THE IMPACT A 4-WEEK TECHNOLOGY BASED NUTRITION INTERVENTION PROGRAM HAS ON THE EATING HABITS OF COLLEGIATE FEMALE DANCERS.

by

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A thesis submitted to the Graduate Council of
Texas State University in partial fulfillment
of the requirements for the degrees of
Master of Science
With a Major in Athletic Training
August 2017

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ACKNOWLEDGEMENTS

I would like to thank my thesis chair, Dr. Marie Pickerill, as well as my two committee members, Dr. Lisa Lloyd and Dr. Darcy Downey. Without the help and motivation from my committee, I would not have been able to complete my thesis and earn my Master’s degree.

I would also like to thank my parents for supporting me throughout my entire educational career. Without their constant support both emotionally and financially, I would not be where I am today.

I would like to thank the Texas State Strutters dance team for participating in my study and Chelsea Burkart for guiding and helping me with my intervention sheets.

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LIST OF ABBREVIATIONS

Abbreviation	**Description**
Kcal	Kilocalories
Pre-	Before the 4-week nutrition intervention
Post-	After the 4-week nutrition intervention
BMR	Basal Metabolic Rate
EE	Energy Expenditure
RDI	Recommended Daily Intake

Abstract

The purpose of the present study was to determine how a technology based 4-week nutrition education intervention impacted the eating habits of collegiate female dancers as well as analyze the participant's knowledge about basic nutrition information. Objectives of this nutrition intervention were to increase basic sport nutrition knowledge and promote a healthier nutritional lifestyle for these collegiate age participants. Students on Texas State Universities "Strutters" dance team age 18-22 years old were recruited for this study. A 4-week intervention consisting of 10 nutritional fact sheets were sent via e-mail to the 32 participants. Assessment of the participant's nutritional knowledge consisted of a 20-question nutrition knowledge questionnaire, dietary intake using a 3-day food record before and after the nutrition intervention, and measurement of energy expenditure wearing an accelerometer to record activity energy expenditure during the same time frame of the food records. The participants were then placed into 2 groups based on their questionnaire scores to analyze how the nutrition intervention impacted knowledge groups separately: unsatisfactory knowledge group (scored below 50%) and satisfactory knowledge group (scored above 50%). The intervention program was ineffective in positively changing energy intake ($p = .364$; t-value = .921; df = 31) of the participants pre- to post-intervention. Energy expenditure pre- to post-intervention was statistically significant with $p = .007$ (t-value= 2.902; df = 31). Statistical analysis of the differences of pre-expenditure/intake and post-expenditure/ intake demonstrate no statistical significance ($p=.412$; $t=.832$; df=31). Analyses showed a statistical difference between post- intervention energy intake to recommended energy

intake ($p < .001$; t-value = -9.597; df = 31). No statistical significance between knowledge groups and energy intake or expenditure was seen (energy intake: p-value = .524; F = .416; df = 31; energy expenditure: (p-value=.814; F=.056, df = 31). The questionnaire results showed a lack of nutrition knowledge. To improve overall nutrition performance and knowledge, a nutrition education intervention that is engaging and effective should be implemented into the training programs of collegiate female dancers to improve confidence levels and eating habits.

I. INTRODUCTION

The aesthetic demand of dance can be problematic when it comes to young female adults wanting to maintain a thin figure. These demands and societal ideals of a thin body make it difficult for elite dancers to properly fuel their bodies and preserve optimal aerobic endurance and muscular strength needed to adequately perform at the highest level.[1] This at a basic level is an imbalance between energy intake and energy expenditure. The dancers' intrinsic ideals of a lean figure, and the external pressures from the media, coaches, parents and other dancers make it common for female dancers to practice disordered eating behaviors.[2]

In order to be successful and attain elite status, dancers place a large amount of physical demands on their body, however the nutritional requirements to meet those physical demands must also be met. Dancers desire a lean figure not only for aesthetic reasons, but also to maximize the muscle strength and endurance necessary for practice and performance.[3] There is a delicate balance between energy intake and energy expenditure due to the intrinsic and extrinsic factors a dancer faces to be thin.[3] The energy intake needed to match the energy expenditure associated with the intense physical training of these dancers, if not balanced, leads to fatigue which has been shown to play a role in injury.[3] Both the intrinsic and extrinsic factors experienced by these dancers emphasize the need for proper nutrition and nutrition education.

For many females, participation in dance begins at a young age. While these young females receive instruction on dance techniques, much of the socialization in dance occurs through observation. In other words, watching and listening to what other older dancers do and say. Recent research conducted on elite dancers has seen a weight differential of 10% to 14% below their ideal body weight for their height.[1,3] These percentage deficits are significant and raise concern for performers, coaches and health care providers alike. In this group of young adult dancers (18-24 years), there is early evidence showing that these young females do not have a good understanding of proper nutrition and how that nutrition impacts their performance and fatigue levels.[1]

The aesthetic nature of dance as a sport, places a higher risk of developing disordered eating patterns in this population.[1,2] Dancers are known to follow diets low in caloric energy and important nutrients.[5] They are often vulnerable to fad diets in order to lose weight quickly.[4] In a review of literature by Byrne et al[5], they found several studies which reported a prevalence of eating disorders and disordered eating patterns ranging from 1% to 62% in elite dancers'. Lack of nutritional knowledge and improper fueling patterns of their bodies demonstrates a need for proper nutrition education.

Dance requires a significant amount of energy due to the long practice hours (2-6 hours per day) expending large amounts of energy within a given workout. Different types of dance focus on different energy pathways due to the execution of the dance style: either fast paced with choppy motions, or slow and fluid motions with the body. Ballet, for example, relies mostly on the anaerobic system and involves many isometric contractions.[6] However, modern dance, jazz and hip hop rely much more heavily on aerobic performance and muscle strength and endurance.[6] No matter the percentage of work relative to anaerobic verses aerobic energy systems during a dance practice or performance, the continuous movement and loss of energy impact how much energy is expended and how important it is to refuel the body after a given practice or performance.

The relationship between proper nutrition and the maintenance of a dancer's health and performance is unquestionable. However current evidence shows that dancers' have poor knowledge on appropriate dietary choices.[7] Female athletes are known to have a deficient intake of macronutrients that can lead to serious health conditions such as the female athlete triad (association between low energy availability, menstruation dysfunctions and low bone mineral density), low bone density, and stress fractures.[8-10] Dancers need to understand how to fuel their bodies appropriately to help their performance, as well as how to live a healthy lifestyle through their lifespan.

The main macronutrients that provide energy sources for the body include carbohydrates, proteins, and fats; with carbohydrates being the most used source for energy production. Consuming daily carbohydrates is essential for a dancer's health and performance. A review of the latest guidelines for exercise and sport nutrition from the American College of Sport Nutrition, the International Olympic Committee and the International Society for Sports nutrition indicates that athletes should consume 6-10 g/kg/BW/day of carbohydrates.[11,12] The recommendation for carbohydrates decreases or increases based on an individual's activity level and intensity[11,12] (ex. 120lb dancer would need 327 – 545 grams of carbohydrates each day depending on their energy expenditure). Not only is it important to eat carbohydrates throughout the day, it is important for dancers to consume carbohydrates at the appropriate time. During brief exercise lasting less than 45 minutes, added carbohydrates are not needed.[11,12] During sustained high-intensity exercise that lasts between 45 and 75 minutes, small amounts are needed to keep the body's glycogen level at the appropriate amount to finish the exercise (ex. 15 grams for the 120lb dancer). During endurance exercise in sports such as soccer, basketball or football with practice and games greater than 75 minutes, 30-60g/hour of carbohydrates should be consumed during exercise.[11] During ultra-endurance exercise lasting over 2.5 hours, up to 90 g/hour of carbohydrates are needed to maintain exercise and decrease the chances of fatigue.[11]

Protein consumption in athletes is extremely important for synthesis of muscle proteins, reducing muscle protein breakdown and repairing muscle damage. Athletes involved in strength or resistance training exercise programs should increase their protein intake to help repair and rebuild the muscles being used. Protein is also important for endurance athletes to help fuel the body when muscle and liver glycogen stores become depleted. Protein recommendations from the American College of Sports Medicine (ACSM) for strength and endurance athletes are 1.2-1.7g/kg body weight per day.[11,12] Protein consumption above these recommendations have shown to have no benefit and can be detrimental to the athlete's health, causing added stress to the function of the kidneys.[11,12]

Fat consumption for athletic performance plays a critical role often overlooked by many athletes. Fat is a main energy source in the body, second only to carbohydrates.[13] Fat consumption helps ensure maintenance of energy balance, is a source for fat-soluble vitamins, and replenishes triacylglycerol (fat) in the muscles that can be used as energy when other sources are depleted.[11] The ACSM's fat recommendation consumption for athletes should be 20-35% of total energy consumption each day.[11,12] Fat consumption should not decrease below 20% of total energy intake consumed by athletes.[11,12] High fat diets are not recommended by the ACSM for on-going high level performance. The expense of decreased carbohydrate intake in exchange for the high fat intake leads to an energy deficit for the body often causing weight loss.[11,12] A range of 20-30% of total energy intake from fat intake is sufficient for an elite athlete.[11,12]

Not only are the three macronutrients important to the diet of female collegiate dancers, the selected micronutrient, calcium, plays an important role in helping reduce the risk of developing premature osteoporosis and maintaining body skeleton structure.[8-10,12] Dancers are already at risk for low bone density and stress fractures.[8-10,12] Not consuming the RDI for calcium can increase the risk of harming the dancer's health and performance.

While energy need and fuel sources necessary for performance are known in the nutrition and exercise science community, how to provide this information to this population of dancers has minimal research. Given that dancers' may come from many different backgrounds and have many interests, it is not clear at what level current dancers have of basic nutrition knowledge, and if the knowledge translates into good nutrition choices. A questionnaire created by Torres-McGehee et al.[10], looking at sports nutrition knowledge among collegiate athletes, coaches, athletic trainers, and strength and conditioning specialists, consisted of 20 questions based on four domains of sports nutrition: micronutrients and macronutrients, supplements and performance, weight management and eating disorders, and hydration. Construct validity for the nutrition questionnaire was established.[10] Knowing the confidence in which a participant is answering the questions can inform the researcher if the participant is simply guessing or truly knows the information. Dancers specifically need to understand the importance of what foods they are putting in their body and how it affects them on a daily basis. Not only is this vital for their performance as a dancer, but it is imperative as a female athlete to understand the importance of fueling their bodies with enough nutrients throughout the day to best perform at their highest ability. The questionnaire is intended to reveal nutrition knowledge deficits and assess confidence in nutrition knowledge to improve nutrition education for this population

As part of investigating the effect of nutrition education on caloric intake and expenditure, assessing the effect of the intervention across the base knowledge levels of the participants is of interest. Recent research by Yannakoulia et al.[4], focusing on disordered eating habits, has indicated that participants with lower knowledge show a greater benefit from an intervention than those with higher knowledge.[7] Similarly, in the present study, a participant with higher nutrition education knowledge should already be implementing proper nutrition into their eating habits. However, a participant with lower nutrition education, should be able to learn more and implement bigger changes to their eating habits after being educated on the proper nutrition concepts.

Based upon previous research [1-12], and the need for female dancers to understand the importance of proper nutrition, this study is intended to serve two purposes. The first purpose of this study was to determine the impact of the nutrition intervention on the dietary habits of collegiate female dancers. In order to better understand the participants' base-line knowledge and confidence in that knowledge to guide nutritional education, a second purpose of this study was to determine the participant's nutritional knowledge.

II. MANUSCRIPT

THE IMPACT A 4-WEEK TECHNOLOGY BASED NUTRITION INTERVENTION HAS ON THE EATING HABITS OF COLLEGIATE FEMALE DANCERS.

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Abstract

The purpose of the present study was to determine how a technology based 4-week nutrition education intervention impacted the eating habits of collegiate female dancers as well as analyze the participant's knowledge about basic nutrition information. Objectives of this nutrition intervention were to increase basic sport nutrition knowledge and promote a healthier nutritional lifestyle for these collegiate age participants. Students on Texas State Universities "Strutters" dance team age 18-22 years old were recruited for this study. A 4-week intervention consisting of 10 nutritional fact sheets were sent via e-mail to the 32 participants. Assessment of the participant's nutritional knowledge consisted of a 20-question nutrition knowledge questionnaire, dietary intake using a 3-day food record before and after the nutrition intervention, and measurement of energy expenditure wearing an accelerometer to record activity energy expenditure during the same time frame of the food records. The participants were then placed into 2 groups based on their questionnaire scores to analyze how the nutrition intervention impacted knowledge groups separately: unsatisfactory knowledge group (scored below 50%) and satisfactory knowledge group (scored above 50%). The intervention program was ineffective in positively changing energy intake ($p = .364$; t-value = .921; $df = 31$) of the participants pre- to post-intervention. Energy expenditure pre- to post-intervention was statistically significant with $p = .007$ (t-value= 2.902; $df = 31$). Statistical analysis of the differences of pre-expenditure/intake and post-expenditure/ intake demonstrate no statistical significance ($p=.412$; $t=.832$; $df=31$). Analyses showed a statistical difference between post- intervention energy intake to recommended energy intake ($p < .001$; t-value = -9.597; $df = 31$). No statistical significance between knowledge groups and energy intake or expenditure was seen (energy intake: p-value = .524; $F = .416$; $df = 31$; energy expenditure: (p-value=.814; $F=.056$, $df = 31$). The

questionnaire results showed a lack of nutrition knowledge. To improve overall nutrition performance and knowledge, a nutrition education intervention that is engaging and effective should be implemented into the training programs of collegiate female dancers to improve confidence levels and eating habits.

Introduction

Collegiate aged female dancers have extreme pressures both intrinsically and extrinsically to be beautiful and thin.[1] Not only are these pressures relevant in the dance community, but are also seen in the female college community at ages 18-22 years old.[1] These extrinsic factors come from the societal ideals of dancers and young adult females having a thin body.[1] Intrinsically, dancers are exposed to the socialization of other dance peers and instruction from coaches that in order to be an elite dancer, they must keep a thin figure.[1] Recent research conducted on elite dancers has seen a weight differential of anywhere from 10% to 14% below their ideal body weight for their height.[1,3] This deficit indicates that collegiate aged female dancers do not have the proper nutritional knowledge to maintain a healthy weight. Educating this population on the importance to refuel their bodies and the impact proper nutrition has on performance and fatigue levels will expose them to healthier nutrition habits and the benefits of healthy eating for performance needs.[1]

Due to the aesthetic nature of the sport, dancers have a higher risk of developing disordered eating patterns.[1,2] The significant amount of energy loss due to long practice hours (2-6 hours) does not give much leniency to the dancer's body when it is under fueled.[6] Different types of dance focus on different energy pathways due to the execution of the dance style: either aerobic pathways with fast paced and choppy motions such as hip hop, or anaerobic pathways with slow and fluid motions with the body seen in ballet.[6] No matter the percentage of work relative to the different energy pathways, the continuous loss of energy needs to be refueled by proper nutrition.[6]

The relationship between proper nutrition and the maintenance of a dancer's health and performance is unquestionable.[1] Yet, there is evidence to show that dancers' have poor knowledge on appropriate dietary choices.[7] Female athletes are known to have a deficient intake of macronutrients that can lead to serious health conditions such as the female athlete triad (association between low energy availability, menstruation dysfunction and low bone mineral density), low bone density, fatigue, or stress fractures.[8-10] Knowing and implementing the recommended dietary allowances for protein, carbohydrates, and fat into the one's diet are important factors in maintaining a healthy lifestyle as well as a high level of dance performance.

Not only are the three macronutrients important to the diet of female collegiate dancers, the selected micronutrient, calcium, plays a key role in helping reduce the risk of developing premature osteoporosis and maintaining the bony skeleton structure.[12] Dancers are already at risk for low bone density and stress fractures.[12] Not consuming the RDI for calcium can increase the risk of harming the dancer's health and performance.

Proper nutrition knowledge is important for female dancers to understand.[1,2,8,12] Investigating their knowledge levels and confidence in their knowledge is an important component to assist them in implementing nutritional changes into their daily life. Evaluation of participants' basic nutrition knowledge and determining acceptable or unacceptable knowledge based on questionnaire scores can help guide the needs of participants to most effectively provide nutrition information as well as to consider how well nutrition education is used by the dancers.[5] It has been suggested that participants with higher nutrition knowledge should be implementing proper nutrition habits into their diet and have a more balanced energy intake to meet their energy needs, while participants with lower nutrition knowledge should have less adequate energy intake balance of macronutrients; and therefore with an education intervention show more substantial changes to their energy intake after receiving nutrition education.[5]

Given the limited understanding of the nutritional habits of young adult dancers and the evidence that nutritional knowledge may be lacking in this population,[1-12] this current study has 2 purposes. The first purpose of this study was to determine the impact of a 4-week technology based nutrition intervention program on the dietary habits of collegiate female dancers. For this purpose, the following hypotheses have been established:

> Hypothesis 1. Participants' daily energy intake will equal their daily energy expenditure after the intervention. Hypothesis 2. Participants will meet the recommended daily intake for daily energy intake after the intervention. Hypothesis 3. Participants will meet the recommended daily intakes for macronutrient and calcium intake after the intervention.

The second purpose of this study is to determine participants' base-line nutrition knowledge and nutrition knowledge confidence, and to assess how that nutrition knowledge may reflect differently in their energy intake. It was hypothesized that:

> Hypothesis 4. Participant's knowledge of basic nutrition will have a group with "high" knowledge (>70%) and a group with "low" knowledge (<70%). Hypothesis 5. The nutrition education intervention will have a greater impact changing energy intake on participants with limited nutritional knowledge compared to those with higher knowledge.

Methods

Participants

Participants were recruited from the Texas State University Strutters dance team. Participants had to have a minimum of 4 years dance experience to qualify for the study and could not be on any specialized diet during the data collection periods.

Recruitment. Potential participants were approached at the end of a practice session. Participants were given a study overview and the importance of the study was explained. The completion of a 3-day food log and the 4-week nutrition intervention was introduced. Potential participants were provided with an Interest Form. Potential participants that indicated interest were scheduled for follow-up appointments to obtain informed consent and discuss the study in more detail.

Instrumentation

Food log. Completion of a 3-day dietary intake log was required pre- and post-intervention. The participants were asked to record everything they consumed for three consecutive days with as much detail and accuracy as possible (i.e. the time each meal/snack was consumed and amount). Participants also included any physical activity performed that day. Participants were asked not to change their eating habits, but to assess what type of food and how much they were consuming throughout each of the three days. A copy of the food log template can be found as Figure 1.

Figure 1:

Food Log Template

ID_______

ID_______

Instructions for 3-Day Food Diary

1. Record everything you ate or drank (including dietary supplements) during the 24-hour time period (12:01 a.m. to midnight). Repeat this for a total of 3 days—**2 week days and 1 weekend day** (as instructed by the researcher).
2. To the best of your ability, describe combination or mixed dishes that were eaten. For example, what ingredients were included on that piece of pizza? Was it thick or thin crust? Include brand names if known.
3. Describe the amounts consumed in terms appropriate for that item. For example: ounces (cups) of milk, tablespoons of salad dressing, slices of bread, pieces of fruit, etc. If you had a piece of pizza, how big was it in inches or sections, etc.? Record exact amounts to the best of your ability. Reading nutrition labels may be helpful for you to record specific amounts of foods you eat.
4. Include beverages and anything you may add to them, such as cream or sweeteners like honey, sugar, stevia, Splenda, etc.
5. Include anything added to a food after it is prepared, such as margarine, salt, condiments, and the estimated amount.
6. If you need additional space attach additional sheets.
7. Answer the question at the bottom of the day's record. (Does this day's record represent your usual food intake? __ Yes __ No). If your answer is no, explain why it wasn't representative. Were you ill or on a special diet? Did you have unexpected guests and you took them out to dinner?
8. Be honest. Our records are only good if they reflect what you actually ate. You do not need to feel embarrassed about eating cookies or cake because you feel that is not what we want to see. Your information will be confidential.

Thank you for your participation!

TEXAS STATE
Exempt Review
06/30/2016

Figure 1 continued

Sample Food Record ID ________

Day _____1____ **Date** _______June 9th, 2016

Time	Meal	Food, Beverage, Condiments (Brand Name & How Prepared)	Amount Eaten (cups, tbsp., oz., etc.)	Exercise
5:00 AM	Breakfast	Instant Oatmeal- HEB brand apple	1 packet	
		Frozen eggo waffles	2	
		Country crock original spread	1 tablespoon	
		Coffee	2 cups	
		Half and half	2 tablespoons	
7:00-9:00 AM		Gatorade	12 oz.	AM practice- 30 min of conditioning + cycling on stationary bike +wind sprints +45 min of skill work with scrimmaging
12:30	Lunch	Whole wheat bread	2 slices	
		Turkey- Oscar Meyer	2 oz.	
		Apple	1 medium	
		Snapple peach tea	16 oz. glass	
3:00-4:30 PM		Water	16 oz.	Weight room practice- 1.5 hrs moderate intensity, 5 sets of 10 reps bench press/squat/lunges at 70% max capacity + abdominal exercises

Sample Food Record ID ________

Day _____1____ **Date** _______June 9th, 2016

5:00 PM	Snack	Clif bar- chocholate chip	1 bar	
7:00 PM	Dinner	Frozen banquet dinner- chicken a la king w/ mashed potatoes, gravy and mixed veggies	1, ate all potatoes and veggies but 3/4 of entrée	
		Iced tea	16. Oz	
		Sugar	3 tablespoons	
9:00 PM	Snack	Wheat thins, ranch flavored	15 crackers	
		Frozen yogurt- Ben and Jerry's Cherry	1 cup	

Does this day's record represent your usual days' intake? __x__ yes ____ no

If no, explain why not ________________________________

Figure 1 continued

ID_______

Day 1:______________ **Date** ___________

Time	Meal	Food, Beverage, Condiments (Brand Name/How prepared)	Amount Eaten (Cups,. tbsp., oz, etc)	Exercise

ID_______

Day 1:______________ **Date** ___________

Time	Meal	Food, Beverage, Condiments (Brand Name/How	Amount Eaten (Cups,. tbsp., oz, etc)	Exercise

Does this day's record represent your usual days' intake? ____ yes ____ no

If no, explain why not ____

Figure 1 continued

Day 2 and 3 logs are a replica of the day 1 food log.

ID________

Daily Supplement & Vitamins Record

Please record all dietary supplements (ex: multivitamins, herbs, extracts, minerals, etc.) that you take regularly. Be specific.

Brand & Name	Amount/ Strength (mg/oz)	Frequency (How many times per day?)
Example: *Nature Made Fish Oil*	*1000 mg*	*2 times a day*

ID________

VISUALIZING SERVING SIZES

Tennis Ball = 1 cup cereal or cooked pasta/rice/grains or 1 medium piece of fruit

Deck of cards = 3 oz of cooked fish, beef or poultry

Golf Ball = 2 tablespoons of peanut butter, jam/jelly, or salad dressing

Baseball = 1 cup fruit or vegetable

One die = 1 tsp butter or margarine
Four dice= 1 oz. of cheese

Computer mouse = 1/2 cup rice, pasta or vegetables

Figure 1 continued

Dietary Analysis Software. Food records were entered in Food Processor ® from Elizabeth Stewart Hands and Associates (ESHA Research, Salem, OR) for nutrient analysis and comparison with recommended nutrient standards as per current FDA recommended daily intake standards.

Energy Expenditure Tracking. The GT3X+ accelerometer was worn during the 3 days of the 3-day food log to measure energy expenditure. The accelerometers were charged and initialized before the start of each data collection. To read the accelerometers, height, weight, sex, date of birth and the location of the device on the body (non-dominant hip) were entered into the software before the data was read. A start date and time (12:00 AM beginning of the first day, and 12:00 AM on the third day) was entered so the accelerometer would start and stop collecting data at the specified times. No action from the participant to turn on the accelerometer was necessary. After completion of the three days, the accelerometers and food logs were returned to the researcher. The raw data was then downloaded at epoch level (frequency of data recording) 10 seconds.

Accelerometers only measure activity energy expenditure, so to calculate total energy expenditure for each of the 3 days, the basal metabolic rate (BMR) for each participant was calculated using the Harris-Benedict equation[13] and then added to each participant's activity energy expenditure.

Nutrition Knowledge Questionnaire. The questionnaire was comprised of 20 basic nutrition questions with a confidence question paired with each question. The participants chose how confident they were in each answer they chose. A level 1 confidence meant they were not at all confident, a level 2 meant they were not very confident, a level 3 meant they were somewhat confident and a level 4 meant they were very confident. The nutrition knowledge questionnaire is shown in Figure 2.[10]

To determine a method of communication technology for the nutrition intervention, an additional question asking for participants to identify which is their preferred method of communication was asked (Email, Text Message, or Facebook). The most preferred method, based on all participant responses was selected as the communication of the nutrition education intervention for the study.

Sport Nutrition Knowledge Survey

Below each of your answers please specify your confidence in the correctness of you response by circling the appropriate level of confidence. Please use the following scale to indicate your level of confidence”

1= Not at all confident

2= Not very confident

3= Somewhat confident

4= Very confident

Question 1:

1. An athlete’s diet should consist of approximately ____ protein, ____ fat, and ____ carbohydrates.
    a. 12% to 15%, 25% to 30%. 55% to 70%
    b. 8% to 10%, 40%-45%, 45% to 55%
    c. 25% to 35%, 55% to 65%, 70% to 80%
    d. 40% to 5-%, 10% to 20%, 30% to 40%.
2. Please specify you confidence in the correctness of you response by selecting the appropriate level of confidence.
    1= Not at all confident
    2= Not very confident
    3= Somewhat confident
    4= Very confident

Question 2:

1. A mega dose of which of the following vitamins is potentially very dangerous?
    a. Thiamin
    b. Vitamin B6
    c. Vitamin C
    d. Vitamin A
2. Please specify you confidence in the correctness of you response by selecting the appropriate level of confidence.
    1= Not at all confident
    2= Not very confident
    3= Somewhat confident
    4= Very confident

Figure 2:

Nutrition Questionnaire

Question 3:

1. From a sports performance perspective, which is the most significant and/or detrimental dietary deficiency?
    a. Iron
    b. Zinc
    c. Calcium
    d. Vitamin C
2. Confidence Question Component omitted to save space.

Question 4:

1. When dining at a fast food restaurant, a healthier low fat food selection would be:
    a. Crispy chicken sandwich
    b. Green salad with ranch and cheese
    c. Grilled chicken sandwich
    d. Medium French fry
2. Confidence Question Component omitted to save space.

Question 5:

1. The optimal timing for consuming a post exercise meal to restore glycogen (muscle carbohydrate store) would be:
    a. Immediately after exercise
    b. Wait until you feel hungry
    c. 1-3 hours post-exercise
    d. 4 hours post exercise
2. Confidence Question Component omitted to save space.

Question 6:

1. Which of the following is not a physiological effect of caffeine?
    a. Decreases the metabolic rate
    b. Stimulates the central nervous system
    c. Increases the secretion of epinephrine
    d. Increases heart rate and force of contraction
2. Confidence Question Component omitted to save space.

Question 7:

1. When following a modified carbohydrate-loading program for an endurance athlete, what should the athlete do the day prior to competition?
    a. Eat a moderately high –carbohydrate meal and perform light exercise
    b. Eat a low-carbohydrate meal and participate in a regular amount of exercise
    c. Eat a high carbohydrate meal and participate in an intense amount of exercise
    d. Eat a low protein diet and participate in a regular amount of exercise
2. Confidence Question Component omitted to save space.

Figure 2 continued

Question 8:

1. What is wrong with an athlete eating a 12- to 16- ounce Ribeye steak, baked potato with butter, green beans and a soda 2 hours prior to an event?
    a. Sugar in the soda may take as long as 3 hours to metabolize
    b. The high fat meal will take longer to digest and hinder performance
    c. Nothing; the pre-event meal should be at least 500 calories or more
    d. Nothing; the athlete should eat what makes him or her feel comfortable
2. Confidence Question Component omitted to save space.

Question 9:

1. Recent research has suggested that creatine supplementation may enhance performance in which of the following types of physical performance tasks?
    a. High intensity, anaerobic exercise such as powerlifting
    b. Cross country competition event lasting about 30 minutes
    c. Marathon running (26.2 miles)
    d. Ultra-marathon such as an Iron man type triathlons
2. Confidence Question Component omitted to save space.

Question 10:

1. Which of the following statements regarding ergogenic aids is false?
    a. Use of any aid that enhances performance is illegal and is grounds for disqualification
    b. Although most nutritional ergogenics are safe, some dietary supplements pose significant health risks
    c. Endorsement of a nutritional ergogenic by a professional athlete does not necessarily mean that is effective as advertises
    d. Some nutritional supplements marketed as ergogenics may contain prohibited drugs
2. Confidence Question Component omitted to save space.

Question 11:

1. The recommended guideline for safe and healthy weight loss:
    a. 3-4 pounds per week
    b. 1-2 pounds per week
    c. 8-10 pounds per week
    d. 15 pounds a month
2. Confidence Question Component omitted to save space.

Figure 2 continued

Question 12:

1. An athlete has been diagnosed with bulimia and has a known history of laxative abuse. Complication of chronic laxative use include which of the following?
    a. Electrolyte imbalance and dehydration
    b. Hyperactivity
    c. Vomiting blood
    d. Chronic nasal congestion
2. Confidence Question Component omitted to save space.

Question 13:

1. To safely increase muscle mass, it is recommended to increase both ______ and ______.
    a. Fat intake, carbohydrate intake
    b. Resistance training, caloric intake
    c. Resistance training, protein only
    d. Protein, water intake
2. Confidence Question Component omitted to save space.

Question 14:

1. The female athlete triad describes the simultaneous presence of which of the following?
    a. Low energy availability, menstrual cycle dysfunction (irregular), decreased bone mineral activity
    b. Depression, premenstrual syndrome (PMS), and osteoporosis
    c. Menstrual cramping, under eating, and decreased iron levels
    d. Eating disorders, menstrual cycle loss, and osteoporosis
2. Confidence Question Component omitted to save space.

Question 15:

1. All of the following are methods of measuring body composition (specifically body fat%) except:
    a. Body mass index (BMI)
    b. Underwater "Hydrostatic" weighing
    c. Bioelectrical impedance analysis
    d. Measuring skin-fold thickness
2. Confidence Question Component omitted to save space.

Figure 2 continued

Question 16:

1. After three weeks of exercise in the heat, the body's ability to adapt more efficiently is supported by all of the following EXCEPT:
    a. Increased sweat production during exercise
    b. A rapid drop in blood pressure with response to exercise
    c. A drop in heart rate with response to exercise
    d. An increased sodium loss per liter of sweat
2. Confidence Question Component omitted to save space.

Question 17:

1. What measure is the best method to determine the amount of fluid loss due to sweat during an exercise session in which the athlete did not drink or go to the bathroom?
    a. Monitoring urine color
    b. Pre-post practice weigh-ins
    c. Thirst
    d. Urination frequency
2. Confidence Question Component omitted to save space.

Question 18:

1. During prolonged endurance exercise in the heat, excessive intake of water and inadequate intake of salt may lead to a life-threatening health condition
    a. Hypertension (high blood pressure)
    b. Dehydration (fluid loss)
    c. Hypernatremia
    d. Hypernatremia (water intoxication)
    e. Hyperkalemia (high potassium)
2. Confidence Question Component omitted to save space.

Question 19:

1. If an athlete loses one pound of fluid during an exercise session, what recommended ounces of fluid should he/she drink after post-exercise?
    a. 16-24 fl. oz
    b. 7 to 10 fl. oz
    c. 24-36 fl. oz
    d. 6 to 8 fl. oz
2. Confidence Question Component omitted to save space.

Figure 2 continued

Question 20:

1. Significant losses of electrolytes (such as sodium, chloride, potassium, or magnesium) during heavy exercise may lead to symptoms such as
    a. Drop in blood pressure, increased production of urine
    b. Stress fracture, swelling
    c. Dyspnea (difficult or labored breathing), indigestion
    d. Muscular cramps, heat illness.
2. Confidence Question Component omitted to save space.

Nutrition Education Intervention Question:

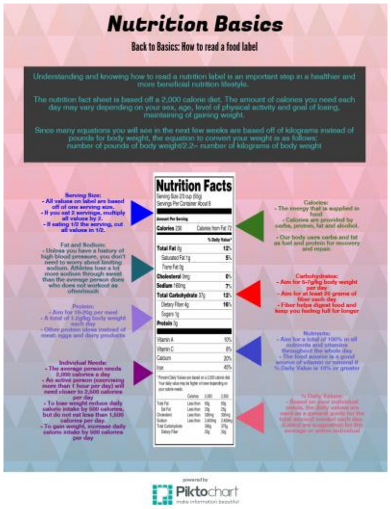
1. How would prefer to receive nutrition education advice on a weekly basis?
    a. Text messages
    b. Email
    c. Facebook group page

Figure 2 continued

Nutrition Education. The nutrition information templates were created by the researcher with collaboration from a registered sports dietician employed by Texas State University.

Nutrition education included topics of proper meal balance for before, during and after performance; fluid intake recommendations; recommended daily amounts of proteins, carbohydrates, and fats; the female athlete triad; proper vitamins and minerals; and how to maintain, lose or gain weight. Selected information was based primarily on results of the Food Knowledge questionnaire outcomes. Questions where 50% or more of the study participants answered incorrectly were used to create the nutrition intervention sheets. (Figure 3)

A.



B.

C.

D.

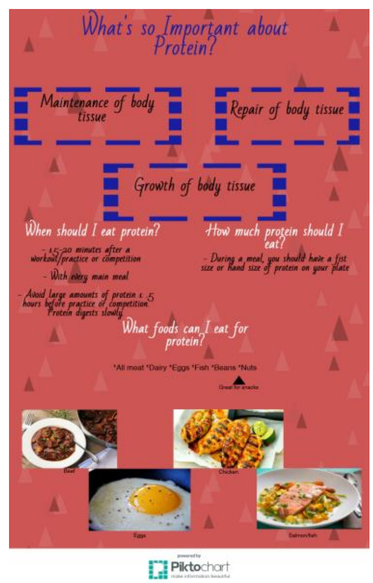
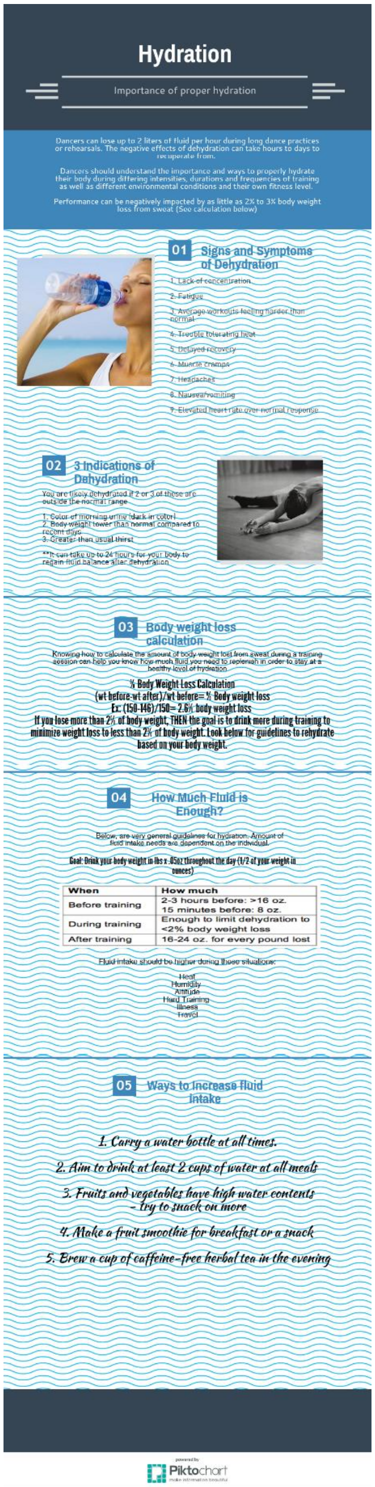


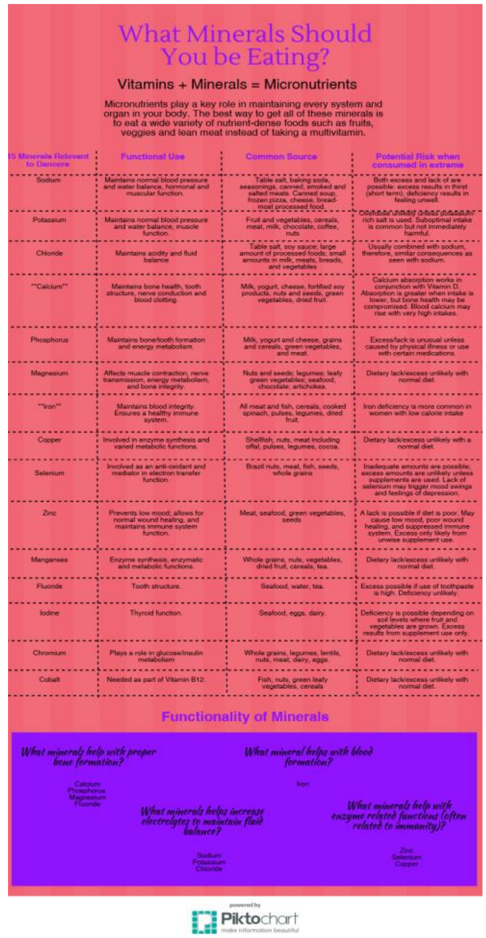
Figure 3: A-J

Nutrition Intervention Sheets

E.



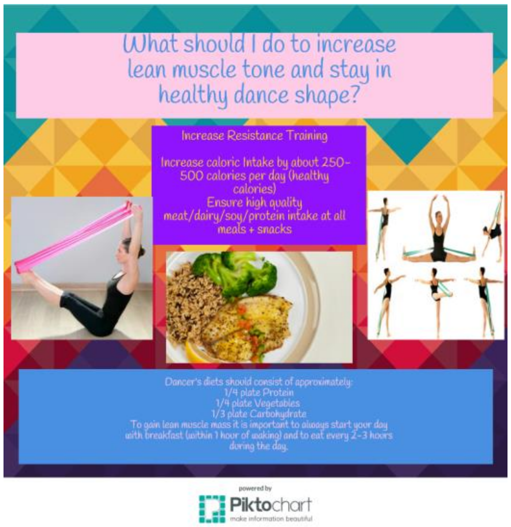
F.



G.

Figure 3 continued

H.



I.

J.

Figure 3 continued

Experimental Procedures. During the initial appointment, participants received detailed information about the study. The participants had time to ask questions for clarification and understanding. The participant then signed the consent form as well as had their height and weight measured. Each participant scheduled a day to begin their 3-day food record and accelerometer activity collection. Once completed, the participant returned the food record and accelerometer, then took the Nutrition Knowledge Questionnaire and responded about their preferred method of communication for the intervention. The nutrition education intervention then started for 4-weeks.

The nutrition education was released to the participants every 2-3 days for a total of 10 nutrition messages. Once the 4-week period had passed, the participant returned to the researcher to complete the three-day food log and wearing of the accelerometers for a second time.

Data Analysis

In order to determine the method of communication for the intervention, simple frequency descriptive statistics were used. The modes of communication were between: email, a private Facebook page or text messaging.

With regards to hypothesis questions 1 - 3, the following data analysis was conducted: Descriptive statistics were reported as well as separate t-tests for each hypothesis question. The pre- and post-intervention values were assessed via dependent t-tests, while the comparisons with recommended daily values used an independent t-test.

To assess hypothesis 4, simple frequency distribution analyses were used. The analyses were evaluated to determine participant grouping to address hypothesis 5. Results were also used to determine nutritional education content. Hypothesis 5 was assessed using ANOVA. A group (satisfactory knowledge / unsatisfactory knowledge) x time repeated measures analysis was conducted to determine if nutritional knowledge influenced dietary intake values after the educational intervention. A priori alpha of 0.05 was used for all analyses.

Results

Thirty-two participants, all female (mean age 19.66 ± 1.12 years) participated in the study. Demographics are shown in Table 1. Thirty-four participants began the study, however, two participants did not complete the second data collection. One participant did not follow accelerometer protocol, only wearing the device 2 hours per day. The other participant opted not to complete the second data collection due to indicated lack of time. Frequency descriptive statistics indicated that the method of communication for the 4-week nutrition intervention was e-mail. Eight participants chose text message, 7 participants chose Facebook and 17 participants chose e-mail.

Table 1: **Participant Characteristics**

	N	Minimum	Maximum	Mean	Std. Deviation
Height (cm)	32	149.86	177.80	162.16	7.527
Weight (Kg)	32	47.27	89.09	58.80	8.036
Age	32	18.0	22.0	19.65	1.125
Years of Dance Exp.	32	4.0	19.0	10.78	4.605

Overall Group Statistical Analysis

Data was screened and met the assumptions of parametric statistical analysis to be utilized.

Energy Intake Pre- versus Post-Intervention. On average, energy intake was 1835.24 kcals/day pre-intervention and 1724.33 kcals/day post-intervention. Despite a decrease in energy intake of 110.91 kcals/day, results of the paired sample t-test revealed no statistical difference in energy intake pre- versus post-intervention on a daily basis ($p = .364$; t-value = .921; df = 31).

Energy Expenditure pre- versus post- intervention. On average, energy expenditure was 2646.17 kcals/day pre-intervention and 2406.47 kcals/day post-intervention. A paired sample t-test demonstrated that the decrease in average energy expenditure of 198 kcals/day was statistically significant with $p = .007$ (t-value= 2.902; df = 31).

Energy Intake versus Energy Expenditure. Hypothesis 1 was tested using paired sample t-tests. For both pre- and post- intervention, energy intake was significantly less than energy expenditure. Pre-intervention average intake was 810.93 kcals/day less than pre-intervention energy expenditure ($p < .001$; t-value = 3.503; df = 31). Post-intervention, average intake was 683.14 kcals/day less than post-intervention energy expenditure ($p < .001$; t-value = 4.423; df = 31). While the individual comparisons are statistically significant, both in combination demonstrate that energy intake did not equal energy expenditure, neither before nor after the intervention. Statistical analysis of the differences of Pre-Expenditure/Intake and Post-Expenditure/Intake demonstrate no statistical significance (p=.412; t=.832; df=31), with participants on average showing a post-intervention difference of 128.9kcal/day less than pre-intervention. Hypothesis 1: Participant's daily energy intake will equal their daily energy expenditure, was not supported. See Table 2 for results.

Table 2. Energy Expenditure vs. Energy Intake

	Pre-Intervention	Difference Pre-Intervention	Post-Intervention	Difference Post-Intervention	p-value /t-score
Ave Daily Energy Expend (kcal/day)	2646.17	810.93	2406.47	683.14	.412 /.832
Average Daily Energy Intake (kcal/day)	1835.24		1724.33		

Recommended versus Actual Energy Intake. Descriptive statistics were run for each of the 3 dietary macronutrients and selected micronutrient (calcium) to help evaluate hypotheses 2 and 3. Table 3 shows the RDI ranges for participant population along with the average pre-intervention and post-intervention energy intakes. The average daily values were compared descriptively to note if intake was within range of the RDI. No nutrients were in range with the RDI. In light, hypotheses 2: Participants will meet the recommended daily allowances for daily energy intake, and hypothesis 3: Participants will meet the recommended daily allowances for macronutrient and calcium intake, were not supported.

Additionally hypotheses 2 and 3 were evaluated using paired sample t-tests. Analyses revealed no statistical difference for overall pre-intervention average energy intake to post-intervention average energy intake (p-value =.364 ; t-value = .921 ; df= 31); however, there was a statistical difference between post-intervention average energy intake to recommended energy intake ($p < .001$; t-value = -9.597 ; df = 31). The means comparison indicates that the participants were consuming 1,035 kcals/day less than the recommended calories each day. In light, hypotheses 2 and 3 were again, not supported. See table 3 for results.

Table 3.	Recommended vs. Actual Energy intake				
	RDI Range	Pre- Average Actual Intake	Post-Average Actual Intake	t-value	p-value
Total Kcals	2471.16 – 3325.34	1835.24	1724.34	.921	.364
Protein (g)	37.74 – 71.12	76.48	65.92	1.806	.081
Carbs (g)	339.78 – 467.23	219.29	217.79	.074	.941
Fat (g)	76.88 – 103.45	76.50	66.88	1.909	.066
Calcium (mg)	1000 – 1300	409.35	435.96	-.490	.628

Nutritional Knowledge Group Analysis

The original data analysis based on high nutritional knowledge vs. low nutritional knowledge had only 3 participants with scores above a 70% on the questionnaire, making it unfit to separate groups into "high" and "low" knowledge. In light, hypothesis 4: Participant's knowledge of basic nutrition will have a group with "high" knowledge (>70%) and a group with "low" knowledge (<70%), was not supported. An alternate group analysis to equalize groups was established at 50%, with separation into a satisfactory knowledge group (scoring 50% or higher) and an unsatisfactory knowledge group (scoring below 50%). Fourteen participants were placed in the satisfactory group, while 18 were placed in the unsatisfactory group. Group comparison analyses were run on the demographic information demonstrating that there were no statistically significant group differences on these participant characteristics. P-values ranged from .498 to .954 for age, height, weight, and years of dance experience (Table 4).

Table 4. **Knowledge Group Characteristics**

	Knowledge Groups	N	Mean	Std. Deviation
Height (cm)	Satisfactory Knowledge	14	64.14	3.009
	Unsatisfactory Knowledge	18	63.61	2.993
Weight (Kg)	Satisfactory Knowledge	14	59.6714	5.86074
	Unsatisfactory Knowledge	18	58.1272	9.50740
Age	Satisfactory Knowledge	14	19.64	1.216
	Unsatisfactory Knowledge	18	19.67	1.085
Years of Dance Exp.	Satisfactory Knowledge	14	10.14	4.688
	Unsatisfactory Knowledge	18	11.28	4.612

Groups Energy Expenditure. A two-way (group x intervention status) repeated measure ANOVA was run for energy expenditure (kcals) comparing knowledge groups across intervention status (pre- and post-). Results showed no significant interaction effect on energy expended (p-value = .749, F=.104, df = 31) (Figure 4). However, a main effect of intervention status on energy expenditure (p-value=.024; F=5.657, df = 31) was demonstrated. Knowledge grouping had no statistical main effect on energy expenditure (p-value=.814; F=.056, df = 31). The analyses showed a 240 kcal/day decrease across groups for expended energy from pre- to post- intervention, indicating less activity of the participants at the end of the study.

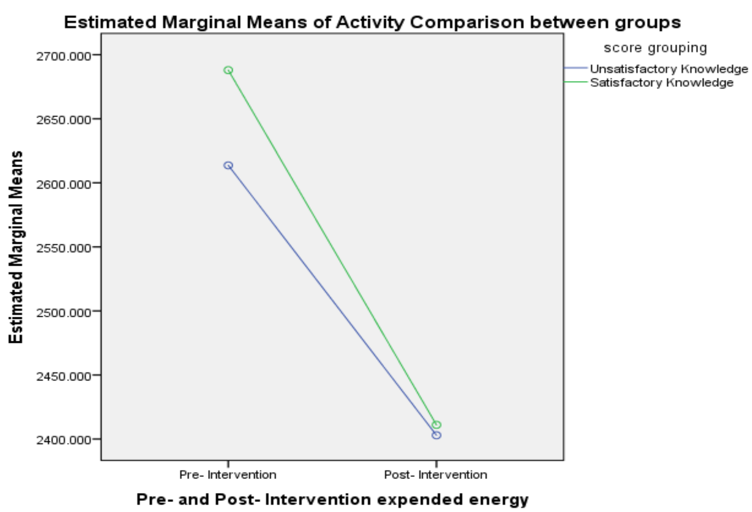


Figure 4: Knowledge Groups pre- to post- Energy Expenditure

Groups Energy Intake. A two-way ANOVA was run for knowledge groups comparing the knowledge groups on their average energy intake. Figure 5 show's a test of within subject's effect on the knowledge groups and average energy intake. Results indicated there was no interaction effect nor main effects for either knowledge group or intervention status for energy intake (Groups energy intake: p-value = .524, F = .416; Intervention status: p-value = .332, F=.972; Between subjects: p-value = .509, F = .448).

In light, hypothesis 5: The nutrition education intervention will have a greater impact changing energy intake on participants with limited nutritional knowledge compared to those with higher knowledge, was not supported. The grouping relative to the intervention did not impact either energy intake nor energy expenditure. While the overall intervention did show significance for decreased energy expenditure, this did not vary across groups.

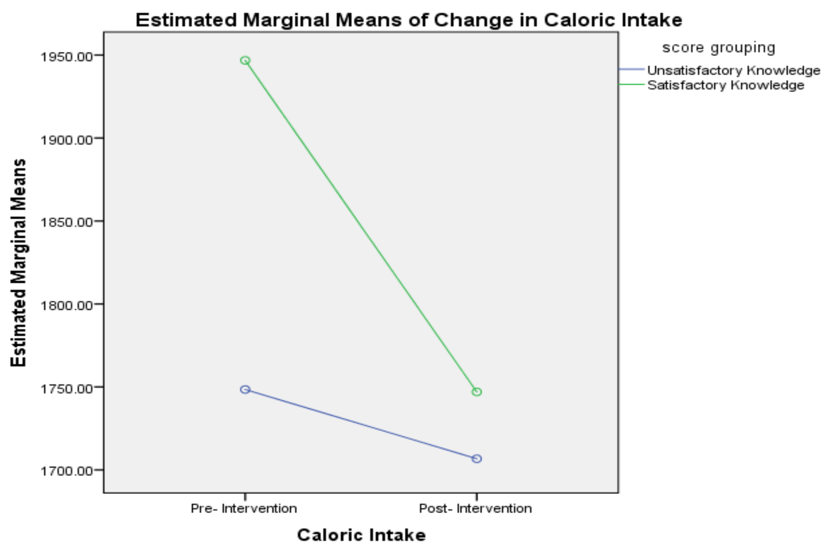


Figure 5: Knowledge Groups pre- to post- Energy Intake

Nutritional Knowledge Assessment

Chi-square analyses were run on each nutrition question in the questionnaire to show the number of participants who got the question right or wrong. Fifty-percent or more participants responded incorrectly to questions 1, 2, 5, 10, 13, 14, 15, 16, 17 and 18.

Table 5 shows the breakdown of each question that 50% or more participants got wrong, and how many participants got it right or wrong.

Table 5: Results of Questions 50% or More Participants Answered Incorrect

Question	# of Right answers	# of Wrong answers
An athlete's diet should consist of approximately ___ protein, ___ fat, and ___ carbohydrates.	9	23
A mega dose of which of the following vitamins is potentially very dangerous?	5	27
The optimal timing for consuming a post exercise meal to restore glycogen (muscle carbohydrate store) would be:	15	17
Which of the following statements regarding ergogenic aids is false?	15	17
To safely increase muscle mass, it is recommended to increase both ___ and ____.	7	25
The female triad describes the simultaneous presence of which of the following?	9	23
All of the following are methods of measuring body composition (specifically body fat %) except.	6	26
After three weeks of exercise in the heat, the body's ability to adapt more efficiently is supported by all of the following EXCEPT.	12	20
What measure is the best method to determine the amount of fluid loss due to sweat during an exercise session in which the athlete did not drink or go to the bathroom?	11	21
During prolonged endurance exercise in the heat, excessive intake of water and inadequate intake of salt may lead to a life-threatening health condition:	16	16

Discussion

The present study aimed to determine how a technology based 4-week nutrition education intervention impacted the eating habits of collegiate female dancers as well as to determine the participant's knowledge about basic nutrition questions. In this study, the majority of participants selected e-mail as the preferred method of communication for the 4-week intervention. After the 4-week intervention, the participants did not meet the recommended daily intake (RDI) for total energy intake per day. In fact, after the intervention, they were further from meeting the RDI for total energy intake, rejecting hypothesis 3. These findings are contrary to research that found nutrition education interventions in dancers improves energy intake and improves healthier eating choices.[3,5,7,10]

This current study also showed that after participating in the 4-week e-mail based nutrition education intervention, the participants did not demonstrate statistical changes in their choices regarding their consumption of recommended macronutrient or calcium requirements, rejecting hypothesis 2; however, two of the three macronutrients (protein and fat) were close to showing statistically significant changes from pre- intervention to post-intervention energy intake and are worthy of note. In the present study, pre-intervention, the participants over consumed protein based on their RDI. The American College of Sports Medicine (ACSM), recommends 1.2-1.7 g/kg body weight per day for strength and endurance athletes.[11,12] Consuming above this recommendations has no benefit and can be detrimental to the athletes, causing the excess protein to turn into fat as well as put stress on the function of the kidneys.[11,12] Although not statistically significant, participants did demonstrate a decrease in protein consumption from pre- to post-nutrition intervention, making a positive change based on the RDI values for protein.

Our results on decreased protein intake are contrary to other findings on this macronutrient. In a study by Lenka et al.[14] observing the dietary intakes and eating habits of female college athletes, participants actually consumed less protein than what was recommended. Similarly, Brown et al.[15] found a trend for lower protein consumption. However, in these previous studies, participant's protein consumption had been below the RDI range values, and carbohydrate consumption were closer, but still under the RDI. In the Lenka et al.[14] and Brown et al.[15] studies, participants consumed too many calories from carbohydrates and not enough from protein, in contrast to our study that demonstrated participants choosing to consume more calories from protein, which decreased the number of calories available for carbohydrates. We speculate the current studies results of low protein and carbohydrate consumption may be due to current nutritional trends of low-carbohydrate consumption to manage weight.

Not only do protein and carbohydrates play a key role in fueling the body with energy, fat is the third macronutrient used for energy in the body. While fat is an energy source for long-term energy needs, the typical dance routine and energy expenditure needs do not necessitate higher levels of fat consumption. However, consuming the proper amount of fat to be utilized as an energy source in the body is still important. The ACSM recommends consuming 20-35% of total caloric intake from fat each day.[11,12] Fat consumption should never decrease below 20% of total caloric intake.[11,12] The fat consumption in the present study was lower after the nutrition education intervention and lower than the RDI range for fat consumption. Participants on average consumed fewer calories from fat pre- to post- nutrition intervention when they should have increased their calories from fat based on the RDI. The participants were only consuming 36% of the RDI of calories from fat. These results are also in contrast to the Lenka et al.[14] study where nearly all participants consumed too many calories from fat. Unlike what was seen in the present study, Lenka et al.[14] suggested the consumption of too many fats may have hindered the proper consumption of carbohydrates in their participants. The present study however, showed an under consumption of both fats and carbohydrates, which we again speculate may be due to the current fad diet trends (Southbeach, Caveman, Atkins Low-Carb™).

In the present study, participants consumed only 47% of the amount of carbohydrate calories that were recommended. Instead of over consuming on fats and under consuming on carbohydrates, as seen in the Lenka et al.[14] study, the participants did not consume enough of either macronutrient, again, rejecting hypothesis 2. This should be concerning to the dance community, athletic trainers and health care professionals involved in the dance community. Consuming daily carbohydrates is essential for a dancer's health and performance. The ACSM, the International Olympic Committee and the International Society for Sports nutrition, recommend 6-10 g/kg body weight of carbohydrates each day.[11] Carbohydrates are needed as a fuel source to be used as energy in the body. The lack of appropriate amounts of fat and carbohydrate consumption translates in to overall lack of calories for this dance population. If young dancers are not consuming the proper energy intake, their performance and their health as athletes will decrease. The intrinsic and extrinsic pressures of the dance community are reasons as to why we see a lack of fat and carbohydrate consumption in dancers.

Participant awareness of consequences of poor nutrition leading to under fueling of the body has been a main goal of this study. The results of the present study are concerning. If these dancers continue to consume less energy then they expend, and do not meet the RDI recommendations for optimal macronutrient composition, then they are at risk for a myriad of health problems such as low bone density, poor reproductive function, fatigue and stress fractures.[8,9] Dancers need to understand how to fuel their bodies appropriately to help their performance as well as how to live a healthy lifestyle throughout their lifespan. This supports the position of better educating this population and the need for better and on-going nutrition education of college-aged dancers with 4 or more years of experience. Just because these participants have been dancers/athletes for a long time, does not mean they are educated about the best way to sustain their health.[3]

A young woman who is at low to moderate activity level should be consuming a minimum of 2,000 kcals/day,[12] and given the high activity levels of the participants in the present study (2,646 expended average kcals/day), this total should be even higher. The issue of over expending significantly more calories than they are consuming in these dance participants is alarming because of the longer-term consequences of improper recovery, decreased performance, and aerobic and anaerobic fatigue.[15,16]

Not only are macronutrients important for the health of dancers, the micronutrient Calcium, plays a key role in helping reduce the risk of developing premature osteoporosis and maintaining the bony skeleton structure.[12] The participants in the present study consumed on average only 33% of the recommended milligrams from Calcium. This value should be a call to action for those that work with these dance athletes due to the known risks of low bone density and stress fractures facing these young women.[8,9] A nutrition intervention sheet on the importance of consuming the RDI for micronutrients such as Calcium, was implemented into the 4-week nutrition intervention. However, this did not impact the dancers calcium intake. Knowing the recommended milligrams for Calcium based on the individual's demographics can help dancers perform at the best of their ability and reduce the risk of stress fractures and developing premature osteoporosis.[12]

To analyze how many calories the participants should be consuming, the expended energy of each participant was compared to their consumption. The participants on average expended more energy than they consumed, rejecting hypothesis 1. Similarly, to a study conducted by Brown et al.[15] the present study showed an average negative energy balance with a daily deficit of consumed calories of -682 kcals/day, post the nutrition intervention. Inadequate energy intake can lead to female athlete triad symptoms, hinder dance performance, cause overall fatigue and decrease the quality of life of dancers.[8,9,15] These results show that the 4-week technology nutrition education intervention did not positively affect the participant's calorie consumption based on their energy expenditure. However, from pre- to post- intervention, the participants decreased both their energy expenditure and caloric intake. Even though they were not consuming nearly enough calories to meet their energy expenditure, they seemed to be aware of their decrease in activity, by consuming less calories as well.

Because only 3 participants scored above a 70% on the nutrition questionnaire, "high" and "low" knowledge groups were unsuccessfully made (hypothesis 4). To keep statistical integrity and equal groups, participants were placed into satisfactory knowledge (scoring 50% or higher on the questionnaire) or unsatisfactory knowledge groups (scoring lower than 50% on the questionnaire). Researchers were interested to know how actual knowledge of nutrition may change eating behaviors as it related to their sport/activity participation, and if a nutrition intervention would alter the nutritional intake of the participants differently given their prior level of nutrition knowledge and confidence in that knowledge. Unfortunately, because of the small number of participants scoring above a 70%, there may not have been a true knowledge difference between groups. This is seen in the data analysis results.

A similarly framed study looking at abnormal eating behaviors by Yannakoulia et al.[4] found that when high-risk abnormal eating behavior participants were separated from those with low-risk of abnormal eating, those with low risks of abnormal eating showed a decline in nutrition knowledge after 6 months (p-value =.013), but not in those with high risk after an educational intervention program. Although the present study did not address abnormal eating behaviors, we were interested in the impact of an educational nutrition intervention and how it may be different across levels of knowledge. We hypothesized (hypothesis 5), that the unsatisfactory knowledge group would benefit more from the intervention than the satisfactory knowledge group. It was thought that those participants with satisfactory knowledge would have better eating habits before the nutrition intervention than those with unsatisfactory knowledge. Additionally, the researchers hypothesized that participants with unsatisfactory nutrition knowledge would benefit more and change their eating habits more drastically than those with satisfactory knowledge. Unfortunately this was not supported in the data analysis.

The main difference, although not significant, between the satisfactory and unsatisfactory knowledge groups was for overall energy intake pre- to post- nutrition intervention. The unsatisfactory knowledge group showed a smaller decrease in energy intake (41.74 kcals) compared to the satisfactory knowledge group (199.83 kcals) from pre- to post- nutrition intervention. In essence, in this small sample, the unsatisfactory knowledge group did not significantly improve or worsen their eating habits, whereas the satisfactory group did demonstrate a decline in their energy intake from pre- to post-intervention. This decrease of caloric intake was a decline in the satisfactory knowledge groups eating behavior. Due to the limitation of a small overall sample size of this study, may be a reason why statistical significance across groups was not seen. Despite age and years of dance experience, there is an overall lack of nutrition education in college aged female dancers. Although groups were sub-divided based on a 50% correct response rate, this rating was used to help keep groups balanced, as a score of even 60% is still considered an exceedingly low score. As dancers, this can be detrimental to their performance, health and recovery.

The nutrition intervention provided was based on results from the nutrition knowledge questionnaire. Topic areas in which participants had the most incorrect responses also had lowest levels of confidence in response correctness from a majority of the respondents. These questions covered topics on dehydration, nutrient consumption breakdown, potential for dangerous vitamin consumption, increasing muscle mass safely, the female athlete triad, and body composition. Nearly all participants had low levels of confidence on their incorrect responses, showing the need for better education techniques in the dance community. A study completed by Frederick and Hawkins[17] shows that dancers had the lowest nutrition knowledge scores compared to track and field athletes and postmenopausal women. However, the present study is the first to investigate the lack of nutrition knowledge in dancers and the importance of proper nutrition. Despite a small sample size this study begins to depict the need for research to be completed on how to engage young populations of dancers to be interested and learn about fueling their body's properly.[1]

Findings from the present study are inconsistent with previous research.[3,4,7,10] While other research has seen positive outcomes with technology based interventions, the present study failed to see a positive outcome.[3,18-21] Findings from the present study, as others, still reveal a potential concern regarding the knowledge base and confidence in nutrition information and the ability of dancers to make sound nutritional choices and changes in eating for themselves. The results provide evidence for a high level of concern about the nutritional intake of college age female dancers. Even after the nutrition intervention was completed, participants did not show improvements in their eating habits.

The present study showed both poor nutritional intake choices as well as a lack of nutrition knowledge in collegiate female dancers. Additionally, this study shows that nutrition education interventions in the dance population need to be addressed to help these athletes perform to their optimal ability and reduce the risk for associated medical issue related to poor nutrition. Dancers, coaches, parents, athletic trainers and any other involved persons should be educating themselves on the importance of proper nutrition for dancers. The fact that these 32 participants were consuming significantly less than what they were expending is a red flag to the dance community. The aesthetic demands of dance and the intrinsic factors to maintain a thin figure are contrary to the importance of fueling their bodies. Without the proper education on nutrition, dancers will continue to perform below their optimal ability. This study reveals the need for better nutrition education programs and interventions for young female dancers.

Future research should investigate the length and type of nutrition interventions completed. E-mail may have been the most preferred method of communication for these 32 participants, however more research should be explored on the best way to engage participants ages 18-22. Paper-based food records have been known to be a great tool for recording food consumption, however a technology-based food record may be more beneficial for this type of population. Future research should look at ways to improve the quality and consistency of food records.

Limitations of this research may have impacted the ability to see comparable results to previous research[3,4,7,10]. Limitations such as an underestimation of total daily energy expenditure, failure to re-asses nutritional knowledge post- intervention, lack of true difference in knowledge groups, and lack of nutritional education intervention engagement may have impacted the results of this study.

Conclusions

The results of the present study did not reveal a change in total caloric or macronutrient and selected micronutrient eating habits of collegiate female dancers, rejecting hypotheses 2 and 3. The participants in this study did not meet the recommended daily intake to meet their energy expenditure post- intervention, rejecting hypothesis 1. Results of this study showed a decrease in total and macronutrient intake post- intervention, when the participants should have been increasing their caloric intake. Results of this study also revealed no statistically significant difference between the unsatisfactory and satisfactory knowledge groups, rejecting hypothesis 4. The participants in this study did not show improvement to the 4-week nutritional education intervention. This study reveals the need for better nutrition education programs for collegiate female dancers.

III. SUMMARY AND RECOMMENDATIONS

Summary

The purpose of the present study was to determine how a technology based 4-week nutrition education intervention impacted the eating habits of collegiate female dancers as well as determine the participant's knowledge levels about basic nutrition questions. The aesthetic demand of dance can be problematic when it comes to young female adults wanting to maintain a thin figure. These demands and societal ideals of a thin body make it difficult for elite dancers to properly fuel their bodies and preserve optimal aerobic endurance and muscular strength needed to adequately perform at the highest level.[1]

In this study, the nutrition education intervention did not positively impact the eating habits of the 32 participants. The nutrition knowledge questionnaire indicated a lack of knowledge in basic nutrition concepts. The present study provides support for the need to educate collegiate female dancers on basic nutrition topics, as well as nutrition topics related specifically for dancers. Additionally, there is support to indicate that the importance of finding a mechanism to engage this population on nutrition education is important to changing eating habits in a way to enhance performance and limit the risks of nutrition related medical conditions.

Recommendations for Future Research

Future research needs to investigate how to effectively communicate nutrition interventions to collegiate aged female dancers. While technology is the wave of the future, mechanisms to ensure intervention key points are implemented into the participants eating habits is a necessary component. Future research also needs to consider testing longer duration interventions. It appears that a 4-week intervention may not be long enough to effectively influence the eating habits of collegiate female dancers. A longer and more interactive intervention may provide for more effective outcomes. Finally, implementing an education program that integrates as part of their on-going practice routine may also help this population positively change their nutrition habits and knowledge of proper nutrition.

APPENDIX SECTION

Purpose

The purpose of the present study was to determine how a technology based 4-week nutrition education intervention impacted the eating habits of collegiate female dancers as well as analyze the participant's confidence levels about basic nutrition questions.

Experimental Hypotheses

Hypothesis 1. Participants will consume enough kcals to meet daily energy needs.

Hypothesis 2. Participants met recommendation requirements for daily kcal intake.

Hypothesis 3. Participants met recommendation requirements for daily macronutrient and selected micronutrient intake.

Hypothesis 4. Participants in the unsatisfactory group will benefit more than participants in the satisfactory group.

Operational Definitions

1. **Kilocalories**: A unit of food energy that is equal to 1,000 small calories.
2. **Accelerometer**: A small device that monitors human rest and activity levels.
3. **Macronutrients**: Nutritional components that are required in relatively large amounts; such as protein, carbohydrates and fat.
4. **Micronutrients**: Nutrients that are required by organisms throughout life in small quantities; such as vitamins and minerals.
5. **Caloric Intake**: The amount of kilocalories a person consumes.
6. **Energy expenditure**: The amount of energy a person uses throughout the day,

whether it be from exercises or normal body functions.

7. **Recommended caloric intake**: How many kilocalories a person should be consuming based on their weight, height, age, and activity level.
8. **BMR**: Basal metabolic rate. The amount of energy you expend to keep your body functioning at rest.

Delimitations:

1. This study is delimited by choosing to only use the Texas State University "Strutters" dance team as the participants.
2. A delimitation to this study is choosing to only use participants that are between the ages of 18-22 with 4 years or more of dance experience.
3. A delimitation to this study is choosing to only use technological devices as the source of communication for the intervention.

Limitations:

1. A limitation to this study is not knowing if what the participants are writing down for their food log is accurate.
2. A limitation of this study is the sample size of 32 participants, giving this study low power.
3. A limitation of this study is not knowing whether the participants read each e-mail sent to them during the intervention.
4. A limitation to this study is not being able to control when the participants took off and put on their accelerometers.
5. A limitation to this study is the underestimation of total daily energy expenditure.
6. A limitation to this study is the failure to re-assess nutritional knowledge post-

intervention.

7. A limitation of this study was the fact that the satisfactory knowledge group did not truly have satisfactory knowledge.

Assumptions:

1. We assume the participants were accurate with their food records.
2. We assume the participants read all the intervention sheets.
3. We assume the participants followed all instructions while wearing the accelerometers.

APPENDIX A

Literature Review

The esthetic demand of dance can be problematic when it comes to young female adults wanting to maintain a thin figure. These demands and societal ideals of a thin body make it difficult for elite dancers to properly fuel their bodies and preserve optimal aerobic endurance and muscular strength needed to adequately perform at the highest level.[1] The dancers' intrinsic ideals of a lean figure, and the external pressures from the media, coaches, parents and other dancers make it common for female dancers to practice disordered eating behaviors, believing this will meet the societal ideals of being a beautiful and thin dancer.[2]

In order to be successful and attain elite status, dancers not only place a large amount of physical demands on their body, but they must also monitor their nutritional levels to meet those demands. Dancers desire a lean figure not only for aesthetic reasons but also to maximize the muscle strength and endurance necessary for practice and performance.[3] The energy consumption needed to match the energy expenditure associated with the intense physical training of these dancers, if not balanced, leads to fatigue which has been shown to play a role in injury. Both the intrinsic and extrinsic factors placed on these dancers emphasize the need for proper nutrition and nutrition education.

For many girls, participation in dance begins at a young age. While these young girls receive instruction on dance techniques, much of the socialization in dance occurs through observation. In other words watching and listening to what other older dancers do and say. As this relates to nutrition and caloric intake recent research conducted on elite dancers has noted a weight differential of 10% to 14% below their ideal body weight for their height.[1,3] Given the age of these young adults (18-24), evidence shows that young female adult dancers do not have a good understanding of the importance to refuel their bodies and the impact proper nutrition has on their performance and fatigue levels.[1] These percentage deficits are significant and should alarm these performers, coaches and health care providers. Due to the aesthetic nature of the sport, dancers have a higher risk of developing disordered eating patterns.[1,2] In a review of literature by Byrne[5], many studies have shown a prevalence of eating disorders and disordered eating patterns ranged anywhere from 1% to 62% in elite dancers,. Dancers are known to follow diets low in caloric energy and important nutrients; often vulnerable to fad diets in order to lose weight quickly.[4] Lack of nutritional knowledge and improper fueling patterns of their bodies demonstrates a need for proper nutrition education.

Nutrition

Caloric Energy Needs

Understanding how the restoration of glycogen stores impacts fatigue levels and injury occurrence due to fatigue is an important aspect of proper nutrition to any physically active individual. As the activity level, volume and type of training changes for athletic participants the component of nutrition becomes even more relevant to avoid illness and or injury that may prohibit participation. The body needs macronutrients such as carbohydrates, proteins and fats to fuel the body with energy. As explained by McArdle et al.[13] , at rest, the body uses fat as its primary energy source. During moderate intensity exercise fat and carbohydrates are used equally to fuel the body. At higher exercise intensity levels carbohydrates are utilized as the primary energy source with fat supplementing as carbohydrate stores are expended. As exercise intensity continues to increase to maximal intensity, only carbohydrates are being used as a fuel source. The longer the duration of exercise, the more likely glycogen will begin to deplete. Muscle and liver glycogen have been seen to significantly reduce in the body after only 120 minutes of continuous exercise at about 64% of maximal aerobic capacity.[22] Knowing what fuel source is being utilized during exercise will help an individual to properly fuel the body before, during and after exercise.[13]

Glycogen. Glycogen, the storage form of glucose derived from carbohydrates consumed through food, is the main source of energy during exercise.[13] Glycogenolysis, the breakdown of stored glycogen, begins when exercise starts.[13] At rest, 80% of glycogen is stored in the muscle and 20% in the liver.[13] When initial exercise starts, the main fuel source comes from muscle glycogen.[13] As exercise continues beyond three minutes, there is a transition of glycogen contribution with 70% of the energy source from muscle glycogen and 30% from liver glycogen; meaning that carbohydrates are the main energy source beyond three minutes of continuous exercise.[13]

As muscle and liver glycogen levels deplete, a decrease in blood glucose levels will also decline, which triggers a release of glucagon from the pancreas.[13] This process increases the breakdown and release of liver glycogen.[13] When liver glycogen completely depletes, gluconeogenesis, the breakdown of protein begins, as well as an increase in fat metabolism known as lipolysis.[13] Gluconeogenesis and lipolysis require more energy for the conversion of these stores into useable fuel by the body.[13] Protein and fat now become the main source of energy to fuel the body during exercise.[13] This change of energy source is why carbohydrate restricting diets are so harmful to an active individual. Without carbohydrate consumption, glycogen stores will never be able to refill the body's main energy source. The use of fat and protein instead of carbohydrates for fuel can cause harm to the body's repair system as the muscles are trying to heal from exercise.

These changes in fuel source usage from carbohydrates to fat and protein have the effect of using the amino acids of proteins in lean muscle mass.[13] This break down of lean muscle mass for energy means that the body is losing the very muscle needed to be active, which leads to decreased ability to perform and puts a person at a higher risk for injury.[13] It is important to note that the long term use of protein and fat stores for energy, from lower carbohydrate intake, inhibits muscle mass gain and increases both muscular fatigue and aerobic fatigue levels.[13] Once this occurs, injuries are much more likely to happen.[12]

Dance Energy Requirements. Dance requires a significant amount of energy due to the long practice hours (2-6 hours) and energy expended within a given workout. Different types of dance focus on different pathways due to the execution of the dance style: either fast paced with choppy motions, or slow and fluid motions with the body. Ballet for example, relies mostly on the anaerobic system and involves many isometric contractions.[6] However, modern dance, jazz and hip hop rely much more heavily on aerobic performance and muscle strength and endurance.[2] No matter the percentage of work relative to anaerobic verses aerobic energy systems during a dance practice or performance, the continuous movement and loss of energy impacts how much energy is expended and how important it is to refuel the body after a given practice or performance.

Due to the extensive amount of time and energy dancers use throughout a given practice or performance, restoration of glycogen stores has been suggested to be the biggest cause of improper recovery and aerobic and anaerobic fatigue.[12] In a study done by Leiderbach and Compagno[23], "a significant difference was found between injured and non-injured dancers with respect to dieting behaviors and eating attitudes." Higher eating disorder inventory scores for the 644 participating dancers for body dissatisfaction, drive for thinness, bulimic tendencies and perfectionism corresponded with the injured dancers.[23] Changes in diet provided strong evidence to an increased chance of injury.[23] These findings show how important it is for female dancers to understand the energy needs for appropriate maintenance of body systems and how it impacts their performance.

A related issue in bouts of exercise over 2.5 hours is the relationship of central nervous system function and its impact on fatigue and performance.[13] It has been shown that in exercise bouts of 2.5 hours or greater that not only does glycogen depletion occur, but central nervous system fatigue occurs.[13] This hampers the function of the neurotransmitters to send signals from the brain to the muscles to contract. Central nervous system fatigue can happen along with or before peripheral fatigue (muscular fatigue).[24,25] Carbohydrates function as an on-going, constant and easily available source of fuel for the central nervous system. Carbohydrates have been found to decrease serotonin [5-hydroxytryptamine (5-HT)] which plays a role in depression, sensory perception, sleepiness, mood, and central nervous system fatigue.[24,25] Carbohydrates have been found to decrease 5-HT in the central nervous system and improve performance.[25] When glycogen levels deplete in the body not enough carbohydrates or glycogen are available to help fuel the central nervous system. When this happens, exercise performance and ability drops immensely.[26]

It is known that impairment of the sensorimotor system effects neuromuscular control which increases the risk of injury. Knowing that depletion of glycogen has many levels of impact on the body's overall ability to function at the desired level of intensity to perform and increases risk of injury, makes it imperative for young female dancers to have awareness of proper fueling for their bodies before, during and after exercise to perform and train at their highest ability. This all starts with nutrition education.

Nutrition Knowledge

The relationship between proper nutrition and the maintenance of an athlete's health and performance is unquestionable. And yet, there is evidence to show that athletes have poor knowledge on appropriate dietary choices.[10] Female athletes are known to have a deficient intake of macronutrients that can lead to serious health conditions such as the female athlete triad (association between low energy availability, menstruation dysfunctions and low bone mineral density).[8,9] Athletes need to understand how to fuel their bodies appropriately to help their performance, as well as how to live a healthy lifestyle through their lifespan.

Carbohydrates. Consuming daily carbohydrates is essential for an athlete's health and performance. In a review of the latest guidelines for exercise and sport nutrition from the American College of Sport Nutrition, the International Olympic Committee and the International Society for Sports nutrition, it is said that athletes should be consuming 6-10 g/kg/BW/day of carbohydrates.[27] The recommendation for carbohydrates decreases or increases based on the individuals activity level and intensity.[27] Not only is it important to eat carbohydrates throughout the day, it is important for athletes to consume carbohydrates at the appropriate time. During brief exercise lasting less than 45 minutes, no carbohydrates are needed.[27] During sustained high-intensity exercise that lasts between 45 and 75 minutes, small amounts or even mouth rinses of liquid carbohydrates are needed to keep the body's glycogen level at the appropriate amount to finish the exercise. During endurance exercise in sports such as soccer, basketball or football, 30-60g/hour of carbohydrates should be consumed during exercise.[27] During ultra-endurance exercise lasting over 2.5 hours, up to 90 g/hour of carbohydrates are needed to maintain exercise and decrease the chances of peripheral and central nervous system fatigue.[27]

Protein. Protein consumption in athletes is extremely important for muscle protein synthesis, reducing muscle protein breakdown and repairing muscle damage.[27] Athletes involved in strength or resistance training exercise programs should increase their protein intake to help repair and rebuild the muscles being used.[27] Protein is also important for endurance athletes to help fuel the body when muscle and liver glycogen become depleted.[27] Protein recommendations from the American College of Sports Medicine (ACSM) for strength and endurance athletes are 1.2-1.7 g/kg body weight per day. Protein consumption above these recommendations have shown to have no benefit and can be detrimental to the athlete's health.[27]

Fat. Fat consumption in athletes is more important than most think. Fat is one of the main energy sources in the body. Fat consumption helps ensure maintenance of energy balance, fat-soluble vitamins, as well as replenishing triacylglycerol (fat) in the muscles to be used as energy.[27] The ACSM's fat recommendation consumption for athletes should be 20-35% of total energy consumption each day.[27] Fat consumption should not decrease below 20% of total energy kcals. High fat diets are frowned upon by the ACSM due to the expense of carbohydrates that can be consumed due to a high fat intake[27]. Staying at the 20-30% of total energy kcals for fat, is sufficient enough for an elite athlete.[27]

Comparing Questionnaires. To measure athletes' knowledge on nutrition, various types of questionnaires have been designed. De Souza et al.[27] used a four-part nutrition knowledge questionnaire to understand the dietary knowledge of adolescent athletes in Germany (10-19 years). The four knowledge-specific sections included knowledge of: Dietary recommendations, sources of nutrients, choosing everyday foods, and diet-disease relationships.[27] All questions in the survey focused on basic nutritional requirements, habits, and primary health implications.[27] The survey did not focus primarily on sports nutrition.[27] However, this study conducted a reliability assessment including a test-retest assessment.[27] Participants completed the newly validated survey twice and results showed that 13 questions were eliminated after the results were analyzed.[27] Correlations from the internal reliability of each section averaged a value of .86.[27] Values for the reliability of answers over time averaged a value of .92.[27] With the newly created survey after validation, De Souza created a reliable assessment of nutrition knowledge.[27]

Another nutritional knowledge questionnaire called the NAK-50+: A nutrition attitude and knowledge questionnaire for adults 50+ years of age was used in a study by Ducak et al.[28]. The NAK-50+ was designed for older adults living independently in the community of the population used.[28] Two constructs of nutrition knowledge and nutrition attitude were used as themes for the questions asked in this questionnaire.[28] There were five ways the participant could respond to each question: “Totally agree”, “Somewhat agree”, “Somewhat disagree”, “Totally disagree”, and “Don’t know”. For the questions asked in first person, the alternative “I’m not sure” was used[28]. The NAK-50+ was designed specifically to meet the nutrition needs of older adults and to develop an understanding of the knowledge they have about their own nutritional needs.[28]

Additionally, questionnaires administered to healthcare professionals have been designed to assess how to improve the delivery of nutrition care and self-perceived confidence in nutrition knowledge. Given the relationship of a healthcare professional to a patient seeking care for fatigue or an injury (acute or chronic), a healthcare professional’s knowledge of nutrition can have an impact on how important a patient perceives nutrition to be related to their health status. A nutrition knowledge questionnaire used in Ball and Leveritt’s[29] study on the development of a validated questionnaire to measure the self-perceived competence of primary health professionals in providing nutrition care to patients with chronic disease, shows the effectiveness of nutrition knowledge questionnaires. Four constructs were confirmed for the inclusion of the questionnaire used: Confidence in knowledge about nutrition and chronic disease, confidence in nutrition skills, confidence in communication and counseling about nutrition, and attitudes towards nutrition care.[29] Demographic and education questions were also included at the end of the questionnaire to understand the association between those characteristics and primary health professionals’ self-perceived competence to provide nutrition care to patients.[29]

Although the primary purpose of this section is to introduce various surveys used to assess nutrition knowledge, it is interesting to note the outcomes of the Ball and Leveritt[29] research. Internal consistency was confirmed within the questionnaire with Cronbach's alpha ranging from .88 to .98 for each constructs listed above.[29] Dietitians scored significantly higher than speech pathologists for all constructs.[29] This confirmed validity of the questionnaire.[29] A test-retest reliability was also found with correlation coefficients ranging from .89 to .94 for the 4 constructs as well.[29] In conclusion, the questionnaire created for health care professionals by Ball and Leveritt has been confirmed valid and reliable.[29]

Although all three of these questionnaires have been successful in the studies they have been included in, to best comply with dance participants, a sports knowledge questionnaire is best fit. Torres-McGehee et al.[10] created a study looking at sports nutrition knowledge among collegiate athletes, coaches, athletic trainers, and strength and conditioning specialists. A sports nutrition knowledge questionnaire was used as the main instrument in this study.[10] The questionnaire consisted of 20 questions based on four different domains of sports nutrition: micronutrients and macronutrients, supplements and performance, weight management and eating disorders, and hydration.[10] Each domain focused primarily on how they relate to sports nutrition directly.[10] All domains were equally weighted during the scoring process.[10] Along with direct correlation to sports nutrition, this survey also included a confidence question after each main question was asked.[10] The participants' were to specify their confidence in the correctness of their answers. They either chose 1 = not at all confident, 2 = not very confident, 3 = somewhat confident, or 4 = very confident.[10]

Construct validity for the above nutrition questionnaire was established.[10] Twelve professionals, including 2 sports dieticians, 5 athletic trainers, 2 exercise physiologists, 2 strength and conditioning coaches and 1 sports medicine physician were involved in the validity process.[10] The athletic trainers and strength and conditioning coaches made sure questions pertaining to their educational competencies were included in the questionnaire.[10] The registered dieticians and physician went over each question for valid questions and responses for all nutrition categories.[10] The questionnaire began with 50 questions and was reduced to 20 questions after review and a pilot study.[10] After completion of the pilot study and review, the appropriate changes were made to make this a valid and reliable nutrition questionnaire.[10]

The importance of a nutrition knowledge questionnaire that fits the population being questioned will make the results of a study much more significant. Not only does the questionnaire need to fit the population, but knowing the confidence in which the participant is answering the questions can let the researcher know if they are simply guessing or truly know the information. Dancers specifically need to understand the importance of what foods they are putting in their body and how it affects them on a daily basis. Not only is this vital for their performance as a dancer, but it is imperative as a female athlete to understand the importance of fueling their bodies with enough nutrients throughout the day.

Tools to collect nutrition information

Means to validly and reliably measure diet quality and quantity is a key factor in assessing nutritional research.[30] Different types of nutrition collection tools have been designed to meet these evaluation needs including: Food frequency questionnaires, 24-hour recall, and food records and interviews.[30,31] Depending on the population of interest, funding available and ease of use and accessibility, these tools can be useful for dietary intake assessments.

Food frequency questionnaires and 24-hour recalls. Thompson et al.[34] and Torre et al.[30], both found that food frequency questionnaires and 24-hour recalls have one major limitation: Both tools have a primary reliance on memory. While these might be fast options to measure dietary intake throughout a day or multiple days, not immediately documenting food intake is ultimately impacted by the participant's memory of what was actually eaten.[30,34] It has also been shown that researchers and/or interviewer can also induce bias on participants by leading the question in a specific way.[30,34]

Technology-based food records. Technology is enhancing the way people research and collect data. Technology based food records have many benefits, but also have limitations as well. Torre et al.[30] developed and evaluated a mobile application, called e-CA (electronic carnet alimentaire, "food record" in French), to facilitate food and beverage recording for research participants and researchers while maintaining a comparable performance with traditional tools. Torre et al.[30] also found that a mobile application had "good agreement" with the 24-hour recall and paper-based food records. The participants found the mobile application intuitive, practical, modern and fun. However, the mobile application did have difficulty estimating portion sizes, compared to paper-based methods.[30] Technology based food records have been proven to be as good as or better than paper-based foods records.[30,32,34]

Paper-Based Food record. Paper-based food records are a very common form of measuring daily food intake.[30-34] The only thing needed is a paper and a pen. While research has shown the benefits of a technology based food record versus a paper-based one, the differences in these two tools have not been sufficiently large.[30,34] Both tools have similar negative participant oriented factors including: forgetting to report some food items, choosing a wrong description for the food, under or overestimating the portion size of the food, and variability between dietitians in interpreting the food records and entering the food items in the food composition database.[34] One positive factor paper-based food records have over a technology-based food records is the decreased time to learn and adapt to the technology-based tool.

In a study done by Monnerie et al.[33] comparing fluid, food and nutrient intake obtained with a paper versus an online version of a 7-day food record results showed no difference between methods in terms of energy intake and the consumption of most food categories. However, the reported water intake was significantly higher in the online version compared to the paper version.[33] This difference however, is not significant enough to say that the online version was better than the paper-based food log.[33]

Another study by Freisling et al.[31] aimed to describe and evaluate the "EPIC-Soft DataEntry" application and to compare two food record-based dietary assessment methods in terms of food description and quantification. Freisling's study looked at using a consecutive 3-day food diary versus a 2 non-consecutive 1-day food diary.[31] The results obtained stated that the 2 non-consecutive 1-day food diary provided more detailed descriptions of consumed foods as compared to the consecutive 3-day food diary.[31] This study was completed with a population among infants, toddlers and children.[31] When an entry is made by the food preparer there is more knowledge of content and portion sizes than if it were to be entered by the consumer of the food.

Nutrition Interventions

Knowledge is power. In order for an individual to make a decision, having the best information in order to make that decision is necessary. As this relates to nutrition information, educational interventions are key to an athlete's nutritional success. Deciding what type of intervention and the best method of communication for that intervention is key to successfully educating the population involved.

In a study by Doyle-Lucas, 321 female professional ballet dancers participated in an intervention program.[3] Participants' dietary status was assessed and showed that participants only consume 70-80% of the recommended dietary allowance (RDA) for total energy.[3] Results demonstrated significant improvement in nutrition knowledge, understanding of the female athlete triad, and self-efficacy for following healthier eating habits in the intervention group.[3] The intervention group also improved their dietary intake, showing decreased consumption of candy, fast food and soda.[3] Fortunately, this intervention positively impacted the ballet dancers eating habits.[3]

Similarly to the study done be Doyle-Lucas et al.[3], a study by Yannakoulia et al.[4], showed beneficial outcomes for an educational intervention for female dancers. Twelve weekly intervention sessions improved the participant's nutrition knowledge and showed significant improvements in eating behavior.[4] One of the main results of the study indicated that nutrition education changed eating behavior and attitudes about food at immediately after intervention ($p=.003$) and was maintained at 6 months ($p \leq .01$).[4] When participants were subdivided into groups with high or low risks of abnormal eating behaviors, it was found that those with low risks of abnormal eating showed a decline in nutrition knowledge after 6 months (p=.013) but not in those with high risk.[4] This recent research demonstrates the relevance of nutrition education towards both eating behaviors as well as body perception related to disordered eating.[4]

Another positively affected intervention was completed by Torres-McGehee and Green[7], demonstrating the positive outcomes of a nutrition education program. This research study looked specifically at preventing eating disorders.[7] Two NCAA Division I university marching bands with female auxiliary dancers participated in this study.[7] Participants from one of the universities were assigned to the intervention group (n=23), while the other universities auxiliary dancers acted as the control.[7] Pre- and post-intervention, body composition was estimated, eating disorder characteristics and behaviors and depression were self-reported, an eating disorder knowledge questionnaire was given, and a nutrition knowledge survey was taken.[7]

The intervention was implemented in a team setting to address the effects of anabolic steroids and other drugs, effects of alcohol on athletic performance, calcium needs, sports nutrition, exercise, depression, and consequences of disordered eating.[7] The intervention included eight, 45-minute classroom sessions over a 4-week period.[7] There was a statistically significant increase in scores on nutritional and overall eating disorder knowledge in the intervention group when compared to the control group.[7] ANCOVA showed statistically significant mean scores on depression, drive for thinness, body dissatisfaction, and maturity fears decrease in the intervention group. Overall, this study reveals the positive impact a nutrition education intervention can have on collegiate level dancers.[7]

Based on the three above research studies, no matter the nutrition information or how it is received, a nutrition intervention program will positively impact an individual's knowledge on how to properly take care of their bodies. A nutrition education intervention will educate individuals on how to fuel their bodies for their appropriate activity level. To better connect with the collegiate population, a technology based intervention will be implemented for this research study.

Technology-based intervention

As individuals get older, their spectrum of education content becomes deeper and broader. The introduction of technology into the education realm has allowed for the availability of education on many topics to reach not only more people, but also increase the breadth and/or depth of their knowledge. In the last 2 decades technology-based education has become part of the norm.[18.35] The prevalence of internet availability has increased the availability of access to education for both younger and older adults without having to be in close proximity.[18,35] Long distance education has become much more interactive in recent years due to television, videos, computers, internet, Skype and other technological advances.[18,35] As Willis and Margrett[18] state, "The use of technology encourages flexible learning and has the advantages of decreasing cost, improving quality, and broadening access to educational materials, perhaps leading to virtual universities in the future." This statement in 2001, has seen current fruition in universities now offering programs that are all or nearly all on-line in 2017. At this juncture, the research continues to look at the effectiveness and quality of learning, but there is no doubt that the access to education has been expanded to reach more people.

Nutrition Specific Technology based Interventions. In the previously mentioned article by Doyle-Lucas et al.[3], 321 female professional ballet dancers participated in an intervention program. Participants in the intervention group watched 3 DVD segments addressing nutrition and the female athlete triad, basic nutrition principles, healthy behavioral habits for dancers, hydration, and eating for optimal health and performance.[3] The control group did not view the DVD materials. Scores from baseline to follow-up increased in the intervention group by 25% but only 8% in the control group.[3] Positive results were seen during this study, showing the effectiveness of a DVD intervention.[3]

Although a DVD intervention is a great way to relay information to young adults, in today's more technology savvy culture, online or social media are used more frequently than other internet based technology.[18,35] Rice et al.[21] found that online and social media interventions are expected to increase in popularity among young people over the next decade. About 95% of young people are using the internet daily.[21] The immediate responses and 24 hour accessibility of the internet and social media gives young people an easy way to access help and education who may not be able to by other means (face-to-face).[21] Rice et al.[21] found that "online and social media-based interventions provide an opportunity to enhance feelings of connectedness in young people, a key component of the interpersonal theory of suicide." Although, not only can social media and online interventions help those in need of suicide help, it can help those seeking any information, including nutritional. These concepts are also supported by work done by Long et al.[20] reporting the results of the effectiveness of a technology-based intervention to teach evidence based practice and Mayer and Harrison[19] looking at the use of social media for food safety education.

Long et al.[20] found that a technology based, evidence-based research tool that can be accessed from computers, iPad's or a smartphone to guide students through the basic steps of finding evidence-based research, improved the students overall research skills. This study however, was not intended to take away from textbooks and outside sources, but to aid in the educational experience for these nursing students.[20] This study shows that a technology based intervention can positively impact how a student learns and absorbs information.[20]

Mayer and Harrison's[19] findings showed that "more than 90% of students identified the Internet as where they would go to access food safety information." Results from this study show that online education for food safety maybe just as effective as a lecture and other educational methods.[19] In a world of smart phones and the internet, easy access to factual information and an intervention program can make educating young adults very efficient.[19] As shown through these studies, technology based nutrition education interventions are more successful and easily accessible to the populations at hand than a classroom or non-technology based intervention.[19]

Technology learning across generations.

Technology is constantly improving and changing, as well as the generations being exposed to these changes. In today's society, the internet is something people have unlimited access to. Young adults and children today are known as 'digital natives'.[36,37] They are 'native speakers of the digital language'.[36,37] The knowledge and accessibility to technology and the internet gives the children and young adults of today the ability to use technology in ways that were not possible 15-20 years ago.[36] Before accessible internet access, the fastest way to send paper information was through the mail. Now, with email and other social media, communication and relaying information can be done in seconds.

Young adults vs. adult population. A study by Grabar et al.[36], examined motivation in using technology, frequency and form of technology use, learner beliefs about computer use in foreign language learning, and the effect of its use on learner motivation to invest effort in language. The participants were high school learners, learners at the university level, and learners over 30 years of age.[36] The outcomes showed that high school and university level participants have a higher computer-mediated communication (CMC) competence and use CMC tools more often than the over 30 y.o. adults.[36] Adult learners were also seen to have the least amount of confidence while using CMC tools.[36] Other significant findings showed that younger participants were less likely to use e-mail as a communication method, and adult learners did not make use of chat, instant messaging or text messaging in comparison to the university and high school learners.[36] The results also suggest that Facebook is a favorite communication tool for younger participants, whereas adults still rely on more personal forms of communication.[36] Grabar et al.[36] suggests that smartphones are a useful tool for academic purposes.

Similarly, to the study done by Grabare et al.[36], Jelfs et al.[38] looked at the use of digital technologies across the adult life span in distance education. This survey-based research looked at access to digital technology, attitudes to digital technology, and approaches to studying across the adult life span in students taking courses with the UK

Open University in 2010 (mostly online courses).[38] Results showed that all students had access to a computer and the internet, however, younger students were more likely to have access to other technologies such as smart phones and tablets.[38] Younger students were also more likely to spend more time on other technologies as well as be more comfortable using them. Students in the older age groups (40-70+), were more likely to have access to a desktop computer than participants below the age of 40, while participants in the <40 y.o. range were more likely to have access to a laptop computer, a mobile phone, a portable digital music player, and handheld/console game players.[38] The younger age groups (below 40) were much more likely to use text messages and their phone as a camera than the older age groups, as well as spending longer periods of time using technology each day.[38] These studies suggest that the younger population, including high school and university level learners, are more comfortable with and prefer technology-based communication and education, rather than other non-technological forms of communication and education.

Preferred method of communication. Young adults, (18-24), prefer use of text messages, social media or e-mail to communicate with peers, professors, bosses or family.[39] In a study among 166 college students at two universities, assessing the preferred method of communication with professors, classmates and group members the results indicated that e-mail was the most frequent method of communication for most purpose.[39] Text messaging came as a close second, especially for socializing. Facebook was used to some extent for socializing, while phone conversations were rarely used as a means to communicate with professors or other students.[39] This shows that e-mail and text message are the preferred methods of communication among college students.

Measuring energy expenditure

The analysis of energy expenditure to correlate with food consumption to determine caloric intake needs for evaluating health status is important. Accurate comparison of caloric and nutrition intake and caloric expenditure is necessary to assist individuals to meet nutrition based health goals such as weight loss/gain, sodium reduction, vitamin mineral supplementation, and energy balance based on training needs. There are many different ways to measure energy expenditure that have been reviewed in the research: Pedometers, prediction equations and accelerometers.

Prediction equations. In a systematic review by Madden et al.[40], researchers looked at identifying which prediction equation based on simple anthropometric and demographic variables provided the most accurate and precise estimates of (1) resting energy expenditure (REE) and (2) total energy expenditure (TEE) in healthy obese adults. After completion of the systematic review, the authors concluded that there was no single prediction equation that provides an accurate and precise REE estimates as well as evidence showing inconclusive results for prediction equations estimating TEE in obese healthy adults.[40]

Pedometers. Electronic pedometers are simple, non-intrusive devices that can be used to assess physical activity.[41] Newer pedometers can now measure distanced traveled as well as energy expended.[41] A study done by Crouter et al.[41], determined the effects of walking speed on steps taken, distance traveled, and energy expenditure from 10 different pedometers. Results showed that pedometers tend to underestimate actual steps, overestimate distance traveled at slower speeds, underestimate distance traveled at higher speeds, and underestimate the cost of most types of “lifestyle” activities.[41] Activities involving the arms, pushing or carrying objects, walking uphill, or stair climbing all underestimated energy expenditure. These results suggest that there is a limitation when using pedometers to measure daily physical activity energy expenditure.[41]

Kumahara et al.[42] and Abeysekera et al.[43], both also assessed energy expenditure using pedometers. The results of Kumahara et al’s.[42] study showed that the total number of steps per day were not a meaningful predictor of physical activity energy expenditure. When body weight was used in the prediction equation, the pedometers did show significant prediction values for assessing physical activity energy expenditure.[42] However, this does not show that pedometers alone are a reliable source for predicting physical activity energy expenditure.[42] Abeysekera et al[43], found that pedometers are unresponsive to differences in gait such as stride length. Pedometers do not record horizontal or upper body movements which means they are less accurate when measuring distances traveled and total energy expenditure.[43] Pedometers can be great tools for measuring steps and how active a person is throughout a day. However, research has shown they are not good tools for measuring energy expenditure due to their lack of reliability and validity in measuring intensities, stride length and other axes other than horizontal.[41-43]

Accelerometers. Accelerometers are non-intrusive, small units that can be worn either around a persons’ waist, wrist, or ankle. They record motion in 1 plane (uniaxial) or 3 planes (triaxial) of movement. Accelerometers are used to determine the frequency, duration and intensity of active energy expenditure. To understand how accelerometers retrieve their information, it is important to know that acceleration is directly proportional to muscular forces. When an accelerometer is worn, the acceleration of the muscle contractions are collected and directly correlated with active energy expenditure. [43,44] Research outcomes have shown that tri-axial accelerometers are the preferred approach for measuring energy expenditure.[43-45] A tri-axial accelerometer enables the most accurate wearable measurement of energy expenditure of a person's activity and postural changes.[45]

Accelerometers, compared with other techniques such as a pedometer or prediction equation can accurately divide data into time spent between sedentary, light, moderate and vigorous activity levels.[43] Accelerometers calculate absolute energy expenditure without measuring the participant's basic metabolic rate.[43] A study completed by Noah et al.[46], looking at the comparison of steps and energy expenditure assessment in adults of Fitbit Tracker and Ultra (brand models) to the Actical and indirect calorimetry (standard devices), found that both the Fitbit and Fitbit Ultra are reliable and valid when compared to the standard devices. Both accelerometers were found suitable for monitoring and reporting energy expenditure and activity results.[46] This study reveals that multiple brands and companies responsible for making accelerometers have been proven to be reliable and valid for use of energy tracking.[46]

Accelerometers have been demonstrated to have established reliability and validity to accurately collect energy expenditure for many populations.[44,46,47] Many studies show the validity of accelerometers and how they are acceptable tools to measure active energy expenditure. In a study by Mensah et al.[47], test-retest reliability and validity of the Sedentary, Transportation and Activity Questionnaire (STAQ) was examined. Ninety-six subjects kept a contextualized activity-logbook and wore a hip accelerometer

(Actigraph GT3x+ TM) for a 7-day or 14-day period.[47] Results showed that the STAQ had acceptable reliability and a good ranking validity score for assessment of context-specific sedentary behavior and transport-related activities.[47] This study shows that the Actigraph GT3x+ accelerometer has been used as a comparison tool to test the reliability and validity of a different energy expenditure tool.[47]

APPENDIX B

IRB Approval

TEXAS STATE UNIVERSITY
SAN MARCOS
The rising STAR *of Texas*

In future correspondence please refer to 2017495

February 22, 2017

Hayley Edenzon
Texas State Univeristy
601 University Dr.
San Marcos, TX 78666

Dear Ms. Edenzon:

Your application 2017495 titled, "The relationship between a 4-week nutrition education intervention program and the eating habits of collegiate female dancers," was reviewed by Texas State University IRB and approved. It has been determined there are: (1) research procedures consistent with a sound research design and they do not expose the subjects to unnecessary risk. (2) benefits to subjects are considered along with the importance of the topic and that outcomes are reasonable ; (3) selection to subjects' welfare and producing desired outcomes ; that indications of coercion or prejudice are absent, and the participation is clearly voluntary.

1. In addition, the IRB found that you need to orient participants as follows: (1) signed informed consent is required; (2) Provision is made for collecting, using and storing data in a manner that protects the safety and privacy of the subjects and the confidentiality of the data; (3) Appropriate safegueards are included to protect the rights and welfare of the subjects.

This project is therefore approved at the Expedited Review Level until January 31, 2018.

2. Please note that the institution is not responsible for any actions regarding this protocol before approval. If you expand the project at a later date to use other instruments, please re-apply. Copies of your request for human subjects review, your application, and this approval, are maintainted in the Office of Research Integrity and Compliance. Please report any changes to this approved protocol to this office. A Continuing Review protocol will be sent to you in the future to determine the status of the project.

Sincerely,

Monica Gonzales
IRB Regulatory Manager
Office of Research Integrity and Compliance
Texas State University

CC: Dr. Marie Pickerill

OFFICE OF THE ASSOCIATE VICE PRESIDENT FOR RESEARCH
601 University Drive / JCK #489 / San Marcos, Texas 78666-4616
Phone: 512.245.2314 / fax: 512.245.3847 / WWW.TXSTATE.EDU

This letter is an electronic communication from Texas State University-San Marcos, a member of the Texas State Univeristy

Recruitment Speech

Hi, my name is Hayley Edenzon and I am a Graduate Student here at Texas State. Along with completing my Master's I am also a Graduate Assistant Athletic Trainer for the Tennis team and for the Strutters dance team. I wanted to reach out to you as members of the Strutters in assisting me as participants for my thesis I will be conducting in the next few weeks.

My research question pertains to you, as dancers, in understanding how a nutrition education intervention can impact your eating habits. As part of this I will determine if participants' nutrition knowledge and follow-up electronic media education can alter nutritional habits as determined through a 3-day food log and survey. What would be asked of you? That you complete a 3-day food log while wearing an accelerometer for those same 3 days, completing a questionnaire, be willing to receive electronic media on nutritional information for four weeks, and then complete the food diary again.

The nutritional information will be evidence-based facts about weight management, weight loss, proper nutrition, and eating disorders we see with many female young adult dancers. The nutritional information will be based on noted nutrition trends from the initial 3-day food diary, to make you aware of some nutrition deficiencies or imbalances in your dietary intake.

Many of you might be wondering why you would want to participate in my study. Not only will you receive evidence based nutrition education for your goals as a dancer, but if you are interested you can receive your pre- and post- food-log nutrition summaries by contacting me after the end of the study. This information is primarily based on typical sports, and my goals is to evaluate this information specifically for dancers. Knowing how to properly fuel your body can decrease chances of injury as well as increase your endurance levels.

I will be passing out interest forms that I would like to get back today. Please let me know if you have any questions. I look forward to working with you girls and learning together.

Interest Form

If you are interested in participating in this study, please fill out the form below. You will be contacted by a researcher to set up your first appointment. The appointment dates and times can be flexible to fit into your schedule.

This information will only be viewed by the research team.

Name:___________________ Date: _______________

I am:

A. interested in participating in this study
B. need more information before making a decision
C. not interested in participating in this study

Preferred method of contact (please circle one): Email or Phone Call

Email: ________________________ Phone Number: _______________________

Consent Form

Study Title: The relationship between a 4-week nutrition education intervention program and the eating habits of collegiate female dancers.

Principal Investigator: Hayley Edenzon

Co-Investigator/Faculty Advisor: Dr. Marie Pickerill

This consent form will give you the information you will need to understand why this research study is being done and why you are being invited to participate. It will also describe what you will need to do to participate as well as any known risks, inconveniences or discomforts that you may have while participating. We encourage you to ask questions at any time. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You will be given a copy of this form to keep.

PURPOSE AND BACKGROUND

You are invited to participate in a research study to learn more about the potential relationship between nutrition knowledge and diet quality in collegiate female dancers. The information gathered will be used to assess the relationship between dietary intake and the assessment of a nutrition education protocol. You are being asked to participate because it is important to understand the proper nutrition needs for female dancers to perform at their highest ability.

PROCEDURES

If you agree to be in this study, you will complete the following:

- One, 21 question Questionnaire
- 3 days of food records completed independently, pre- and post-intervention
- Wearing an accelerometer for 3 days pre- and post- intervention
- A 4-week nutrition education intervention

Visit 1: Assessments:

The first visit will take place in Jowers Center room B160 on the Texas State University Campus. You will review the consent form given to you and ask any questions you may have. You will then set up a start day for your 3-day food log and the wearing of the accelerometer. You will have your height and weight measured at this time.

Visit 2: Nutrition Questionnaire

You will meet in Jowers Center room B160 to turn in your 3-day food log/accelerometer and complete the nutrition knowledge questionnaire.

Nutrition Intervention:

You will be checking some form of social media every 2-3 days for 4 weeks for a nutrition fact or suggestion. You will read each posting carefully for full understanding.

Visit 3: **Schedule to start 2nd 3-day food log**

After the 4-week intervention, you will schedule another day to start your second 3-day food log and wearing of the accelerometer.

Visit 4: Return 2nd 3-day food log and accelerometer

At the completion of the second 3-day food log and wearing of the accelerometer you will turn both in at Jowers Center room B160.

Additional Materials:

- Food Records: The researchers will ask that you record the amount and types of fluids and foods you consume on three different days of eating. The researchers will assign you days to record your eating habits. Each food record should take no more than 10 minutes to complete. Time commitment for completing three food records: 30 minutes.

RISKS/DISCOMFORTS

There are very little to no risks in participating in this study. You will be asked to wear an accelerometer on your hip for 3 straight days. You may apply the accelerometer over your pants or directly on your skin. You may have some discomfort wearing the accelerometer for 3 days.

BENEFITS/ALTERNATIVES

If you agree to take part in this study, there may or may not be a health benefit to you. We ask for your participation to further our understanding of the relationship between nutrition knowledge and diet quality in collegiate female dancers. Upon request, you will receive your dietary log analysis for your own benefit and knowledge after the conclusion of the study.

EXTENT OF CONFIDENTIALITY

All responses or information you provide will be confidential. Identifying information will not be available to anyone outside of our research group. All data collected will be numerically coded so that no individual data will be identifiable. If information form this study is published or presented in scientific meetings, your name and other personal information will not be used. Your personal information will be disclosed only with your permission or as required by law. Records will be kept in a locked file cabinet in the Jowers Center for 3 years, and after this time all files will be shredded.

Your name will not be used in any written reports or publications which result from this research. Data will be kept for three years (per federal regulations) after the study is completed and then destroyed.

PAYMENT/COMPENSATION

You will not be paid for your participation in this study.

PARTICIPATION IS VOLUNTARY

You do not have to be in this study if you do not want to. You may also refuse to answer any questions you do not want to answer. If you volunteer to be in this study, you may withdraw from it at any time without consequences of any kind or loss of benefits to which you are otherwise entitled.

QUESTIONS

If you have any questions or concerns about your participation in this study, you may contact the principle investigator, Hayley Edenzon: hme19@txstate.eduor co-investigator Dr. Marie Pickerill: mlpi146@txstate.edu

Pertinent questions or concerns about the research, research participants' rights, and/or research-related injuries to participants should be directed to the IRB Chair, Dr. Jon Lasser 512-245-3413 – (lasser@txstate.edu) or to Monica Gonzales, IRB Regulatory Manager 512-245-2314 - (meg201@txstate.edu).

DOCUMENTATION OF CONSENT

I have read this form and decided that I will participate in the project described above. Its general purposes, the particulars of involvement and possible risks have been explained to my satisfaction. I understand I can withdraw at any time.

Printed Name of Study Participant	**Signature** of Study Participant	Date

Signature of Person Obtaining Consent	Date

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