well-being (Pelletier et al., 2004). Extrinsic motivation promotes a behavior for the external associated rewards or to prevent negative consequences from occurring and can be broken down into integrated regulation, identified regulation, introjected regulation, and external regulation. Intrinsic regulation is more self-determined than integrated regulation. Integrated regulation is when someone autonomously engages in self-regulation based on their own needs because they feel it is essential for their individual life and they easily choose to do it. Integrated regulation is more self-determined than identified regulation. Identified regulation occurs when someone autonomously engages in self-regulation because they think it is the right thing to do for their long-term well-being. Integrated regulation is more self-determined than introjected regulation. Introjected regulation occurs when someone controls their self-regulation because they may feel guilty or shameful if they did not. Introjected regulation is more self-determined than external regulation. External regulation consists of someone controlling their behavior due to the pressure from an outside force, such as peer pressure or societal pressure one may feel to have their body look a certain way. Amotivation is associated with non-regulation and occurs when someone is not motivated to regulate their behavior because they do not see benefits or risks of doing so (Pelletier et al., 2004).

The idea behind the Self-Determination Theory in the context of eating regulation is that individuals who feel more self-determined, or motivated, will be more likely to regulate their behavior and engage in healthy eating (Pelletier et al., 2004). Another way that the six forms of behavior regulation can be approached is through dividing them into two separate constructs of autonomous motivation and controlled motivation (Pelletier, Fortier, Vallerand, Tuson, & et al, 1995). Autonomous motivation for healthy eating is the self-determined and positive drive to choose healthful foods and self-regulate eating behavior. Autonomous motivation for healthy eating is measured with the Regulation of Eating Behaviors Survey with the three subscales of identified, integrated, and intrinsic regulation (Pelletier et al., 2004). On the contrast, controlled motivation for healthy eating is regulating eating and choosing foods based on being in control and potentially being influenced by external forces. Controlled motivation for healthy eating is less self-determined than autonomous motivation for healthy eating and measured with the Regulation of Eating Behaviors Survey with three subscales of amotivation, external regulation, and introjected regulation (Pelletier et al., 2004). While researchers can examine each of the six construct of eating regulation, they can also examine the autonomous and controlled motivation scores to get a better picture of an individuals' positive (autonomous, more self-determined) and negative (controlled, less self-determined) motivations for healthy eating (Pelletier et al., 2004, 1995).

Self-efficacy, or trusting in one's own capacities, is another factor that influences behavior change by allowing one to feel in power and control of their situation and like they can meet their goals (Bandura, 1977). In one study, researchers found that participants with cardiovascular disease who were more autonomously motivated to regulate their eating also had higher self-efficacy for healthy eating scores (Guertin et al., 2015). Similarly, other studies have examined the relationship between motivation and self-efficacy on behavior change and found that both motivation and self-efficacy are key components in the initiation and maintenance of behavior change (D'Angelo & Reid, 2007; Guertin et al., 2015; Slovinec D'Angelo, Pelletier, Reid, & Huta, 2014).

The Self-Determination Theory and behavior regulation have been used as a method to gauge motivation in relation to nutrition-related concerns, including weight status and overall health in female college students and patients with cardiovascular disease (Guertin et al., 2015; Pelletier & Dion, 2007; Pelletier et al., 2004). Moreover, studies have shown that self-determination can predict consumption of unhealthy versus healthy foods, amount of food consumed, and diet quality in female college students (Guertin et al., 2015; Pelletier & Dion, 2007). Individuals who are intrinsically motivated to eat healthy are more likely to have more nutritious food choices and maintain long-term health (Guertin et al., 2015).

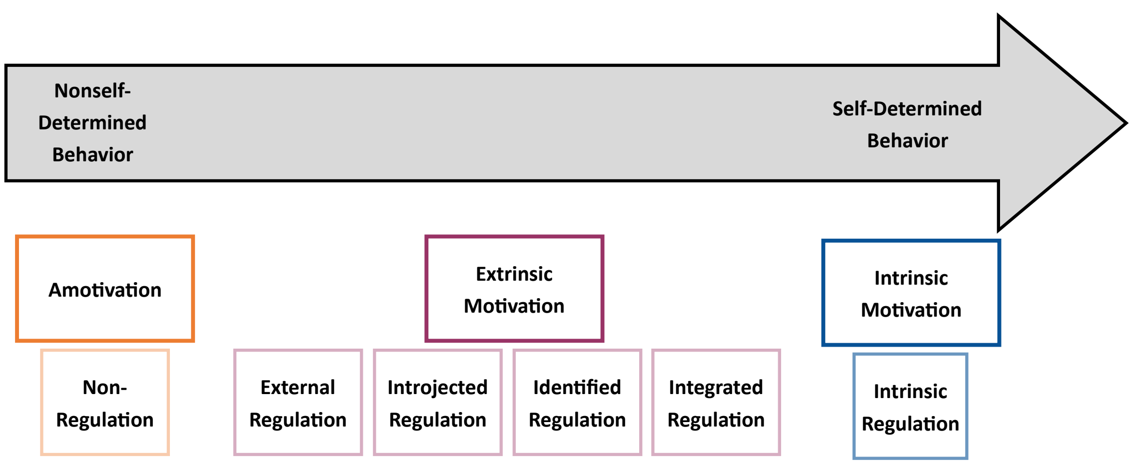

Figure 3. Self-Determination Theory constructs
(Adapted from Johnson, 2007)

The SDT continuum (Figure 3) vacillates from being nonself-determined with amotivation, being slightly more self-determined with external motivations' forms of regulation and being the most self-determined with intrinsic motivation (Pelletier et al., 2004). Motivation may begin with external pressures which can then grow and evolve into internal, intrinsic motivation in individuals (Pelletier et al., 2004). External pressures, such as social pressure to maintain a certain weight, can potentially influence one's motivation (Pelletier et al., 2004). With this in mind, interventions may be able to be designed to positively maximize external motivation opportunities, which can then potentially impact one's intrinsic sense of motivation and self-regulation strategies (Guertin et al., 2015; Pelletier & Dion, 2007; Pelletier et al., 2004). No military or ROTC studies have gauged motivation in the context of eating behaviors. The Self-Determination Theory has the potential to guide nutrition interventions including nutrition education and nutrition counseling by identifying an individual's level of motivation for healthy eating and adjusting the delivery of the intervention appropriately (Guertin et al., 2015).

Registered dietitians and other healthcare professionals work to promote motivation for healthy eating through motivational interviewing by assisting individuals' behavior changes based on the internal motivation and self-efficacy (Markland, Ryan, Tobin, & Rollnick, 2005; Resnicow et al., 2002). The components of motivational interviewing include rolling with resistance, developing discrepancy, expressing empathy, and supporting self-efficacy (Markland et al., 2005). Although successfully used in nutrition counseling settings, the motivation interviewing model lacks theoretical framework (Markland et al., 2005). Motivational interviewing and SDT may be able to be used hand-in-hand to provide nutrition intervention using an evidence-based tool that works and is framed by a conceptual model (Appendix D) (Markland et al., 2005).

Motivation for healthy eating can be measured with the validated Regulation of Eating Behaviors Survey (Pelletier et al., 2004). The researchers developed the survey questionnaire and conducted exploratory factor analysis and obtained four items per subscale within each of the six constructs (intrinsic regulation, integrated regulation, identified regulation, introjected regulation, external regulation, amotivation) of the SDT with Cronbach's alphas ranging from 0.79 to 0.91, demonstrating that this tool has sufficient internal consistency amongst items. After validating the survey, they conducted a second part of the study to further validate the survey and to examine the role of regulation in eating behaviors of university female students and found that individuals who were more autonomously motivated for healthy eating scored higher were more likely to report better dietary consumption compared to those who reported lower autonomous motivation for healthy eating (Pelletier et al., 2004). The Regulation of Eating Behaviors Survey can also be divided into autonomous motivation for healthy eating (intrinsic regulation, integrated regulation, and identified regulation) and controlled motivation for healthy eating (introjected regulation, external regulation, amotivation) to examine positive, self-determined and negative, nonself-determined constructs (Pelletier et al., 2004).

ASSOCIATION AMONG NUTRITION KNOWLEDGE, MOTIVATION FOR HEALTHY EATING, AND DIET QUALITY

Since nutrition is directly related to peak performance, it is important for individuals to have nutritional knowledge and motivation for healthy eating to sustain diet quality and health outcomes (Lukaski, 2004). In order to be able to provide strategies, it is crucial to know what factors influence weight status and dietary patterns in college students, particularly ROTC cadets. A systematic review examined 25 articles on nutrition knowledge in civilian adults. Although methods varied from study to study, researchers found that nutrition knowledge was positive associated with healthy eating behavior (Barbosa, Vasconcelos, Correia, & Ferreira, 2016). Further research has supported that increased knowledge is related to improved dietary patterns in college students (Kolodinsky, Harvey-Berino, Berlin, Johnson, & Reynolds, 2007). In an intervention study, nutrition education provided to first year college-students helped them to make better dietary decisions as well as increase reading nutrition labels (Tallant, 2017).

Although nutrition knowledge may support enhanced food choices, it is not the only thing that must be done in order to potentially impact dietary patterns. There are many other factors that also influence consumers food choices, including attitudes and behavior with food as well as self-efficacy (Contento, 2008). For example, researchers have found that healthy eating attitudes are a partial mediator between nutrition knowledge and diet quality (Tabbakh & Freeland-Graves, 2016). In another study, higher motivation for healthy eating has been shown to be associated with how much food individuals consume as well as what types of foods they choose to consume (Guertin et al., 2015; Pelletier & Dion, 2007).

ROTC Cadets and Military. Unlike college students, ROTC cadets have additional pressures due to the increased emphasis on body composition and physical fitness test standards that they must meet every six months in order to remain in the program. No ROTC program or military studies have examined how motivation for healthy eating can mediate the relationship between nutrition knowledge and diet quality. The limited available literature on military service members suggests that they have undesirable dietary behaviors and insufficient nutrition knowledge (Clark et al., 2017; Connell et al., 2017; Dept of Defense, 2013). Furthermore, there is some evidence to suggest that individuals may have the motivation to make dietary changes, such as the ArmyMOVE! program (Piche et al., 2014). Participants completed an Army-sponsored weight loss program and researchers found that participants were motivated to lose weight, but yet participants are still not meeting dietary recommendations (Dept of Defense, 2013; Piche et al., 2014).

One of the limitations of some of the previous military studies have been that they have not been grounding nutrition interventions in a theoretical framework. Based on the existing body of knowledge, nutrition knowledge, attitudes and behaviors, and diet quality in service members are lower than desired (Clark et al., 2017; Connell et al., 2017; Dept of Defense, 2013).

Even if service members do have the nutrition knowledge, they do not always have the proper nutrition attitudes or behaviors to support a healthy lifestyle (Piche et al., 2014). It is also important to examine if service members have sufficient motivation for healthy eating, which may mediate the relationship between nutrition knowledge and diet quality in ROTC cadets and other military service members (Cole et al., 2016; Tabbakh & Freeland-Graves, 2016).

College Athletes. Specific disciplines of college athletes, such as wrestlers and gymnasts, have increased pressures to meet specific body composition or performance standards. This pressure can increase one's likelihood to be more restrictive in their eating. Concurrently, athletes may take dietary supplements in an effort to boost performance. Collegiate athletes with increased nutrition knowledge have demonstrated the possibility of increased healthful food choices, which can aid in maximizing performance (Skinner et al., 2001). Athletes are also more likely to have constructive attitudes regarding nutrition (Zawila, Steib, & Hoogenboom, 2003). These findings and other studies support the need for nutrition intervention and education to assist athletes in amplifying function (Abbey et al., 2017; Heaney et al., 2011; Rash et al., 2008; Rosenbloom, Jonnalagadda, & Skinner, 2002).

With the two goals of body composition and increased performance in mind, much of the emphasis has been focused on the body composition component, leading athletes to go to extremes and to not properly fuel their bodies. Since nutrition plays a key role in athletes' performance, it is crucial to equip them with the nutrition knowledge and spur their motivation to potentially impact their nutrition attitudes and behavior. More research is needed on the other factors influencing athletes' dietary intake in order to better meet their needs.

College Students. Tabbakah and Graves (2016) examined nutrition knowledge, diet quality, and psychological determinants in college women (n=114) (Tabbakh & Freeland-Graves, 2016). Their nutrition knowledge questionnaire consisted of 20 multiple-choice questions on different nutrition topics such as nutrition recommendations and dietary guidelines with a Cronbach's alpha of 0.74, a sufficient internal consistency among items (Tavakol & Dennick, 2011). They reduced the final questionnaire to 19 items for a model with a better fit (Tabbakh & Freeland-Graves, 2016). Participants completed a three-day food record and HEI-2010 scores were calculated as a measure of diet quality. They provided participants with questions on psychological determinants of eating with sub-scales such as emotionally eating. A mediation model was used to assess the relationship between nutrition knowledge, diet quality, and psychological determinants (Tabbakh & Freeland-Graves, 2016). Researchers found that attitudes towards healthy eating ($p<0.01$), nutrition knowledge ($p<0.05$), and positive fat habits ($p<0.01$) were positively related to diet quality. Additionally, attitudes towards eating healthy was a partial mediator of the path between nutrition knowledge and diet quality (Tabbakh & Freeland-Graves, 2016). This suggests that psychological determinants, such as motivation for healthy eating or healthy eating attitudes, may play an important role in the process of utilizing nutrition knowledge and eating healthy.

Table 3. Selected literature on military nutrition knowledge, attitudes, and behavior

Author	Population	Aim	Methods	Results	Conclusion
Ramsey et al. (2013)	Army service members (n=39)	To examine the nutritional intake of service members in a garrison	Anthropometrics, online National Cancer Institute Online Diet History Questionnaire	• 66.7% (n=26) were officers • No significant differences between calorie intake and weight or waist circumference after controlling for sex • Calorie intake, sodium, and vitamin E were lower than the MDRIs	• Waist circumference and weight are both metrics to assess when screening for disease risk • Military service members had inadequate nutrition compared to dietary recommendations
Piche et al. (2014)	ArmyMOVE![a] participants (n=312)	Nutrition attitudes, behaviors, and beliefs of participants	Survey on nutrition attitudes, behaviors, and beliefs	• 64.3% had >30 BMI (obese) and 33.9% had 25-29.9 BMI (overweight) • 68% reported that poor nutritional intake led to weight gain • Most participants wanted to lose weight (95.5%), felt like they could make modifications to their nutrition (88.8%), and felt like they had to make dietary modifications (86.9%) • 45.3% tried to lose weight by skipping meals and 48.7% tried using diet pills • 55% failed to accurately categorize their own weight status	• Participants were motivated to lose weight, but their efforts did not align with nutrition principles • Used descriptive statistics; did not report nutrition knowledge; survey was validated only by face validity
Trent et al. (1992)	Active duty Navy (n=2,938)	Nutrition knowledge	Self-administered survey on nutrition knowledge using true/false questions	• Average nutrition knowledge scores was 65% • Higher mean nutrition knowledge scores were related to age, sex, rank, and education levels (p<0.001)	• Nutrition knowledge is one of the components needed in service members to promote health and well-being

[a]ArmyMOVE is a weight-loss program providing nutrition education and support for Army service members (Piche et al., 2014)

Table 4. Selected literature on college athletes' nutrition knowledge, attitudes, and behavior

Author	Population	Aim	Methods	Results	Conclusion
Enns et al. (1987)	College wrestlers (n=26) College swimmers and skiers (n=21)	Nutrition attitudes, body composition, and body size	Three-day food records, body weight, body composition, Eating Attitude Test (EAT), body composition perception	• No significant differences in body composition estimates between wrestlers, swimmers, and skiers • Wrestlers had more restrictive eating, attitudes towards endorsing dieting, and lost more weight over the season than swimmers and skiers	• Emphasis on weight and performance leads to more restrictive eating patterns and weight loss
Jonnalagadda et al. (2001)	College football players (n=31)	Functional status, dietary practices, and attitudes	Self-administered survey on eating habits, nutrition attitudes, nutrition beliefs, use of supplements, and goals with body composition, body weight, height, blood lipids	• 42% of the freshman football players reported taking dietary supplements • 23% of participants were very satisfied with their bodies • Most commonly wanted to increase lean body mass • Average nutrition knowledge score 5.55 (SD $\pm$1.72) out of 11 • 97% desired to learn more about nutrition to increase performance	• Athletes were motivated to learn about nutrition, but lacked the nutrition knowledge and ideal dietary practices
Andrews et al. (2016)	College athletes (n=123)	Nutrition knowledge	Validated sports nutrition knowledge survey	• Average survey score 56.9% (SD 14.3%) was below the "adequate" 75% • 10% (n=12) scored the "adequate" 75%	• Sports-related nutrition knowledge may be lacking in some college athletes
Hornstrom et al. (2011)	College softball players (n=185)	Nutrition knowledge, attitudes, practices, and where they got their nutrition information	Survey with nutrition knowledge score (true or false questions), nutrition choice score, nutrition practice score, and attitude toward a sport-enhancing diet score	• Average nutrition knowledge score of 57% • Average nutrition choice score of 19.4$\pm$3.8 out of 28 (higher score = poorer diet) • Met only 2.8$\pm$1.3 out of 5 USDA MyPyramid food groups • Relied on their medical doctors as the primary source for nutrition information	• Athletic pressured for performance; nutrition knowledge and practices remain poorer than desired

CHAPTER THREE: METHODS

STUDY AIMS

This cross-sectional study aimed to examine the associations among nutrition knowledge, motivation for healthy eating, and diet quality in Army ROTC cadets. A secondary aim of the present study was to collect in-depth dietary assessments from a sub-group of participants.

RESEARCH SITES AND DESIGN

Prior to recruitment of the ROTC cadets for the present cross-sectional study, the MSU research team secured approval from the Seventh Brigade Commander located in Fort Knox, Kentucky, on potential sites regarding the purpose of the study and request for participation in the study's execution. The MSU research team contacted five ROTC directors and staff of individual university sites based on locations, times, and dates for recruitment and data collection. The MSU research team chose to conduct the study at two ROTC programs that agreed to participate in the study due to logistical barriers including distance, availability, and the university calendar. Convenience samples of Army ROTC cadets were recruited from Michigan State University and Western Michigan University from January through May 2018. Data collection only began once participants consented to be a part of the study.

INSTITUTIONAL RESEARCH APPROVALS AND COLLABORATIONS

Michigan State University and United States Army Research Institute of Environmental Medicine (USARIEM) established a Cooperative Research and Development Agreement (CRADA) in August 2017 prior to the onset of this research. The IRB approval (Study ID STUDY00000073) was secured from Michigan State University (Appendix E). The legal entity of US Army Cadet Command, who oversee Army ROTC programs, legally reviewed and approved the study in January 2018.

This study parallels with two ongoing studies: 1) The US Army Research Institute of Environmental Medicine (USARIEM) on eating behaviors and mediators of eating behaviors in the military by sharing research instruments. 2) An MSU research study examining military body image and eating behaviors in Army ROTC cadets. Due to these collaborations, good rapport was established with the Seventh Brigade commander for smooth communication with the research sites.

DATA COLLECTION TEAM

The data collection team consisted of the primary author (KM), principle investigator (Dr. Won Song), doctoral student (BG), and other trained researchers. All of the researchers were trained in data collection procedures by the PI of the parent study, RC. Training included: recruitment, informed consent, administration of survey instruments, anthropometric measurements, inter- and intra-rater reliability, participant check-out procedures, and debriefing.

SAMPLE SIZE ESTIMATION AND STUDY SUBJECTS

The necessary sample size for the main part of this study was estimated to be 154 participants. This was calculated using G*Power 3.0.10 with the assistance of a statistician consultant with a power of 80%, significance level of 5%, attrition rate of 20%, and small to medium effect size (Erdfelder, Faul, & Buchner, 1996). For the second in-depth study on dietary assessment methods, a sample size of 35 participants was estimated in order to calculate a correlation consistent with the previous literature with an attrition of 20% (Kvale, 1996).

The ROTC program allows cadets to be between the ages of 18 to 35 years old and all qualifying cadets were asked to participate in the study. ROTC cadets who were 17 years of age and needed parental consent to be in the ROTC program were excluded from being able to participate.

PROCEDURES

ROTC directors and staff were instructed by US Army Cadet Command that researchers would have direct contact with cadets about the study to prevent coercion from ROTC leadership to participate in the study. The informed consent form can be found in Appendix F. Prior to participants agreeing to be in the study, the research team received a roster of ROTC cadets and emailed recruitment flyers prior to visiting (Appendix G). Prior to a normally scheduled military science class, ROTC cadets gathered to receive a five-minute recruitment brief on the purpose of the study, participation steps involved, and potential benefits/risks if they chose to participate. If they agreed to participate in the study, they were directed to a separate room to sign the informed consent form and begin the study during scheduled class time. ROTC directors and staff had a separate activity planned for cadets that chose not to participate in the study.

The location(s), time(s), and date(s) of data collection were arranged with each ROTC program. Upon arrival, ROTC cadets received a recruitment brief including purpose of the study, what the study entailed, potential risks and benefits, confidentiality/privacy, compensation for participating in the study, counseling services contact information, and contact information for the PI of the study. The cadets received a questionnaire packet that containing included an informed consent form, demographic questionnaire, military eating behaviors survey, mediators of eating behaviors survey, regulation of eating behaviors survey, anthropometric data collection sheet, and a checkout sheet. Prior to beginning the study, cadets signed the informed consent form, including indicating if they consented to be contacted for a phone interview. Participants then received instructions on how to fill out the surveys. Participants were instructed to keep the checkout sheet at the top of their desk and fill out the surveys. As they were finished with one survey, they would put it on top of the checkout sheet. This served as an indicator for research team members to come and check each survey for completeness instead of waiting until the end to check all of the surveys. Participants were encouraged to get up, take breaks, grab refreshments, and have their anthropometric measurements taken whenever was most convenient for them to mitigate survey fatigue. The questionnaire completion took approximately one hour for most participants to complete. Upon completion of the questionnaire packet, the cadets were introduced to an opportunity to participate in a follow-up study on dietary assessment methods.

In the room where cadets completed the questionnaires, two private anthropometric stations were set up and separated by a privacy divider and equipped with a portable stadiometer and digital SECA scale. Each station was attended by 2-3 trained research team members to take measurements. After completing all of the surveys and anthropometric measurements, the cadets completed a final checkout with one of the research team members and received a bag of nutrition resources with a $10 Meijer gift card as incentives.

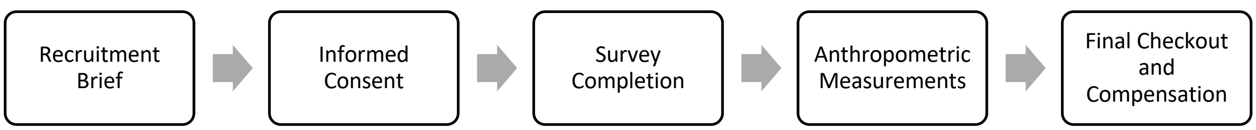

Figure 4. Flow chart of data collection process

PROCEDURES FOR DIETARY ASSESSMENT METHODS

Individuals who consented to be contacted for phone interviews were eligible to be considered for the dietary assessment component of the study. The research team contacted participants via telephone to set up a time for their phone interviews. Dietary intake was collected from these participants through interview-administered 24-hour recalls utilizing the USDA's Multiple-Pass Approach Method (USDA, 2016). The script is available in Appendix H. Individuals were asked if the day prior were a typical day of eating. If they said yes, dietary information would be collected from the day before. If they said the day prior had not been a typical day of eating, participants were probed to share what a typical day of eating usually consists of. Additionally, interview-administered food frequency questionnaire data were collected using the National Cancer Institute's NHANES Food Frequency Questionnaire from these participants (NIH National Cancer Institute, 2004). Participants who completed this part of the study were sent a $20 Amazon gift card as compensation for their time.

STUDY MEASURES

Diet Quality. Diet quality was measured utilizing the Healthy Eating Score-5 (HES-5) Questionnaire (Appendix I) that is utilized as part of an ongoing military study, which asks about frequency of intake of fruits, vegetables, dairy, whole grains, and fish. Each of the five categories is scored on a five-point scale for a total possible HES-5 score ranging from 0 to 25 (Golenbock et al., 2016). In addition to measuring diet quality with HES-5, 24-hour recalls using the USDA's Multiple Pass Approach Method and NHANES Food Frequency Questionnaires were administered over the phone to a subset of participants to assess diet quality in ROTC cadets. 24-hour recall data and food frequency questionnaires were analyzed for macronutrient distribution.

Nutrition Knowledge. Nutrition knowledge was measured with 24 true/false questions about macronutrients, energy, hydration, and vitamins and minerals by "Development of a Military-Specific Eating Behavior Survey" questions that are a part of the ongoing USARIEM study (Appendix J) (Cole, 2016).

Development of USARIEM's nutrition knowledge questions began with a literature review to look at what existing tools were validated and may be pertinent to the military. However, due to the unique nutrition needs of the military, the scope of the tools examined was broadened to look at some non-validated athletic nutrition knowledge surveys that were shared with USARIEM. The relevant questions were pulled. A subject matter expert panel of military registered dietitians decided what questions to retain based on all of the compiled nutrition knowledge questions using face validity. The experts made sure to include themes covered in performance nutrition education slides that entry-level soldiers receive as part of basic training. The questions were then validated with content validity through cognitive interviews with 44 soldiers in nine sessions to make sure that the questions were clear. The questions were pre-tested with 500 soldiers each in three iterations. Researchers considered factor analysis and variability using item analysis with pre-testing. They excluded questions that were too easy, difficult, and confusing. Initially, they started with 40 questions, and trimmed it down to 19 questions. After the second pre-test, they added 6 questions for a new total of 24 nutrition knowledge questions for the third iteration. The questions address crucial areas of nutrition knowledge for ROTC cadets and service members including the topics of macronutrients, energy, hydration, and vitamins and minerals (Cole, 2016).

Motivation for Healthy Eating. Motivation for healthy eating was measured utilizing the validated Regulation of Eating Behaviors Survey (Appendix K) (Pelletier et al., 2004). The questions were divided into two different forms of motivation: autonomous motivation (with the constructs of intrinsic motivation, integrated regulation, identified regulation) and controlled motivation (with the constructs of introjected regulation, external regulation, and amotivation) with four questions per category. An average score was computed for each of the six constructs. The three mean autonomous motivation constructs were averaged to compute one autonomous motivation for healthy eating score. The three mean controlled motivation for healthy eating constructs were averaged to compute one controlled motivation for healthy eating score (Guertin et al., 2015; Pelletier et al., 2004).

Demographic Characteristics. Self-reported age, sex, race/ethnicity, living arrangements, and ROTC year was collected from participants on a demographic form.

Anthropometric Measurements. Height was measured with a portable stadiometer and weight was measured with a digital scale. Height and weight were used to calculate body mass index and compared to the CDC body mass index classifications (CDC, 2018).

STATISTICAL ANALYSIS

The first aim to assess nutrition knowledge, motivation for healthy eating, and diet quality in Army ROTC cadets was achieved through descriptive statistics. The second aim to assess the associations among nutrition knowledge, motivation for healthy eating and diet quality in Army ROTC cadets was achieved through a mediation model.

Data was analyzed using SPSS Version (IBM Corp, 2017). After the raw data was entered into SPSS, it was cleaned. Descriptive statistics and frequencies were run on sociodemographic characteristics and each variable. Variables were explored for missingness, linearity, homoscedasticity, and multicollinearity (Rosner, 2006). Data was checked for univariate and multivariate normality. The skewness and kurtosis of the data was within an acceptable distribution and no transformations of the data were made (Rubio & Steel, 2015). Cronbach's alpha values were analyzed for Healthy Eating Score-5 and motivation for healthy eating to assess the reliability of each measure. Kuder-Richardson 20 was used to assess the reliability of the nutrition knowledge survey since it is a dichotomous variable (Kuder & Richardson, 1937). Pearson's correlation test was conducted to assess the strength of the linear relationship between Healthy Eating Score-5, nutrition knowledge, intrinsic motivation, integrated motivation, identified motivation, identified motivation, introjected motivation, external motivation, and amotivation.

We created a parallel mediation model in Mplus to look at how motivation for healthy eating mediates the relationship between nutrition knowledge and diet quality, similar to another study that examined diet quality, psychological dietary determinants, and nutrition knowledge in college women (Muthén & Muthén, 2010; Tabbakh & Freeland-Graves, 2016). Race/ethnicity, age, sex, and BMI were included as covariates in the mediation model because they are four factors that have previously been shown to have differences in nutrition knowledge, motivation for healthy eating, and diet quality in other studies (Pelletier & Dion, 2007; Purvis et al., 2013). The mediation model input code can be found in Appendix L.

24-hour recalls were inputted into ASA 24 and the data was exported to SPSS to run descriptive statistics (IBM Corp, 2017; USDA, 2016). FFQ data was entered utilizing NHANES's DHQ III and then exported to SPSS to run descriptive statistics (IBM Corp, 2017; NIH National Cancer Institute, 2004).

CHAPTER FOUR: RESULTS

SOCIODEMOGRAPHIC CHARACTERISTICS

Of the total 288 Army ROTC cadets (Michigan State University, n=145; Western Michigan University, n=143), overall, 205 Army ROTC cadets (71.2%) participated in the present study with 78.6% participation of Michigan State University Army ROTC cadets and 63.6% of Western Michigan University Army ROTC cadets. Sociodemographic characteristics of participants are summarized in Table 5. The majority of the participants were men (68.3%), non-Hispanic Whites (77.6%). A larger sample of students came from Michigan State University (n=114) compared to those from Western Michigan University (n=91). The majority of participants were first year students (43.9%), lived on campus (55.1%), were between 18-20 years old (70.3%), had not yet contracted (54.9%), and had a BMI of less than 25 (56.2%).

The ROTC year differed between the two schools ($p<0.001$) as Michigan State University had higher percentages than Western Michigan University for Year 1 (46.5% vs. 40.7%) and Year 2 (28.9% vs. 11.0%) and lower percentages of Year 3 (11.4% vs. 30.8%) and Year 4 (13.2% vs. 17.6%). Consequently, Michigan State University had younger participants compared to Western Michigan University ($p<0.001$). There were no significant differences between schools for sex, race/ethnicity, living arrangements, contract status, or BMI.

Table 5. Demographic characteristics of Army ROTC cadets in the present study

Category	Total (n=205)		MSU[a] (n=114)		WMU[b] (n=91)			
	n	%	n	%	n	%	χ^2	Significance
Sex (n=205)							2.42	0.12
Men	140	68.3	83	72.8	57	62.1		
Women	65	31.7	31	27.2	34	28.9		
Race/Ethnicity[c] (n=205)							0.28	0.59
White, Non-Hispanic	159	77.6	90	78.9	69	75.8		
Other	46	22.4	24	21.1	22	24.2		
Living Arrangements[d] (n=205)							4.49	0.37
On-campus	113	55.1	65	57.0	48	52.7		
Off-campus	92	44.9	49	43.0	43	47.3		
ROTC Year (n=205)							18.32	0.00
Year 1	90	43.9	53	46.5	37	40.7		
Year 2	43	21.0	33	28.9	10	11.0		
Year 3	41	20.0	13	11.4	28	30.8		
Year 4	31	15.1	15	13.2	16	17.6		
Age (years) (n=202)							7.71	0.00
18-20	142	70.3	87	78.4	55	60.4		
21-32	60	29.7	24	21.6	36	39.6		
Contracted[e] (n=204)							2.51	0.11
Yes	112	54.9	57	50.0	55	61.1		
No	92	45.1	57	50.0	35	38.9		
Body Mass Index (kg/m^2)[f] (n=204)							0.21	0.65
< 25	109	56.2	60	57.4	49	54.4		
≥ 25	85	43.8	44	42.3	41	45.6		

[a]Michigan State University
[b]Western Michigan University
[c]Hispanic (n=17), non-Hispanic (n=188), White (n=173), Black/African American (n=16), Native American/Alaskan Native (n=2), Asian (n=8), Other (n=6)
[d]On-campus living arrangements includes living in on-campus (n=108) and on-base family housing (n=5); off-campus living arrangements includes living off-campus (n=91) and in temporary lodging (n=1)
[e]Contract involves committing years of service as an officer in exchange for a scholarship during college. Cadets usually contract during the junior year of college
[f]Body mass index of 18.5-24.9 is considered healthy, body mass index over 25 indicates overweight (n=76) and obese (n=9) weight status

AIM ONE. TO ASSESS NUTRITION KNOWLEDGE, MOTIVATION FOR HEALTHY EATING, AND DIET QUALITY IN ARMY ROTC CADETS

Nutrition Knowledge. The distribution of mean nutrition knowledge scores is in Figure 5 and was normally distributed. The nutrition knowledge questions, category, correct answer, and frequency of participants getting each question correct be found in Table 6. The least number of participants scored correctly on “True or false: A recovery beverage or snack should always be consumed after exercise” (14.6%) and “True or false: Fruits and vegetables are good sources of zinc” (18.5%). Most participants knew the answer to “True or false: At least half of the food on your plate should be fruits and vegetables” (84.4%), “True or false: Replacing lost body weight from an exercise session with fluid is important” (83.9%), and “True or false: Most plants, fish, nuts, and seeds are sources of healthy unsaturated fats” (80.5%).

Nutrition knowledge subcategory scores are in Table 7. The mean $\pm$ SD, median, and range of composite nutrition knowledge scores were 16 $\pm$ 3, 16, and 8-22, respectively, out of a maximum possible score of 24. Composite nutrition knowledge score mean was 66.7%. The mean $\pm$ SD, median, and range scores of eight questions on macronutrients (maximum score of 8) were 5.5 $\pm$ 1.4, 6, and 2-8, respectively. The mean, median, and range of eight questions on vitamins and minerals (maximum score of 8) were 5.2 $\pm$ 1.3, 5, and 1-8, respectively. The mean, median, and range of five questions related to energy (maximum score of 5) were 3.5 $\pm$ 1.1, 4, and 1-5, respectively. The mean, median, and range of three questions related to hydration (maximum score of 3) were 1.8 $\pm$ 0.6, 2, and 0-3, respectively. Participants scored the mean highest percentage of questions correct in the energy category with a mean score of 3.5 out of 5 (70% of questions correct). Participants scored the mean lowest percentage of questions correct in the hydration category with a mean score of 1.8 out of 3 (60% of questions correct).

Data showing the mean nutrition knowledge score by ROTC year, race/ethnicity, weight status, age, school, and sex are in Table 8. There were no significant differences on mean nutrition knowledge score by ROTC year, race/ethnicity, school, sex, weight status, or age.

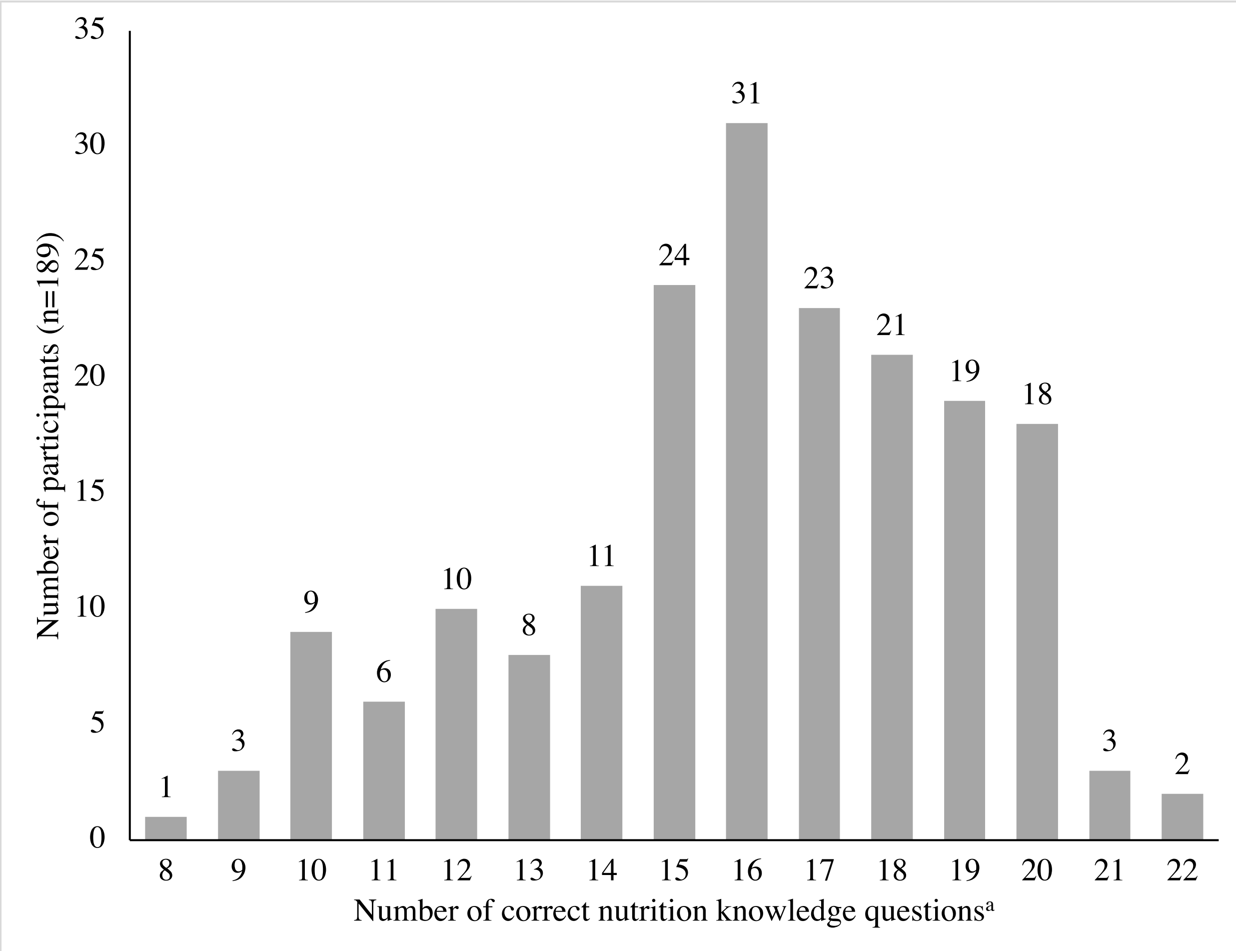

Figure 5. Nutrition knowledge score distribution of Army ROTC cadets
[a]Nutrition knowledge assessed with 24 true/false questions developed by the US Army Research Institute of Environmental Medicine on energy, macronutrients, hydration, and vitamins/minerals. Mean (SD) = 16 $\pm$ 3.0, Median = 16. Each question scored correct/incorrect for a maximum possible score of 24. Skewness (SE) = -0.48 (0.17), kurtosis (SE) = -0.35 (0.34)

Table 6. Nutrition knowledge questions and correct response frequencies

True/False Question[a]	Category[b]	Correct Answer	n	% Correct
Dietary supplements are regulated by the government for purity (cleanliness) and safety before sale.	V	False	95	46.3
Replacing lost body weight from an exercise session with fluid is important.	H	True	172	83.9
Fruits and vegetables are good sources of zinc.	V	False	38	18.5
As long as I am physically active or not overweight, I can eat whatever I want and be healthy.	E	False	152	74.1
Good sources of calcium include bread, steak, and corn.	V	False	158	77.1
Most plants, fish, nuts and seeds are sources of healthy unsaturated fats.	M	True	165	80.5
Whole milk is a better source of protein than 2% or skim milk.	M	False	84	41.0
A recovery beverage or snack should always be consumed after exercise.	H	False	30	14.6
A post-workout supplement is better for recovery than a snack or meal.	E	False	146	71.2
Vitamins and minerals are sources of calories.	V	False	147	71.7
Dietary fat is not considered an important part of a balanced diet.	M	False	159	77.6
Protein is the most important source of energy (calories) for physical activity.	E	False	114	55.6
At least half of the food on your plate should be fruits and vegetables.	M	True	173	84.4
Most Military personnel require about four times more protein than civilians.	M	False	103	50.2
Meat is a good source of fiber.	M	False	138	67.3
Leafy green vegetables, root vegetables, and dairy products are good sources of potassium.	V	True	113	55.1
Carbohydrates are the main fuel for mental performance.	E	True	140	68.3
As long as enough calories are consumed, vitamin and mineral needs of Military personnel are met.	V	False	156	76.1
Sports drinks are always the preferred beverage when exercising at moderate intensity.	H	False	163	79.5
Complex carbohydrate-rich foods include fruit, vegetables, and beans.	M	True	139	67.8
Iron is found in dark green vegetables, eggs, and fortified cereal.	V	True	155	75.6

Table 6. (cont'd)

Body fat is an important source of energy at rest and during long-duration exercise.	E	True	152	74.1
Vitamin D is sometimes called the sunshine vitamin because the sun helps your body make it.	V	True	170	82.9
Regardless of how much protein I eat, my body will use it to build muscle.	M	False	133	64.9

[a]Kuder Richardson-20 value=0.57
[b]V=vitamins and minerals, H=hydration, E=energy, M=macronutrients

Table 7. Nutrition knowledge survey descriptive statistics

Category[a]	**Max Possible Score**	**n**	**Mean ± SD**	**Median**	**Min-Max**
Nutrition Knowledge Composite Score	24	189	16 ± 3.0	16	8-22
Topic					
Macronutrients	8	195	5.5 ± 1.4	6	2-8
Vitamins and Minerals	8	196	5.2 ± 1.3	5	1-8
Energy	5	198	3.5 ± 1.1	4	1-5
Hydration	3	199	1.8 ± 0.6	2	0-3

[a]measured utilizing US Army Research Institute of Environmental Medicine's nutrition knowledge survey containing 24 true/false questions on macronutrients, energy, hydration, and vitamins/minerals. Each question is scored correct/incorrect with a maximum possible score of 24.

Table 8. Mean nutrition knowledge score by participant demographic characteristics

Demographic Characteristic	Mean ± SD[a]	p-value
ROTC Year[b,c]		0.108
1	15.4 ± 3.2	
2	16.8 ± 2.9	
3	16.3 ± 2.8	
4	16.1 ± 2.8	
Race/ethnicity[d,e]		0.462
White, Non-Hispanic	16.1 ± 3.0	
Other	15.7 ± 3.1	
School[d]		0.626
Michigan State University	16.1 ± 2.9	
Western Michigan University	15.9 ± 3.1	
Sex[d]		0.810
Men	16.0 ± 3.0	
Women	16.1 ± 3.1	
Weight Status[d,f]		0.427
BMI < 25	16.0 ± 2.9	
BMI > 25	16.0 ± 3.0	
Age, years[d]		0.579
18-20	16.1 ± 3.0	
21-32	15.9 ± 3.0	

[a]Nutrition knowledge measured with 24 true or false questions on macronutrients, energy, hydration, and vitamins/minerals developed by the US Army Research Institute of Environmental Medicine. Each question is marked as correct or incorrect with a maximum possible score of 24.
[b]Differences in mean nutrition knowledge score between groups with ANOVA test
[c]ROTC year indicates a participant's year, or level, in the Army ROTC program
[d]Differences in mean nutrition knowledge score between groups by independent t-test
[e]Other race/ethnicity includes Hispanics, Black/African Americans, Asians, Native American/Alaskan Natives, and those with self-reported other race/ethnicity
[f]BMI= body mass index; BMI greater than or equal to 25 is considered overweight/obese according to CDC guidelines (CDC, 2018).

Diet Quality. The distribution of Healthy Eating Score-5 values is in Figure 6. Cronbach's alpha measuring inter item reliability of the Healthy Eating Score-5 questionnaire was 0.65, demonstrating moderate reliability (Tavakol & Dennick, 2011). Figure 7 shows the frequency of consumption of fruit by Army ROTC cadets. The majority of participants (78.8%) reported consuming fruit less than two times per day. Similarly, the majority of participants (93.5%) also reported consuming less vegetables less than three times per day (Figure 8). Most of the participants reported consuming whole grains less than three times per day (92.5%, Figure 9) and servings of dairy less than three times per day (89.4%, Figure 10). However, the majority of participants (63%) consumed fish 1-2 times per week (Figure 11). Only two participants (1%) reported consuming USDA's recommended level of all five food groups of fruit, vegetables, dairy, whole grains, and fish (data not shown).

As shown in Table 9, the mean and median scores for Healthy Eating Score-5 (maximum score of 25) were 11.8 ± 3.97 and 11.0, respectively. Each subcategory had a maximum score of 5. The mean score for fruit was 2.4 ± 1.24 and median score was 2. The vegetable category had a mean score of 2.64 ± 1.3 and a median score of 2. Whole grains had a mean score of 2.82 ± 1.22 with a median score of 3. Dairy had a mean score of 2.94 ± 1.25 with a median of 3. Lastly, fish had a mean score of 1.05 ± 1.14 with a median of 1. Participants most frequently reported consuming dairy and whole grains and had the lowest frequency of consumption with fish. With the moderation indices, alcohol had mean score of 0.56 ± 0.85, energy drinks/shots had a mean score of 0.45 ± 0.90, sugar beverages had a mean score of 1.17 ± 1.3 and eating out had a mean score of 1.07 ± 0.92.

There were no significant differences between mean Healthy Eating Score-5 by ROTC year or race/ethnicity (Table 10). Table 10 also shows the comparison by Healthy Eating Score-5 means by school, sex, weight status, and age. Participants at Michigan State University had significantly higher mean Healthy Eating Score-5 compared to Western Michigan University ($p<0.05$). There were no significant differences in mean diet quality scores by sex, weight status, or age. There were also no differences in mean Healthy Eating Score-5 by on-campus versus off-campus living arrangements by school and overall (data not shown).

Tables summarizes the comparison of dietary information of subgroup who completed 24-hour recalls and food frequency questionnaires. On the 24-hour recalls, there was a significant difference by sex for intake of calories (3085 kcal + 1170 vs. 1765 kcal + 701, $p<0.01$), protein (143 g + 61 vs. 81 g + 29, $p<0.01$), fat (122 g + 60 vs. 73 g + 34, $p<0.05$), and carbohydrates (357 g + 151 vs. 198 g + 100, $p<0.01$). There were no significant differences between or within groups on the food frequency questionnaire for all participants who had food frequency questionnaires complete (n=35) nor differences for those who had food frequency questionnaires and 24-hour recalls complete (n=23).

Figure 12 and Table 12 shows 24-hour recall and food frequency questionnaire self-reported intake compared to MyPlate recommendations. Participants reported inadequate consumption of fruit, vegetables, and dairy on both 24-hour recalls and food frequency questionnaires. Participants reported higher than recommended intake of protein for both dietary assessment tools. For grains, participants reported higher than recommended on 24-hour recall data and less than recommended on food frequency questionnaires.

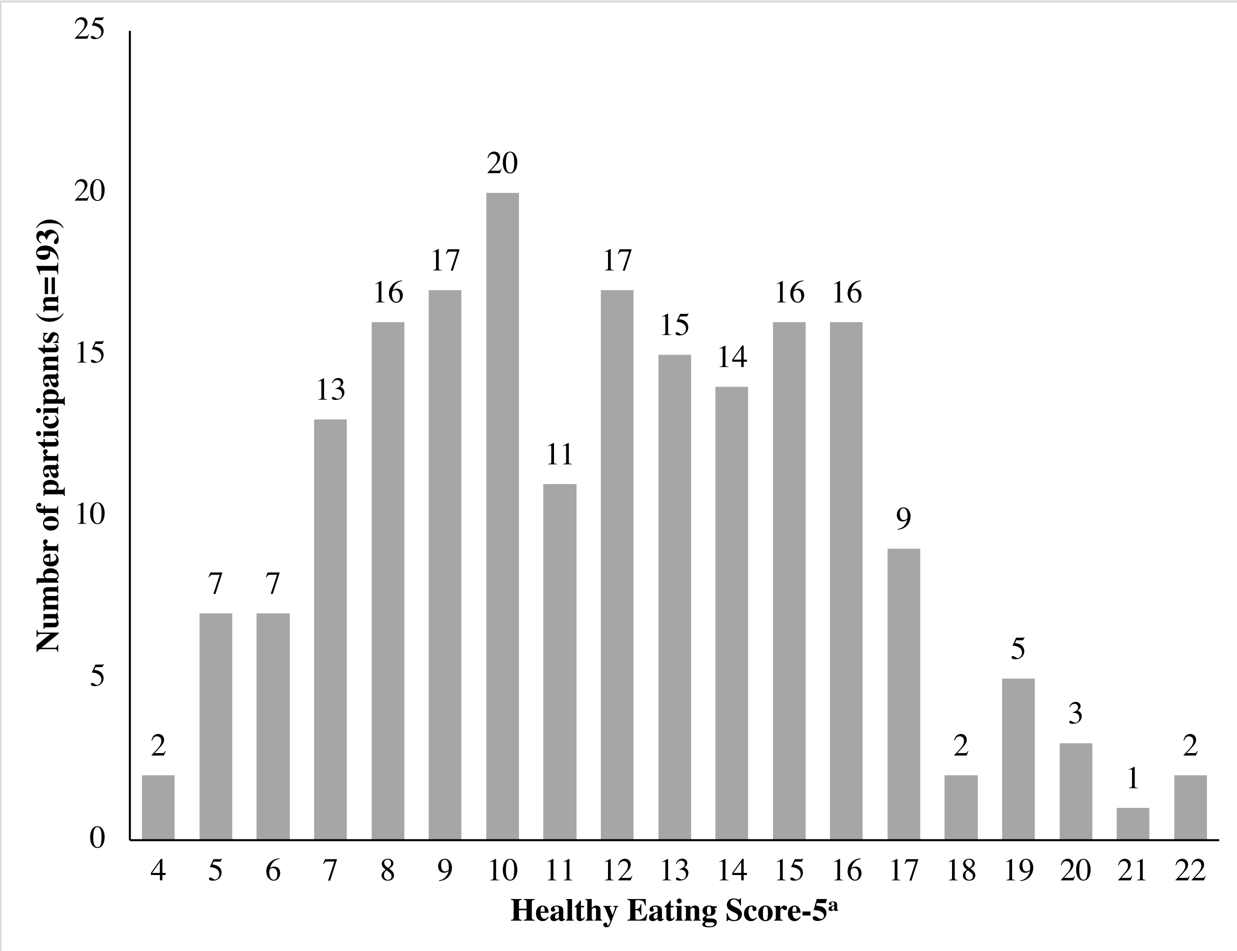

Figure 6. Healthy Eating Score-5 score distribution of Army ROTC cadets
[a]Healthy Eating Score-5 measured using validated tool to examine diet quality developed by Golenbock et al. to assess frequency of consumption of fruits, vegetables, whole grains, dairy, and fish over the last 30 days. Each category is summed with a maximum possible score of 25.

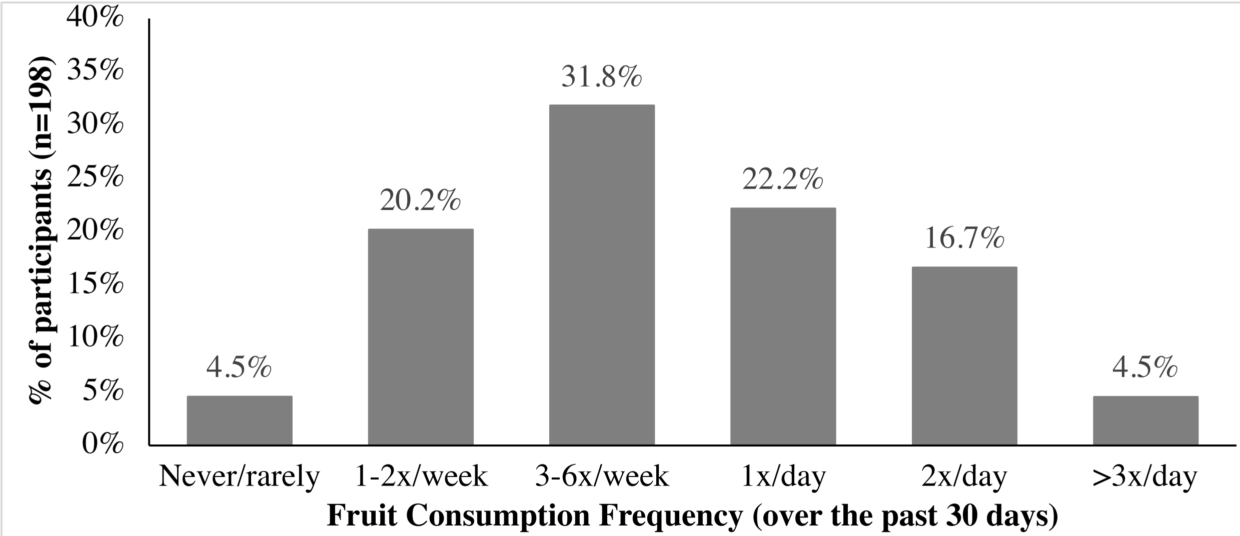

Figure 7. Frequency of self-reported fruit consumption
[a]Fruit consumption over the last 30 days was one of the questions on the Healthy Eating Score-5 questionnaire. Healthy Eating Score-5 is a validated tool to examine diet quality developed by Golenbock et al. to assess frequency of consumption of fruits, vegetables, whole grains, dairy, and fish over the last 30 days. Each category is summed with a maximum possible score of 25.

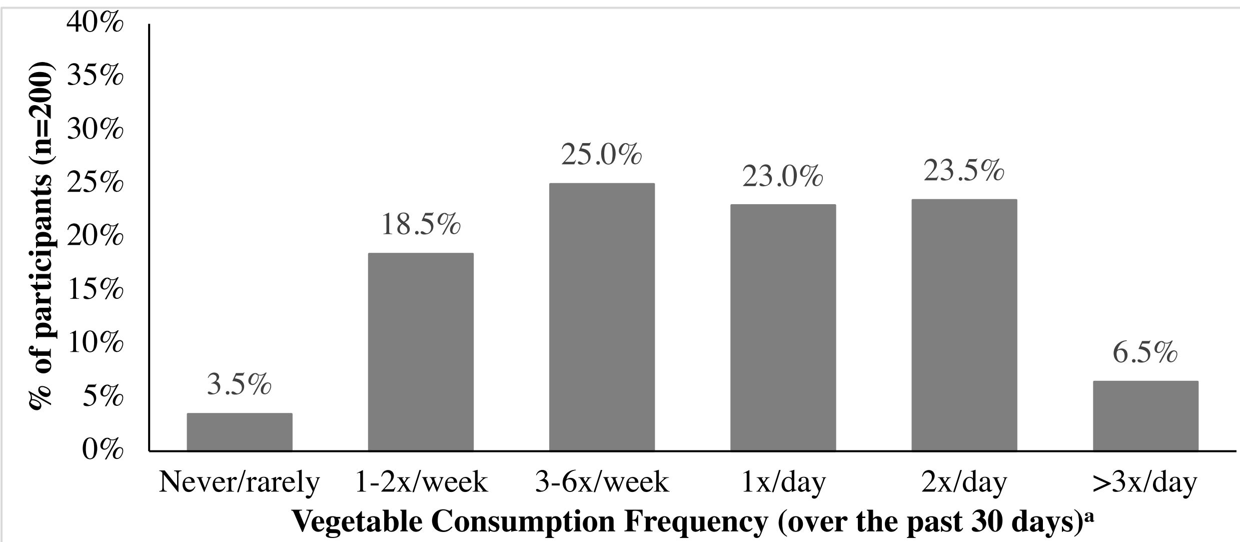

Figure 8. Frequency of self-reported vegetable consumption
[a]Vegetable consumption over the last 30 days was one of the questions on the Healthy Eating Score-5 questionnaire. Healthy Eating Score-5 is a validated tool to examine diet quality developed by Golenbock et al. to assess frequency of consumption of fruits, vegetables, whole grains, dairy, and fish over the last 30 days. Each category is summed with a maximum possible score of 25.

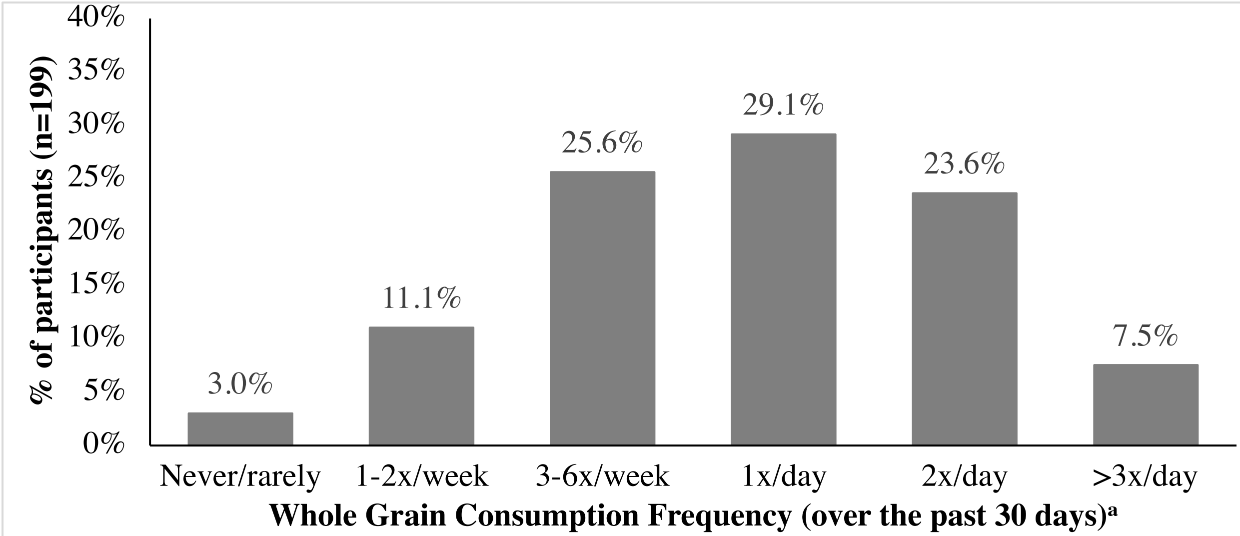

Figure 9. Frequency of self-reported whole grain consumption
[a]Whole grain consumption over the last 30 days was one of the questions on the Healthy Eating Score-5 questionnaire. Healthy Eating Score-5 is a validated tool to examine diet quality developed by Golenbock et al. to assess frequency of consumption of fruits, vegetables, whole grains, dairy, and fish over the last 30 days. Each category is summed with a maximum possible score of 25.

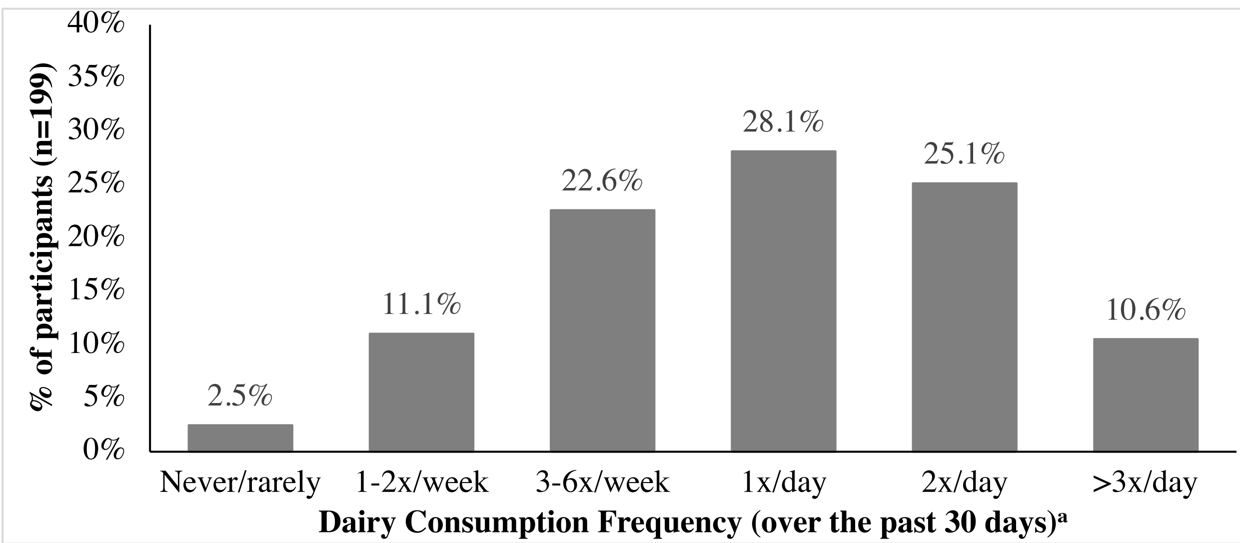

Figure 10. Frequency of self-reported dairy consumption
[a]Dairy consumption over the last 30 days was one of the questions on the Healthy Eating Score-5 questionnaire. Healthy Eating Score-5 is a validated tool to examine diet quality developed by Golenbock et al. to assess frequency of consumption of fruits, vegetables, whole grains, dairy, and fish over the last 30 days. Each category is summed with a maximum possible score of 25.

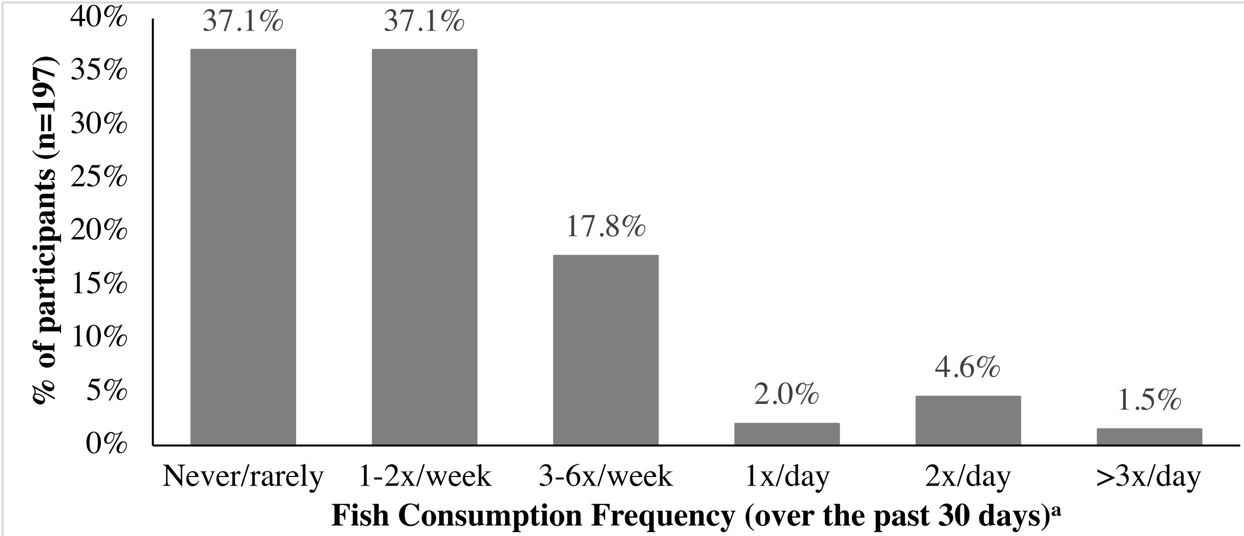

Figure 11. Frequency of self-reported fish consumption
[a]Fish consumption over the last 30 days was one of the questions on the Healthy Eating Score-5 questionnaire. Healthy Eating Score-5 is a validated tool to examine diet quality developed by Golenbock et al. to assess frequency of consumption of fruits, vegetables, whole grains, dairy, and fish over the last 30 days. Each category is summed with a maximum possible score of 25.

Table 9. Healthy Eating Score-5, diet quality and moderation indices

Healthy Eating Score-5[a]			
Total Score	**n**	Mean ± SD	**Median**
HES-5	193	11.8 ±3.97	11.0
Diet Quality[b]			
Category	**n**	Mean ± SD	**Median**
Fruit	198	2.40 ± 1.24	2.00
Vegetables	200	2.64 ± 1.30	2.00
Whole Grains	199	2.82 ± 1.22	3.00
Dairy	199	2.94 ± 1.25	3.00
Fish	197	1.05 ± 1.14	1.00
Moderation Indices[c]			
Category	**n**	Mean ± SD	**Median**
Alcohol	199	0.56 ± 0.85	0.00
Energy drinks/shots	199	0.45 ± 0.90	0.00
Sugar beverages	200	1.17 ± 1.30	1.00
Eating out	200	1.07 ± 0.92	1.00

[a]Healthy Eating Score-5 (HES-5) is a tool used in the Army and by the US Army Research Institute of Environmental Medicine as a measure of diet quality by asking five questions on frequency of consumption over the last 30 days of fruits, vegetables, dairy, whole grains, and fish with a maximum possible score of 25
[b]Each category has a maximum possible score of 5
[c]Each category has a maximum possible score of 5

Table 10. Mean Healthy Eating Score-5 by participant demographic characteristics

Demographic Characteristic	Mean $\pm$ SD[a]	p-value
ROTC Year[b,c]		0.379
1	11.9 $\pm$ 4.0	
2	12.5 $\pm$ 4.1	
3	10.9 $\pm$ 3.8	
4	11.6 $\pm$ 3.9	
Race/ethnicity[d,e]		0.537
White, Non-Hispanic	11.9 $\pm$ 3.9	
Other	11.5 $\pm$ 4.3	
School[d]		**0.024**
Michigan State University	12.4 $\pm$ 4.0	
Western Michigan University	11.1 $\pm$ 3.8	
Sex[d]		0.471
Men	11.9 $\pm$ 3.9	
Women	11.5 $\pm$ 4.2	
Weight Status[d,f]		0.427
BMI < 25	11.6 $\pm$ 3.8	
BMI > 25	11.9 $\pm$ 4.2	
Age, years[d]		0.158
18-20	12.0 $\pm$ 4.0	
21-32	11.2 $\pm$ 3.8	

[a]Healthy Eating Score-5 (HES-5) is a tool used in the Army and by the US Army Research Institute of Environmental Medicine as a measure of diet quality by asking five questions on frequency of consumption over the last 30 days of fruits, vegetables, dairy, whole grains, and fish with a maximum possible score of 25

[b]Differences in mean Healthy Eating Score-5 between groups with ANOVA test

[c]ROTC year indicates a participant's year, or level, in the Army ROTC program

[d]Differences in mean Healthy Eating Score-5 between groups by independent t-test

[e]Other race/ethnicity includes Hispanics, Black/African Americans, Asians, Native American/Alaskan Natives, and those with self-reported other race/ethnicity

[f]BMI= body mass index; BMI greater than or equal to 25 is considered overweight/obese according to CDC guidelines (CDC, 2018).

Table 11. Comparison of macronutrient intake data collected by 24-hour recalls and food frequency questionnaires

	Calories (kcal)			Protein (g)			Fat (g)			Carbohydrates (g)		
	Min	**Max**	**Mean ± SD**	**Min**	**Max**	**Mean ± SD**	**Min**	**Max**	**Mean ± SD**	**Min**	**Max**	**Mean ± SD**
24-Hour Recall												
Men (n=15)	1380	6630	3085 ± 1170	59	251	143 ± 61	40	313	122 ± 60	172	704	357 ± 151
Women (n=9)	969	3053	1765 ± 701	43	128	81 ± 29	32	137	73 ± 34	106	353	198 ± 100
Total (n=24)	969	6631	2590 ± 1196	43	251	120 ± 59**	32	313	104 ± 56*	106	704	297 ± 154**
Food Frequency Questionnaires												
Men (n=18)	766	4457	2006 ± 899	30	216	90 ± 49	35	192	77 ± 38	76	477	236 ± 101
Women (n=17)	812	5145	1837 ± 993	37	227	77 ± 46	32	188	66 ± 37	88	658	235 ± 126
Total (n=35)	766	5145	1924 ± 936	30	227	84 ± 47	32	192	72 ± 37	76	658	235 ± 112
Complete FFQ Data[a]												
Men (n=14)	766	3094	1864 ± 656	30	148	81 ± 34	35	121	70 ± 26	76	358	223 ± 80
Women (n=9)	812	5145	1858 ± 1331	37	227	82 ± 61	32	188	68 ± 49	88	658	235 ± 168
Total (n=23)	766	5145	1862 ± 948	30	227	81 ± 45	32	188	69 ± 36	76	658	228 ± 119

*$p<0.05$ between men and women by ANOVA

**$p<0.01$ between men and women by ANOVA

[a]Complete FFQ data includes with participants that completed both food frequency questionnaire and 24-hour recall; no significant differences in macronutrients between 24-hour recalls and food frequency questionnaires ($p>0.05$)

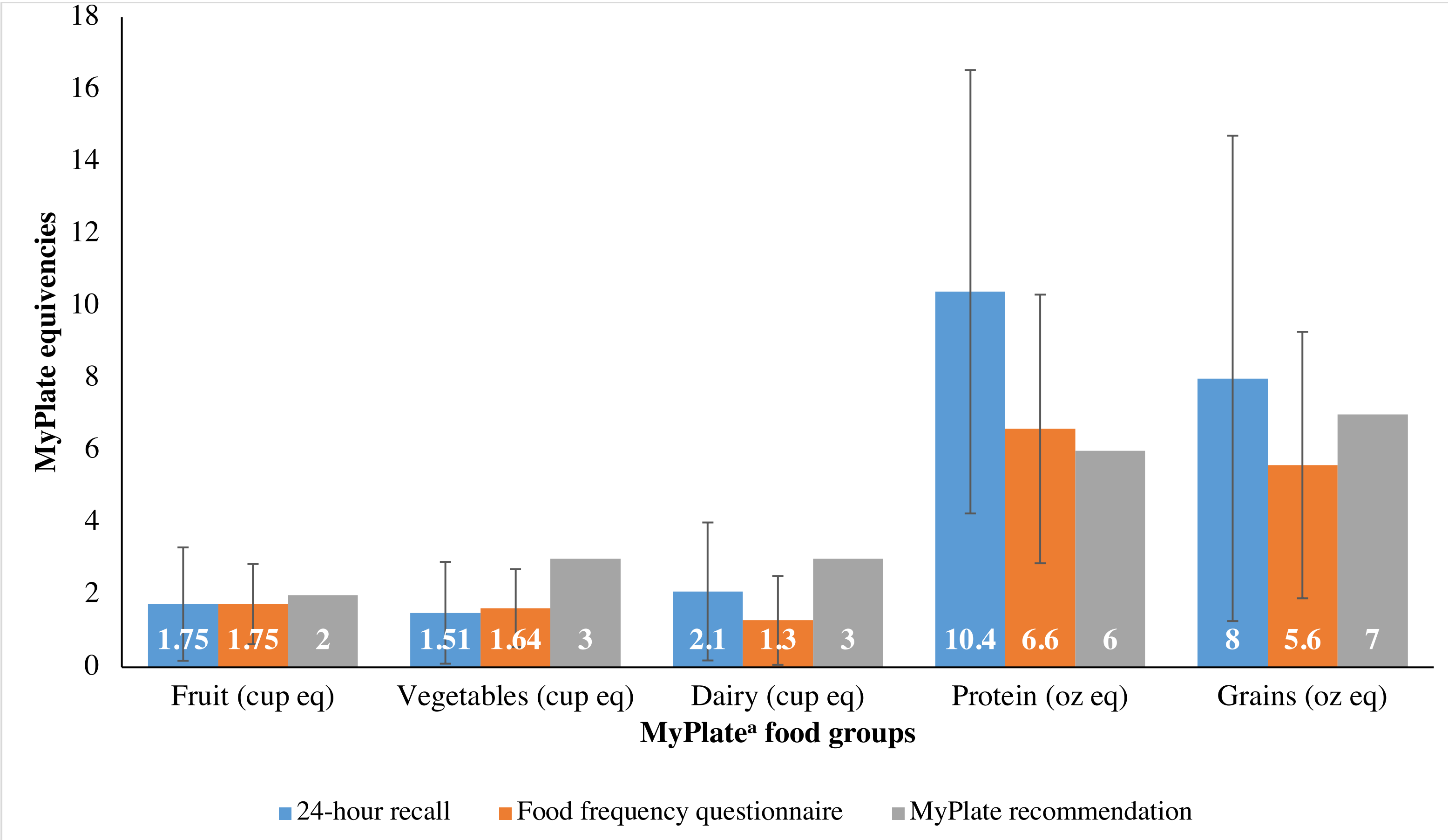

Figure 12. Mean self-reported intake collected by 24-hour recall and food frequency questionnaire compared to MyPlate recommendations

[a]MyPlate is a public health initiative to encourage a nutritious diet by recommending filling up half plate with fruits and vegetables, one-quarter with grains, one-quarter with protein, and with a little bit of dairy (USDA, 2018). Mean MyPlate equivalencies and standard deviations of participants are shown. 24-hour recall mean MyPlate eq (± SD): fruit=1.75±1.57, vegetables=1.51±1.41, dairy=2.1±1.91, protein=10.4±6.14, grains=8±6.72; Food frequency mean MyPlate eq (± SD): fruit=1.75±1.11, vegetables=1.64±1.08, dairy=1.3±1.23 protein=6.6±3.72, grains=5.6±3.69

Table 12. Mean self-reported frequency collected by 24-hour recall and food frequency questionnaire compared to MyPlate recommendations

MyPlate food group[a]	USDA Recommendation	% Meeting Recommendation	
		24-hour recall	Food frequency questionnaire
Fruits (cup eq)	2	43.5	43.5
Vegetables (cup eq)	3	13.0	8.7
Dairy (cup eq)	3	26.1	4.3
Protein (oz eq)	6	82.6	47.8
Grains (oz eq)	7	43.5	30.4

[a]MyPlate is a public health initiative to encourage a nutritious diet by recommending filling up half plate with fruits and vegetables, one-quarter with grains, one-quarter with protein, and with a little bit of dairy (USDA, 2018).

Motivation for Healthy Eating. Cronbach's alpha to test inter-item reliability for the autonomous motivation for healthy eating survey was 0.91 indicating good reliability (Tavakol & Dennick, 2011). Measurements of motivation for healthy eating are summarized in Table 13. The maximum possible answer on the questionnaire was a 7, which indicates that a statement corresponded with how strongly a participant felt. The range of each subcategory was 1-7 with the exception of amotivation, which had a range of 1-6.25. Participants had a higher mean autonomous motivation for healthy eating score of 4.5 $\pm$ 1.4 compared to the mean controlled motivation for healthy eating score of 2.4 $\pm$ 1.0. Participants had the highest average scores in identified, integrated, and intrinsic motivation, which are all forms of autonomous motivation. Participants scored the lowest in amotivation. Intrinsic motivation had a mean score of 4.2 $\pm$ 1.6. Integrated motivation had a mean score of 4.3 $\pm$ 1.6. Identified motivation had a mean score of 4.8 $\pm$ 1.5. Introjected motivation had a mean score of 2.8 $\pm$ 1.4. External motivation had a mean score of 2.6 $\pm$ 1.2. Amotivation had a mean of 1.8 $\pm$ 1.1.

Autonomous and controlled motivation for healthy eating scores by ROTC year, race/ethnicity, school, sex, weight status, and age are in Table 14. There were no significant differences in mean autonomous motivation for healthy eating nor controlled motivation for healthy eating by any of the aforementioned demographic characteristics. The majority of motivation subcategories were significantly and positively correlated with each other, while amotivation was inversely correlated with integrated motivation (Table 15, $r=-0.154$, $p<0.05$).

Table 13. Motivation for healthy eating descriptive statistics

Motivation Name	Type	n	Mean $\pm$ SD[a]	Min-Max
Intrinsic	Autonomous	197	4.2 $\pm$ 1.6	1-7
Integrated	Autonomous	198	4.3 $\pm$ 1.6	1-7
Identified	Autonomous	199	4.8 $\pm$ 1.5	1-7
Introjected	Controlled	198	2.8 $\pm$ 1.4	1-7
External	Controlled	198	2.6 $\pm$ 1.2	1-7
Amotivation	Controlled	199	1.8 $\pm$ 1.1	1-6.25
Motivation Scores				
Autonomous Score[b]		196	4.5 $\pm$ 1.4	1-7
Controlled Score[c]		197	2.4 $\pm$ 1.0	1-5.42

[a]measured utilizing Pelletier et al.'s tool to assess eating regulation 24 questions divided into 6 sub-categories of motivation type with a 7-point scale of 1 being "does not correspond at all" to 7 being "corresponds exactly." Each sub-category's questions were averaged, and the means are reported

[b]calculated by taking the average of the sum of intrinsic, integrated, and identified motivation scores

[c]calculated by taking the average of the sum of introjected, external, and amotivation scores

Table 14. Mean motivation for healthy eating by participant demographic characteristics

	Autonomous Motivation for Healthy Eating[a,b]		Controlled Motivation for Healthy Eating[a,c]	
Demographic Characteristic	Mean ± SD	p-value	Mean ± SD	p-value
ROTC Year[d,e]		0.558		0.434
1	4.3 ± 1.5		2.4 ± 1.0	
2	4.4 ± 1.5		2.2 ± 1.0	
3	4.6 ± 1.4		2.6 ± 1.2	
4	4.7 ± 1.4		2.4 ± 0.9	
Race/ethnicity[f,g]		0.937		0.587
White, Non-Hispanic	4.5 ± 1.5		2.4 ± 1.0	
Other	4.5 ± 1.4		2.5 ± 1.0	
School[f]		0.098		0.437
Michigan State University	4.3 ± 1.6		2.4 ± 1.0	
Western Michigan University	4.6 ± 1.3		2.5 ± 1.0	
Sex[f]		0.182		0.189
Men	4.4 ± 1.5		2.3 ± 0.9	
Women	4.7 ± 1.4		2.6 ± 1.2	
Weight Status[f,h]		0.058		0.756
BMI < 25	4.3 ± 1.5		2.4 ± 1.1	
BMI > 25	4.7 ± 1.4		2.4 ± 1.0	
Age, years[f]		0.498		0.585
18-20	4.4 ± 1.5		2.4 ± 1.0	
21-32	4.5 ± 1.4		2.5 ± 1.0	

[a]measured utilizing Pelletier et al.'s tool to assess eating regulation 24 questions with each question being on a 7-point scale of 1 being "does not correspond at all" to 7 being "corresponds exactly."
[b]calculated by taking the average of the sum of intrinsic, integrated, and identified motivation scores with a possible range of 1-7
[c]calculated by taking the average of the sum of introjected, external, and amotivation scores with a possible range of 1-7
[d]Differences in mean autonomous and controlled motivation for healthy eating scores between groups with ANOVA test
[e]ROTC year indicates a participant's year, or level, in the Army ROTC program
[f]Differences in mean autonomous and controlled motivation for healthy eating scores between groups by independent t-test
[g]Other race/ethnicity includes Hispanics, Black/African Americans, Asians, Native American/Alaskan Natives, and those with self-reported other race/ethnicity
[h]BMI= body mass index; BMI greater than or equal to 25 is considered overweight/obese according to CDC guidelines (CDC, 2018).

AIM TWO. TO EXAMINE HOW NUTRITION KNOWLEDGE AND MOTIVATION FOR HEALTHY EATING ARE ASSOCIATED WITH DIET QUALITY IN ARMY ROTC CADETS

We hypothesized: (1) Nutrition knowledge would be indirectly and positively associated with diet quality through autonomous motivation for healthy eating; (2) Nutrition knowledge would be positively associated with autonomous motivation for healthy eating in Army ROTC cadets; (3) Nutrition knowledge would be negatively associated with controlled motivation for healthy eating in Army ROTC cadets; (4) Autonomous motivation for healthy eating would be positively associated with diet quality in Army ROTC cadets; and (5) Controlled motivation for healthy eating would be negatively associated with diet quality in Army ROTC cadets.

Associations among Nutrition Knowledge, Motivation for Healthy Eating, and Diet Quality. The associations among three major variables were examined by Pearson's correlations (Table 14). Diet quality score had positive correlations with intrinsic motivation ($r=0.323$, $p<0.001$), integrated motivation ($r=0.302$, $p<0.001$), identified motivation ($r=0.253$, $p<0.001$), and nutrition knowledge ($r=0.215$, $p<0.005$). Diet quality score had inverse correlations with external motivation ($r=-0.154$, $p<0.05$) and amotivation ($r=-0.251$, $p<0.001$). The autonomous motivation for healthy eating subcategories were significantly correlated as described above. Nutrition knowledge had weak correlations with intrinsic motivation ($r=0.229$, $p=0.001$), integrated motivation ($r=0.277$, $p<0.001$), and identified motivation ($r=0.344$, $p<0.001$), and amotivation ($r=-0.317$, $p<0.001$).

The mediation model examined if nutrition knowledge explains diet quality independently or mediated through motivation for healthy eating (autonomous and controlled) can be found in Figure 13 with the full output in Appendix M. The mediation model was saturated (RMSEA=0.00, CFI=1.00, SRMR=0.00, TLI=1.00, chi-square of model fit=0.00, 0 df, p=0.00). Sex had a significant relationship with BMI (p=0.05). There were no other significant relationships amongst covariates of race, sex, age, or BMI. After including the covariates in the model, autonomous motivation for healthy eating was a significant, positive predictor of diet quality (β=1.071, SE=0.178, p<0.001) and controlled motivation for healthy eating was a significant, negative predictor of diet quality (β=-1.093, SE=0.241, p<0.001). We tested the indirect effect through bootstrap estimation with 1000 samples and found no significant indirect relationship between nutrition knowledge and diet quality through motivation for healthy eating.

Table 15. Pearson correlation of Healthy Eating Score-5, motivation for healthy eating, and nutrition knowledge

		Diet Quality	Intrinsic Motivation[a]	Integrated Motivation[a]	Identified Motivation[a]	Introjected Motivation[a]	External Motivation[a]	Amotivation[a]	Nutrition knowledge
Diet Quality	*Corr coeff*		**0.323****	**0.302****	**0.253****	-0.027	**-0.154***	**-0.251****	**0.215****
	P-value		0.000	0.000	0.000	0.713	0.035	0.000	0.003
	n		187	188	189	188	188	189	191
Intrinsic Motivation	*Corr coeff*			**0.775****	**0.672****	**0.303****	**0.242****	-0.118	**0.229****
	P-value			0.000	0.000	.000	0.001	0.099	0.001
	n			196	197	196	196	193	
Integrated Motivation	*Corr coeff*				**0.748****	**0.401****	**0.248****	**-0.154***	**0.277****
	P-value				0.000	0.000	0.000	0.030	0.000
	n				198	197	197	198	194
Identified Motivation	*Corr coeff*					**0.398****	**0.244****	-0.138	**0.344****
	P-value					0.000	0.001	0.051	0.000
	n					198	198	199	195
Introjected Motivation	*Corr coeff*						**0.651****	**0.396****	0.079
	P-value						0.000	0.000	0.275
	n						197	198	194
External Motivation	*Corr coeff*							**0.540****	-0.750
	P-value							0.000	0.300
	n							198	194
Amotivation	*Corr coeff*								**-0.317****
	P-value								0.000
	n								195
Nutrition knowledge	*Corr coeff*								1
	P-value								
	n								200

[a]Intrinsic, integrated, identified, introjected, external, and amotivation are subcategories under motivation for healthy eating
*p<0.05, **p<0.01

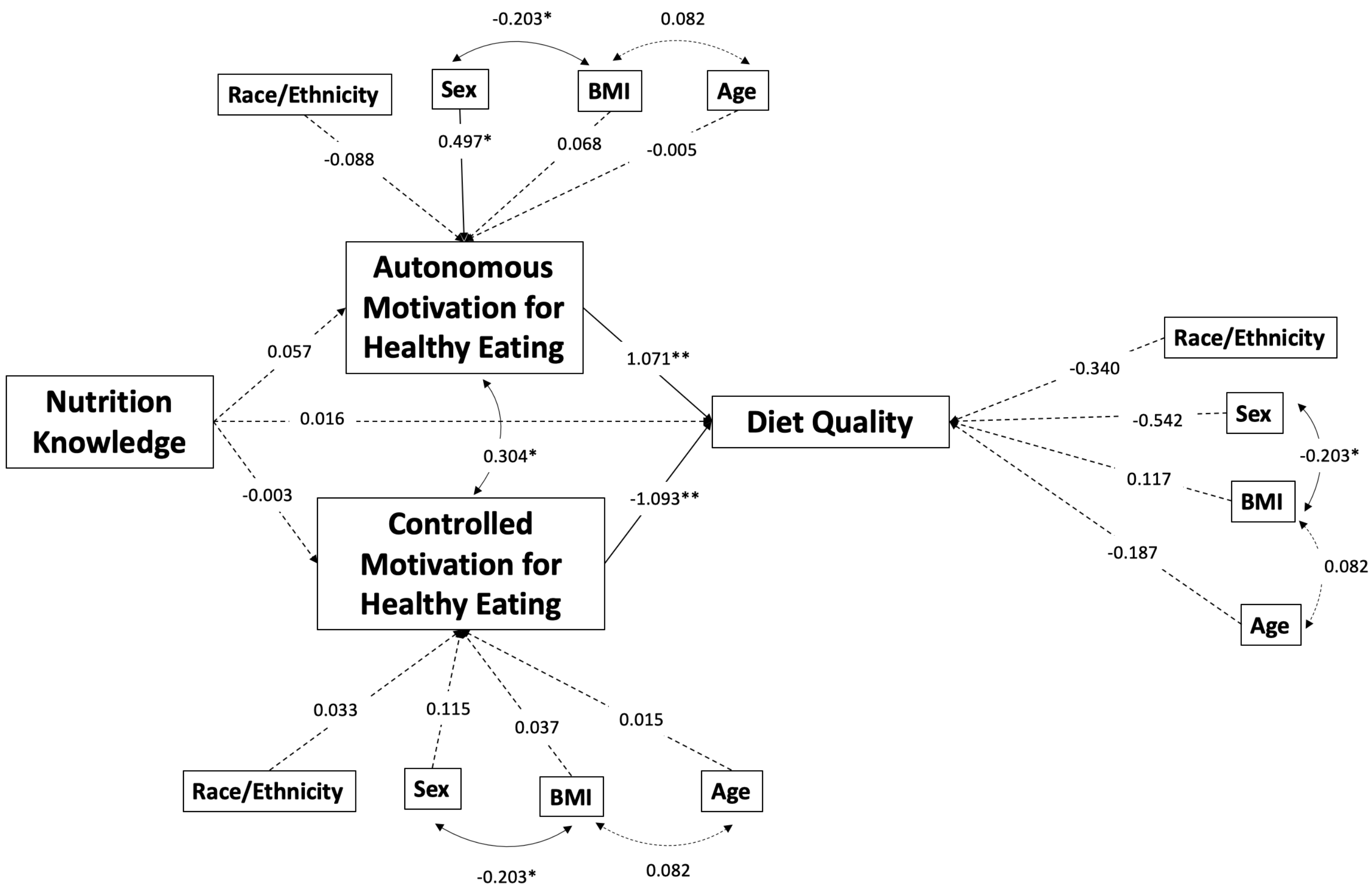

Figure 13. Parallel mediation model
Multigroup modeling results of the effects of nutrition knowledge on diet quality through autonomous motivation for healthy eating and controlled motivation for healthy eating with race/ethnicity sex, age, and BMI as covariates. Unstandardized regression coefficients are displayed. RMSEA=0.00, CFI=1.00, SRMR=0.00, TLI=1.00, chi-square of model fit=0.00, 0 df, p=0.00.
*p<0.05, **p<0.01

CHAPTER FIVE: DISCUSSION

Army ROTC cadets face immense pressure to meet body composition and physical fitness standards while also partaking in military training and completing college coursework. The ROTC program prepares cadets for a "lifetime of service and commitment" as officers in the Army (Dept of Army, 2018b). It is important that they are well equipped to maintain healthy lifestyles and dietary intake for their own health and also to model healthful eating behavior to their subordinates. Previous literature reported that service members had poor dietary intake, which can lead to obesity, chronic diseases, and dismissal from the Army (Bovill et al., 2003; Niebuhr et al., 2013; Pierce et al., 2017). In the process of meeting physical activity and body composition standards, service members are reported to partake in bouts of dietary restriction and overconsumption (Cole et al., 2016; Crombie et al., 2012).

Our study used a parallel mediation model to examine the effects of nutrition knowledge on diet quality through motivation for healthy eating. We hypothesized: (1) Nutrition knowledge would be indirectly and positively associated with diet quality through autonomous motivation for healthy eating; (2) Nutrition knowledge would be positively associated with autonomous motivation for healthy eating in Army ROTC cadets; (3) Nutrition knowledge would be negatively associated with controlled motivation for healthy eating in Army ROTC cadets; (4) Autonomous motivation for healthy eating would be positively associated with diet quality in Army ROTC cadets; and (5) Controlled motivation for healthy eating would be negatively associated with diet quality in Army ROTC cadets.

Nutrition knowledge as measured by the US Army Research of Environmental Medicine nutrition knowledge survey was not associated with diet quality using Healthy Eating Score-5 in our study. We found that autonomous motivation for healthy eating was a significant, positive predictor of diet quality and that controlled motivation for healthy eating was a significant, negative predictor of diet quality in the present study. The mean nutrition knowledge score in our population was 66.7 ± 12.5%. ROTC cadets reported suboptimal intake of fruits, vegetables, dairy, and whole grains over the past 30 days through the Healthy Eating Score-5 questionnaire. Based on our findings, we reject hypotheses 1, 2, and 3 and accept hypotheses 4 and 5, as exhibited in Figure 13 and Appendix M. Through mediation model analysis, autonomous motivation for healthy eating significantly and positively predicted diet quality and controlled motivation for healthy eating significantly and negatively predicted diet quality, but autonomous motivation for healthy eating did not serve as a mediator for this process. This indicates that cadets who reported higher levels of autonomous motivation to regulate their eating were more likely to report higher consumption of fruits, vegetables, dairy, whole grains, and fish on the Healthy Eating Score-5 questionnaire. Cadets who reported higher levels of controlled motivation to regulate their eating were more likely to report lower consumption of fruits, vegetables, dairy, whole grains, and fish on the Healthy Eating Score-5 questionnaire.

Nutrition Knowledge on Diet Quality through Motivation for Healthy Eating. The current literature is controversial on if nutrition knowledge is the primary determinant on dietary intake (Abbey et al., 2017; Andrews et al., 2016; Heaney et al., 2011; Rash et al., 2008; Wardle et al., 2000). In the present study, a mediation model was used to examine the role of nutrition knowledge on diet quality through the mediators of autonomous motivation for healthy eating and controlled motivation for healthy eating in Army ROTC cadets. This study is novel in its approach to use mediation modeling to assess two psychological determinants in Army ROTC cadets and how these determinants may influence diet quality. We found that nutrition knowledge did not have an indirect effect on diet quality through autonomous motivation for healthy eating in our population. However, autonomous motivation for healthy eating and controlled motivation for healthy were significant predictors of diet quality. Since nutrition knowledge did not have significant relationships with autonomous motivation for healthy eating nor controlled motivation for healthy eating, our findings do not support that autonomous motivation for healthy eating and controlled motivation for healthy eating mediate the relationship between nutrition knowledge and diet quality.

Additionally, nutrition knowledge was not directly or indirectly associated with diet quality in the present study. The nonsignificant relationship between nutrition knowledge and diet quality in the present study is inconsistent with another study examining the role of nutrition knowledge on diet quality through healthy eating attitudes as a mediator (Tabbakh & Freeland-Graves, 2016). Researchers used a validated healthy eating attitudes survey, multiple choice nutrition knowledge questionnaire and 3-day dietary intake data in college women. They used a mediation model to examine the relationships between the variables. Results revealed a significant relationship between nutrition knowledge and diet quality (β=1.40, 95% CI 0.19-2.61, $p<0.05$, reduction in β=33.9%). This supports that those who had higher knowledge levels on concepts such as MyPlate, physical activity, and dietary guidelines, had better dietary intake compared to those who had lower nutrition knowledge (Tabbakh & Freeland-Graves, 2016). Secondarily, the authors found that nutrition knowledge had a significant relationship with healthy eating attitudes (β=0.11, 95% CI 0.3-0.19, $p<0.015$) which is also contrary to what we found in the present study. In their study, participants who demonstrated higher nutrition knowledge levels also scored higher on having more favorable attitudes towards eating healthy (Tabbakh & Freeland-Graves, 2016).

Another study examining nutrition knowledge, attitudes, and nutrition label use in college students in the United Kingdom also found that nutrition knowledge and attitudes towards healthy eating were predictive of diet quality (Cooke & Papadaki, 2014). The study used a validated nutrition knowledge survey (α=0.7-0.97), validated attitudes towards healthy eating survey (α=0.71), questions on nutrition label use, and a dietary quality survey that consisted of dietary screeners and questionnaires (Cooke & Papadaki, 2014). The study population was 75% female with the majority having normal BMI (68.8%). The researchers found that nutrition knowledge and nutrition attitudes significantly projected diet quality. This is consistent with the study by Tabbakh and Freeland-Graves, but inconsistent with the present study (Cooke & Papadaki, 2014; Tabbakh & Freeland-Graves, 2016).

In our study, nutrition knowledge did not have a significant association with autonomous motivation for healthy eating nor controlled motivation for healthy eating. It may be due to the tools utilized and their interitem reliabilities. While all of the above discussed studies were cross-sectional in nature, our study focused on Army ROTC cadets, with a majority male sample, while the other studies focused on general university students consisting of primarily females. The gender differences may account for why our findings were different than the other two studies. In another study using the Regulation of Eating Behaviors survey and food frequency questionnaire data, women reported dietary intake more consistent with recommendations and higher motivation for healthy eating compared to men (Leblanc, Bégin, Corneau, Dodin, & Lemieux, 2015). The present study and these other studies support that psychological determinants may be important predictors in diet quality and that more research is warranted to examine psychological determinants' roles in more depth in the context of eating behaviors (Tabbakh & Freeland-Graves, 2016).

Motivation for Healthy Eating. In the current study, autonomous motivation for healthy eating and controlled motivation for healthy eating were significant predictors of diet quality. We assessed each sub-category of motivation for healthy eating before computing two motivation and controlled motivation scores. We found no significant differences in motivation for healthy eating by BMI, sex, age, or race/ethnicity. In one longitudinal study, researchers found there were significant relationships between motivation for healthy eating and BMI in females, specifically (Gropper et al., 2014). They recommended that the first two years of college were utilized by public health interventionists to influence the eating behavior and determination in college students (Gropper et al., 2014). In another previous study on college women, mean identified motivation for healthy eating scores were the highest compared to the other constructs, such as intrinsic motivation and amotivation (Pelletier et al., 2004). Similarly, in our study, identified motivation for healthy eating had the highest mean score. Identified motivation comes about when something is becoming internally and personally important to someone (Ryan & Deci, 2000). This should be maximized as someone is beginning to become more autonomously motivated, which could be a potential opportunity for intervention and to support them in their motivation journey to become even more self-determined, which has been associated with more intrinsic forms of eating regulation for long-term health and well-being (Pelletier et al., 2004; Ryan & Deci, 2000).

Our findings of significant associations between autonomous and controlled motivation for healthy eating with diet quality are consistent with other literature on psychological determinants affecting eating behaviors and diet quality (Cooke & Papadaki, 2014; Guertin et al., 2015; Pelletier et al., 2004; Slovinec D'Angelo et al., 2014). One study examined dietary behavior change in the context of autonomous motivation for healthy eating and found that individuals who were more motivated for healthy eating were more likely to change their dietary habits compared to less motivated participants (Pelletier et al., 2004). In another study on patients with cardiovascular disease, researchers found that participants with higher autonomous motivation for healthy eating scores had better eating habits and higher self-efficacy over a 12-month period using structural equation modeling (Guertin et al., 2015). These studies support that motivation for healthy eating may be an important determinant to consider when assessing diet quality as it has demonstrated to influence how much food is consumed and what types of foods are consumed (Guertin et al., 2015; Pelletier & Dion, 2007; Pelletier et al., 2004; Slovinec D'Angelo et al., 2014).

Based on the current study's findings and existing body of literature, it may be important for nutrition professionals to examine motivation for healthy eating and other psychological determinants as they may be playing an important role in diet quality and eating behaviors (Cole et al., 2016; Cooke & Papadaki, 2014; Tabbakh & Freeland-Graves, 2016). Motivation for healthy eating and the Self-Determination Theory go hand-in-hand with motivational interviewing by providing a theoretical framework and backing to explain the underlying processes of how motivational interviewing is effective (Markland et al., 2005; L. S. Miller & Gramzow, 2016). As previously mentioned, autonomy, competence, and a sense of relatedness are essential for one to feel more self-determined and become more intrinsically motivated to regulate their behavior (Deci & Ryan, 1985). Healthcare professionals may plan an important role in helping a patient to become more self-determined by promoting autonomy, competence, and sense of relatedness (Williams, Grow, Freedman, Ryan, & Deci, 1996). Healthcare professionals can help someone to feel in control and able of their situation by promoting self-efficacy in order for them to feel determined to engage in a behavior change for their long-term health, well-being, and personal commitment to that goal (Williams et al., 1996). In one study, researchers found that individuals who had higher autonomous motivation for healthy eating lost more weight and were more likely to maintain their weight loss better than individuals with lower autonomous motivation for healthy eating (Williams et al., 1996). The researchers suggest it is extremely important for healthcare professionals to help individuals feel like they are in an environment that supports their autonomy (Williams et al., 1996). Healthcare professionals should roll with resistance and not pressure their patients into engaging in behavior change (Markland et al., 2005). Healthcare professionals can brainstorm different options with a patient, but let the patient make the ultimate decision so that they feel in control and empowered (Markland et al., 2005). During the counseling session, registered dietitian nutritionists and other healthcare professionals can maximize this opportunity by assessing one's quality of motivation for healthy eating and adjusting the nutrition intervention according to where they are at (Teixeira, Palmeira, & Vansteenkiste, 2012). Dietitians can provide structure through goal-setting, promoting self-efficacy, and presenting the evidence-base to Army ROTC cadets and service members so that they feel competent (Markland et al., 2005). Dietitians also can promote autonomy in the client through weighing pros and cons of different options and rolling with resistance so that the client feels autonomous (Markland et al., 2005). Lastly, the dietitian should be involved through sharing empathy and active listening so that the client feels like (s)he can relate to the healthcare professional (Markland et al., 2005).

Nutrition Knowledge. There is a paucity of literature pertaining to lower than desired nutritional intake and less than ideal nutrition knowledge, attitudes, and behaviors in service members (Petrie et al., 2008; Piche et al., 2014; Ramsey et al., 2013). Service members may engage in extreme eating behaviors, including restricting food intake, which can later lead to overeating and obesity and other health risks (Cole et al., 2016; Petrie et al., 2008; Piche et al., 2014; Ramsey et al., 2013).

In the present study, the mean nutrition knowledge was 66.7 $\pm$ 12.5%. In other studies, adequate nutrition knowledge has been considered being able to answer over 75% of the questions correctly (Andrews et al., 2016). This suggests that our population has demonstrated room for improvement with their mean nutrition knowledge scores. Other studies on nutrition knowledge in ROTC cadets, college athletes, and college students have supported that nutrition knowledge scores were inadequate (Andrews et al., 2016; Connell et al., 2017; Heaney et al., 2011; Rosenbloom et al., 2002; Zawila et al., 2003). One study examined nutrition knowledge and dietary supplement use in elite Army soldiers with a 54-item survey to assess sports nutrition knowledge in the participants (Bovill et al., 2003). The study population consisted of all male soldiers as female soldiers were not allowed to be a part of this section of the Army. Results discovered a mean nutrition knowledge score of 48.5 $\pm$ 15.2%, meaning that soldiers were able to answer less than half of the questions correctly (Bovill et al., 2003). Although this study examined only male soldiers and was not a validated survey, it supports that service members do not have adequate nutrition knowledge. In another study on college athletes, the average nutrition knowledge score was 56.9% (Andrews et al., 2016). Although our study population had higher mean nutrition knowledge scores compared to the Army study and college athlete study, there is room for improvement in promoting and improving the nutrition knowledge of ROTC cadets.

The present study's nutrition knowledge questionnaire covered macronutrients, micronutrients, hydration, and energy through a series of true or false questions. Similarities among the current nutrition knowledge questionnaire and other studies include the focus on sports nutrition (performance), hydration, energy, macronutrients, and micronutrients (Abbey et al., 2017; Andrews et al., 2016; Bovill et al., 2003). Differences include the format of the test as some researchers opt for multiple choice tests while others use true and false questionnaires to assess nutrition knowledge. When comparing true and false to multiple choice surveys, researchers have found that they are equal in their difficulty (Tasdemir, 2010). Therefore, it is unlikely that the format of nutrition knowledge surveys matter as much as the content and reliability of the tools used. Other studies on nutrition knowledge utilized validated tools with higher inter-item reliability than the reliability of the present study's nutrition knowledge survey, which had an inadequate Kuder-Richardson 20 value of 0.57 (Cooke & Papadaki, 2014; Tabbakh & Freeland-Graves, 2016). While the present study's survey had questions consistent with other nutrition knowledge surveys utilized in similar populations, one limitation of our study is the internal consistency of our nutrition knowledge tool.

Regardless, there is an opportunity to further advance the nutrition education and nutrition knowledge that Army ROTC cadets receive. Currently, it is only a part of the suggested curriculum with no standardized implementation nor surveillance or monitoring of ROTC cadets' nutrition knowledge obtained through the ROTC program (Dept of Army, 2018b). Nutrition education is usually delivered by ROTC program leadership, who may have insufficient nutrition knowledge themselves. Nutrition knowledge did not have an effect on diet quality in our study, but it has been established as one of many important nutritional determinants throughout the literature (Abbey et al., 2017; Bovill et al., 2003; Cooke & Papadaki, 2014; Tabbakh & Freeland-Graves, 2016).

Diet Quality. In the present study, the mean value for Healthy Eating Score-5 was 11.8 $\pm$ 3.97. There was a significant difference in Healthy Eating Score-5 by school ($p<0.05$). Additional tests were run to see if it may have to do with the on-campus dining options at Michigan State versus Western Michigan by seeing if there were differences in Healthy Eating Score-5 by on-campus compared to off-campus status and there were no differences. With the assumption that individuals' self-reported frequency of consumption aligning with standard serving sizes compared to the USDA recommended servings for food groups, the majority of participants were not meeting recommendations for fruit, vegetables, dairy, or whole grains (USDA, 2018). Participants reported consuming little alcohol, energy drinks, and not eating out frequently. The Healthy Eating Score-5 for our population was lower than in a similar study on 14,850 Army soldiers (Purvis et al., 2013). They used the same exact questionnaire and found that the mean Healthy Eating Score-5 was 15.7 $\pm$ 3.4 in their sample. They examined Healthy Eating Score-5 scores in quartiles and found that participants with healthy BMIs and who were younger had higher relative odds of being in the highest quartile compared to the lowest, OR=1.35, CI=1.20-1.50, p<0.003; OR=1.46, CI=1.32-1.61, p<0.003, respectively (Purvis et al., 2013). Individuals with higher Healthy Eating Score-5 scores were more likely to partake in healthful behaviors like eating breakfast, drinking adequate water, and snacking within 60 minutes of an intense workout (Purvis et al., 2013). In their study, participants had insufficient intake of fruit, vegetables, whole grain, dairy, and fish compared to recommendations (Purvis et al., 2013). Similarly, in the Health-Related Behaviors Survey conducted by the Department of Defense, soldiers have also demonstrated insufficient nutritional intake of vegetables, fruit, and whole grains compared to their needs (Dept of Defense, 2013). This puts service members at nutritional risk if they are unable to provide their bodies with adequate nutrients to support functioning and performance. Furthermore, this also puts service members at risk for nutrition-related diseases including iron-deficiency anemia, cancer, and obesity (Baker-Fulco et al., 2001; Dept of Defense, 2013; Purvis et al., 2013).

We collected 24-hour recalls and food frequency questionnaires from a sub-group of participants to get a better understanding of Army ROTC cadets' dietary intake thinking that cadets may be regimented and set in their routine of going to physical training, eating, studying, and partaking in military training with fairly stable diets. However, while collecting 24-hour recalls and food frequency questionnaires from participants, we observed that ROTC cadets' lifestyle makes their dietary intake quite variable. The cadets are very busy between their coursework, ROTC commitments, extracurriculars, and trying to balance their social lives. This is supported through the 24-hour recall and food frequency questionnaire data. Participants were asked to complete a 24-hour recall and food frequency questionnaire over the phone. The 24-

hour recall was conducted before the food frequency questionnaire. On more than one occasion, participants would provide conflicting information from one dietary assessment tool to the next. For example, a participant would say that they had eggs for breakfast yesterday. However, when asked about egg consumption on the food frequency questionnaire, they would report that they had not consumed eggs over the past 12 months. Participants may have reported conflicting information due to the interviews taking place on the phone and/or interview fatigue. We probed participants for if the day prior had been a typical day of eating for the 24-hour recalls and asked for a typical day of eating if it had not been. However, it is well-established that 24-hour dietary data poorly reflects typical intake (Raina, 2013). There are strengths and limitations of different dietary assessment methods which may also account for the differences in conflicting information reported (Ortega et al., 2015; Shim et al., 2014).

According to the Military Dietary Reference Intakes (Appendix B), energy recommendations for men and women are 3400 and 2300 kilocalories per day, respectively (Baker-Fulco et al., 2001). The mean energy and carbohydrate intake of both dietary assessment methods falls short of this recommendation. Participants were on the border of low of their protein recommendations for the food frequency questionnaire and met the recommendations for fat intake. The macronutrient data for both 24-hour recalls and food frequency questionnaire reveals large variability in reported participant intake both with the range and standard deviations. Individuals were not consuming adequate fruit, vegetables, or dairy consistent with the other literature on service members' inadequate intake of food group recommendations (Dept of Defense, 2013; Purvis et al., 2013).

There have been some military pilot studies that have intended to improve the intake of service members. For example, an intervention study on military dining facilities aimed to improve the dietary quality of Army soldiers through labeling the best foods for performance with green signs, moderate foods for performance with yellow signs, and low performance foods with red signs (Arsenault et al., 2014). Researchers found that individuals who utilized the signs consumed less fat than those who did not utilize the signs when choosing what to consume (Arsenault et al., 2014). Similarly, this could be applied potentially to college settings. A large number of Army ROTC cadets live on campus and an even larger number utilize on-campus dining options in between classes and military training. Promoting performance through signs and other interventions throughout dining facilities on-campus may also be one way to improve diet quality in ROTC cadets.

More research should focus on the reasons why Army ROTC cadets and service members are not meeting dietary recommendations. Both the Army ROTC program environment and military environment offer unique challenges that may make meeting nutritional needs quite difficult. ROTC cadets are in and out of class and training while Active Duty service members may be in and out of the field with limited access to food on some days and a surplus of food on others. Our data was collected from January through April 2018, but it should be noted that we did not ask questions about stress or collect data about exams and project, which may influence diet quality in college students (Ross et al., 1999). Service members sometimes have limited time to eat food, so they eat as much as they can as quickly as they can, without being intentional to the quality of what they are consuming (Arsenault et al., 2014; Purvis et al., 2013).

POTENTIAL LIMITATIONS AND STRENGTHS

This study has potential limitations and also strengths. Potential limitations include the parallel mediation model being saturated and the differences in site by age and ROTC year. Although the mediation model's fit statistics indicate that the model is saturated, which means model fit is unable to be interpreted, this is likely due to the number of parameters estimated in the model and common in the field (Sacks, 2009). Although there were differences between

Michigan State University and Western Michigan University by age and ROTC year, there were no differences in scores for nutrition knowledge, motivation for healthy eating, or Healthy Eating Score-5 by age or ROTC year.

This study took a novel approach to examine nutrition knowledge through motivation for healthy eating in Army ROTC cadets. The strengths of this study include the high proportion of Michigan State University and Western Michigan University Army ROTC cadets participating in the present study, basis on a theoretical framework of the Self-Determination Theory, focus on the psychological determinant of motivation for healthy eating and approach of using mediation modeling to assess the indirect and direct effects of nutrition knowledge on diet quality through motivation for healthy eating. Overall, 205 Army ROTC cadets (71.2%) participated in the present study with 78.6% participation of Michigan State University Army ROTC cadets and 63.6% of Western Michigan University Army ROTC cadets. The high participation rate likely indicates that our sample is representative of Michigan State University and Western Michigan University's Army ROTC programs. The basis on the theoretical framework of the Self-Determination Theory and focus on motivation for healthy eating provides a structure for motivational interviewing which can be used by health professionals, including registered dietitians, to promote behavior change (Markland et al., 2005; W. R. Miller & Rose, 2009).

IMPLICATIONS AND FUTURE DIRECTIONS

This study has multiple implications. Future studies should examine which dietary assessment tool is the best to use in this population. ROTC cadets and service members are in a unique environment making it difficult to collect dietary information from participants, but it is important for healthcare professionals to be able to assess diet quality in cadets and service member as it does impact performance and health (Academy of Nutrition and Dietetics et al., 2016). Future studies should examine other psychological determinants' role in mediating the relationship between nutrition knowledge, such as self-efficacy or intuitive eating characteristics. More research needs to be completed on how to improve motivation for healthy eating and test motivation for healthy eating in ROTC cadets with a ROTC-specific motivation for healthy eating tools.

Our findings demonstrate that service members reported suboptimal diet quality and inadequate consumption of food groups compared to recommendations. Diet quality is key to performance and health (Academy of Nutrition and Dietetics et al., 2016; Rash et al., 2008). If Army ROTC cadets are not getting the nutrients that they need, they may be at an increased risk for injury and fatigue (Academy of Nutrition and Dietetics et al., 2016). Since motivation for healthy eating was a significant predictor of diet quality in our study, this suggests that one way to influence diet quality may be through motivation for healthy eating. Healthcare professionals can play a role in maximizing motivation for healthy eating through helping individuals to feel autonomy, competence, and a sense of relatedness, which can then make someone more self-determined and more likely to intrinsically regulate their eating (Markland et al., 2005).

Secondarily, motivation for healthy eating was a significant predictor of diet quality in the present study. This suggests that more focus should be on nutrition-related psychological determinants. Although the present study only addressed autonomous motivation for healthy eating and controlled motivation for healthy eating, we recommend that Army ROTC programs and the US Army consider developing and utilizing nutrition-related psychological assessment tools, such as measures of self-efficacy, motivation for healthy eating, and intuitive eating characteristics, in Army ROTC cadets. In another study, it was revealed that cadets may receive weight loss counseling advice from ROTC leadership, who may not have formal nutrition training (Nevarez, 2018). Studies do convey that healthcare professionals play an important role in increasing one’s self-determination and we recommend more focus on the Self-Determination

Theory and motivational interviewing when trying to initiate behavior change in Army ROTC cadets. Nutrition intervention is warranted to maximize diet quality with evidence-based nutrition resources, such as registered dietitian nutritionists.

Lastly, although nutrition knowledge did not have a significant association with diet quality in the present study, the existing body of literature suggests that it still may be an important determinant in diet quality (Andrews et al., 2016; Heaney et al., 2011; Spronk et al., 2014; Wardle et al., 2000). Based on the suggested curriculum available to us in the literature review process of this project, we recommend a standardized curriculum Army ROTC program-wide with the consideration of adding nutrition knowledge more intensely into the curriculum. Prior to being able to do that, we recommend more comprehensive testing of nutrition knowledge using other validated tools in this population to where there are opportunities for improvement and what content should be covered as part of this curriculum.

CONCLUSION

Army ROTC cadets are at a critical point in their lives as they transition to become leaders in the military. We examined the associations between nutrition knowledge, motivation for healthy eating, and diet quality in Army ROTC cadets. We demonstrated that autonomous motivation for healthy eating is a significant, positive predictor of diet quality and that controlled motivation for healthy eating is a significant, negative predictor of diet quality. We recommend that registered dietitians, US Cadet Command, and the Department of Defense focus on how motivation for healthy eating and other psychological determinants may impact eating behavior and dietary intake of Army ROTC cadets and service members. Although autonomous motivation for healthy eating did not mediate the relationship between nutrition knowledge and diet quality in our study, we recommend more research is conducted to further assess how psychological determinants may mediate the relationship between nutrition knowledge and diet quality.

More studies are needed to examine the nutritional status of ROTC cadets and service members. We recommend longitudinal studies that follow service members from when they commit to service across their lifetime to get a better overall picture of the many factors that influence nutrition, eating behaviors, and disease risk. Moreover, we recommend that all ROTC cadets and service members have access to registered dietitians over the lifetime of their service on campus, on base, in the field, and at Veterans Affairs facilities. Dietitians can motivational interview, provide nutrition education, and individualize nutrition recommendations to maximize diet quality (Academy of Nutrition and Dietetics et al., 2016). Registered dietitians are the nutrition experts and can collaborate with the interdisciplinary team to better holistically care for cadets and service members to keep them healthy for service and beyond (Academy of Nutrition and Dietetics et al., 2016).

APPENDICES

APPENDIX A: THESIS DISCLOSURE

The opinions or assertions contained herein are the private views of the author(s) and are not to be construed as official or as reflecting the view of the US Army or the Department of Defense.

APPENDIX B: WEIGHT-FOR-HEIGHT SCREENING TABLE

Table 16. Army Weight-For-Height Screening Table

		Male weight in pounds, by age				Female weight in pounds, by age			
Height (inches)	Min. weight (pounds)	17-20	21-27	28-39	40+	17-20	21-27	28-39	40+
58	91	-	-	-	-	119	121	122	124
59	94	-	-	-	-	124	125	126	128
60	97	132	136	139	141	128	129	131	133
61	100	136	140	144	146	132	134	135	137
62	104	141	144	148	150	136	138	140	142
63	107	145	149	153	155	141	143	144	146
64	110	150	154	158	160	145	147	149	151
65	114	155	159	163	165	150	152	154	156
66	117	160	163	168	170	155	156	158	161
67	121	165	169	174	176	159	161	163	166
68	125	170	174	179	181	164	166	168	171
69	128	175	179	184	186	169	171	173	176
70	132	180	185	189	192	174	176	178	181
71	138	185	189	194	197	179	181	183	186
72	140	190	195	200	203	184	186	188	191
73	144	195	200	205	208	189	191	194	197
74	148	201	206	211	214	194	197	199	202
75	152	206	212	217	220	200	202	204	208
76	156	212	217	223	226	205	207	210	213
77	160	218	223	228	232	210	213	215	219
78	164	223	229	235	238	216	218	221	225
79	168	229	235	241	244	221	224	227	230
80[a]	173	234	240	247	250	227	230	233	236

(Adapted from US Army, 2006)

[a]Add 6 pounds per inch for males over 80 inches and 5 pounds per inch for females over 80 inches.

APPENDIX C: MILITARY DIETARY REFERENCE INTAKES

Table 17. Military Dietary Reference Intakes

Nutrient	Unit	Men	Women
Energy[2] **General/routine**[3]	kcal/d	3400	2300
Light activity	kcal/d	3000	2100
Moderate activity	kcal/d	3400	2300
Heavy activity	kcal/d	3700	2700
Exceptionally-heavy activity	kcal/d	4700	3000
Protein[4]	g/d	102 (68-136)	83 (55-110)
Carbohydrate[5]	g/d	510 (340-680)	414 (276-552)
Fiber	g/d	34	28
Fat[6]	g/d	<113 (100-157)	<77 (70-100)
Linoleic acid	g/d	17	12
α-linolenic acid	g/d	1.6	1.1
Vitamin A[7]	IU/d	3000	2333
Vitamin D[8]	μg/d	15	15
Vitamin E[9]	mg/d	15	15
Vitamin K	μg/d	120	90
Vitamin C	mg/d	90	75
Thiamin	mg/d	1.2	1.1
Riboflavin	mg/d	1.3	1.1
Niacin[10]	mg NE/d	16	14
Vitamin B6	mg/d	1.3	1.3
Folate11	μg DFE/d	400	400
Vitamin B12	μg/d	2.4	2.4
Calcium[12]	mg/d	1000	1000
Phosphorus[13]	mg/d	700	700
Magnesium[14]	mg/d	420	320
Iron[15]	mg/d	8	18
Zinc	mg/d	11	8
Sodium[16]	mg/d	<2300	<2300
Iodine	μg/d	150	150
Selenium	μg/d	55	55
Fluoride[17]	mg/d	4	3
Potassium[18]	mg/d	4700	4700

1 Dept of Army, Navy and Air Force, 2017; values for energy, protein, and associated nutrients are expressed as average daily nutrient intakes based on moderate activity levels and reference body weights of 85 kg (187 pounds) for military men and 69 kg (152 pounds) for military women. Reference anthropometrics values characterize the averages of actual measurements attained from a 2007 pilot study of active and reserve duty Army Soldiers (Paquette, 2009). Data were weighted by sex to match 2007 Total Army Component by age and by racial and/or ethnic distributions as reported by Defense Manpower Data Center
2 Energy recommendations for various activity levels are estimates only and vary among individuals. The general values are for moderate levels of activity and are appropriate for most personnel in garrison. Values are rounded up to the nearest 50 kilocalories (kcal).
3 Recommended protein intakes (0.8 to 1.6 g protein per kg body weight) for stated activity levels should be consistent with the AMDR (10 to 35 percent of total calories).
4 The initial values in the table represent the midpoints of the ranges calculated using military reference body weights and protein intake recommendations of 0.8 to 1.6 g per kg body weight.
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5 See paragraph 2–4a in AR 40-25

6 Total energy from fat should not exceed 30 percent of total kcal. The DRI range for total fat is 25 to 30 percent of total calories. The initial value in the table was calculated using the omega fatty acids linoleic and α-linolenic, and should be included in this 30 percent calculation.
7 The unit of measure is microgram of retinol activity equivalent (μg RAE). 1 μg RAE = 1 μg retinol = 12 μg ß-carotene = 24 μg other provitamin A carote- noids. Vitamin A will also be expressed in international units (IUs), a standard unit for the nutrition labeling in the United States. 1 IU = 0.3 μg retinol = 0.6 μg ß-carotene = 1.2 μg provitamin A carotenoids.
8 As calciferol. 1μg calciferol = 40 IUs vitamin D.
9 The unit of measure is milligram α-tocopherol that includes RRR-α-tocopherol, the only form of α-tocopherol that is found in food and the 2R-stereoisomeric forms that are found in fortified foods and dietary supplements. This does not include the 2S-stereoisomeric forms that are also found in fortified foods and dietary supplements.
10 The unit of measure is niacin equivalent (NE). 1 mg NE = 1 mg niacin or 60 mg dietary tryptophan.
11 The unit of measure is micrograms of dietary folate equivalent (μg DFE). 1 μg DFE = 1 μg food folate = 0.6 μg of folate from fortified foods with meals or 0.5 μg folate from fortified foods on an empty stomach.
12 The MDRI for calcium will meet the needs of most military personnel. However, personnel less than 19 years old have higher calcium needs not accounted for by the MDRI. A more appropriate dietary goal of personnel in this age group is 1300 mg per day.
13 The MDRI for phosphorus will meet the needs of most military personnel. However, personnel less than 19 years old have higher phosphorus needs not accounted for by the MDRI. A more appropriate dietary goal of personnel in this age group is 1250 mg per day.
14 The MDRI for magnesium will meet the needs of most military personnel. However, female personnel less than 19 years old have higher magnesium needs not accounted for by the MDRI. A more appropriate dietary goal of personnel in this age group is 360 mg per day.
15 The MDRI for iron will meet the needs of most military personnel. However, male personnel less than 19 years old have higher iron needs not accounted for by the MDRI. A more appropriate dietary goal of personnel in this age group is 11 mg per day.
16 Sodium recommendations are based on the DRI, which for sodium is an upper limit.
17 The MDRI is based on a recommended daily intake of 0.05 mg/kg body weight.
18 The minimal requirement for potassium is approximately 1600 to 2000 mg per day. The MDRI is based on a recommended daily intake of 40 mg/kg body weight.

APPENDIX D: SELF-DETERMINATION THEORY AND MOTIVATIONAL INTERVIEWING FRAMEWORK

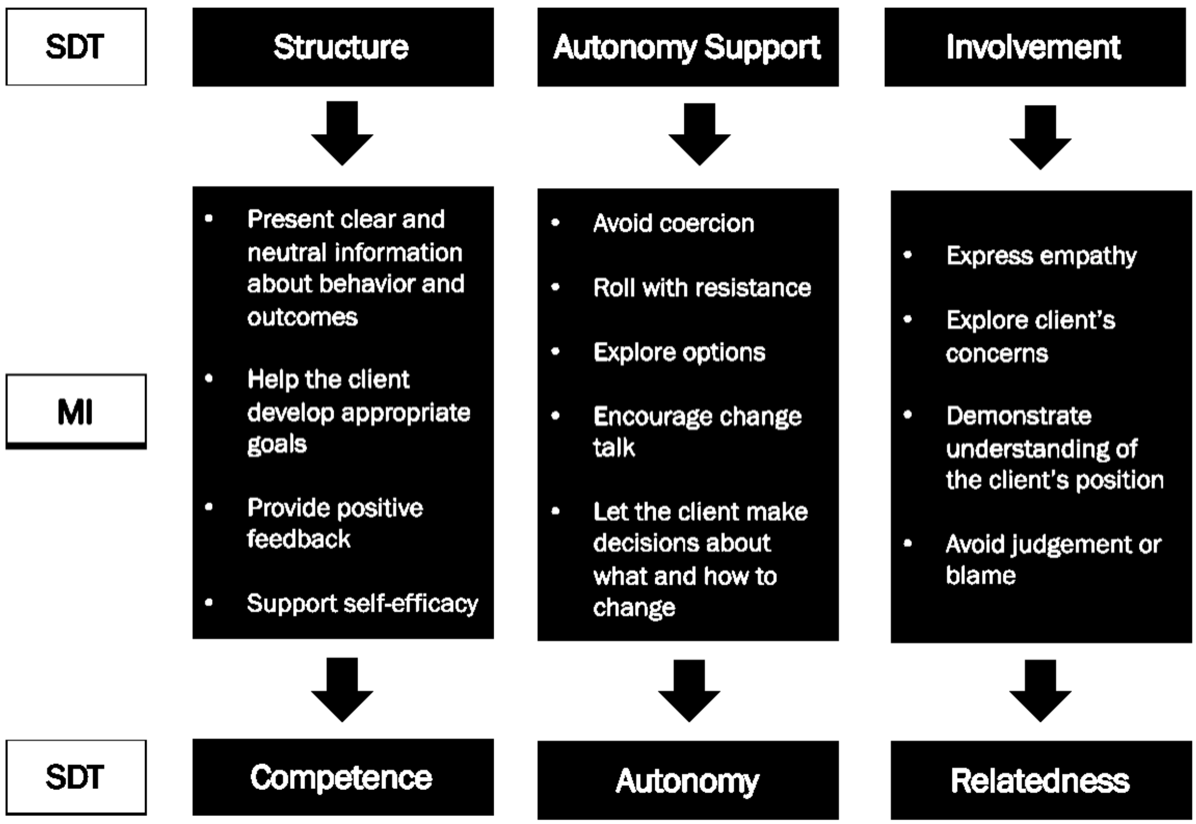

Figure 14. Self-Determination Theory and Motivational Interviewing framework (Adapted from Markland et al., 2005)
SDT = Self-Determination Theory
MI = Motivational Interviewing

APPENDIX E: IRB APPROVAL

MICHIGAN STATE
UNIVERSITY

Initial Study APPROVAL

January 4, 2018

To: Won O Song

Re: **MSU Study ID:** STUDY00000073
IRB: SIRB
Principal Investigator: Won O Song
Category: Expedited 4, 6, 7
Submission: Initial Study STUDY00000073
Submission Approval Date: 12/30/2017
Effective Date: 12/30/2017
Project Expiration Date: 12/29/2018

Title: Military body image and eating behaviors in Reserve Officer Training Corps (ROTC) Cadets.

This submission has been approved by the Michigan State University (MSU) SIRB. The submission was reviewed by the Institutional Review Board (IRB) through the Non-Committee Review procedure. The IRB has found that this research project protects the rights and welfare of human subjects and meets the requirements of MSU's Federal Wide Assurance (FWA00004556) and the federal regulations for the protection of human subjects in research (e.g., 45 CFR 46, 21 CFR 50, 56, other applicable regulations).

Documents Approved:
- FSHN ROTC Flyer, Category: Recruitment Materials;
- FSHN ROTC Informed Consent Revised, Category: Consent Form;

Continuing Review: IRB approval is valid until the expiration date listed above. If the research continues to involve human subjects, you must submit a Continuing Review request at least one month before expiration.

Modifications: Any proposed change or modification with certain limited exceptions discussed below must be reviewed and approved by the IRB prior to implementation of the change. Please submit a Modification request to have the changes reviewed. If changes are made at the time of continuing review, please submit a Modification and Continuing Review request.

Immediate Change to Eliminate a Hazard: When an immediate change in a research protocol is necessary to eliminate a hazard to subjects, the proposed change need not be reviewed by the IRB prior to its implementation. In such situations, however, investigators must report the change in protocol to the IRB immediately thereafter.

Office of Regulatory Affairs
Human Research Protection Program

4000 Collins Road
Suite 136
Lansing, MI 48910

517-355-2180
Fax: 517-432-4503
Email: irb@msu.edu
www.hrpp.msu.edu

APPENDIX F: INFORMED CONSENT

Research Participant Information and Consent Form

Michigan State University, in cooperation with the US Army Research Institute of Environmental Medicine (USARIEM) is asking you to participate in this research study because you are an Army Reserve Officer Training Corps (ROTC) Cadet 18 years or older participating in ROTC at Michigan State University, Western Michigan University, Central Michigan University, or Eastern Michigan University. Researchers are required to provide a consent form to inform you about the research study, to convey that participation is voluntary, to explain risks and benefits of participation, and to empower you to make an informed decision. You should feel free to ask the researchers any questions you may have.

Title of Research: Military body image and eating behaviors

Principal Investigator: Dr. Won O. Song, PhD, MPH, RD, Professor, Department of Food Science and Human Nutrition, Michigan State University

1. PURPOSE OF RESEARCH

The purpose of this research study is to learn about the nutrition-related behaviors of Army ROTC Cadets. Not much is known about the nutrition-related behaviors of ROTC Cadets and how aspects of military culture, such as physical fitness and performance standards, influence these behaviors. You will be asked to provide information about some of your nutrition and exercise habits, as well as some of the things you do to prepare for the Army Physical Fitness Tests, and your thoughts and feelings on some aspects of your nutrition and physical fitness. We are conducting this study in order to learn about how military culture influences nutrition-related behaviors, as well as how these behaviors impact health and performance in order to develop strategies to enhance performance, readiness, and health.

2. WHAT YOU WILL DO

In order to participate in this study, you must be an Army ROTC Cadet and at least 18 years of age. Participation in this study is voluntary, and if you agree to participate, you will complete this informed consent form.

If you volunteer for this study, we will ask you to complete four survey questionnaires. The first questionnaire asks you about your demographics, such as your background and which branch of the military you serve in. The second questionnaire asks about your nutrition-related behaviors, such as the types of food you eat, where you eat your foods, and your eating style. The third questionnaire asks about influences to your nutrition-related behaviors, such as sleep and physical activity. The fourth questionnaire asks about your thoughts and feelings related to different aspects of nutrition and physical appearance. The questionnaires should take about 60 minutes to complete. You are free to skip any questions that you would prefer not to answer.

In addition, you will have your height, weight, and body circumferences measured using the same method that the Army uses to measure body composition, which should take about five to ten minutes to complete.

Finally, you will be asked if you agree to be contacted for a one-on-one telephone interview. Not everyone that agrees to participate will be selected. You will be asked to provide a telephone number you can be reached at, as well as the best days and times to contact you. If you are selected to conduct the interview, you will be contacted to set up a date and time to conduct the interview over the phone. The interview will take about 60 to 75 minutes to complete and will ask you to describe, in your own words, experiences related to nutrition behaviors and meeting the Army physical fitness standards. The interview will be recorded for accuracy. You do not have to do the interview to participate in the study.

Research Participant Information and Consent Form

3. POTENTIAL BENEFITS
You may not benefit personally from being in this study. However, we hope that, in the future, other people might benefit from this study because the information learned from this study may improve how we develop and deliver nutrition-related information and resources.

4. POTENTIAL RISKS
We do not expect any risks to you during this study. The small time commitment and number of questionnaires might be inconvenient to you. Or you may feel uncomfortable answering some of our survey questions. We will not include your name or birthday on any of the questionnaires. We will use an ID code on all of your data to protect your identity.

5. PRIVACY AND CONFIDENTIALITY
We will take steps to help make sure that all the information we collect about you is kept private. Your name will not be used wherever possible. We will use a code instead. Any information connecting your name to this code number will be stored separately from the data. All the study data we collect from you will be kept locked up or in password-protected computer files. The codes will be kept locked up as well. When the study is over and we have analyzed all of the data, the code list will be destroyed. If any reports and talks are given about this research, we will not use your name.

Sponsors, funders, and inspectors from the Institutional Review Board may have to research records to make sure that this study is being done correctly and that your rights and welfare are being protected.

Despite efforts to keep your personal information confidential, absolute confidentiality cannot be guaranteed.

6. YOUR RIGHTS TO PARTICIPATE, SAY NO, OR WITHDRAW
Taking part in this study is voluntary. You have the right to say no to participate in the research. You can stop at any time after it has already started. There will be no consequences if you stop and you will not be criticized. You will not lose any benefits that you normally receive. You do not have to answer any questions you do not want to answer.

7. COSTS AND COMPENSATION FOR BEING IN THE STUDY
Participation in the research study is provided free of charge. You are not expected to incur any costs for participation.
For your participation in the survey questionnaire and Army body measurements portion of the study you will receive a $10 grocery gift card and a nutrition resource packet.
If you are selected to participate in the one-on-one telephone interview, you will receive a $20 Amazon gift card. However, participants currently serving on Active duty during the study cannot receive the $10 grocery gift card or $20 Amazon gift card.

8. ALTERNATIVE OPTIONS
If you do not wish to participate in this research study, but would like to know more about your nutrition-related behaviors and your thoughts and feelings related to them, you may receive additional assistance from:

- Michigan State University Student Health Services, 517-884-6546
  - Counseling and Psychiatric Services, 517-355-8270
- Western Michigan University Sindecuse Health Center, 269-387-3287
  - Counseling Services, 269-387-1850

- Central Michigan University Health Services, 989-774-6599
  - Counseling Center, 989-774-3381
- Eastern Michigan University Health Services, 734-487-1122
  - Counseling and Psychological Services, 734-487-1118

9. CONFLICT OF INTEREST
There are no conflicts of interest to report.

10. CONTACT INFORMATION
If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact the researcher Dr. Won O. Song, PhD, RD, Professor of Human Nutrition, Department of Food Science and Human Nutrition, Michigan State University, 135A GM Trout Building, 469 Wilson Road, East Lansing, MI 48824, 517-353-3332, song@msu.edu.

If you have questions or concerns about your role and rights as a research participant, would like to obtain information or offer input, or would like to register a complaint about this study, you may contact, anonymously if you wish, the Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, or e-mail irb@msu.edu or regular mail at 4000 Collins Rd, Suite 136, Lansing, MI 48910.

11. DOCUMENTATION OF INFORMED CONSENT.

Your signature below means that you voluntarily agree to participate in this research study.

____
Print Name

______________________________________ ____________________________
Signature Date

You will be given a copy of this form to keep. Please indicate below if you would like a paper copy or emailed copy of this form.
☐ Paper
☐ Email Initials____________ Email address: _________________________________

12. If you agree to participate and are selected to participate in the telephone one-on-one interview, the interview will be recorded in order to transcribe the interview accurately.

- Telephone one-on-one interviews will be audiotaped in order to allow for accurate transcription of the conversation. The recordings will only be transcribed by trained investigators. Once the data is completely analyzed, the audio recordings will be deleted.

- The audio recordings will be stored as a media file on a password-locked computer. The transcriptions of the audio recordings will be stored as a word processing document on a password-locked computer. Once the data is completely analyzed, audio recordings and files will be deleted.

- I would like to be considered to participate in the telephone one-on-one interview.
  ☐ Yes ☐ No

______________________________________ Phone number: ____________________________
Signature

APPENDIX G: RECRUITMENT FLYER

RESEARCH VOLUNTEERS NEEDED

Michigan State University Department of Food Science and Human Nutrition, in cooperation with the **US Army Research Institute of Environmental Medicine** (USARIEM), is conducting a research study to learn about **nutrition-related behaviors** and their impact on **physical performance**, **readiness**, and **health** in **Army ROTC Cadets**.

We are seeking volunteers that are Army ROTC Cadets and at least **18 years of age** or older to complete **survey questionnaires** about nutrition-related behaviors, mediators of those behaviors (for example, sleep and physical activity), and thoughts and feelings about nutrition-related behaviors. We are also measuring height, weight, and body measurements using the **Army tape test procedures**.

In addition, we are seeking volunteers to complete **one-on-one telephone interviews** to provide greater details about nutrition-related behaviors and the mediators of those behaviors.

Participation in this study will include:

(1) Informed consent process with a full description of the study
(2) Screening for age
(3) Completion of four survey questionnaires
(4) Army height, weight, and tape measurements
(5) One-on-one telephone interview (optional, eligible for $20 Amazon gift card)

Time required for this participation will be **approximately 2 hours** for the survey questionnaires and **approximately 1 hour for** the telephone interview.

Volunteers not currently on Active duty will be provided with a $10 grocery gift card and nutrition-related resources for completing this study.

The researchers of this study will coordinate research study dates with **your local Army ROTC** Professional Military Studies staff and email you with these dates, times, and locations.

If you have any questions about the study, please contact:
Dr. Won O. Song, PhD, MPH, RD
Professor of Human Nutrition
Michigan State University
135A GM Trout Building
469 Wilson Road
East Lansing, MI 48824
517-353-3332
song@msu.edu
ROTCnutritionstudy@msu.edu

APPENDIX H: DIET ASSESSMENT INTERVIEW PHONE SCRIPT

Hello, is ____ there? Thanks so much for taking the time to take the call! How are you doing today? **Establishing rapport**
Today I am going to be asking you about your dietary intake to give us a better picture of your experiences related to nutrition behaviors and meeting the Army physical fitness standards. I will ask you everything you ate and drank for breakfast, lunch, dinner, and snacks yesterday and will write it down.
Before we get started, was yesterday a typical day of eating? If not, instead of the last 24-hours, can you please provide me with what you eat on a typical day? Are you ready to get started?

1. Quick list
   a. What foods did you eat yesterday?
2. Forgotten foods
   a. Did you have any crackers, breads, rolls, or tortillas that you may have forgotten about?
   b. Did you eat any hot or cold cereals?
   c. Did you add cheese on vegetables or on a sandwich as a topping?
   d. Did you eat any chips, candy, nuts, or seeds?
   e. Did you eat any fruit with meals or snacks?
   f. Did you have any coffee, tea, soft drinks, or juices?
   g. Did you have any beer, wine, cocktails, brandies, or other drinks with liquor that you may have forgotten?
3. Time and occasion
   a. What time of day and occasion/activities were you taking part in while eating these food items?
4. Detailed food descriptions
   a. Can you please describe the foods/drinks? (brand/restaurant, how it was prepared, how it was served, anything added, etc.)
5. Amounts
   a. Can you describe how much was consumed?
6. Final probe
   a. Is there anything else you could think of that you may have forgotten

"Thank you so much for your time in completing this providing us this information about your dietary intake related to your nutrition behaviors."

APPENDIX I: DIET QUALITY QUESTIONNAIRE

Over the last 30 days, how often did you eat/drink the following foods/beverages? (Note: only a few examples of each category are listed to remind you of the types of foods – many more are possible.)

	Rarely or never	1 or 2 times per week	3 to 6 times per week	Once per day	Twice per day	3 or more times per day
Fruit: fresh, frozen, canned or dried, or 100% fruit juices						
Vegetables: fresh, frozen, canned, cooked or raw: dark green vegetables (broccoli, spinach, most greens), orange vegetables (carrots, sweet potatoes, winter squash, pumpkin), legumes (dry beans, chick peas, tofu), starchy vegetables (corn, white potatoes, green peas), and other (tomatoes, cabbage, celery, cucumber, lettuce, onions, peppers, green beans, cauliflower, mushrooms, summer squash, etc.)						
Whole grains: rye, whole-wheat, or heavily seeded bread; brown or wild rice; whole-wheat pasta or crackers; oatmeal; corn tacos						
Dairy: regular/whole fat milk; low- or reduced-fat milk (2%, 1%, 0.5% or skim), yogurt, cottage cheese, low-fat cheese, frozen low-fat yogurt, soy milk, or other calcium-fortified foods (orange juice, soy/rice milk, breakfast cereals, etc.)						
Fish: tuna, salmon, or other non-fried fish						
Alcohol: beer, wine, hard liquor						
Energy drink/shot: such as Monster, Red Bull, Rip-It, NoZ, 5-Hr						
Sugary beverage: such as Coke, Sprite, flavored Soda, Mountain Dew, Sweet Tea, Lemonade, Frappuccino						
Dining out: such as a restaurant, Fast-food, or takeout						

APPENDIX J: NUTRITION KNOWLEDGE QUESTIONNAIRE

This section is intended to assess your general knowledge about nutrition: First tell us if each statement is TRUE or FALSE, then tell us if you are confident with your answer (YES) or not confident in your answer (NO).

1. Dietary supplements are regulated by the government for purity (cleanliness) and safety before sale.
2. Replacing lost body weight from an exercise session with fluid is important.
3. Fruits and vegetables are good sources of zinc.
4. As long as I am physically active or not overweight, I can eat whatever I want and be healthy.
5. Good sources of calcium include bread, steak, and corn.
6. Most plants, fish, nuts and seeds are sources of healthy unsaturated fats.
7. Whole milk is a better source of protein than 2% or skim milk.
8. A recovery beverage or snack should always be consumed after exercise.
9. A post-workout supplement is better for recovery than a snack or meal.
10. Vitamins and minerals are sources of calories.
11. Dietary fat is not considered an important part of a balanced diet.
12. Protein is the most important source of energy (calories) for physical activity.
13. At least half of the food on your plate should be fruits and vegetables.
14. Most Military personnel require about four times more protein than civilians.
15. Meat is a good source of fiber.
16. Leafy green vegetables, root vegetables, and dairy products are good sources of potassium.
17. Carbohydrates are the main fuel for mental performance.
18. As long as enough calories are consumed, vitamin and mineral needs of Military personnel are met.
19. Sports drinks are always the preferred beverage when exercising at moderate intensity.
20. Complex carbohydrate-rich foods include fruit, vegetables, and beans.
21. Iron is found in dark green vegetables, eggs, and fortified cereal.
22. Body fat is an important source of energy at rest and during long-duration exercise.
23. Vitamin D is sometimes called the sunshine vitamin because the sun helps your body make it.
24. Regardless of how much protein I eat, my body will use it to build muscle.

APPENDIX K: MOTIVATION FOR HEALTHY EATING QUESTIONNAIRE

WHY ARE YOU REGULATING YOUR EATING BEHAVIORS?

Listed below are several statements concerning possible reasons why people might try to regulate their eating behaviors. Using the scale from 1-7 below, please indicate the degree to which the proposed reasons correspond to your reasons for *regulating your eating behaviors.* Circle the appropriate number.

Intrinsic Motivation

1. It is fun to create meals that are good for my health
2. I like to find new ways to create meals that are good for my health
3. I take pleasure in fixing healthy meals
4. For the satisfaction of healthy eating

Integrated Regulation

5. Eating healthy is an integral part of my life
6. Eating healthy is part of the way I have chosen to live my life
7. Regulating my eating behaviors has become a fundamental part of who I am
8. Eating healthy is congruent with other important aspects of my life

Identified Regulation

9. I believe it will eventually allow me to feel better
10. I believe it's a good thing I can do to feel better about myself in general
11. It is a good idea to try to regulate my eating behaviors
12. Is a way to ensure long-term health benefits

Introjected Regulation

13. I don't want to be ashamed of how I look
14. I feel I must absolutely be thin
15. I would feel ashamed of myself if I was not eating healthy
16. I would be humiliated I was not in control of my eating behaviors

External Regulation

17. Other people close to me insist that I do
18. Other people close to me will be upset if I don't
19. People around me nag me to do it
20. It is expected of me

Amotivation

21. I don't really know. I truly have the impression that I'm wasting my time trying to regulate my eating behaviors
22. I don't know why I bother
23. I can't really see what I'm getting out of it
24. I don't know. I can't see how my efforts to eat healthy are helping my situation

APPENDIX L: MEDIATION MODEL CODE

```
TITLE: 12152018mediation;
    DATA:
        file=new.dat;
        variable:
        names=ID NK SDM NSDM DQ
        site sex eth race
        rotcyear age BMI;
        usevar=NK SDM NSDM DQ race sex age BMI;
        missing= all (-99);
        analysis:
        bootstrap=1000;
        model:
        DQ on NK race sex age BMI;
        DQ on SDM race sex age BMI;
        DQ on NSDM race sex age BMI;
        SDM on NK race sex age BMI;
        NSDM on NK race sex age BMI;
        NK; DQ; SDM; NSDM; race; sex; age; BMI;
        SDM with NSDM; sex with BMI; age with BMI;
        model indirect:
        DQ IND NK;
        output:
        cinterval (bootstrap);
```

APPENDIX M: MEDIATION ANALYSIS OUTPUT

INPUT READING TERMINATED NORMALLY

12152018mediation;

SUMMARY OF ANALYSIS

Number of groups	1
Number of observations	205
Number of dependent variables	3
Number of independent variables	5
Number of continuous latent variables	0

Observed dependent variables

Continuous
SDM NSDM DQ

Observed independent variables
NK RACE SEX AGE BMI

Estimator	ML
Information matrix	OBSERVED
Maximum number of iterations	1000
Convergence criterion	0.500D-04
Maximum number of steepest descent iterations	20
Maximum number of iterations for H1	2000
Convergence criterion for H1	0.100D-03
Number of bootstrap draws	
Requested	1000
Completed	1000

Input data file(s)
new.dat

Input data format FREE

SUMMARY OF DATA

Number of missing data patterns 13

COVARIANCE COVERAGE OF DATA

Minimum covariance coverage value 0.100

PROPORTION OF DATA PRESENT

Covariance Coverage

	SDM	NSDM	DQ	NK	RACE
SDM	0.956				
NSDM	0.946	0.961			
DQ	0.907	0.912	0.941		
NK	0.878	0.883	0.868	0.922	
RACE	0.956	0.961	0.941	0.922	1.000
SEX	0.956	0.961	0.941	0.922	1.000
AGE	0.946	0.951	0.937	0.912	0.985
BMI	0.927	0.932	0.902	0.878	0.946

Covariance Coverage

	SEX	AGE	BMI
SEX	1.000		
AGE	0.985	0.985	
BMI	0.946	0.941	0.946

UNIVARIATE SAMPLE STATISTICS

UNIVARIATE HIGHER-ORDER MOMENT DESCRIPTIVE STATISTICS

Variable/ Sample Size	Mean/ Variance	Skewness/ Kurtosis	Minimum/ Maximum	% with Min/Max	Percentiles 20%/60%	40%/80%	Median
SDM	4.455	-0.600	1.000	4.59%	3.333	4.250	4.667
196.000	2.083	-0.080	7.000	1.53%	4.917	5.833	
NSDM	2.410	0.823	1.000	6.09%	1.500	2.083	2.250
197.000	1.024	0.320	5.417	0.51%	2.583	3.250	
DQ	11.803	0.225	4.000	1.04%	8.000	10.000	12.000
193.000	15.681	-0.595	22.000	1.04%	13.000	15.000	
NK	15.989	-0.488	8.000	0.53%	14.000	16.000	16.000
189.000	8.984	-0.313	22.000	1.06%	17.000	19.000	
RACE	0.224	1.321	0.000	77.56%	0.000	0.000	0.000
205.000	0.174	-0.254	1.000	22.44%	0.000	1.000	
SEX	1.317	0.786	1.000	68.29%	1.000	1.000	1.000
205.000	0.217	-1.382	2.000	31.71%	1.000	2.000	
AGE	20.064	2.740	18.000	14.36%	19.000	19.000	20.000
202.000	4.060	11.589	32.000	0.50%	20.000	21.000	
BMI	24.620	0.268	17.561	0.52%	21.938	23.672	24.328
194.000	8.962	-0.306	32.688	0.52%	25.305	27.262	

THE MODEL ESTIMATION TERMINATED NORMALLY

MODEL FIT INFORMATION

Number of Free Parameters 44

Loglikelihood

H0 Value -2763.501
H1 Value -2763.501

Information Criteria

Akaike (AIC) 5615.003
Bayesian (BIC) 5761.215
Sample-Size Adjusted BIC 5621.808
(n* = (n + 2) / 24)

Chi-Square Test of Model Fit

Value 0.000
Degrees of Freedom 0
P-Value 0.0000

RMSEA (Root Mean Square Error Of Approximation)

Estimate 0.000
90 Percent C.I. 0.000 0.000
Probability RMSEA <= .05 0.000

CFI/TLI

CFI 1.000
TLI 1.000

Chi-Square Test of Model Fit for the Baseline Model

Value 64.465
Degrees of Freedom 18
P-Value 0.0000

SRMR (Standardized Root Mean Square Residual)

Value 0.000

MODEL RESULTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
DQ ON				
NK	0.016	0.094	0.174	0.862
RACE	-0.340	0.659	-0.516	0.606
SEX	-0.542	0.606	-0.895	0.371
AGE	-0.187	0.155	-1.210	0.226
BMI	0.117	0.095	1.237	0.216
SDM	1.071	0.178	6.033	0.000
NSDM	-1.093	0.241	-4.535	0.000
SDM ON				
NK	0.057	0.035	1.614	0.107

```
   RACE            -0.088      0.260     -0.340      0.734
   SEX              0.497      0.218      2.280      0.023
   AGE             -0.005      0.052     -0.099      0.921
   BMI              0.068      0.036      1.909      0.056

 NSDM     ON
   NK              -0.003      0.025     -0.116      0.908
   RACE             0.033      0.186      0.180      0.857
   SEX              0.115      0.178      0.648      0.517
   AGE              0.015      0.031      0.485      0.628
   BMI              0.037      0.030      1.235      0.217

 SDM      WITH
   NSDM             0.304      0.118      2.574      0.010

 SEX      WITH
   BMI             -0.203      0.103     -1.962      0.050
   NK               0.082      0.097      0.840      0.401
   RACE             0.026      0.014      1.892      0.058

 AGE      WITH
   BMI              1.000      0.575      1.739      0.082
   NK               0.656      0.334      1.965      0.049
   RACE             0.099      0.080      1.240      0.215
   SEX              0.068      0.075      0.906      0.365

 RACE     WITH
   NK              -0.068      0.093     -0.736      0.462

 BMI      WITH
   NK               0.314      0.727      0.432      0.666
   RACE             0.170      0.099      1.717      0.086

 Means
   NK              15.971      0.215     74.136      0.000
   RACE             0.224      0.029      7.704      0.000
   SEX              1.317      0.032     40.894      0.000
   AGE             20.058      0.139    144.526      0.000
   BMI             24.621      0.219    112.575      0.000

 Intercepts
   SDM              1.339      1.215      1.101      0.271
   NSDM             1.079      0.957      1.128      0.259
   DQ              11.020      3.702      2.977      0.003

 Variances
   NK               8.981      0.842     10.663      0.000
   RACE             0.174      0.016     10.866      0.000
   SEX              0.217      0.012     18.121      0.000
   AGE              4.061      1.029      3.949      0.000
   BMI              8.943      0.797     11.214      0.000

 Residual Variances
```

SDM	1.962	0.188	10.416	0.000
NSDM	1.008	0.110	9.184	0.000
DQ	12.593	1.229	10.245	0.00

TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

	Estimate	S.E.	Est./S.E.	Two-Tailed P-Value
Effects from NK to DQ				
Total	0.081	0.108	0.748	0.454
Total indirect	0.064	0.046	1.391	0.164
Specific indirect				
DQ				
SDM				
NK	0.061	0.040	1.535	0.125
DQ				
NSDM				
NK	0.003	0.027	0.116	0.908
Direct				
DQ				
NK	0.016	0.094	0.174	0.862

CONFIDENCE INTERVALS OF MODEL RESULTS

	Lower .5%	Lower 2.5%	Lower 5%	Estimate	Upper 5%	Upper 2.5%	Upper .5%
DQ ON							
NK	-0.226	-0.158	-0.135	0.016	0.176	0.209	0.268
RACE	-2.108	-1.641	-1.438	-0.340	0.689	0.871	1.359
SEX	-2.075	-1.805	-1.594	-0.542	0.434	0.624	1.033
AGE	-0.655	-0.543	-0.473	-0.187	0.023	0.064	0.145
BMI	-0.154	-0.078	-0.044	0.117	0.262	0.293	0.371
SDM	0.575	0.716	0.774	1.071	1.357	1.410	1.550
NSDM	-1.649	-1.514	-1.455	-1.093	-0.672	-0.557	-0.417
SDM ON							
NK	-0.031	-0.006	0.004	0.057	0.120	0.131	0.158
RACE	-0.736	-0.645	-0.534	-0.088	0.332	0.402	0.556
SEX	-0.053	0.060	0.119	0.497	0.846	0.901	0.989
AGE	-0.127	-0.099	-0.083	-0.005	0.088	0.108	0.145
BMI	-0.027	-0.002	0.008	0.068	0.126	0.141	0.163
NSDM ON							
NK	-0.062	-0.052	-0.045	-0.003	0.039	0.045	0.061
RACE	-0.418	-0.322	-0.274	0.033	0.354	0.394	0.518
SEX	-0.328	-0.241	-0.177	0.115	0.412	0.484	0.588
AGE	-0.089	-0.050	-0.042	0.015	0.060	0.071	0.087
BMI	-0.046	-0.018	-0.010	0.037	0.088	0.096	0.114

SDM WITH0

NSDM	-0.035	0.059	0.108	0.304	0.501	0.537	0.600

SEX WITH

BMI	-0.466	-0.402	-0.369	-0.203	-0.025	0.001	0.058
NK	-0.178	-0.118	-0.080	0.082	0.238	0.263	0.330
RACE	-0.010	-0.001	0.003	0.026	0.049	0.053	0.061

AGE WITH

BMI	-0.282	0.027	0.168	1.000	2.070	2.272	2.696
NK	-0.237	0.007	0.106	0.656	1.183	1.329	1.563
RACE	-0.094	-0.039	-0.022	0.099	0.238	0.264	0.332
SEX	-0.111	-0.074	-0.052	0.068	0.192	0.217	0.272

RACE WITH

NK	-0.313	-0.250	-0.227	-0.068	0.087	0.114	0.154

BMI WITH

NK	-1.489	-1.113	-0.942	0.314	1.535	1.712	1.984
RACE	-0.097	-0.017	0.013	0.170	0.332	0.364	0.439

Means

NK	15.425	15.563	15.619	15.971	16.335	16.398	16.554
RACE	0.151	0.171	0.176	0.224	0.273	0.278	0.298
SEX	1.224	1.254	1.263	1.317	1.371	1.380	1.395
AGE	19.713	19.803	19.834	20.058	20.287	20.352	20.475
BMI	24.003	24.199	24.265	24.621	24.977	25.064	25.219

Intercepts

SDM	-2.452	-1.361	-0.854	1.339	3.149	3.379	3.923
NSDM	-1.737	-0.718	-0.472	1.079	2.663	2.994	3.602
DQ	2.026	4.790	5.678	11.020	17.897	18.853	22.372

Variances

NK	6.458	7.312	7.575	8.981	10.339	10.568	11.351
RACE	0.128	0.142	0.145	0.174	0.199	0.201	0.209
SEX	0.174	0.189	0.194	0.217	0.233	0.236	0.239
AGE	1.909	2.310	2.524	4.061	5.809	6.415	7.204
BMI	6.869	7.383	7.624	8.943	10.264	10.538	11.003

Residual Variances

SDM	1.419	1.549	1.599	1.962	2.218	2.282	2.430
NSDM	0.720	0.764	0.804	1.008	1.166	1.199	1.297
DQ	8.945	9.610	9.990	12.593	14.025	14.573	15.160

CONFIDENCE INTERVALS OF TOTAL, TOTAL INDIRECT, SPECIFIC INDIRECT, AND DIRECT EFFECTS

	Lower .5%	Lower 2.5%	Lower 5%	Estimate	Upper 5%	Upper 2.5%	Upper .5%
Effects from NK to DQ							
Total	-0.200	-0.128	-0.089	0.081	0.258	0.307	0.385
Total indirect	-0.038	-0.016	-0.004	0.064	0.148	0.157	0.190
Specific indirect							
DQ							
SDM							
NK	-0.032	-0.007	0.004	0.061	0.133	0.150	0.176
DQ							
NSDM							
NK	-0.076	-0.051	-0.041	0.003	0.047	0.058	0.078
Direct							
DQ							
NK	-0.226	-0.158	-0.135	0.016	0.176	0.209	0.268

APPENDIX N: STATISTICAL DISTRIBUTION OF VARIABLES IN THE STUDY

Table 18. Statistical distribution of variables in the study

	Skewness		Kurtosis	
	Statistic	**SE**	**Statistic**	**SE**
Nutrition knowledge	-0.492	0.177	-0.289	0.352
Healthy Eating Score-5	0.226	0.175	-0.579	0.348
Autonomous motivation for healthy eating	-0.605	0.174	-0.051	0.346
Controlled motivation for healthy eating	0.830	0.173	0.360	0.345

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