Within-Day Energy Balance and the Relationship to Injury Rates in Pre-Professional Ballet Dancers.

Emily Cook Harrison

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Within-Day Energy Balance and the Relationship to Injury Rates in Pre-Professional Ballet Dancers

By

Emily Cook Harrison
B.S., Georgia State University, 2007

A Thesis Submitted to the Graduate Committee
In the Division of Nutrition at Georgia State University in Partial Fulfillment
of the
Requirements of the Degree

MASTER OF SCIENCE

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ATLANTA, GEORGIA
2009
APPROVAL

Within-Day Energy Balance and the Relationship to Injury Rates in Pre-Professional Ballet Dancers

By

Emily Cook Harrison

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ACKNOWLEDGEMENTS

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I would like to dedicate this thesis to my husband Paul Harrison and to my family, in deep gratitude for their tremendous support and encouragement.
ABSTRACT

Introduction: Body weight and body mass index (BMI) of ballet dancers have been shown to be below recommended levels, and total energy intake is often sustained at a level below the predicted energy requirement. While data on daily energy balance (EB) exist, less is known about the ability of dancers to manage energy balance during the day, as energy requirements fluctuate between periods of rest and intense activity. Past studies on a variety of athlete groups suggest that compromised within-day energy balance (WIDEB) and EB may both result in decreased athletic performance, higher body fat percentage, and increased injury risk.

Purpose: To assess WIDEB and EB during a typical training day in a group of pre-professional ballet dancers, and to assess the relationship between WIDEB and inadequate EB and injury rates in these dancers.

Methods: Following an IRB-approved protocol, a two-part assessment tool was developed to measure hourly energy intake and expenditure within a single 24-hour time period. BMI, resting energy expenditure, WIDEB, EB, and energy deficits > -400 kcal were predicted and also used in the analysis. Participants were asked to document the number of injuries incurred within the previous dance season, and how many days of practice were lost or compromised as a result of the injury. Data analysis included descriptive statistics, ANOVA, and Spearman’s correlation to assess relationships and gender differences between WIDEB, EB and injury rates.

Results: Data were collected from 21 (5 males, 16 females) pre-professional ballet dancers from the Atlanta Ballet. Mean BMI was 21.9 ±1.4 for male dancers (MD) and 19.1 ±1.0 for female dancers (FD). Negative EB was found in 90.5% of participants. Mean energy intake for all dancers was 2,382 kcal (± 921) and the mean predicted energy expenditure was 3,317 kcal (± 592). Mean EB for all participants was -781.2 (±689.4). The mean EB for MD was -223.6 (±629.7) and -1156.9 (±582.5) for FD. The largest WIDEB energy deficits (>900 kcal) were found between the hours 17 and 20. Participants spent a mean of 660.0 (±192.6) minutes per day in negative WIDEB > - 400 kcal. Total group (TG) injury days and WIDEB minutes > - 400 kcal were not significantly correlated. The number of WIDEB minutes > - 400 kcal and the number of injuries reported per dancer were weakly but significantly correlated (r = -0.44; P = 0.046). MD (n = 5) injury days were significantly associated with WIDEB at hours 1 through 7 (r = 0.90; P = 0.37). MD total number of times injured was also significantly associated with WIDEB at hours 1 through 7 (r = 0.89; P = 0.04). A significant association was also found in FD between the number of times injured and WIDEB deficits > - 400 kcal (r=-0.54; P=0.03).

Conclusions: Ballet dancers have large energy deficits during a typical training day that increase injury risk. Improving energy intake (both EB and WIDEB) through nutrition education programs should be considered an important injury prevention strategy for dancers.

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ABBREVIATIONS

ACL: Anterior Cruciate Ligament
ACSM: American College of Sports Medicine
ADA: American Dietetic Association
ATP: Adenosine Triphosphate
BMI: Body Mass Index
cm: Centimeters
CP: Creatine Phosphate
CT Scan: Computerized Tomography scan
CTLEA: Computerized time-line energy assessment
DEXA: Dual Energy X-ray Absorptiometry
EB: Energy Balance
FD: Female Dancers
IPAIRS: International Performing Arts Injury Reporting System
IRB: Institutional Review Board
Kcal: Kilocalories
kg: Kilograms
MD: Male Dancers
NCAA: National Collegiate Athletic Association
NHANES: The National Health and Nutrition Examination Survey
RDA: Recommended Daily Allowance
REE: Resting Energy Expenditure
SCAN: Sports, Cardiovascular, and Wellness Nutrition. ADA dietetic practice group
SD: Standard Deviation
SPSS: Statistical Package for the Social Sciences
TG: Total Group
US: United States
WIDEB: Within-Day Energy Balance
CHAPTER I
INTRODUCTION

The dance world is a highly competitive and cloistered environment in which dancers are expected to perform at high levels of physical fitness, and choreographic demands continue to increase as this art form becomes progressively more athletic. The intensity of training at the pre-professional level in national professional ballet schools is similar to that of elite level athletes who compete at national and international level competitions, including rhythmic gymnastics and ice skating. Due to the physical demands experienced by pre-professional dancers and professional dancers, they are considered similar to athletes competing in aesthetic sports for the purposes of this thesis. Young pre-professional dancers in training or in the early years of their professional careers experience psychological and physiological pressure to achieve the technical skills and endurance to be competitive for company level positions. Dancers must be proficient in a variety of dance styles including classical ballet, contemporary ballet, jazz, and modern dance. The culture of this aesthetic art form also requires that dancers maintain lean physiques (i.e., low body fat levels) often leading dancers to intentionally or unknowingly engage in restrictive eating practices that may result in eating pathology. Dancers’ body weight and BMI have been shown to be below recommended levels or below the body weight of comparable non-dancer controls, and total energy intake is often sustained at a level below the predicted energy requirement, suggesting some level of adaptive thermogenesis. Less is known about the ability of dancers to manage energy balance during the day, as energy requirements fluctuate as a result of periods of rest and intense
activity. Compromised energy balance in athletes may result in decreased athletic performance, higher body fat percentage, and increased injury risk.

The purpose of this study is therefore, to assess within-day energy balance (WIDEB) during a typical training day in a group of pre-professional ballet dancers, and to assess the relationship between inadequate energy balance and injury rates in these dancers. Past studies suggest that negative energy balance may result in a loss of lean muscle mass, fatigue, and menstrual dysfunction, which may increase the risk of injury. Additionally, hypoestrogenemia and amenorrhea, are associated with low bone mass and increased risk of musculoskeletal injury.

Injuries can be devastating physically and financially. Even minor injuries can derail training and performance and have short-or long-term consequences. Dancers between the ages of 15-23 are especially vulnerable to ignoring injury warning signs, overtraining, and eating pathology leading to fatigue. Injuries may be related to a variety of factors. Dancers have little control over environmental or activity specific factors such as a slippery surface, rapid direction changes, or unanticipated landings, but they do have a measure of control over their nutritional status, which could improve mental acuity and physical capability that could contribute to injury prevention. According to the American College of Sports Medicine, “Inadequate energy intakes can result in loss of muscle mass, menstrual dysfunction, loss or failure to gain bone density, an increased rate of fatigue, injury, and illness”. Nutritional factors can play an important role in injury prevention and prevention is a far better option than even the best treatment.

Becoming a professional ballet dancer begins with training long hours in an elite ballet school. This study focused on a population of dancers who were admitted, through
audition, to a large and accredited, pre-professional ballet school that is affiliated with a national ballet company. It has been previously reported that disordered eating habits associated with poor energy balance are more common among pre-professional dancers in schools affiliated with national professional ballet companies. It has also been documented that professional dancers have higher rates of eating pathology. It is hoped that the study results can be used as a rationale for the development of a comprehensive nutrition and injury prevention program for the Atlanta Ballet which could target intervention strategies for assisting dancers with understanding the importance of energy balance. These data could also be used to secure sources of funding for Atlanta Ballet’s nutrition and injury prevention program.

CHAPTER II

REVIEW OF THE LITERATURE
Disordered Eating Prevalence and Energy Balance in Ballet and Related Activities

Disordered eating, fasting, and dieting are well documented in the dance world. However, there is limited energy balance research specifically on dancers, and even less on energy balance throughout training days. There are many similarities in training between dancers and other athletes, and eating pathology and inadequate energy intake can be found in other athletic disciplines. For these reasons, the literature reviewed included research on weight restricted and aesthetic sports/activities, including ballet, modern dance, gymnastics, ice skating, running, basketball, wrestling, Judo, and other forms of athletics. Athletes in aesthetic sports, including dancers, are known to have eating patterns that result in states of severe negative energy balance, and female athletes with disordered eating patterns but who have not been medically diagnosed with an eating disorder (sub-clinical eating disorder) also have significantly higher rates of negative energy balance. At the pre-professional and professional level, dancers have been shown to exhibit eating pathologies that include fasting, energy restriction, and excessive dieting. Body weight issues are common in this aesthetic art form, so it is not surprising that ballet dancers have significantly higher rates of underweight and low body mass index (BMI) than age-matched controls. Several studies that have included ballet dancers have found that subjects with abnormal eating behaviors and/or excessive dieting without a diagnosis of an eating disorder had higher rates of negative energy balance with lower mean dietary intakes of all macronutrients. Additionally, underfeeding resulting in an energy deficit is associated with loss of lean mass and decreased resting energy expenditure.
WIDEB has been found to be a predictive factor in estimating body fat percentage. An energy deficit, defined as inadequate calories to support any given level of energy expenditure, such as in athletic training, is positively associated with higher percentage of body fat. Using a computerized time-line energy assessment (CTLEA), which assessed energy intake compared to expenditure minute by minute in a 24 hour period, it was reported that elite level rhythmic gymnasts had higher within-day energy deficits, larger single-hour calorie deficits, and higher percentage of body fat than artistic gymnasts or runners. Energy deficits as measured by hours with a deficit greater than 300 kcal were associated with increased body fat percentage. It has been suggested that staying within +/- 400 kcal throughout the day is a more desirable energy balance for athletes. Ballet dancers also been shown to have both lower total body fat and lower body fat percentage than age matched controls. Artistic gymnasts, rhythmic gymnasts, and ballet dancers do not differ significantly in BMI. However, the ballet dancers had a statistically significant difference in body fat percentage than artistic gymnasts. The artistic gymnasts had a mean body fat of 12.4% while ballet dancers had a mean body fat of 17.4%. Restrictive eating practices play a role in body fat percentage. When athletes were given 250 calorie snacks between meals in an effort to reduce negative energy balance, they had a statistically significant decrease in body fat percentage, but did not experience a significant weight change. They were found to self-manage meal size at other times during the day in order to keep total calorie levels roughly the same in spite of the added calories in the snacks. This change to smaller more frequent meals was also associated with increased lean mass thus changing body composition without significantly changing weight.
Young dancers at the pre-professional level or early years of professional careers are especially vulnerable to engaging in restrictive eating practices. Professional dancers were quoted in the *Journal of Dance Medicine and Science* saying “When I was younger, when I just came into the company, there were times that I didn’t allow myself to eat anymore. I wanted to look like the others”, another dancer stated “You can’t eat much over the weekend because Monday you have to be in a leotard”. The etiology of eating pathology has many more layers than just cultural or environmental pressures. The time period particularly around the age of puberty and shortly thereafter is when natural physical changes may influence or trigger eating pathology. It has been documented that disordered eating practices may have a hereditary and biological basis, with average age of onset occurring in early adolescence. Additionally, periods of fasting, dieting, or eating restriction may disrupt nutritionally regulated hormones including leptin, adiponectin, and ghrelin, thereby contributing to the etiology and cycle of eating disorders. In female dancers in a summer ballet intensive workshop (mean age 15 years) it was found that this age group scored high on the *Eating Disorder Inventory* measures of fasting, drive for thinness, and other disordered eating behaviors. Professional ballet dancers (mean age 23.2) were found to score significantly higher than controls on the *Eating Attitudes Test (EAT26)*, an assessment tool designed to measure abnormal eating behaviors such as anorexic thoughts or behaviors, bulimic behaviors, dieting behavior and oral control.

Energy intake is consistently found to be lower than the predicted needs of dancers, gymnasts and skaters. Adolescent elite female figure skaters with the mean age of sixteen were found to consume significantly fewer calories than estimated needs. Similarly, adolescent rhythmic gymnasts with a mean age of fifteen were found to have an average
energy deficit of five hundred calories per day and particularly restricted dietary fat intake. In addition, elite level female figure skaters reported consuming less than recommended calorie levels for athletes based on three day food records, and reported consuming significantly less total energy than age matched subjects from The Third National Health and Nutrition Examination Survey (NHANES III).

**Energy Substrate Distribution**

Researchers found that adolescent gymnasts did attain recommended levels of macronutrient distribution as percent of total calories even though total calories were less than recommended. When macronutrient intake was assessed based on gram amount of energy substrate per kilogram of body weight, artistic gymnasts reported significantly higher intakes of carbohydrates per kg than rhythmic gymnasts or ballet dancers. Female runners with injuries were found to consume significantly lower intakes of dietary fat than female runners without injuries in spite of fat intake as percent of total calories within recommended levels. Elite figure skaters and figure skating dancers were found to consume adequate amounts of dietary fat. However, it is important to note that in both of these studies the total the caloric intake was below the recommended intake level. Another study also found that total caloric intake and fat intake as percent of total calories were below recommended levels in the US National Women’s artistic gymnastics team.

**Vitamin and Mineral Intake**

Research findings on the intake of vitamins and minerals in athletes and dancers are conflicting. The average vitamin and mineral intakes of athletes from a variety of
Disciplines were found to meet or closely approach the recommended daily allowance (RDA). Some exceptions were that vitamin E intake was below recommendations, and calcium and potassium intake were found to be lower than recommended levels. In a study on female artistic gymnasts, 92% of gymnasts were reported to be taking either a prescription or over the counter type of vitamin and mineral supplement.

Dietary Intake and the Relationship to Menstrual Status

There is an important relationship between dietary intake, menstrual function and bone density. Tomten and Hostmark (2006) found that female runners who had more eating episodes throughout the day were found to have lower rates of menstrual dysfunction than those who had fewer eating episodes. They also found that inadequate energy intake and compromised energy balance were two variables significantly associated with impaired menstrual function. They stated that “a significant negative energy balance was calculated for the irregular menstrual status group”. Energy intake in the evening (post-exercise) meal was almost twice as high in the regular menstrual status runners compared to runners with irregular menstrual status.

Energy deficits also have an impact on increased rates of amenorrhea and injury. It is well documented that amenorrhea and/or oligomenorrhea are problems in ballet dancers and are linked to low bone mineral density. Ballet dancers have been found to have higher rates of amenorrhea than did age and weight matched non-dancer controls. When dancers were compared to non-dancer controls, the dancers were significantly more underweight, had higher rates of dieting, ate fewer meals per day and had a higher prevalence of oligomenorrhea and amenorrhea. Ballet dancers and female athletes in aesthetic sports
have been found to have later age of menarche (from 14-16 years) than age matched controls. However, in the study by Stokic et al. (2005) subjects were not weight matched and the ballet dancers had significantly lower BMIs than the controls. Female ballet dancers (mean age 17) have been found to be oligomenorrheic with menstrual cycles longer than 30 and 60 days compared with non-athletic, age matched girls. The female athlete triad, low energy intake, amenorrhea, and osteoporosis, has been reported in female dancers. In female athletes, irregular menstrual function is associated with significantly lower calorie and dietary fat intake, and lower total body fat and body fat percentage.

**Energy Restriction, Menstrual Dysfunction and Bone Density**

There is a large body of evidence documenting inadequate energy intake compared to energy needs as a primary factor associated with hypoestrogenemia and amenorrhea, which are associated with low bone mass and increased risk of musculoskeletal injury. In women experiencing episodes of energy restriction, poor nutrient intake and amenorrhea, an association with reduced metabolic rate and lower bone mineral density was observed. This study found that the main predictor variable of osteopenia and menstrual dysfunction was decreased resting metabolic rate (as measured by fasting indirect calorimetry), and the authors suggested that restrictive eating behavior was the dominant causal factor. Dancers who exhibit restrictive eating habits and are underweight are at a significantly higher risk for stress fractures. A prospective study on stress fracture risk factors found that a later age of menarche and fewer menstrual cycles per year were significantly associated with increased stress fractures. A significantly later age of menarche was found in female athletes with stress fractures (age 15.6 ±2.2) compared to those without stress fractures.
(age 13.9 ±1.3). Interestingly, beverage choices also had an effect on stress fracture risk. Dancers who were documented to have had a stress fracture also had eight times greater consumption of diet sodas compared to dancers or non-dancer controls without stress fractures. Intake of calcium and vitamin D did not differ between groups. Female athletes who were diagnosed by bone scan or CT scan with a stress fracture had significantly lower bone mineral density and lean mass (as measured by DEXA) in the lower extremity compared to female athletes who did not sustain stress fractures. The relationship between female hormonal disruptions related to inadequate energy intake and low body fat is well established, but the male athletes who developed stress fractures did not have significantly different bone mass variables than men who did not develop stress fractures. Although the sample size of 49 males did show a trend toward lower total body bone mineral density in the stress fracture group. Additionally, there were no significant differences in men with and without stress fractures in body composition or dietary habits.

Male Dancers

While athletic females have been shown to have lower body weight, higher rates of energy restriction, and exhibit more dieting behaviors than males; male dancers and athletes may also be at risk for dangerous practices that include restricting energy and fluid intake. Typically, male dancers are not required to ‘weigh in’, but it is a part of ballet culture for male dancers to be both physically strong and also extremely lean. Research specific to male dancers and eating patterns is, however, limited. It is unknown if male dancers restrict eating or fluids before performance, auditions or regular training episodes.
for aesthetic reasons. Therefore, data on other male athletes participating in sports in which weight is a consideration are reviewed.

**Male Athletes Competing in Weight Restricted Sports**

Tarnopolsky et al. (1996) found that non-professional male athletes who compete in weight class sports such as wrestling or Judo may compete in a weight class 5-10% below their usual weight and also engage in extreme energy and fluid restrictions pre-competition to make weight. Additionally, they found a significant (54%) decrease in muscle glycogen concentrations in wrestlers asked to decrease weight before a weigh-in. Reported energy intakes for the college level wrestlers during the weight loss time period were 1117-1141 kcal/day. In wrestling, athletes are allowed up to 17 hours from weigh-in to competition during which time food and fluid can be consumed as needed. This may be adequate time to replenish glycogen stores and therefore it is unclear whether there may be a relationship between weight loss methods, fatigue and thus injury in this population. However, Judo athletes are different in that they have only 1-2 hours from weigh-in until competition and therefore may not have time to replenish energy reserves or fluids necessary for competition. Energy restriction and energy deficits affect the performance and physiology of dancers and athletes of both sexes.

**Injuries and their Relationship to Nutrition**

Conditions other than stress fractures may also be associated with nutritionally related factors, including fatigue, overtraining, undernutrition, and/or poor hydration.
Fatigue, defined generally as sensations of tiredness and accompanying decrements in physical performance, is an expected part of life for any dancer or athlete. Normal fatigue follows training or performance and recovery can be expected within a few hours or even days. However, fatigue can have significant detrimental effects when prolonged and particularly if it is due to energy deficits as opposed to normal training. Fatigued muscles produce significant changes in landing biomechanics. Fatigued thigh muscles significantly compromise the ability to protect knees and ankles in jump landings, leading to the conclusions that fatigue is a contributor to higher injury risk of the lower extremities especially when landing on one leg.

When lower extremity muscles are pushed to fatigue there is an increase in total knee range of motion during single-leg hop landings. Ballet and modern dance have been described as jump intensive activities. In a typical 1.5 hour classical ballet class, dancers execute over 200 jumps, most of which land on one leg. Single leg landings require increased ability of the lower extremity muscles to absorb impact and decelerate the center of mass primarily in the vertical direction placing the individual at higher risk for injury when fatigued. Because ballet dancers are highly trained to land both large and small jumps in a way that minimizes risk to the knee, the rates of ACL injuries are approximately 0.3 injuries per year in a company of 20 dancers. This is relatively low compared to other athletic disciplines in which non-contact ACL injuries have been described as reaching “epidemic proportions” with fatigue cited as one factor that preceded the injury. However, a five year prospective study on one of the leading US ballet companies found that most reported injuries were to the lower extremities or spine. It has been reported that
ACL injuries have been on the rise in athletes over the past 30 years and that women are more susceptible than men.

Modern dancers have been associated with higher rates of ACL injuries when compared to ballet dancers. However, not all studies on dancers agree. A study on dancers from a leading international company found that classical ballet dancers had higher rates of ACL injuries and also found that classical ballet dancers generally have a higher risk for injury than professional modern dancers. The risk for injury in the different styles of dance is important to note when designing an injury prevention program for young dancers because students at the pre-professional and early-professional levels are expected to study and be proficient in all styles of dance in order to be competitive for professional company positions. Any style of dance will require quick decision making and sometimes unanticipated maneuvers which can contribute to hip, knee and ankle flexion that increases risk for ACL injury. Finding nutrition related ways to combat fatigue would be an important component of an injury prevention program for dancers.

Fatigue and overreaching symptoms that can lead to injury and impair performance can be delayed by providing adequate energy intake before exercise and if prolonged, carbohydrate intake during exercise may be necessary. Working muscles require calories in order to provide adequate adenosine triphosphate (ATP) and creatine phosphate (CP) to provide readily available energy particularly for short high intensity bursts of activity. Longer bouts of exercise require mobilization of stored energy in the form of muscle and liver glycogen in addition to triglycerides. The body adjusts the mix of energy substrates used based on energy output, level of exercise intensity, and level of training.
Physiological Effects of Inadequate Energy Intake

When restrictive eating practices lead to inadequate intake to meet energy demands, gluconeogenesis results in a catabolism of fat free mass (FFM) to use the free amino acids as a fuel source. This reduction of lean tissue leads to fatigue and impairs strength, endurance, and musculoskeletal function. Insufficient carbohydrate intake may further lead to decreased immune function by elevated cortisol and other hormonal influences on the immune system. When athletes are given snacks between meals in an effort to reduce within-day energy deficits, subjects reported increased jump height, increased aerobic power, and increased energy output. Adequate nutrition and dietary intake, in particular carbohydrate, can help athletes respond to training, competition, or performance with less fatigue and can promote tissue repair from minor injuries. Restrictive eating practices compromise the body’s production of ATP, and glycogen stores and lead to greater fatigue which is linked to increased rates of injuries. For athletes, the current American College of Sports Medicine (ACSM) and American Dietetic Association (ADA) recommendations for carbohydrate are 6-10g/kg body weight/day depending of individual energy expenditure. Protein requirements are 1.2-1.7g/kg with sufficient energy intake to maintain body weight and fat intake is recommended to be 20-35% total calories.

Nutrition intervention post-exercise is an important component of energy balance and injury prevention by ensuring an adequate supply of stored energy and by reducing fatigue. Replenishing glycogen stores by consuming a source of carbohydrate post-exercise is one way to reduce future fatigue and optimize the immune system, both important nutrition-related injury prevention strategies. An important component of an injury prevention program for dancers would be nutrition education about energy intake
and energy substrate utilization during exercise as well as post exercise strategies for replenishing glycogen stores.

**The Financial Impact of Injuries**

The financial impact of injuries can be significant. In a large professional ballet company, 104 dancers reported 309 injuries over three years which totaled almost $400,000 in workers’ compensation insurance payments. Worker’s compensation insurance represents a substantial piece of a non-profit company’s budget. Interestingly, 23% of the dancers who reported injuries had five or more injuries each and accounted for 52% of the cost paid to insurance. The authors report that “The experience of this ballet company is similar to that of a college athletic department or a professional sports team. All could employ similar strategies to reduce injuries and associated costs”.

Unsurprisingly, a higher percentage of injuries were reported after a lay-off time period or at the beginning of the dance season which typically runs from August to May. In a major American modern dance company, a comprehensive injury prevention program was phased in over 5 years and reduced new workers compensation cases from a high of 81% (pre-intervention) to a low of 17% (year 5) and decreased number of days dancers missed training or performance time. This study reported that a higher percentage of injuries came from the younger second company or pre-professional company dancers, and the second company dancers had a higher number of injuries per dancer. In this case, the pre-professional dancers were covered by the company’s insurance or worker’s compensation policy. However, it is common for young dancers in training or in the early years of professional dance to be responsible for their own medical costs when injuries happen.
Injury Reporting

Athletic or performing arts injuries are often self-reported and may not always accompany a medical assessment. In the performing arts in particular, injury documentation and treatment may vary widely due the culture, and/or limited resources. For ballet dancers, injuries are often overlooked or seen as a sign of weakness. Dancers may avoid medical attention, work injured, or perform against medical advice for a variety of reasons including the belief that roles will be taken away if management knows they are injured.

In an attempt to standardize injury reporting in the performing arts, a system was created called the International Performing Arts Injury Reporting System (IPAIRS). Companies are encouraged to track injuries as an important step in prevention. As previously discussed, injuries are often underreported and smaller dance companies may lack the resources to follow through with injury reporting. Standardized injury reporting systems have been used in sports and athletics for many years. One example is the National Collegiate Athletic Association Injury Surveillance System currently the largest collegiate athletic injury database in the world providing a resource for safety and prevention protocols. As a result of systems like these, a clear definition of what constitutes an injury is established. The definition used by IPAIRS is “any injury resulting in one or more complete or partial sessions of time lost beyond the day of the injury event itself”. A similar definition is used by the NCAA and allows for comparisons of injury rates and circumstances leading to injury between athletics and the performing arts.
Injuries are caused by a variety of circumstances and an individual’s nutritional status is one key factor.

Designing an injury prevention program for dancers would be advantageous for both dancers as well as company management. Incorporating nutrition as a key component is supported by previous research, and has the potential to increase performance and improve body composition. There is a significant body of research documenting that inadequate energy intake, restrictive or disordered eating practices, low total body fat and percentage body fat are contributory to decreased athletic performance, decreased lean mass and increased body fat percentage and increased risk for injury. As noted previously, these problems of inadequate energy intake and disordered eating practices, low body fat and low BMI have been documented in the dance world. There is insufficient research on within day energy balance in a population of pre-professional dancers and dancers in the early years of their careers, and there is little research on the relationship between within day energy balance and injury rates.
CHAPTER III

METHODS AND PROCEDURES

The study design is cross-sectional, exploratory, and descriptive in nature, and uses a convenience sample of talented pre-professional dancers enrolled in a national ballet school and pre-professional dancers in trainee positions in the early years professional careers. The study protocol was approved by the Institutional Review Board of Georgia State University (June 2009, appendix A). Permission was obtained in writing from the Dean of the Atlanta Ballet Center for Dance Education to ask for volunteer dancers (appendix B). This ballet school was chosen because of its accessibility, its affiliation with a national ballet company, and it serves as a training ground for professional dancers. Atlanta Ballet Center for Dance Education is the sixth largest dance school in the United
States. The Atlanta Ballet, the professional company, is the oldest continuously operating company in the United States and is considered a national level ballet company.

Approximately 50 ballet students ages 14-20 and including both males and females currently enrolled in the pre-professional division comprised the pool of potential participants. Additionally, Atlanta Ballet has a more advanced Fellowship Program that acts as a bridge between the ballet school and professional company, which employs an additional 10 potential volunteer subjects ranging in age of between 18-22 years.

Types of quantitative data obtained:

- Gender
- Self-reported Height
- Self-reported weight (for those participants willing, a bioelectrical impedance scale (Tanita) was offered as an optional data collection device to achieve a more accurate weight).
- Time of last meal/snack eaten the previous night
- Estimated calories stored from previous day (based on reported time of last meal/snack eaten the previous night)
- Calories from types of food or food groups consumed hour by hour
- Activity described as an activity factor hour by hour

Resting energy expenditure (REE) was predicted based on the Harris Benedict equation and hourly resting energy expenditure was obtained by dividing REE by 24 hours.

Participants were recruited by posted flyer which included study information (appendix C) and by multiple meetings with small groups of dancers in which the project was explained. Participants were informed both verbally and in writing that participation was entirely voluntary. Consent forms were obtained from all participants and their parents if the participant was under the age of 18 (appendix D and E). Each volunteer participant was given a paper copy of the assessment tool data collection page which included instructions and an example (appendix F). They were given both verbal instructions and detailed written instructions (appendix H) on methods for completing the chart based on recall of
their most recent typical training day. A typical training day is defined as a day in which the dancer has dance classes, rehearsals, and/or performances. They documented serving sizes of each food or food group listed in the chart based on what they ate for each hour of the day. In addition, they entered their activity factor hour by hour into the chart based on how light or strenuous their activity was. Participants were asked to document on their forms if they have experienced any injuries within the previous dance season lasting August 2008- June 2009 that affected their ability to fully participate in dance. The IPAIRS definition of injury was used “any injury resulting in one or more complete or partial sessions of time lost beyond the day of the injury event itself”. Additionally, participants were asked to describe how the injury affected their dancing and how long (reported in days) they were required to modify or stop their dancing.

The two part assessment tool was designed on Microsoft Excel and calculated calories consumed and expended based on the individual’s predicted resting energy expenditure (appendix G). Resting energy expenditure was calculated using the Harris Benedict equation, which had been reported to closely estimate energy expenditure for an athletic population. Part one of the assessment tool was for the participants to fill out and part two was for the student investigator to enter into the computer. Participants were not required to perform any calculations themselves. A within-day energy balance graph was generated on Microsoft Excel for each participant, which showed the energy balance for each hour of the day and the times of the day the subject was in a state of energy surplus or energy deficit. A final number at hour 24 determined if the subject finished the day in energy surplus or energy deficit. However, more importantly for practical application, is
the graph which demonstrates number of hours during the day the subject is in an energy
deficit of more than 400 calories. The following variables were evaluated in analysis:

- Energy balance at hour 24
- Energy balance hour by hour
- Estimated calories (kcal) consumed and expended
- Average day energy balance
- Number of hours/minutes within the 24 hour period that energy balance was below 400 kcal
- Number of injuries reported, and total number of reported injury days within the past season August 2008- May 2009.
- Body Mass Index (BMI) defined as kg/m²

SPSS version 16.0 was used to analyze the data. While the mean score is helpful, it was more important to determine what percentage of participants dipped below 400 calories at any one or more points during the 24 hour period. Lastly, Spearman’s rho was used to evaluate relationships between energy balance deficits below 400 calories and rates of injuries described as number of days injured and number of injuries per dancer.

**Hypotheses:**

Hypothesis 1: Pre-professional ballet dancers have at least one energy deficit that exceeds 400 kilocalories during a typical training day.

Null Hypothesis 1: Pre-professional ballet dancers do not have any energy deficits of at least 400 kilocalories during a typical training day.

Hypothesis 2: There is a relationship between energy deficits and injury rates in pre-professional ballet dancers.

Null hypothesis 2: There is no relationship between energy deficits and injury rates in pre-professional ballet dancers.
CHAPTER IV

RESULTS

Data gathered in this study represent a cross-sectional view of a single 24-hour period representing a typical training day in a group of ballet dancers at the pre-professional level. Data were collected from 21 dancers (16 females, 5 males) from three different divisions of Atlanta Ballet Center for Dance Education. Subjects were either enrolled in the Pre-Professional division of Atlanta Ballet Center for Dance Education (n = 7) or under contract with the more advanced Fellowship division (n = 3). Pre-professional participants were ages 15-18 and Fellowship participants were ages 18-22. Due to the timing of data collection, participants were also from the highest division or Professional Camp of the Atlanta Ballet’s summer dance program (n = 11) and were ages 18-23. Eleven dancers came from geographic regions of the United States other than Atlanta, Georgia, and one participant was from outside the United States. Mean age of participants: 18.8 (±2.2) years. All participants were considered pre-professional dancers either training in the ballet school or gaining experience in the summer camp before auditioning for company positions. No Atlanta Ballet professional company dancers were included in this
study. Average body mass index (BMI) was 21.9 ±1.4 for male dancers (MD) and 19.1 ±1.0 for female dancers (FD). Table 1 provides descriptive statistics for participants.

Using SPSS 16.0, descriptive statistics, t-tests, and Spearman’s correlation were performed to evaluate within-day energy balance and relationship to injuries.

Table 1. Subject Characteristics.

<table>
<thead>
<tr>
<th>Descriptive Statistics</th>
<th>Total Subjects N = 21 Mean (SD)</th>
<th>Male Subjects N = 5 Mean (SD)</th>
<th>Female Subjects N= 16 Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>18.8 (2.2)</td>
<td>18.8 (2.4)</td>
<td>18.8 (2.2)</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>169.8 (8.3)</td>
<td>180.3 (6.2)</td>
<td>166.5 (5.6)</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>57.2 (9.4)</td>
<td>71.3 (8.3)</td>
<td>52.8 (3.6)</td>
</tr>
<tr>
<td>REE</td>
<td>1485.1 (204.5)</td>
<td>1821.6 (128.6)</td>
<td>1379.9 (42.6)</td>
</tr>
<tr>
<td>BMI</td>
<td>19.7 (1.6)</td>
<td>21.9 (1.4)</td>
<td>19.0 (1.02)</td>
</tr>
<tr>
<td>Kcal in</td>
<td>2382.9 (921.4)</td>
<td>3818.0 (353.7)</td>
<td>1934.4 (444.3)</td>
</tr>
<tr>
<td>Kcal out</td>
<td>3317.5 (592.2)</td>
<td>4041.6 (450.7)</td>
<td>3091.2 (428.9)</td>
</tr>
<tr>
<td>Total Day Energy Balance (EB)</td>
<td>-934.6 (706.9)</td>
<td>-223.6 (629.7)</td>
<td>-1156.9 (582.5)</td>
</tr>
</tbody>
</table>

By the end of a typical training day, a total of 19 (90.5%) participants finished in negative energy balance (EB) at hour 24. A total of 2 participants, both males, finished the day at hour 24 achieving energy intake that met or exceeded their estimated energy expenditures. Average energy intake for all dancers was 2,382 kcal (± 921) and the average predicted energy expenditure was 3,317 kcal (± 592). Mean EB at hour 24 for all participants was -781.2 (±689.4). There was a difference between male and female dancers ability to consume energy based on changing energy needs throughout the day. The average day EB for males was -223.6 (±629.7) and for females it was -1156.9 (±582.5).
The largest energy deficits (>900 kcal) compared to estimated expenditures were found between the hours 17 and 20. The greatest mean energy deficit peaked at hour 19 (-1235 kcal ± 601) when dancers reported participating in the majority of their dance activity.

Table 2. Energy Deficits and Injury Data.

<table>
<thead>
<tr>
<th></th>
<th>Total Subjects N = 21 Mean (SD)</th>
<th>Male Subjects N = 5 Mean (SD)</th>
<th>Female Subjects N= 16 Mean (SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% subjects with &gt;1 hourly energy deficit &gt; -400 kcal</td>
<td>100 %</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td># minutes &gt; -400 kcal</td>
<td>660.0 (192.6)</td>
<td>564.0 (263.6)</td>
<td>690.0 (163.9)</td>
</tr>
<tr>
<td>Largest energy deficit</td>
<td>-2121</td>
<td>- 908</td>
<td>-2121</td>
</tr>
<tr>
<td># of injuries per dancer</td>
<td>1.0 (1.3)</td>
<td>1.4 (1.5)</td>
<td>1.0 (1.3)</td>
</tr>
<tr>
<td>Total days injured</td>
<td>28.0 (55.2)</td>
<td>55.6 (99.0)</td>
<td>19.3 (33.4)</td>
</tr>
</tbody>
</table>

100% of subjects were found to have at least one energy deficit > - 400 kcal. Participants were found to spend an average of 660.0 (±192.6) minutes per day in negative EB > - 400 kcal. An example graph of a 15 year old female (figure 1) is shown to have spent 7 hours or 420 minutes within the 24 hour period in a calorie deficit of > - 400 kcal.
Relationships between number of injuries per dancer, number of days injured, and energy deficits were analyzed using Spearman’s correlation. For the total group (TG) (n = 21) injury days and energy deficit data (number of minutes > -400 kcal) were not significantly correlated. However, a significant correlation was found between number of minutes > -400 kcal and number of injuries reported per dancer (r = -0.44 P = 0.046). EB at hour 9 was found to be correlated with injury days (r = 0.47 P = 0.03).

MD (n = 5) injury days were significantly associated with EB at hours 1 through 7 (r = 0.90 P = 0.37). Total number of times injured was associated with EB at hours 1 through 7 (r = 0.89 P = 0.04). Deficits > -400 kcal in minutes were not found to be significantly associated with injury rates in MD. Additionally, there were no significant relationships found between injury rates and total day EB or EB at hour 24 in MD.
Figure 2 - Male Dancers (n = 5) Within-Day Energy Balance
FD (n = 16) injury days and injury times were not found to be associated with day energy balance or energy balance at hour 24. However, a significant association was found between number of times injured and energy deficits > -400 kcal ($r = -0.54$ $P = 0.03$)

**Figure 3 - Female Dancers (n = 16) Within-Day Energy Balance**

**Table 3. Associations Between Injuries and Energy Balance.**
Based on these data, we can reject null hypothesis 1: Pre-professional ballet dancers do not have any energy deficits of at least 400 kilocalories during a typical training day. Ballet dancers in this study were found to have significant energy deficits throughout a typical training day in total minutes spent in energy deficit of > -400 kcal. There is some evidence to reject null hypothesis 2: There is no relationship between energy deficits and injury rates in pre-professional ballet dancers. However, significant relationships were found only between number of injuries per dancer and minutes spent in negative EB > -400 kcal in total subjects and female subjects. Injury days in male subjects were found to be significantly associated with EB at hours 1 through 7 (r = 0.90 P = 0.37).

<table>
<thead>
<tr>
<th></th>
<th>Total Subjects N = 21</th>
<th>Male Subjects N = 5</th>
<th>Female Subjects N = 16</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>r (p-value)</td>
<td>r (p-value)</td>
<td>r (p-value)</td>
</tr>
<tr>
<td>Injury Rates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Injury Days</td>
<td>0.25(0.2)</td>
<td>0.21(0.4)</td>
<td>0.21(0.4)</td>
</tr>
<tr>
<td>Injury Times</td>
<td>0.25(0.2)</td>
<td>0.33(0.2)</td>
<td>0.33(0.2)</td>
</tr>
<tr>
<td>Day Energy Balance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deficits minutes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt; - 400 kcal</td>
<td>-0.33(0.1)</td>
<td>-0.44(0.04)*</td>
<td>-0.35(0.2)</td>
</tr>
<tr>
<td></td>
<td>-0.4(0.5)</td>
<td>-0.22(0.7)</td>
<td>-0.54(0.03)*</td>
</tr>
</tbody>
</table>

* Statistically significant at P = < 0.05
By analyzing energy balance hour by hour throughout a typical training day we were able to differentiate energy deficits at various activity levels, and evaluate relationships between deficits and injuries. In the male dancers, total number of times injured was strongly associated with energy balance at hours 1 through 7 ($r = 0.89$ P = 0.04). But these same relationships were not seen in the female dancers. The male dancers reported a greater number of training days lost to injury than the female dancers 55.6 days ($\pm 99.0$) vs. 19.3 days ($\pm 33.4$). It is possible that this difference in injury days was because there were fewer male dancers than female dancers, and one male subject reported a total of 232 days injured, the highest number of days injured of all subjects. However, one of the female dancers reported the highest total number of separate injury events (5 injuries) including 4 stress fractures. Despite her injuries, she reported only 30 days in which she stopped or modified her dancing. Another female dancer with a stress reaction reported taking 7 days off. All injury data were self-reported and may be subject to over or underreporting. Due to the wide range of injury types, number of separate injury events, and number of days of modified dancing, it was decided not to eliminate dancers from the study based on injury reports. Data was included from all subjects in the statistical analysis.

Many studies evaluate energy intake and expenditure over a 24 hour time period or multiple 24 hour time periods. However, it has been suggested that there are benefits to differentiating data into smaller units such as hours or minutes throughout the day for greater flexibility in analysis when researching energy balance, athletic performance, and body fat percentage. Using this method of examining energy balance hour by hour it has been previously reported that energy deficits greater than 300-400 kcal are associated with increased body fat percentage and decreased athletic performance. In our study, all dancers
were shown to have multiple hourly deficits below 400 kcal. In the total group of subjects and in the women’s group, significant associations were found between minutes in negative energy balance and number of injuries reported per dancer. We can infer that there is potential in these subjects for negative energy balance to affect bone density and fatigue which possibly played a role in certain reported injuries such as stress fractures and fatigue related injuries. The dancers included in this study were shown to have significant energy deficits particularly at key hours during the day in which training demands were the greatest. Subjects were found to have an average of 660 minutes in an energy deficit of > -400 kcal throughout the day. The highest energy deficits were found later in the day. ACSM recommends that athletes consume adequate fluid, carbohydrate and protein post-exercise to replace muscle glycogen, aid in recovery and prevent future fatigue. However, the dancers in our study reported consuming their last meal of the day on average at hour 20.7 (±1.36). This may be inadequate intake post-exercise to meet their needs and creates a longer fasting time prior to the first meal of the subsequent day.

Engaging in dance class, rehearsal or performance without adequate energy increases a dancer’s reliance on alternative, less efficient fuel sources such as metabolized amino acids therefore potentially decreasing their lean mass and increasing body fat percentage. Additionally, adequate energy intake is necessary to spare protein needed for other physiological functions. Previous research has demonstrated that training in energy deficits results in decreased athletic performance, increased rates of amenorrhea, low bone mineral density, decreased resting metabolic rate, decreased lean mass, and increased body fat percentage. The student investigator is a faculty member in the pre-professional division of the Atlanta Ballet Center for Dance Education, and some of the subjects
included in this study are former or current students. Therefore, the potentially sensitive nature of certain personal information with this population prohibited the assessment of body composition and menstrual status. Another limitation of this study is the small sample size (n = 21). It would be beneficial for future studies to include a larger sample size, body composition measurements, bone density, and menstrual status.

The timing of data collection occurred at a time when many of the pre-professional dancers from the school left Atlanta for other summer dance programs. For that reason, Atlanta Ballet Professional Summer Camp participants were included with the Pre-Professional and Fellowship division dancers remaining in Atlanta. One benefit of this was that subjects came from a more diverse geographic area, and included eleven dancers who had graduated from a ballet school but were gaining experience in a summer camp environment before auditioning for professional company positions. They are considered pre-professional dancers transitioning into the early years of professional careers.

This study utilizes an assessment tool that requires dancers to self-report energy intake by documenting serving sizes of certain foods or food groups consumed on a typical training day. This method of grouping foods and estimating calories is similar to types of food frequency questionnaires. It has been shown that energy intake can often be underreported particularly in certain populations characterized as “low energy reporters” described as having fear of negative evaluation, having a history of weight loss and low BMI. According to the criteria described, dancers could be considered “low energy reporters”. Using four day food records, classical ballet dancers have been shown to underreport energy intake compared to actual intake by 667 kcal or 21% of real intake. The mean reported caloric intake of Atlanta Ballet dancers was 2382 (± 921) kcal. If 21%
was added to this figure it would still fall below mean dancers estimated energy output reported to be 3317 (± 592) kcal.

A study on elite female gymnasts used 3-day food records and evaluated the ratio of energy intake to estimated basal metabolic rate to determine cut off values which helped identify potential underreporters of energy intake. They found that 61% were classified as “low energy reporters”. Interestingly, they found a correlation between higher BMIs and lower energy intakes and found that the low energy reporters had a higher percent body fat that the adequate energy reporters. A study on the general population found that energy intake was underreported in 85% of women and in 61% of men in 24-hour dietary recalls. Body image and history of dieting was correlated with energy underreporting.

FD in this study were found to have energy deficits +/- 1000 kcal later in the day during hours 17-24 (figure 3). While it is plausible that some of the FD may restrict energy intake later in the day, the possibility should be considered that regular energy deficits such as these would imply that FD would begin subsequent days in significant energy deficits.

It is important to take into consideration that this study on Atlanta Ballet dancers was designed as a cross sectional analysis of a single 24 hour period and it is possible that dancers may have underreported their actual energy intake.

BMI, defined as kg/m², can be one measurable parameter for evaluating nutritional status in this population. In this study, the average dancers’ BMI was 19.7 (± 1.6) was within normal range of 18.5-24.9. Average body mass index (BMI) was 21.9 (±1.4) for males and 19.1 (±1.0) for females. Out of the total number of subjects, 23.8% (n = 5) of female dancers had an underweight BMI < 18.5 (range 17.0-18.4). No male dancers were underweight. While we had a small sample size, these findings are similar to a larger study.
on ballet dancers in the same age range in which approximately 50% of female dancers had a BMI of < 18.5 and dancers at all BMI levels were shown to have increased risk for menstrual dysfunction compared to controls. Another study on 21 ballet dancers (average age 23.2 ± 2.8) found that in spite of subjects having an average BMI within normal range (19.5 ± 2.3), dancers had higher rates of amenorrhea and lower bone mineral density than non-dancer controls. As stated previously, the student investigator in this study is a faculty member with Atlanta Ballet and, therefore, it was decided that subjects would not be required to ‘weigh in’ in order to participate in this study because it is Atlanta Ballet policy that dancers are not weighed as part of their dance experience. It was explained verbally to potential participants that body weight was needed in order to predict REE and that body weight was not the main focus of this study. Therefore, participants were given the option of using a provided scale (Tanita) in a private and confidential setting or they could self-report weight on their assessment forms. All individual body weight and BMI data remained confidential and the total group’s data was aggregated in reporting. It is possible, especially considering this is a population of aesthetic athletes, that there was underreporting of body weight in this study. Previous studies on the general population in this same age range found that self-reported anthropometrics were surprisingly accurate. A study on the validity of self-reported height and weight in adolescents found strong correlations between self-reported height and actual height in both males and females (males r = 0.87, females r = 0.76). Self-reported and actual weight were also strongly correlated (males r = 0.94, females r = 0.95). Another study on college aged females found strong correlations between self-reported height, weight and BMI (r = 0.94). While BMI can be one helpful parameter in a comprehensive assessment, it should be noted that BMI
and body weight may be different for athletes than for non-athletes and should not be used as sole criteria.

It has been previously reported that low or inadequate energy intake places dancers and athletes at higher risk for low bone mineral density, amenorrhea, and related injuries such as stress fractures. Stress fractures are a common injury for dancers and could significantly impact the ability to be competitive in training for and auditioning for company positions. Out of 21 subjects, 4 females (19% total subjects) reported having been diagnosed by a physician with a stress fracture or stress reaction within the past dance season. The dancer with the greatest number of total injuries within the designated time period reported multiple stress fractures (2 in the vertebrae and 2 the foot). Interestingly, this dancer was estimated to have energy intake (intake: 2093 kcal) and expenditure (2330 kcal) within 237 calories during the 24 hour period. However, she had multiple energy deficits of > -1100 kcal during key training hours during the day. This dancer’s Within-Day Energy Balance graph is shown in figure 4. A total of 23.8% (n = 5) dancers reported more than 1 injury (mean 1.0 ±1.4), and all of these dancers were shown to have multiple energy deficits > - 400 kcal during hours in which training demands were greatest. We can infer from data collected in this study that injury rates may be influenced by not only total energy intake in a 24 hour period but how the dancer distributes that energy intake hour by hour particularly during times of increased activity.
Injury distribution as self-reported by dancers is shown in figure 5. A total of 6 out of 21 dancers reported no injuries that prevented them from engaging in full dance participation. It is difficult to know for certain how or why certain injuries happen and if there is a link to poor nutritional status or energy balance, but fatigue and overtraining have been shown to be key factors in injury risk and can be linked to nutrition. In figure 5, dancers’ self-reported injuries are categorized. Injuries can be categorized in multiple ways, but for the purposes of this study fatigue related injuries are categorized as sprained ankles, muscle tears, and swelling or pain. Overuse injuries are categorized as back injury/disc injury, knee injury, tendonitis, and torn Achilles tendon.
Companies that have initiated injury prevention programs have been shown to decrease injury rates and insurance costs overtime. A major American ballet company significantly decreased workers’ compensation costs over 5 years by changing how dancers’ injury care was paid for by directly paying for medical services and by providing in-house access to physicians, physical therapists and preventive health care, reporting an estimated cost savings of 1.2 million over 5 years. A major American modern dance company significantly reduced new workers’ compensation claims by instituting an in-house injury prevention program. Both studies reported fewer injuries among dancers and increased company morale, but interestingly neither in-house program reported including the services of a registered dietitian. Based on the results of our study, we can infer that nutrition services would play an important role in a cost-saving, injury prevention program of a dance company.

An original goal of this study was that it was hoped that data collected could provide support for the foundation of a comprehensive nutrition and injury prevention program at Atlanta Ballet similar to programs initiated in other national level dance
companies. In group settings or in individual counseling, explaining how energy balance relates to performance, body composition, and injuries while using visual charts such as figures 1 and 4, can be influential methods in a nutrition and injury prevention program. Using visual tools similar to the assessment and evaluation tools used in this study can show dancers how energy restriction affects them personally during critical hours in which training demands are greatest. In addition to energy balance, it has been previously suggested that important components of a nutrition program for dancers would include screening for eating disorders and female athlete triad, education on the unique macro and micronutrient needs of dancers, and fluid and electrolyte balance. From a financial perspective, demonstrating to company directors the potential financial impact including insurance savings of such a program is a critical component in the non-profit dance world.

In *SCAN’S Pulse* (Fall 2008), A Doyle-Lucas stated that “The aesthetic demands placed on dancers can be even greater than the physical demands”. While much emphasis has been placed on ballet’s athleticism, it is fundamentally an art form of the human body, and dancers’ lifestyles and performance demands are very different from other athletes. While there can be many parallels drawn to athletes in sports, particularly sports with an aesthetic component, ballet is a performing art. There is evidence demonstrating that the rigors of dance training and performance are comparable to gymnastics, ice skating, wrestling, and other competitive sports. However, dance is unique in that many dancers may not consider themselves athletes and often have a pattern of low energy intake and inadequate refueling post-performance that is detrimental to athletic performance and may support a hypometabolic state requiring increasing lower energy intakes to maintain the classic dancers physique. Additionally, total intake below estimated needs and inadequate
energy balance throughout the day may be associated with increased injury risk. Competitive young dancers in the emerging years of careers in dance are at higher risk for injuries than more experienced dancers, and need expert guidance on how to nourish their bodies for maximum physical capability and injury prevention while maintaining the “sleek, yet toned body that is the requisite of the dance world”. It would be necessary for a nutrition and injury prevention program to be accessible during periods of lay off as it has been reported that injuries peak in the opening months of the season and post mid-winter lay off. Health care providers should encourage an environment of respect and cooperation while understanding the unique aesthetic demands of the dance world.

To summarize, this study has shown that dancers consume inadequate energy particularly at key training times during the day and that this may be associated with higher risk for injuries. Female dancers have greater energy deficits during the day than male dancers which may be in part to ballet culture and the pressure placed on female dancers to achieve very lean physiques. Height, weight, and injury rates were all self-reported and may be subject to over or underreporting. Dancers and dance companies could mutually benefit from nutrition and injury prevention services from qualified professionals such as a registered dietitian. This study could have been strengthened a larger sample size, a more even distribution of males and females, and by evaluating WIDEB during multiple 24 hour periods. Additionally, future studies would benefit by evaluating menstrual status and bone density.
June 9, 2009

Principal Investigator: Benardot, Dan

Protocol Department: Nutrition - 155000000

Principal Investigator Department: CHHS - Dean's Office - 150000000

Protocol Title: Within-Day Energy Balance in Pre-Professional Ballet Dancers

Funding Agency:

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Review Type: Expedited Review

Approval Date: June 8, 2009

Expiration Date: June 7, 2010

The Georgia State University Institutional Review Board (IRB) reviewed and approved the above referenced study and enclosed Informed Consent Document(s) in accordance with the Department of Health and Human Services. The approval period is listed above.

Federal regulations require researchers to follow specific procedures in a timely manner. For the protection of all concerned, the IRB calls your attention to the following obligations that you have as Principal Investigator of this study.

1. When the study is completed, a Study Closure Report must be submitted to the IRB.

2. For any research that is conducted beyond the one-year approval period, you must submit a Renewal Application 30 days prior to the approval period expiration. As a courtesy, an email reminder is sent to the Principal Investigator approximately two months prior to the expiration of the study. However, failure to receive an email reminder does not negate your
APPENDIX A

responsibility to submit a Renewal Application. In addition, failure to return
the Renewal Application by its due date must result in an automatic termination
of this study. Reinstatement can only be granted following resubmission of the
study to the IRB.

3. Any adverse event or problem occurring as a result of participation in this study
must be reported immediately to the IRB using the Adverse Event Form.

4. Principal investigators are responsible for ensuring that informed consent is
obtained and that no human subject will be involved in the research prior to
obtaining informed consent. Ensure that each person giving consent is provided
with a copy of the Informed Consent Form (ICF). The ICF used must be the
one reviewed and approved by the IRB; the approval dates of the IRB review
are stamped on each page of the ICF. Copy and use the stamped ICF for the
coming year. Maintain a single copy of the approved ICF in your files for this
study. However, a waiver to obtain informed consent may be granted by the
IRB as outlined in 45CFR46.116(d).

All of the above referenced forms are available online at https://irbwise.gsu.edu. Please do
not hesitate to contact Susan Vogtner in the Office of Research Integrity (404-413-3500) if
you have any questions or concerns.

Sincerely,

Ann C. Kruger, IRB Chair

Federal Wide Assurance Number: 00000129
February 3, 2009

As a representative of the Atlanta Ballet Center for Dance Education, I give permission to Emily Cook Harrison and Georgia State University to use the pre-professional division students as subjects in a research study on energy balance in dancers.

I understand that all participants' information will remain confidential and all participants and participant’s parents will be notified ahead of time about the study.

Permission to participate in the study will be obtained from each participant and participant’s parent if the student is under the age of 18.

I understand that any participant who wishes to withdraw from the study is free to do so at any time with no consequences.

I have been given information pertaining to the nature of the study and I have contact information for all parties administering the study if I have questions.

I understand that the information gathered in this study will be used as a foundation for establishing a nutrition program at the Atlanta Ballet, and may be used in the writing of grant proposals or in the procurement of other funding sources.

Sharon Story
Dean for the Center for Dance Education
Ballet Mistress, Atlanta Ballet
Seeking Volunteer Dancers to Participate in a Study

Pre-professional and/or Fellowship dancers enrolled at the Atlanta Ballet Center for Dance Education are invited to take part in a study on energy balance and injuries.

The purpose of this study is to assess energy balance and injuries in high level ballet students. We hope to gain a better understanding of what and when dancers eat and how this may or may not affect risk for injury. It is hoped that the results of this study can be used for the development of a nutrition program for the Atlanta Ballet.

Participation is entirely voluntary and there are no consequences for deciding not to participate.

Volunteers will be asked to complete a written assessment form based on their most recent typical class/ rehearsal/ performance day. They will fill in what they ate and how active they were during the day. Volunteers will be asked if they have had any injuries within the past six months that affected their ability to dance. They will be asked their height and weight. Participants will have the option of having these measured for them in a private and confidential setting. Obtaining actual weight is entirely optional and self-reported weight is fine for the scope of this study.

Approximate amount of time it will take to complete form and assessment: 1 hour
This form can be completed at the ballet before or after regular class time.

Assessment forms will be filled out without any identifying information such as name. Each form will be assigned a number as the only identifying information. All forms will be kept confidential, and data will be aggregated for reporting. Atlanta Ballet management will not have access to individual assessment forms that have been filled out, only the final compiled data. Data will be stored in a locked location at Georgia State University.

All volunteers, and their parents if minors, will have access to their own individual data if they wish (identified by number only). Group aggregated data will be reported to the Atlanta Ballet and will be presented as a master’s thesis at Georgia State University. Participants will have the option of individually and privately having their results explained. Detailed individual information will be made available to those interested.

All volunteer participants will be free to quit the study at any time with no consequences.

Emily Cook Harrison will be available to answer any questions by phone or in person. 404-245-5379

Assessment forms, instructions, and information will be handed out on: Monday, Tuesday, and Wednesday at lunch. June 15-17th any additional questions will be answered then.
Within-Day Energy Balance in Pre-professional Ballet Dancers

Principal Investigator: Dr. Dan Benardot PhD, RD, LD, FACSM
Student Investigator: Emily Cook Harrison

I. Purpose:
Pre-professional or Fellowship dancers enrolled at the Atlanta Ballet Center for Dance Education are invited to take part in a study on energy balance and injuries. The purpose of this study is to assess energy balance and injuries in high level ballet students. We hope for a total number of 30 volunteers for this study. Participation will require 1 hour of your time on 1 day.

II. Procedures:
If you decide to participate, you will fill out a 1 page written assessment form based on your most recent typical dancing day. You will fill in what you ate and how active you were during the day. Volunteers will be asked if they have had any injuries within the past six months that affected their ability to dance. You will be asked your height and weight. You will have the option of having these measured for you in a private and confidential setting. Obtaining actual weight is entirely optional and self-reported weight is fine for the scope of this study.

Participants will fill out the assessment form, and have the option of having height and weight measured (confidentially) at the Atlanta Ballet.

III. Risks:
In this study, you will not have any more risks than you would in a normal day of life.

IV. Benefits:
Participation in this study may help you to gain knowledge about the energy you take in and expend in a typical training day and how this may affect you as a dancer. Overall, we hope to gain a better grasp of what and when dancers eat and how this may or may not affect risk for injury. It is hoped that the results of this study can be used for the development of a nutrition program for the Atlanta Ballet.

V. Voluntary Participation and Withdrawal:
Participation in research is voluntary. You do not have to be in this study. If you decide to be in the study and change your mind, you have the right to drop out at any
time. You may skip questions or stop at any time. Whatever you decide, you will not lose any benefits to which you are otherwise entitled.

VI. Confidentiality:
We will keep your records private to the extent allowed by law. Assessment forms will be filled out without any ID information such as name. Each form will be given a number as the only identifying information. All forms will be kept confidential, and data will be pooled for reporting. Atlanta Ballet management will not have access to individual forms that have been filled out, only the final compiled data. Assessment forms will be stored in a locked location at Georgia State University (GSU). Consent forms will be stored in a different locked location at GSU.

All volunteers, and their parents if minors, will have access to their own individual data if they wish (you must remember your number). In addition, participants will get help making sense of the data if they wish. Group data will be reported to the Atlanta Ballet and will be presented as a master’s thesis at GSU. Your name and other facts that might point to you will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. You will not be identified personally.

VII. Contact Persons:
Contact Emily Cook Harrison at 404-245-5379 or ecook2@student.gsu.edu if you have questions about this study.

If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu.

VIII. Copy of Consent Form to Subject:
We will give you a copy of this consent form to keep.

If you are willing to volunteer for this research, please sign below.

______________________________________________

______________________
Participant Date

______________________________________________

______________________
Principal Investigator or Researcher Obtaining Consent Date
Within-Day Energy Balance in Pre-professional Ballet Dancers

Principal Investigator: Dr. Dan Benardot PhD, RD, LD, FACSM
Student Investigator: Emily Cook Harrison.

I. **Purpose:**
Pre-professional or Fellowship dancers enrolled at the Atlanta Ballet Center for Dance Education are invited to take part in a study on energy balance and injuries. The purpose of this study is to assess energy balance and injuries in high level ballet students. We hope for a total number of 30 volunteers for this study. Participation will require 1 hour of your time on 1 day.

II. **Procedures:**
If your child decides to participate, he or she will fill out a 1 page written assessment form based on the most recent typical dancing day. He or she will fill in what he or she ate and how active he or she was during the day. Volunteers will be asked if they have had any injuries within the past six months that affected their ability to dance. We will need to know height and weight. Participants will have the option of having these measured for them in a private and confidential setting. Obtaining actual weight is entirely optional and self-reported weight is fine for the scope of this study.

Participants will fill out the assessment form, and have the option of having height and weight measured (confidentially) at the Atlanta Ballet.

III. **Risks:**
In this study, you will not have any more risks than you would in a normal day of life.

IV. **Benefits:**
Participation in this study may help your child to gain knowledge about the energy taken in and expend in a typical training day and how this may affect them as a dancer. Overall, we hope to gain a better grasp of what and when dancers eat and how this may or may not affect risk for injury. It is hoped that the results of this study can be used for the development of a nutrition program for the Atlanta Ballet.

V. **Voluntary Participation and Withdrawal:**
Participation in research is voluntary. Your child does not have to be in this study. If they decide to be in the study and change their mind, they have the right to drop out at
any time. They may skip questions or stop at any time. Whatever decision, they will not lose any benefits to which they are otherwise entitled.

VI. Confidentiality:
We will keep all records private to the extent allowed by law. Assessment forms will be filled out without any ID information such as name. Each form will be given a number as the only identifying information. All forms will be kept confidential, and data will be pooled for reporting. Atlanta Ballet management will not have access to individual forms that have been filled out, only the final compiled data. Assessment forms will be stored in a locked location at Georgia State University (GSU). Consent forms will be stored in a different locked location at GSU.

All volunteers, and their parents if minors, will have access to their own individual data if they wish (you or your child must remember your number). In addition, participants will get help making sense of the data if they wish. Group data will be reported to the Atlanta Ballet and will be presented as a master’s thesis at GSU. Names and other facts that might point to your child will not appear when we present this study or publish its results. The findings will be summarized and reported in group form. No one will be identified personally.

VII. Contact Persons:
Contact Emily Cook Harrison at 404-245-5379 or ecook2@student.gsu.edu if you have questions about this study. If you have questions or concerns about your rights as a participant in this research study, you may contact Susan Vogtner in the Office of Research Integrity at 404-413-3513 or svogtner1@gsu.edu.

VIII. Copy of Consent Form to Parent or Guardian
We will give you a copy of this consent form to keep.

If your child is willing to volunteer for this research, please sign below.

______________________________________________
Parent or guardian for participants under the age of 18 Date

______________________________________________
Principal Investigator or Researcher Obtaining Consent Date
<table>
<thead>
<tr>
<th>ENERGY EXPENDITURE PREDICTION</th>
<th>PROTEIN (Meat, Poultry, Eggs)</th>
<th>CALORIES</th>
<th>MIXED DISHES</th>
<th>CALORIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>DEFINITIONS</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RESTING</td>
<td></td>
<td>1.0</td>
<td>140</td>
<td>360</td>
</tr>
<tr>
<td>Sleeping or reading</td>
<td></td>
<td></td>
<td>180</td>
<td>380</td>
</tr>
<tr>
<td>VERY LIGHT</td>
<td></td>
<td>1.5</td>
<td>135</td>
<td>325</td>
</tr>
<tr>
<td>Seated and standing activities, painting trades, driving, laboratory work, typing, sewing, ironing, cooking, playing cards, playing a musical instrument</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LIGHT</td>
<td></td>
<td>2.5</td>
<td>100</td>
<td>265</td>
</tr>
<tr>
<td>Walking on a level surface at 2.5-3 mph, garage work, electrical trades, carpentry, restaurant trades, house-cleaning, child care, golf, sailing, table tennis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODERATE</td>
<td></td>
<td>5.0</td>
<td>25</td>
<td>55</td>
</tr>
<tr>
<td>Walking 3.5 to 4 mph, weeding and hoeing, carrying a load, cycling, skiing, tennis, dancing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HARD</td>
<td></td>
<td>7.0</td>
<td>60</td>
<td>100</td>
</tr>
<tr>
<td>Walking with load uphill, tree felling, manual digging, basketball, climbing, football, soccer, figure skating routine</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Instructions:**
1. Enter gender, age, and weight (lb).
2. Enter the “activity” factor (from 1 to 7) for each hour of the day.
3. Enter the time (24 hour clock) of your last snack/meal the PREVIOUS day.
4. In columns "101" to "F31" enter the serving size of the foods consumed in the box representing which hour of the day it was consumed.

**Example:** If you consumed 1.5 cups of fruit juice (food 24) between 7 and 8am, you would enter the number 1.5 (1.5 times the amount listed) in column "F24" in row "7-8am".

**NOTES:**
- Protein: 1 plain Danish, enter 3.5 under food 31
- Donut: 1 plain donut, enter 2.6 under food 31
- Glazed donut: 1 plain donut, enter 3.0 under food 31
- Vegetable Soup: 1 cup under food 31
- Vegetable Beef Stew: 1 cup under food 31
- Green Pea Soup: 1 cup under food 31

53
<table>
<thead>
<tr>
<th>Category</th>
<th>Daily Servings</th>
<th>Calories</th>
<th>Carbohydrates</th>
<th>Protein</th>
<th>Fat</th>
<th>Fiber</th>
<th>Total Saturated Fat</th>
<th>Total Trans Fat</th>
<th>Cholesterol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meat (including fish and poultry)</td>
<td>3-4 oz.</td>
<td>259</td>
<td>37</td>
<td>31</td>
<td>20</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dairy and Alternatives</td>
<td>3 cups</td>
<td>233</td>
<td>28</td>
<td>24</td>
<td>17</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grains (including legumes)</td>
<td>3-4 oz.</td>
<td>230</td>
<td>35</td>
<td>5</td>
<td>23</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruits and Vegetables</td>
<td>2-3 cups</td>
<td>230</td>
<td>18</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oils</td>
<td>1 Tbsp.</td>
<td>120</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Total Calories:** 800

**Total Carbohydrates:** 100 g

**Total Protein:** 100 g

**Total Fat:** 60 g

**Total Fiber:** 20 g

**Total Saturated Fat:** 10 g

**Total Trans Fat:** 3 g

**Total Cholesterol:** 300 mg

---

### Activity Factor

- Sedentary: 1.0
- Light activities: 1.2
- Moderate: 1.5
- Very light: 1.7
- Heavy: 2.0
- Very heavy: 2.3

### Energy Check

C. J. Smith completed the following activity patterns in the past year:

- 12 hours of light activities
- 3 hours of moderate activities
- 2 hours of very light activities
- 1 hour of very heavy activities

Total Calories: 800

---

### Energy Balance Graph

**Within-Day Energy Balance:**

**Within-Day Energy Balance Graph:**

---

### Other Foods

- Carrots (100 g): 49 calories
- Oranges (100 g): 57 calories
- Green beans (100 g): 37 calories
- Chicken (100 g): 150 calories
- Milk (100 g): 103 calories
- Bread (100 g): 125 calories
- Butter (100 g): 102 calories
- Cheese (100 g): 113 calories
- Yogurt (100 g): 122 calories
- Eggs (100 g): 78 calories

---

### Additional Notes

1. Calorie intake should be adjusted for individual needs and goals.
2. Consult a healthcare professional for personalized advice.
3. Always seek professional guidance before making significant changes to your diet.
4. beverages should be included in the calorie count.

---

### Glossary

- Calories: A unit of energy.
- Carbohydrates: Sugar, starch, and fiber that provide energy.
- Protein: Essential building blocks for body tissues.
- Fat: Source of energy and essential nutrients.
- Fiber: Non-digestible parts of plant foods, including cellulose, hemicellulose, pectins, gums, and mucilages.
- Saturated Fat: Fats that raise cholesterol levels.
- Trans Fat: Fats that raise cholesterol levels and increase the risk of heart disease.
- Cholesterol: A type of fat, found in animal products and processed food, that can contribute to heart disease.

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**APPENDIX G**
APPENDIX H

Instructions for Within-Day Energy Balance (WIDEB) Analysis

Energy-Check™ © 2009, Dan Benardot

Entering Basic Subject Information

There are places to enter your height in inches, you weight in pounds, your name, your age in years, and the time of the last meal on the previous day. See below for specific instructions for each ‘variable’.

Height in Inches

Your height in inches can be calculated by multiplying your height in feet by 12, and then adding the additional inches. Example: For someone 5 ft, 10 inches tall, you would multiply 5 x 12 (=60), and add 10 (60 + 10= 70 inches total). For someone 6 ft, 2 inches tall, you would multiply 6 x 12 (=72), and add 2 (72 + 2 = 74 inches tall). This is an important value for predicting your energy (calorie) expenditure, so enter the most accurate value for your current height. (The computer program automatically calculates your height in centimeters (cm) from your entered height in inches.)

Weight in Pounds

Enter your weight in pounds to the closest half pound. It is important that you enter your current weight and not your goal weight. Your current accurate weight is an important value used to predict energy expenditure, so try to be accurate with your entry. (The computer program automatically calculates your weight in kilograms (kg) from your entered weight in pounds.)

Name

Enter your name or, if you are part of a study and have been given a study ID number, your study ID number. Your name or ID number will never be used to personally identify you in any public way with the information you provide.

Age in years

Enter your current age in years, even if you are close to your birthday. Age is an important value used to predict energy expenditure, so being accurate with this value is important.

Time of Last Meal Previous Day

The WIDEB analysis is used to assess within-day and end-of-day energy balance for a single day from midnight to midnight. However, knowing when you consumed your last snack or meal the day before helps to predict your beginning energy balance for the day being analyzed. Enter this value in military time. Example: If the last time you ate something before you went to bed the day before the analysis day was at 9:00pm, enter 21:00. If it was at 9:30, enter 21:30. Make certain you only enter the time for the last snack/meal that contained energy (calories). If you have your last snack at 9:00pm, but drink a glass of water at 10:30pm, enter 21:00 for 9:00pm, as the glass of water does not contribute to your energy balance.

Gender

Circle “Male” if you are male and circle “Female” if you are female. This is an important value for accurately predicting energy expenditure, so please don’t skip this.

WIDEB Instructions: Page 1 of 3
APPENDIX H

Entering Activity Factor

Entering an accurate activity factor for each hour of the day is important for predicting within-day and end-of-day energy balance. There is a tendency to over-estimate the activity factor using the definitions provided, so use the examples below to help you enter accurate activity factors using the 1 to 7 scale provided on your data entry sheet.

Activity Factor Example 1: Sleep all day long.

If you were to sleep all day long, you would enter the number ‘1’ for each hour under the “Activity Factor” column. At no time could you leave an hour blank, because you are always expending energy even when you are asleep.

Activity Factor Example 2: Wake up at 7, go to sleep at 10, and never ‘exercise’.

If you wake up at 7:00am in the morning, you would enter the number “1” for every hour from midnight through 6am, and from 10pm to midnight because you were sleeping. From 7am through 10pm (which is listed on the data entry sheet at 7-8am through 9-10pm) you would enter the number “1.5” for each hour, as that value represents the activity factor for normal daytime (non-exercise) activities.

Activity Factor Example 3: Wake up at 7, go to sleep at 10, and exercise (very intense) for 30 minutes from 2:00pm to 2:30pm.

You would enter the same values as for Example 2 above, except that you have to account for the exercise you did for 30 minutes from 2:00pm to 2:30pm. Assuming you were working as hard as you possibly could for that 30 minutes (activity factor 7.0 for Heavy), you would have to adjust what you would enter from 2:00-3:00pm because that is a 1 hour time interval, and you only exercised for 30 minutes. The value you would enter would be somewhere between 1.5 and 7.0, but with a slight emphasis toward a higher value because your heart rate stays elevated for awhile after you finish exercising (and higher heart rates are associated with higher energy expenditures). The average of 1.5 and 7.0 is 4.5, but because of the sustained elevated heart rate it would be reasonable to enter ‘5’ as your activity factor for that hour.

Entering Consumed Foods

Entering the foods you consume accurately for each hour of the day that you consume food is important for predicting both within-day and end-of-day energy balance. To accurately enter the foods you have consumed you should reasonably estimate both the food type (i.e., fried chicken has a different calorie value than baked chicken) and amount. To simplify data entry, 30 food categories have been provided of foods commonly consumed and in portions commonly consumed. Your task is to identify the food on the list, and enter the amount consumed as multiples (or fractions) of the amounts listed. See the examples below to help you understand the food entry system.

Food Entry Example 1: How to enter breakfast consumed from 7-8am.

Let’s say you had 1 bowl (about 1.5 cups worth) of breakfast cereal, and 1.5 cups of skim milk between 7 and 8am. Breakfast cereal is listed as “Food 12" in an amount that is exactly the amount you consumed. In other words, you had 1 serving of food 13 between 7 to 8am. Find column “F13”

WIDEB Instructions: Page 2 of 3
APPENDIX H

Food Entry Example 2: You can’t find the food consumed in the provided list, but you know the caloric content of what you ate.

There is a special column for entering foods that you can’t find on the food list (Foods 1 through 30), and that is column 31. This column has a fixed 100 calorie amount, so if you know you ate foods that amounted to 350 calories at 12 noon, you would enter “3.5” under the column labeled “F31”, and row labeled “12-1pm/13”. (3.5 times the listed serving size of 100 calories is 350 calories.) You can use this strategy for an entire day of intake, or use it in conjunction with foods that you can find on the food list.

(Note: Any multiple/fraction of 100 is OK. If you had a food that provided 125 calories, enter “1.25”; and for a food that gave you 33 calories you would enter “.33”. If you ate half a serving of a food that provided 100 calories for a full serving you would enter “.5”.

Food Entry Example 3: You can’t find the food consumed in the provided list, and you don’t know the caloric content of what you ate.

As much as possible, try to find your food on the food list provided or use Food 31 (100 calories) if you know the caloric content. If you can’t find the food and don’t know the caloric content, write in the food consumed, the amount consumed, and the time consumed. We’ll use a program to find the caloric content of what you consumed and add it to your daily intake.

If you use this option, try to be as descriptive as possible so as to help make your energy balance assessment accurate.

*Dr. Dan Benardot is Professor of Nutrition and Director of the Laboratory for Elite Athlete Performance at Georgia State University. This system for within-day energy balance assessment is used with elite, Olympic level athletes to help them achieve optimal performance, weight, and body composition. The system is only as good as the accuracy of the information entered into it. Please try to enter information that is as accurate as you can make it so as to give you meaningful results.