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Knowledge of personal energy requirements in college students

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KNOWLEDGE OF PERSONAL ENERGY REQUIREMENTS IN COLLEGE STUDENTS

by

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ABSTRACT

Knowledge of Personal Energy Requirements in College Students

by

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This study explored whether university students enrolled in health science classes were able to estimate their energy requirements within a range of calories equal to predicted Estimated Energy Requirements (EER) $\pm$ two standard deviations. The International Physical Activity Questionnaire (IPAQ) and a participant survey were given to a convenience sample of 63 male and 92 female undergraduate students (19-23 years) with subsequent measurements of height, weight and body fat percentage. Results from the IPAQ yielded metabolic equivalents which were converted to physical activity coefficients for use in the EER equation. Students significantly underestimated their EER by an average of 700 calories ($p<.001$), and they underestimated their basal energy expenditures (BEE) by an average of 644 calories ($p<.001$).

Female students were better able to estimate energy requirements as compared to their male counterparts, 41.3% vs. 20.6%, X^2 (1) = 7.236, p=.007.

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CHAPTER 1

INTRODUCTION

It is appropriate to initiate a dietary recommendation with an assessment of energy requirements which are normally based upon an individual's body mass and health status (Lee & Nieman, 2003). In the healthy adult, daily energy requirements can be estimated using the Estimated Energy Requirements (EER) equation, which takes into account the individual's age, gender, usual physical activity level, height and weight (Food and Nutrition Board, Institute of Medicine of the National Academy of Science, 2005). These determinants should not vary greatly, with the exception of the physical activity level, and they should be easy to collect either through self-report or physical measurement. It is preferable to collect height and weight information by performing actual measurements as self-reported weights tend to be understated (Adderley-Kelly, 2007) and self-reported heights tend to be overstated (Rowland, 1990).

A Recommended Dietary Allowance (RDA) has not been set for energy because even the smallest caloric excess beyond EER would likely lead to a gain in weight, thus the prediction equations were developed with the intention of maintaining energy balance. The prediction equations for EER were derived using data from doubly labeled water studies and observed basal energy expenditure (BEE) in 767 normal weight, overweight, and obese adults (FNB, IOMNAS, 2005). Because the equations are estimates, it is important to use them as starting points to make energy recommendations, with the ultimate confirmation of energy balance reflected in weight stability.

Once a person is made aware of the amount of energy required to achieve balance, both dietary changes and modifications to physical activity levels to meet a healthy weight goal become more relative. Dietary changes resulting in a negative or positive energy balance can be made by altering the amount of energy consumed in food and beverages, and this is facilitated by tools such as the nutrition facts label and the public posting of calories for meals on restaurant menus. The usefulness of these tools however is limited by the knowledge of the user. If an individual looks at the kcal content, yet does not know his/her total daily energy needs, the calories per serving become arbitrary. The usefulness of that information is limited as it applies to that individual's energy needs, and its value is then diminished to a tool for comparing two like items.

Likewise, once a person's estimated energy requirement is established, a plan to modify physical activity levels becomes another tangible way to help meet or maintain healthy weight goals. Because the

EER equation uses a physical activity level (PAL) as a major determinant of energy needs, a change in this level should bring about a corresponding change in energy balance. There are 4 PAL groups used in the EER equations (Table 1).

Table 1 Physical activity levels (PALs) used in EER equations[a]

Group	*Physical activity level (PAL)*	*Corresponding activity (Walking, miles per day)*
Sedentary	≥ 1 to < 1.4	0
Low active	≥ 1.4 to < 1.6	2.2
Active	≥ 1.6 to < 1.9	7.3
Very active	≥ 1.9 to < 2.5	16.7

[a]Based on a 70-kg adult walking between 2-4 miles per hour.
Estimated Energy Requirements (EER)
(Food and Nutrition Board, Institute of Medicine of the National Academy of Science, 2005)

For example, a 43 year-old female who is sedentary would have a PAL between 1 and 1.4, representing little to no activity beyond the usual activities of daily living. If she began a physical activity regime equivalent to walking 2.2 miles per day, she would then move from the sedentary category to the low active category and thus increase her physical activity level to a number between 1.4 and 1.6. Assuming her weight is 64 kilograms and her height is 1.65 meters, her EER would increase from 1854 calories to 2069 calories.

The individual can closely approximate a goal of calories expended in physical activity when working with a fitness professional who can design a fitness program intelligently, using the FITT principles of frequency, intensity, timing (duration) and type of activity (Oberg, 2007). Without an EER baseline, the energy cost of physical activity is merely a stated calorie amount devoid of a meaningful relationship to the individual who is pursuing a healthy weight goal. An EER helps the individual understand how physical activity can alter energy needs.

The components of diet and physical activity make up the energy balance concept of energy consumption versus expenditure. Energy balance is achieved when caloric intake is equivalent to energy expenditure, and any imbalance over time will result in a net weight gain or loss (FNB, IOMNAS, 2005). The energy equation has been tipped to the positive side for many adults, as is indicated by the "growing" population; adult overweight and obesity in the U.S. has risen from 47.4% of the population in 1980 to 66% in the year 2004 (National Center for Health Statistics, 2007). Despite what appears to be easy access to nutrition and physical activity information, more Americans have higher body mass indexes (BMIs) indicating a detachment of sorts between public health goals and public practice.

Instructions to healthcare personnel regarding the use of the EER equation to help patients control their weight are covered extensively in an overview by Heymsfield, Harp, Rowell, Nguyen and Pietrobelli. The overview explains the effects of each determinant in the EER equation, including age, gender, physical activity level, height and weight. It is a good attempt to educate healthcare professionals on making energy determinations with the authors' acknowledgement that knowledge regarding energy recommendations is very limited among healthcare providers (2006).

When one takes a close look at the EER equation (Table 2), one can understand why knowledge regarding energy requirements is limited.

Table 2 Estimated Energy Requirement (EER) equations

Gender	*Normal-weight, overweight, and obese > 19 years*
Males	$864 - (9.72 \times age[y]) + PA \times (14.2 \times weight[kg] + 503 \times height[m])$
Females	$387 - (7.31 \times age[y]) + PA \times (10.9 \times weight[kg] + 660.7 \times height[m])$

(Food and Nutrition Board, Institute of Medicine of the National Academy of Science, 2005)

The equation is very complicated and the user needs to have an adequate mathematical proficiency level to use it correctly. Fortunately, the EER equation can be loaded into an Excel spreadsheet which can then automatically perform the calculations. A user-friendly template spreadsheet has been created to address this limitation of difficulty, and includes a factorial method to account for physical activity, making the EER equation a bit easier to use. The authors anticipate that facilitating the use of the EER equation will encourage healthcare providers to motivate more adult men and women towards energy balance (Gerrior, Juan & Basiotis, 2006).

Since the template spreadsheet was created to be easy to use, it takes the guesswork out of determining physical activity levels by incorporating a listing of physical activities which automatically calculate the PAL. The approach of calculating energy cost by assigning metabolic equivalents (METs) to a particular type of physical activity has been aided by a compendium of MET information for hundreds of different types of physical activities, including those from occupational, household and leisure time domains. Although this information does not serve as an exact method to evaluate energy expenditure, it is useful for establishing physical activity classifications (Ainsworth et al., 2000). By listing the time spent in each physical activity along with its associated impact on total PAL (PALi), one can classify an individual into one of the 4 categories of PALs mentioned previously (Table 1). This enables a physical activity coefficient determination to be made for use in the EER equation.

A listing of daily physical activities would take a lot of effort on behalf of the participants and would make the job of evaluating data to assign a PAL quite extensive (Valanou, Bamia & Trichopoulou, 2006), making that type of data collection ill-advised for a short study with limited resources. Other instruments have been designed and validated for use to collect and classify physical activity information, including the International Physical Activity Questionnaire (IPAQ) (Craig, et al., 2003). This survey instrument is easy to administer and collects physical activity information from 4 domains: occupational, transportation, household, and leisure time. The survey results in a categorical physical activity classification of low, moderate, or high, but it also yields MET values which can be used as a continuous measure reported in median MET-minutes. It is suggested that the information obtained regarding METs could then be used to determine an individual's PAL for use in the EER equation, a similar approach used by the authors of the EER template spreadsheet, only more objective and easier for the researcher to collect and score data.

Some nutrition professionals believe that people have a tendency to underestimate how many calories they eat and overestimate their caloric expenditure from physical activity. Observations made in the academic environment suggest that many students have a similar misperception regarding energy balance. Coincidentally, weight gain in college students appears to be an inevitable rite of passage (Racette, Deusinger, Strube, Highstein & Deusinger, 2005), (Hajhosseini et al., 2006), (Levistky, Halbmaier & Mrdjenovic, 2004). While some of the reasons for that weight gain have been attributed to evening snacking, how often meals were eaten over the weekends, eating junk foods and recent dieting

(Levistky, Halbmaier & Mrdjenovic, 2004), the bottom line is that weight gain is always attributable to a state of positive energy balance.

The assumption that college students in general had little knowledge of their daily energy needs and the further supposition that estimates of those needs would not fall within a large range of calories was made for this study. However, students enrolled in introductory nutrition courses are taught about energy balance and are usually assigned a personal dietary analysis as part of their class grade, so theoretically they should have an awareness of how many calories they need daily to maintain a state of energy balance. It was thought that a comparison of EER estimates made between those who have taken a nutrition course in college and those who have not should reveal differences, and thus the study was designed.

Purpose of the Study

The purpose of this study is to determine if college students know their estimated energy requirements in calories within a range of $\pm$ two standard deviations.

Research Questions

Question #1

Is there a significant difference between college students' self-estimated and predicted EERs?

Question #2

Is there a significant difference between college students' self-estimated and predicted BEEs?

Question #3

Is there a significant difference between either college students' perceived and actual height and/or college students' perceived and actual weight?

Question #4

Is there an association between having taken a college nutrition class and one's ability to estimate EER?

Question #5

Is there an association between gender and one's ability to estimate EER?

Significance of the Study

The rates of overweight and obesity in the U.S. have risen over the years, and currently the adult overweight and obesity rate is 66% and for children it is 17.5% (NCHS, 2007). Obesity and overweight adversely affect health, and the negative effects can be felt throughout the lifespan. Fifty percent of the children who are obese will grow up to be obese adults (Dietz, 1998). Merely attending college is associated with an increase in weight during the transition from childhood to early adulthood (Racette et al., 2005), (Hajhosseini et al., 2006), (Levistky, Halbmaier & Mrdjenovic, 2004). Studies have shown that adult mortality may be related to BMI in childhood (Dietz, 1998) through early and mid-adulthood independent of the weight status as an adult (Jeffreys, McCarron, Gunnell, McEwen & Smith, 2003). Finally, it is well-known that weight status can be a risk factor for many chronic diseases, which in turn can decrease quality and years of life. Because of its impact on health, the subject of overweight and obesity is one of the 10 Leading Health Indicators for the Healthy People 2010 set of health objectives for the nation (U.S. Department of Health and Human Services, 2000).

Although so much of the population is overweight, it is estimated that only about 31% is actively trying to lose weight. The most common approaches used to lose weight include decreasing calorie intake, consuming less fat, and increasing physical activity (Kruger, Galuska, Serdula & Jones, 2004). These approaches are commonly prescribed by clinicians, and general weight loss recommendations of reducing dietary intake by 500 – 1000 calories per day and increasing physical activity to meet minimum adult daily recommendations are given to promote a weight loss of 1-2 pounds per week (National Heart, Lung and Blood Institiute, 2000), however promoting an understanding of the concept of energy balance as it relates to the individual is rarely addressed.

One determinant of energy-balance related behavior is the ability or perceived ability of the individual to perform a particular behavior (Kremers, Vissher, Seidell, van Mechelen & Brug, 2005). Since a computer based search for studies assessing the personal knowledge level of individuals regarding the components of energy balance yielded no results, it appeared that an establishment of this knowledge would be beneficial for future research. If people are unaware of their personal energy requirements, it is possible that this will diminish their ability to maintain energy balance. This study examined whether college students could estimate the amount of calories needed to maintain their current weight, thus providing an indirect method of exploring whether they understand energy balance as it relates to them.

Definition of Terms

The following definitions are given for the purpose of clarification:

1. Dietary Reference Intakes (DRI's) are a set of reference values compiled by the Institute of Medicine for nutrients designed for healthy people living in the U.S. and Canada. They include the Recommended Dietary Allowances (RDA's), the Estimated Average Requirements (EAR's), the Adequate Intakes (AI's), the Tolerable Upper Intake Levels (UL's), and the Acceptable Macronutrient Distribution Ranges (AMDR's). They are based on hundreds of high-quality, peer-reviewed studies using animal models, human feeding studies, observational studies, and randomized clinical trials, and provide the basis for nutrient recommendations for both individuals and populations. They also include estimated energy

requirements which are useful to those interested in energy balance.

2. Physical Activity Level (PAL) is the ratio of total energy expenditure (TEE) to basal energy expenditure (BEE) and is used to classify an individual's usual level of daily activity according to the Dietary Reference Intakes (DRI's). There are four levels used in this study: sedentary (PAL $\geq$ 1.0 < 1.4), low active (PAL $\geq$ 1.4 < 1.6), active (PAL $\geq$ 1.6 < 1.9), and very active (PAL $\geq$ 1.9 < 2.5) (NAS, IOM, FNB, 2005).
3. Physical Activity (PA) coefficient is the numerical value assigned to a given Physical Activity Level (PAL) for use in the estimated energy requirement (EER) prediction equation. It will differ between genders.
4. Body Mass Index (BMI) is an index of health using weight in kilograms divided by height in meters squared. A BMI of <18.5 denotes underweight, 18.5 – 24.9 denotes a healthy range, 25 – 29.9 indicates overweight, and a BMI >30 classifies an individual as obese.
5. Basal Metabolic Rate (BMR) is defined as the rate of energy expenditure measured in a supine position upon waking after a 12-14 hour fast. The metabolic rate increases once an individual has been awake and performs regular activities of daily living, therefore BMR is variable upon waking.

6. Basal Energy Expenditure (BEE) is the 24-hour extrapolation of Basal Metabolic Rate (BMR) and does not include energy expenditure due to the Thermic Effect of Food (TEF) or Excess Post-exercise Oxygen Consumption (EPOC).
7. Thermic Effect of Food (TEF) is the energy expended to digest, absorb and metabolize food and its associated nutrients.
8. Excess Post-exercise Oxygen Consumption (EPOC) is an increased rate of oxygen consumption following a bout of physical activity.
9. Metabolic Equivalent (MET) is energy expenditure relative to a VO_2 of 3.5 ml/kg body weight/min.

CHAPTER 2

REVIEW OF RELATED LITERATURE

Prevalence of Overweight and Obesity in Adults and Associated Health Consequences

The prevalence of adult overweight and obesity in the U.S. is currently 66.4% (NCHS, 2006). It is widely recognized that overweight and obesity is related to an increased morbidity from chronic diseases and an increase in mortality in general (NHLBI, 2000), and the Center for Disease Control estimates that 112,000 deaths are related to obesity every year in the U.S. (Center for Disease Control and Prevention, 2005). A leading Healthy People 2010 health objective is to raise the rate of adult Americans age 20 and over at a healthy weight from the latest estimate of 32% in 2004 to 60% by the year 2010. Conversely, another health objective is to reduce the percentage of obese adults from 31% to 15% (CDC, 2007).

Weight status in early adulthood is related to an increased mortality in later life, as results suggest from a study that tracked 629 male University of Glasgow alumni. A mean weight gain of 8.6 kg was noted between the median age of 22 yrs. and 38 yrs, with a corresponding mean increase in BMI from 21.4 to 24.2. Only 46 participants were overweight in college, but that number increased to 246; however these gains in BMI were not well associated with mortality. A strong relationship was observed between BMI in college and all cause mortality demonstrating that BMI in early adulthood has more impact on mortality than does BMI in midlife (Jeffreys et al., 2003).

Even the most active college students are subject to weight gain after graduation. Weight gain fours years after college graduation averaged 6.73 kg ($p<0.05$) in 26 males who were very active as students but later became sedentary. Mean BMI increased from 23.18 to 25.40, and a nearly 50% increase was found in the sum of 5 skinfolds with a 35% increase in body fat. In addition, some measures of physiological work capacity decreased significantly. Although the participants recognized their need to stay active, the reasons for their sedentary behavior were mostly due to lack of time, making a living, promoting their careers, and adjusting to life with a significant other and/or family (Zsolt et al., 2007).

Weight, Perception and Knowledge in College Students

Weight Gain

Anecdotally, college students are known to put on the “freshmen 15,” the popular term used to describe the typical weight gain a college student gains during his/her first year in college. However studies examining this phenomenon have arrived at different results. In a follow up study of 290 students at Washington University, 69% had significantly increased their BMI from 22.6 to 23.2 ($p<0.001$) between the beginning of their freshman year and the end of their sophomore year. They averaged a weight gain of 1.8 kg ($p<0.001$), although the mean weight gain for those who gained was 4.1 kg ($p<0.001$), close to 9 pounds each (Racette et al., 2005).

Weight gain in college students is subtle, but significant, as demonstrated by a study on 27 newly admitted freshmen at San Jose State University. Although not statistically significant, they averaged a positive energy balance of 55 calories over a period of 16 weeks. This small amount of additional calories likely contributed to the significant mean weight gain of 3.0 lbs ($p<0.001$) experienced by the group (Hajhosseini et al., 2006).

Regular, daily weighing with weekly feedback helped female college freshmen maintain energy balance compared to females in a control group that received no treatment. The control group gained an average of 3.1 kg ($p<0.01$) while the treatment group gained an insignificant 0.1 kg (Levitsky, Garay, Nausbaum, Neighbors, & DellaValle, 2006).

Self-Perceived Weight Status

In a study at a predominantly black university, 50.4% of the 123 male students who participated were classified as overweight or obese. Out of those who were overweight or obese, 59.7% incorrectly stated their weight as "normal" as compared to guidelines from the National Institutes of Health. They also chose healthy weights that were higher than those chosen by their normal weight counterparts (p<.001) and were more likely to disagree that weight loss would be beneficial to health. In this particular group, over half of those that were overweight did not perceive they were at unhealthy weights (Gross, Scott-Johnson, & Browne, 2005).

Self-reported weight may not be as accurate as self-reported height. The researchers of a study on 151 health sciences students took both self-reported and objectively measured height and weight measurements. A mean height of 65 inches was the same for both self-reported and subjective measurements, however self-reported weight was 155 pounds as compared to the measured mean weight of 165 pounds (Adderley-Kelly, 2007).

A study using female college students reported they had correct perceptions of their weight status, particularly the overweight students, however the study used self-reported measures of weight which the authors pointed out tend to be underreported. Another interesting finding was the negative association between exercise and restraint dieting (limiting caloric intake), even in those trying to lose weight. This finding suggests that these females used dieting practices as their main method to lose weight, ignoring either by choice or through ignorance the importance of physical activity in the energy balance equation (Shamaley-Kornatz, Smith, & Tomaka, 2007).

Nutrition Knowledge Level

A Spanish university study compared the nutrition knowledge and associated behaviors of 4 groups of university students from different colleges, including nutrition students. Although nutrition students had the highest level of nutrition knowledge, their dietary behaviors were not significantly different than those from the other colleges who had lower levels of nutrition knowledge. There was no difference in self-reported energy consumption; however a gender difference did exist in self-reported height and weight. Females tended to overestimate height and underestimate weight while males reported more realistic measurements. The researchers concluded that nutrition knowledge did not have an effect on food or health behaviors (Montero Bravo, Úbeda Martín, & García González, 2006).

A 2-year randomized controlled trial examined the effects of an intervention giving healthy lifestyle seminars to healthy, non-obese freshmen students. At the end of the study, the control group which received no intervention had gained weight, while the treatment group had slightly lost weight overall, resulting in a mean difference of 1.3 kg between the two groups. Although small in this study, the changes in weight over a longer period of time can become large leading to potential adverse health implications (Hivert, Langlois, Bérard, Cuerrier, & Carpentier, 2007).

Two groups of female freshmen were compared to assess weight status at the end of a 16-month period. The treatment group completed a one semester nutrition science college course with emphasis on physiology and metabolism whereas the control group did not. Among the students in both groups with BMI's above 24, those in the treatment group maintained their weight while those in the control group gained an average of 9.2 kg ($p<0.012$) (Matvienko, Lewis, & Schafer, 2001).

BMI may be related to dietary habits and specific nutritional knowledge. A study examined the food habits and nutritional knowledge of Spanish 21-30 year old college students with normal and high BMI's. Although both groups of students lacked knowledge and did not have balanced diets, females with healthy BMI's tended to consume more dairy products than the females with high BMI's (Mena et al., 2002).

Methods to Assess Both Sides of the Energy Equation

Estimating Energy Requirements and Caloric Intake

Diet records are often underreported making it difficult to assess the intake portion of the energy balance equation, thus the BMI becomes useful when determining the adequacy of energy intake (NAS, IOM, FNB, 2005). Compounding the issue, BMI and an individual's desire to lose weight have been shown to impact the self-reported components of energy balance. A study on young Spanish women showed that women with the highest BMI's tended to report an intake 15.7% less than their estimated expenditure needs while women with the lowest BMI's reported intakes 9.3% greater than their estimated expenditure needs (Ortega et al., 1996).

The normal weight prediction equations for EER were derived from doubly labeled water studies and observed BEE in 407 adults. The TEE equations including overweight and obese adults also used data from an additional 360 adults who were overweight and obese. The data in the equations is assumed to be representative of the metabolism of healthy individuals, excluding those that engage in physical activity full time. Analysis of the equations was accomplished using SPSS, version 10.0, and the best predictions resulted when the data was fitted separately by specific age groups and gender (NAS, IOM, FNB, 2005).

Measurement of Physical Activity and Energy Expenditure

The most accurate methods of measuring energy expenditure include doubly labeled water, direct calorimetry, and indirect calorimetry methods, however these methods are not suitable to study large groups. There are several methods that may be used to study large groups including self-reporting instruments, direct observation, and motion sensors, each with their corresponding advantages and limitations. Of these, the self-reporting instruments (physical activity records and questionnaires) are easiest to administer and lowest in cost. They have the advantage of not influencing behavior, but possess the limitations that accompany self-reporting and recall (Valanou et al., 2006).

The Stanford 7-day physical activity recall tended to overestimate the energy expenditure of 24 male subjects by a mean amount of 30.6% when compared to the doubly labeled water method. There was also a high level of individual variability and the data indicated that the error was due to a misperception of exertion levels on behalf of the subjects. The authors suggested that the recall's usefulness was geared toward large epidemiological studies, not to estimate individual energy expenditures or for small groups (Conway, Seale, Jacobs Jr., Irwin, & Ainsworth, 2002).

The International Physical Activity Questionnaire (IPAQ) has been shown to be both a reliable and valid tool to determine physical activity in people ages 15-69 years (Craig et al., 2003). There are two versions of the questionnaire, a short and a long form, and versions of both are also available in self-administered versions. A person's physical activity reported in MET's can be obtained with the data from the IPAQ. The long version IPAQ was recently studied for validity against data from both accelerometers and physical activity logs and shown to possess high concurrent validity. Total energy expenditure expressed as MET-h week[1] was significantly correlated between the IPAQ and the log book (ρ = .067, P <0.0001), with the difference being -2.9 $\pm$ 44 MET-h week $^{-1}$ (*ns*). Total physical activity was significantly correlated between the IPAQ and the accelerometer (ρ = .055, P <0.0001). The results indicate that the long version IPAQ is a suitable tool to collect physical activity data derived from several domains where physical activity can occur (Hagströmer, Oja, & Sjöström, 2006).

CHAPTER 3

METHODS

Collection of the Data

A convenience sample was taken from undergraduate students enrolled in health science classes at the University of Nevada, Las Vegas (UNLV). According to the National Center for Education Statistics (NCES), over 50% of traditional college students are under the age of 23 years old (2000), so data from students over the age of 23 was excluded from the study. Because the estimated energy requirement equations are designed for people 19 years of age and over, data from students below the age of 19 was also excluded. Human subject rights were protected and research approval was granted by the UNLV Institutional Review Board before proceeding with the study.

A medical balance beam scale equipped with a measuring rod (Detecto Model, Cardinal Scale Manufacturing Co., Webb City, MO 64870) was used to measure individual participant's heights and weights. This scale was moved around campus on a wheeled cart and was zeroed and checked for calibration (Acevedo & Starks, 2003) prior to the collection of heights and weights from each group of students. Body fat percentages were assessed using an HBF-306 Omron body fat analyzer (Omron Healthcare, Inc., 300 Lakeview Parkway, Vernon Hills, IL 60061). The Omron handheld bioimpedance body fat analyzer was compared to hydrostatic weighing for predictive accuracy and found to be 65% accurate for women and 72% accurate for men $\pm$ 3.5% body fat, making it a suitable tool to measure body fat in people with similar characteristics (Gibson, Heyward, & Mermier, 2000).

Data collection was accomplished in two separate meetings. During the initial meeting, students were informed of the study prior to the end of their class meeting, and after their class instructor had adjourned and left the classroom. Students were given the opportunity to decline participation and leave at that time or elect to participate and stay for the remaining portion of their scheduled class meeting time. Those choosing to participate were given informed consent forms to sign, along with two uniquely coded surveys, a Participant Survey and the self-administered long version of the IPAQ. Instructions on survey completion were given to the class as a whole and read from a script, and participants were asked to write down and memorize the code assigned to their surveys. The code was given to afford participant confidentiality and to provide a way to match anthropometric measurements to survey responses during analysis of the data.

During the second encounter, participants were handed a brightly colored index card at the beginning of their class meeting which they placed on their desk for ease of identification. The card instructed each participant to quietly exit the classroom when tapped so he/she could be measured. As the class was conducted, any student with a card was taken out individually to be measured in a quiet area outside the classroom set up with a calibrated balance beam scale. Participants were asked to empty their pockets and remove footwear and outerwear. Height measurements were taken with the balance beam scale measuring rod to the nearest half inch as participants stood with heels together, legs straight, and arms at their sides with their head aligned in the Frankfort plane. Two weights were taken to the nearest pound and body fat percentage was analyzed. All measurements were transcribed to a coded index card. A standardized coded form explaining the participant's energy balance and results was created for every participant and handed out after data entry was accomplished to provide an educational opportunity regarding energy balance.

Treatment of the Data

Data entry was accomplished using an Excel spreadsheet which was formatted to automatically calculate the following: BMI, BEE, MET's, PAL, physical activity coefficient, EER, correct EER estimate.

Body Mass Index (BMI)

Height was entered in inches and converted to meters (m) by multiplying by 2.54 and then dividing by 100. Weight was entered in whole pounds and converted to kilograms (kg) by dividing by 2.2. The BMI was then calculated as follows:

$$\text{BMI} = \frac{kg}{m^2}$$

Basal Energy Expenditure (BEE)

Age was entered in years, and metric height and weight was calculated previously. The BEE in kilocalories per day (kcal/d) was calculated as follows:

Normal-weight, overweight, and obese men:

$$\text{BEE} = 293 - (3.8 \times age[y] + 456.4 \times height(m) + 10.12 \times weight(kg)$$

Normal-weight, overweight, and obese women:

$$\text{BEE} = 247 - (2.67 \times age[y] + 401.5 \times height(m) + 8.60 \times weight(kg)$$

Metabolic Equivalents (METs)

Data from the IPAQ was cleaned and truncated in accordance with the *Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ).* Survey responses relating to time spent in any physical activity were converted to minutes, and any values less than 10 minutes were recoded to zero. Three main categories of METs were used for this study: walking (3.3 METs), moderate intensity (3-6 METs) and vigorous intensity (8 METs). The moderate intensity category included different activities as sub-categories which were as follows: cycling (6 METs), vigorous yard chores (5.5 METs), moderate yard chores (4 METs) and moderate inside chores (3 METs). No values beyond 3 hours in any main MET category were permitted, thus only a maximum of 21 hours per week spent in each main MET category was reflected although participants may have reported spending more time in a particular category. The average time in minutes spent per day in each MET category was determined for use in the PAL equation.

Physical Activity Level (PAL)

The impact of physical activity from each MET category on energy expenditure (ΔPAL) was calculated as follows:

$$\Delta \text{PAL} = \frac{(\#METs - 1)x\{(1.15/0.9)xDuration(\min)]/1440}{BEE/[0.0175x1440xweight(kg)]}$$

The numerator reflects the number of net METs multiplied by a correction factor derived by dividing a factor of 1.15 for EPOC by a factor of 0.9 to account for the TEF. This is multiplied by the time spent in that activity and the resulting number is divided by 1440 which is the number of minutes in one 24-hour period. The denominator reflects a correction factor that results from the division of BEE by the amount of calories burned by an individual at rest (1 MET) in a 24 hour period as determined by weight.

There was a total of 6 different MET values used in this study, thus the impact for each (ΔPALi) was summed together with a factor of 1.1 which accounts for the impact of basal activity. This results in the PAL; the equation is as follows:

PAL = 1.1 + sum of ΔPALi

Physical Activity Coefficient (PA)

The physical activity coefficient (PA) is based upon the PAL and is different for men and women. Following is a list of PA coefficients:

Men

PA = 1.00 if PAL is estimated to be $\geq$1.0 <1.4 (sedentary)

PA = 1.12 if PAL is estimated to be $\geq$1.4 <1.6 (low active)

PA = 1.27 if PAL is estimated to be $\geq$1.6 <1.9 (active)

PA = 1.54 if PAL is estimated to be $\geq$1.9 <2.5 (very active)

Women

PA = 1.00 if PAL is estimated to be $\geq$1.0 <1.4 (sedentary)

PA = 1.14 if PAL is estimated to be $\geq$1.4 <1.6 (low active)

PA = 1.27 if PAL is estimated to be $\geq$1.6 <1.9 (active)

PA = 1.45 if PAL is estimated to be $\geq$1.9 <2.5 (very active)

Estimated Energy Requirement (EER)

The EER is based upon an individual's gender, age, PA coefficient, weight, and height. The equations follow:

Normal-weight, overweight, and obese men ages 19 years and older:

$$\text{EER} = 864 - (9.72 \times age[y]) + PA \times (14.2 \times weight[kg] + 503 \times height[m])$$

Normal-weight, overweight, and obese women ages 19 years and older:

$$\text{EER} = 387 - (7.31 \times age[y]) + PA \times (10.9 \times weight[kg] + 660.7 \times height[m])$$

Correct Estimated Energy Requirement

(EER) Estimate

A participant's estimate of his/her energy requirement was counted as correct if the estimate fell within a range equal to the calculated estimated energy requirement $\pm$ 2 s.d. (Table 3).

Table 3 Estimated standard deviation of EER in kcal/d[a]

BMI	*Males*	*Females*
$\geq$18.5 <25	199	162
$\geq$25	208	160

[a]Estimated Energy Requirements (EER) in kilocalories per day for individuals $\geq$19 years
(adapted from Food and Nutrition Board, Institute of Medicine of the National Academy of Science, 2005)

The formula was entered into Excel to give the following range:

Correct EER = Calculated EER - 2(sd) : Calculated EER + 2(sd)

CHAPTER 4

FINDINGS OF THE STUDY

Analysis of the Data

In order to provide information on the characteristics of the sample, simple descriptive statistics were conducted. A chi-square test was conducted on the primary research question to determine if a significant number of students incorrectly estimated their energy expenditure requirements. Once significance was established, paired sample *t*-tests were used to examine the mean difference between self-estimated and predicted total daily energy requirements, and differences between self-estimated and predicted basal energy expenditures were also analyzed. Paired sample *t*-tests were also used to determine if differences existed between perceived and actual heights and weights. Associations between prior nutrition instruction and the ability to estimate total daily energy requirements were explored, as was gender with the ability to estimate, using chi-square tests. A significance level of .05 was used for all tests. Statistical analysis was accomplished using SPSS (SPSS Inc., 233 S. Wacker Drive, Chicago, IL 60606-6307), version 15.0.

Results

Sample Characteristics

Participation in the study was limited to students between the ages of 19 and 23 years, and the mean age was 20.3 ± 1.3 years. The gender distribution was 92 females and 63 males, and of the total sample of 155 participants only 38 (24.5%) reported having received no prior formal nutrition instruction. The remaining 117 students had either completed an introductory nutrition course in college, or were within the last 2 weeks of completing an introductory nutrition class. Mean BMI was 24.3 ± 4.6, with classification breakdowns as follows: 5.8% unhealthy low (<18.5), 60% healthy (18.5-24.9), 24.5% overweight (25-29.9), and 9.7% obese (>30). The mean PAL was 1.8 ± .5, reflecting an active lifestyle, and the PAL classification breakdowns were as follows: 30% sedentary, 12.3% low active, 23.9% active, and 33.5% very active.

Table 4 Characteristics of the participants

	Total (N = 155)	*Female (n = 92)*	*Male (n = 63)*
Height (inches)	66.4 ± 3.8	64.2 ± 2.4	69.7 ± 3
Weight (pounds)	153.5 ± 39	134 ± 23.3	181.9 ± 39.9
Body Mass Index (BMI)	24.3 ± 4.6	23 ± 3.9	26.3 ± 5
Body Fat Percentage	20.7 ± 7.2	23.5 ± 6	16.5 ± 6.9
Physical Activity Level (PAL)	1.8 ± .5	1.7 ± .5	1.9 ± .5

Values are means ± standard deviation

Differences between Self-Estimated and Predicted Values

In order for a participant's estimate of EER to be counted as correct, the estimate needed to fall within a range equal to the calculated EER $\pm$ 2 standard deviations. There were 51 correct estimates and 104 considered to be incorrect. The initial chi-square analysis determined that there was a significantly lower amount of students than expected that were able to estimate energy requirements correctly, $X^2(1) = 18.123$, $p<.001$. A paired t-test showed that college students significantly underestimated their total daily energy requirements by a mean of 700 calories, $t(147) = 10.54$, $p<.001$. They also significantly underestimated their basal energy expenditure by a mean of 645 calories, $t(144) = 10.15$, $p<.001$.

Differences between Perceived and Actual Heights and Weights

College students overestimated their height by an average of 0.4 inches, $t(154) = 6.68$, $p<.001$, and they underestimated their weight by an average of 2.1 pounds, $t(153) = 5.39$, $p<.001$.

Associations Related to Ability to Estimate Total Daily Energy Requirements

The ability of each participant to estimate total daily energy requirements was determined by verifying that the estimate fell within a range of calories equal to the calculated estimated energy requirement $\pm$

2 standard deviations. Females were better able to estimate their total daily energy requirements than males, 41.3% vs. 20.6%, X^2 (1) = 7.236, p=.007.

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Discussion of Results

The research hypothesis for this study was that college students would not know their EER within a range of calories equivalent to two standard deviations. The hypothesis was confirmed in that 67% of the students surveyed were unable to estimate their energy needs correctly, despite being given a target range of calories equal to two standard deviations above and below their calculated EER. Self-estimated EER were generally underestimated by an average of 700 calories, and the mean of the self-estimated EER was 2085 $\pm$ 808 calories. This amount of calories approaches the 2000 calorie reference for percent daily value recommendations which is posted on food labels, and this number was the mode, so it may have been a number that easily came to mind. There is a possibility that the physical activity level used in the EER equation did not accurately reflect usual physical activity levels, resulting in either higher or lower calculated EERs. However it is unlikely that the difference would have resulted in more correct estimates as the EER was underestimated by an average of 700 calories, a number much greater than a difference one or two variations in a physical activity level would make.

To test whether students understood the concept of BEE they were asked, "If you did absolutely nothing except lie quietly in bed all day, how many calories do you estimate your body would use? Students underestimated BEE significantly by an average of 644 calories, with the average BEE estimated at 929 $\pm$ 760 calories as compared to the calculated BEE of 1574 $\pm$ 282 calories. Self-estimated BEEs ranged from 0 to 3500 calories, indicating that many students had no idea what amount of energy their body consumes at rest. The BEE was calculated using objective measurements of gender, age, height and weight thus eliminating error caused by subjective reasons.

On average, students estimated that BEE accounted for 47% of their EER, however assuming that BEE is comparable to resting energy expenditure, then it usually accounts for 60 – 75% of an average individual's total energy expenditure. The thermic effect of food accounts for about 10%, and the most variable component of total energy expenditure of physical activity can vary between 15 – 30% in the average person (Mahan & Escott-Stump, 2003). In general, students greatly minimized the contribution of BEE to their total energy expenditure, leaving the possibility that they may attribute a greater amount of energy expended due to of physical activity than is actually true.

College students tended to state that they were taller than they actually were. Height on average was overestimated by less than a half inch, although some heights were in error by as much as 2 inches. The mean overestimate of .43 inches was not clinically significant, and measured heights could have been inaccurate despite the efforts to properly measure participants. The measuring rod attachment on the medical balance beam scale is not recommended for use in height measurements and thus a portable stadiometer would have eliminated that possible error.

This sample of students underreported their weight by an average of 2.1 pounds, but this amount could have been accounted for by the light clothing they wore, for which no allowance or subtraction to weight was made. However, some students underestimated their weight by as much as 21 pounds which goes beyond the normal fluctuation of daily weight due to water content variation or clothing (Levitsky, 2005). The underreporting of weight is consistent with existing literature (Adderley-Kelly, 2007), (Montero Bravo et al., 2006), (Rowland, 1990), and this introduced the possibility that underreported weight and overstated height would compound an error when calculating the BMI. However the statistically significant mean of 2.1 pounds was not clinically significant for the purpose of this study, and a comparison of the means between the BMIs resulting from measured and self-reported heights and weights revealed no significant differences.

Because students were informed at the beginning of the study that a physical height and weight measurement would be taken, it was unlikely that they would purposely misrepresent their height and weights. In order to truly study whether students would purposely misstate their heights and weights, it would be necessary to surprise them with physical measurements taken with a scale and stadiometer after collecting their self-reports. Additionally, these students were enrolled in health science classes and should have been more familiar with indicators of health, such as height and weight, and as such may have been sensitized to those two variables.

Whether a student had attended a college nutrition class or not did not improve his/her ability to self-estimate energy requirements. The range that was created by the 2 $\pm$ standard deviations for the estimated energy requirement should have given ample room for error, allowing student estimates to vary by a large margin of calories yet still be considered a correct answer. This was a curious finding as the topic of energy balance is normally discussed in introductory nutrition classes. In addition, many nutrition classes require the completion of a 3-day dietary analysis which includes the calculation of estimated energy requirements.

Another observation is that the majority of students who did not estimate correctly (n=104) underestimated their EER by a mean of 1043 calories, making it remotely possible that students overstated the time spent in physical activity as reported on the IPAQ. This possibility is rather unlikely though, since it would take a severe overestimation of physical activity, similar to the difference created between the sedentary and very active categories, to approach such a large amount of calories. Conversely, the students who estimated correctly were within a mean amount of 98 calories of their EER.

There was an association between gender and the ability to estimate EER correctly, with 41.3% of the females compared to 20.6% of the males making a correct estimate. Fewer males than expected were able to estimate correctly, demonstrating that the females in this study had a better idea of how many calories they needed on a daily basis to maintain their weight. This result is in agreement with other findings showing that females have a greater tendency to be actively trying to manage their weight as compared to males (McCracken, Jiles & Blanck, 2007), (Kruger et al., 2004).

More than 1/3 of the total sample was either overweight or obese (Table 4) which is reflective of nationwide estimates among the age group of 18-24 year olds, yet is still lower than nationwide adult averages of 66.4% that include all ages >19 years (NCHS, 2007). Since participation in the study was optional, many students chose not to participate, so actual BMI data will differ.

Table 5 Body Mass Index (BMI) comparisons

Group	*Behavioral Risk Factor Surveillance System (BRFSS) 2003*	*University of Nevada, Las Vegas (UNLV)*
Normal weight[a] (<25.0 kg/m^2)	60.3	65.2
Overweight (25.0 – 29.9 kg/m^2)	26.1	25.2
Obese (≥30.0 kg/m^2)	13.6	9.7

[a]Data for Underweight (≤18.5 kilograms per meter squared kg/m^2) BMI category is combined with normal weight
Adapted from McCracken, Jiles & Blanck, 2007

Although the average males' BMI of 26.3 categorized them as overweight, the average body fat percentage was 16.5 which is well below the 20-24% predicted body fat percentage associated with a BMI between 25.0 and 29.9. The females' average BMI was 23 which fell in the 21-32% range associated with that BMI (American College of Sports Medicine, 2006). It has been suggested that non-athlete college students have a greater amount of muscle mass than older adults which causes misclassification of many into the overweight BMI. A revised BMI cut point of 26.5 for males and 24.0 for females was recommended to overcome this problem in the non-athlete college student population (Ode, Pivarnik, Reeves &

Knous, 2007). This revision would move 7 males out of the overweight category into the normal weight category, but it would also move 10 females out of the normal weight category into the overweight category. However, it should be noted that this correction is not made in the 2003 Behavioral Risk Factor Surveillance System (BRFSS), so interpretation of overweight and obesity statistics with young adults should be done with caution.

The mean PAL of 1.8 ± .5 is skewed by the amount of participants classified as either sedentary or very active, and although the mean PAL indicates an "active" physical activity level, 47 participants (30.3%) were classified as sedentary (Table 5). The 2003 BRFSS results showed that 10.9% of the 18-24 year-olds in their sample were inactive meaning that they had no leisure time, household or transportation related physical activity, and that 33.2% had insufficient activity (McCracken et al, 2007).

Table 6 Characteristics by physical activity level (PAL) category

	Sedentary (n = 47)	*Low Active (n = 19)*	*Active (n = 37)*	*Very Active (n = 52)*
Males	8 (17%)	8 (42%)	16 (43%)	31 (60%)
Females	39 (83%)	11 (58%)	21 (57%)	21 (40%)
Body Mass Index	22.8 ± 4.2	25.5 ± 4.9	24.2 ± 4.8	25.3 ± 4.6
Fat Percentage	22 ± 6.7	21.3 ± 6.9	20.6 ± 6.5	19.4 ± 8.2
PAL	1.2 ± .1	1.5	1.7 ± .1	2.4 ± .4
Correct EER[a]	27 (57%)	10 (53%)	9 (24%)	5 (10%)

[a]Estimated Energy Requirement (EER)
Values are means ± standard deviation, except where noted

Conclusions and Recommendations for Further Study

Overall, this study has shown that college students were unable to estimate their EER within a range equal to $\pm$ 2 standard deviations. The ability to estimate was improved when gender was considered, with females correctly estimating their energy requirements better than the males, however having taken a college nutrition class did not significantly improve the ability to estimate the EER correctly. Although self-reported heights and weights were significantly different from measured heights and weights, the differences were not clinically significant and did not significantly affect BMI's that were calculated using self-reported data.

Whether possessing the ability to estimate energy needs has a bearing on the ability to maintain energy balance or not is something that should be studied in the future. If knowledge of energy balance concepts including personal energy requirements helps the individual maintain energy balance, efforts to teach these concepts should be included in healthy weight interventions and public messages designed to promote healthy weight. It would also be useful to find out why nutrition students were not able to estimate their energy needs any better than students with no prior college nutrition class. There were no significant differences in ability to estimate the EER between the two groups.

A lot of data related to physical activity was collected during this study that could be analyzed further, including MET-minutes per week spent in each physical activity domain and at different intensities of work. It would be of interest to study further the effects of reported physical activity from certain domains, and explore if associations exist with healthy BMIs. The students in this study used the work domain to report much of their physical activity which indicates that many students have a job outside of their studies.

Another area of study could be designed around the validity of using IPAQ data to classify physical activity levels for use in the EER equation. Although the IPAQ has been validated for use as an instrument to classify the level of physical activity recommendations (Craig et al., 2003), this is the first time the author is aware of that data derived from the IPAQ has been used to classify PALs to assess energy requirements. Yet another topic of interest is the ability of the individual to classify his/her usual level of physical activity correctly when using interactive programs like diet analysis software. A person's EER could be falsely inflated if the physical activity level is exaggerated.

Greater than 50% of students in the sedentary and low active physical activity level categories were able to estimate their EER needs correctly, and this could be attributed to the amount of females in those categories. However, large percentages of females in the active and very active categories were observed also, and despite their gender very few of the females in these two categories were able to estimate their EER correctly. A closer analysis of the means of the estimated EER errors for females according to PAL category could reveal significant differences and would raise new questions.

This study has demonstrated that the majority of college students are not able to estimate their EER within a range equal to $\pm$ 2 standard deviations. These preliminary findings suggest that people are not aware of the energy required to maintain their personal state of energy balance, and further assessment of this topic could provide a better understanding to assist people in the achievement and maintenance of healthy weight.

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APPENDIX I

PROSPECTUS

KNOWLEDGE OF PERSONAL ENERGY REQUIREMENTS

IN COLLEGE STUDENTS

by

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CHAPTER 1

STATEMENT OF THE PROBLEM

Self-reported caloric intakes are often underreported, while self reported physical activity is often exaggerated. Because intake and expenditure are the two components that make up the energy equation, errors in self-reporting make it difficult to evaluate energy imbalance, however the scale does not lie. Do people actually misreport the information because they want to "save face," or is it because they do not understand how this information impacts their personal energy balance, thus minimizing the importance of accurate reporting?

The problem directing this study is: do college students understand the concept of energy balance as it relates to them? Related questions include: do college students know their basal energy expenditure? Do college students know their total daily estimated energy requirements? Can students accurately state their height and weight? Is gender or nutrition education related to how well a student answers the aforementioned questions?

Assumptions

The following assumptions will guide this study:

1. Objective anthropometric measurements, such as height, weight, and body fat, can be taken with ease and minimal discomfort to participants.
2. A person's average daily physical activity level can be estimated using data from a self-administered 7-day physical activity questionnaire.
3. Basal energy expenditure (BEE) and total energy expenditure (TEE) can be predicted with equations.
4. The traditional college student age ranges between 19-24 years of age.
5. The estimated energy requirement equation (EER) is best used to determine energy needs for an individual with a healthy BMI and may vary within two standard deviations. For example, the EER for a 140 lb. 42-year old low active woman with a height of 65 inches would be 2148 kcals, but expenditure could differ by two standard deviations either way. A better estimate of EER would be to give a range determined by a 95% confidence interval, or 2148 $\pm$ (2 x SD) which is 2148 $\pm$ (2 x 162) = 1824 – 2472 kcals (National Academy of Sciences, Institute of Medicine, Food and Nutrition Board, 2005, p. 950).

6. A handheld bioimpedance analyzer can give a quick estimate of body fat.
7. All equipment will be calibrated prior to use and personnel taking anthropometric measurements will be trained to standardize measurement techniques.
8. College student participants will be totally honest when filling out surveys.

Hypotheses

The research hypothesis states that college students do not know their EER within a range of calories equivalent to two standard deviations. The null hypothesis states that college students know their EER within a range of calories equivalent to two standard deviations.

Definitions

The following definitions are given for the purpose of clarification:

1. The Physical Activity Level (PAL) is the ratio of total energy expenditure (TEE) to basal energy expenditure (BEE) and is used to classify an individual's usual level of daily activity according to the Dietary Reference Intakes (DRI's). There are four levels used in this study: sedentary (PAL $\geq$ 1.0 < 1.4), low active (PAL $\geq$ 1.4 < 1.6), active (PAL $\geq$ 1.6 < 1.9), and very active (PAL $\geq$ 1.9 < 2.5) (NAS, IOM, FNB, 2005, p.157).

2. The Physical Activity (PA) coefficient is the numerical value assigned to a given PAL for use in the EER prediction equation. It will differ between genders.
3. The Total Energy Expenditure (TEE) is based upon the Estimated Energy Requirement (EER) prediction equation used to determine an individual's energy needs in kilocalories and is based on requirements for weight maintenance.
4. Body Mass Index (BMI) is an index of health using weight in kilograms divided by height in meters squared. A BMI of <18.5 denotes underweight, 18.5 – 24.9 denotes a healthy range, 25 – 29.9 indicates overweight, and a BMI >30 classifies an individual as obese.
5. Basal Metabolic Rate (BMR) is defined as the rate of energy expenditure measured in a supine position upon waking after a 12-14 hour fast.
6. Basal Energy Expenditure (BEE) is the 24-hour extrapolation of BMR and does not include energy expenditure due to the Thermic Effect of Food (TEF) or Excess Post-Exercise Oxygen Consumption (EPOC).
7. Metabolic Equivalent (MET) is energy expenditure relative to a VO_2 of 3.5 ml/kg body weight/min.

Limitations

As with any study that depends on subjective data obtained from self-reported means, actual physical activity levels may be different than those estimated from the data due to inaccuracies in self-reporting. Physical activity levels may vary from day to day depending on the amount of leisure activity performed. In addition, fidgeting is not taken into account and may contribute to an individual's TEE. These limitations however can be minimized since the variable being measured is the amount of agreement between an individual's perceptions of his/her PAL and a calculated PAL estimate obtained from a PA questionnaire.

Because the BMI does not measure body fat and muscle mass, it may erroneously classify an extremely muscular individual in the overweight or obese category. However, the omicron handheld body fat analyzer will be used in addition to the BMI and should be useful in cases when an individual's BMI is affected by muscularity. Although it is not a highly accurate tool to measure body fatness, it is convenient and easy to use, and it will give an additional piece of data. This limitation of accuracy however may be addressed by instead using additional measures of waist circumference in males, or triceps skin folds in females, whose BMI is $\geq$ 25 yet do not obviously appear overweight or obese (NAS, IOM, FNB, 2005, p. 124).

CHAPTER 2

REVIEW OF THE LITERATURE

Major Concepts

Prevalence of overweight and obesity in adults and associated health consequences

The prevalence of adult overweight and obesity in the U.S. is currently 66.4% (National Center for Health Statistics, 2006). It is widely recognized that overweight and obesity is related to an increased morbidity from chronic diseases and an increase in mortality in general (National Heart, Lung and Blood Institute, 2000), and the CDC estimates that 112,000 deaths are related to obesity every year in the U.S. (Center for Disease Control and Prevention, 2005). A leading Healthy People 2010 health objective is to raise the rate of adult Americans age 20 and over at a healthy weight from the latest estimate of 32% in 2004 to 60% by the year 2010. Conversely, another health objective is to reduce the percentage of obese adults from 31% to 15% (Center for Disease Control and Prevention, 2007).

Weight status in early adulthood is related to an increased mortality in later life, as results suggest from a study that tracked 629 male University of Glasgow alumni. A mean weight gain of 8.6 kg was noted between the median age of 22 yrs. and 38 yrs, with a corresponding mean increase in BMI from 21.4 to 24.2. Only 46 participants were overweight in college, but that number increased to 246; however these gains in BMI were not well associated with mortality. A strong relationship was observed between BMI in college and all cause mortality demonstrating that BMI in early adulthood has more impact on mortality than does BMI in midlife (Jeffreys, McCarron, Gunnell, McEwen, & Davey Smith, 2003).

Even the most active college students are subject to weight gain after graduation. Weight gain fours years after college graduation averaged 6.73 kg ($p<0.05$) in 26 males who were very active as students but later became sedentary. Mean BMI increased from 23.18 to 25.40, and a nearly 50% increase was found in the sum of 5 skinfolds with a 35% increase in body fat. In addition, some measures of physiological work capacity decreased significantly. Although the participants recognized their need to stay active, the reasons for their sedentary behavior were mostly due to lack of time, making a living, promoting their careers, and adjusting to life with a significant other and/or family (Zsolt et al., 2007).

Weight gain in college students

Anecdotally, college students are known to put on the "freshmen 15," however studies examining this phenomenon have arrived at different results. In a follow up study of 290 students at Washington University, 69% had significantly increased their BMI from 22.6 to 23.2 ($p<0.001$) between the beginning of their freshman year and the end of their sophomore year. They averaged a weight gain of 1.8 kg ($p<0.001$), although the mean weight gain for those who gained was 4.1 kg ($p<0.001$), close to 9 pounds each (Racette, Deusinger, Strube, Highstein, & Deusinger, 2005).

Weight gain in college students is subtle, but significant, as demonstrated by a study on 27 newly admitted freshmen at San Jose State University. Although not statistically significant, they averaged a positive energy balance of 55 calories over a period of 16 weeks. This small amount of additional calories likely contributed to the significant mean weight gain of 3.0 lbs ($p<0.001$) experienced by the group (Hajhosseini et al., 2006).

Regular, daily weighing with weekly feedback helped female college freshmen maintain energy balance compared to females in a control group that received no treatment. The control group gained an average of 3.1 kg ($p<0.01$) while the treatment group gained an insignificant 0.1 kg (Levitsky, Garay, Nausbaum, Neighbors, & DellaValle, 2006).

Nutrition knowledge level of college students

A Spanish university study compared the nutrition knowledge and associated behaviors of 4 groups of university students from different colleges, including nutrition students. Although nutrition students had the highest level of nutrition knowledge, their dietary behaviors were not significantly different than those from the other colleges who had lower levels of nutrition knowledge. There was no difference in self-reported energy consumption; however a gender difference did exist in self-reported height and weight. Females tended to overestimate height and underestimate weight while males reported more realistic measurements. The researchers concluded that nutrition knowledge did not have an effect of food or health behaviors (Montero Bravo, Úbeda Martín, & García González, 2006).

A 2-year randomized controlled trial examined the effects of an intervention giving healthy lifestyle seminars to healthy, non-obese freshmen students. At the end of the study, the control group which received no intervention had gained weight, while the treatment group had slightly lost weight overall, resulting in a mean difference of 1.3 kg between the two groups. Although small in this study, the changes in weight over a longer period of time can become large leading to potential adverse health implications (Hivert, Langlois, Bérard, Cuerrier, & Carpentier, 2007).

Two groups of female freshmen were compared to assess weight status at the end of a 16-month period. The treatment group completed a one semester nutrition science college course with emphasis on physiology and metabolism whereas the control group did not. Among the students in both groups with BMI's above 24, those in the treatment group maintained their weight while those in the control group gained an average of 9.2 kg (p<0.012) (Matvienko, Lewis, & Schafer, 2001).

BMI may be related to dietary habits and specific nutritional knowledge. A study examined the food habits and nutritional knowledge of Spanish 21-30 year old college students with normal and high BMI's. Although both groups of students lacked knowledge and did not have balanced diets, females with healthy BMI's tended to consume more dairy products than the females with high BMI's (Mena et al., 2002).

<u>Self-perceived weight status</u>

<u>of college students</u>

In a study at a predominantly black university, 50.4% of the 123 male students who participated were classified as overweight or obese. Out of those who were overweight or obese, 59.7% incorrectly stated their weight as "normal" as compared to guidelines from the National Institutes of Health. They also chose healthy weights that were higher than those chosen by their normal weight counterparts (p<.001) and were more likely to disagree that weight loss would be beneficial to health. In this particular group, over half of those that were overweight did not perceive they were at unhealthy weights (Gross, Scott-Johnson, & Browne, 2005).

Self-reported weight may not be as accurate as self-reported height. The researchers of a study on 151 health sciences students took both self-reported and subjectively measured height and weight measurements. A mean height of 65 inches was the same for both self-reported and subjective measurements, however self-reported weight was 155 pounds as compared to the measured mean weight of 165 pounds (Adderley-Kelly, 2007).

A study using female college students reported they had correct perceptions of their weight status, particularly the overweight students, however the study used self-reported measures of weight which the authors pointed out tend to be underreported. Another interesting finding was the negative association between exercise and restraint dieting (limiting caloric intake), even in those trying to lose weight. This finding suggests that these females used dieting practices as their main method to lose weight, ignoring either by choice or through ignorance the importance of physical activity in the energy balance equation (Shamaley-Kornatz, Smith, & Tomaka, 2007).

Methods to estimate energy requirements and caloric intake

Diet records are often underreported making it difficult to assess the intake portion of the energy balance equation, thus the BMI becomes useful when determining the adequacy of energy intake (NAS, IOM, FNB, 2005, p. 955). Compounding the issue, BMI and an individual's desire to lose weight have been shown to impact the self-reported components of energy balance. A study on young Spanish women showed that women with the highest BMI's tended to report an intake 15.7% less than their estimated expenditure needs while women with the lowest BMI's reported intakes 9.3% greater than their estimated expenditure needs (Ortega et al., 1996).

The normal weight TEE prediction equations for EER were derived from DLW studies and observed BEE in 407 adults. The TEE equations including overweight and obese adults also used data from an additional 360 adults who were overweight and obese. The data in the equations is assumed to be representative of the metabolism of healthy individuals, excluding those that engage in physical activity full time. Analysis of the equations was accomplished using SPSS, version 10.0, and the best predictions resulted when the data was fitted separately by specific age groups and gender (NAS, IOM, FNB, 2005, p. 157).

Measurement of physical activity and energy expenditure

The most accurate methods of measuring energy expenditure include doubly-labeled water (DLW), direct calorimetry, and indirect calorimetry methods, however these methods are not suitable to study large groups due to lack of feasibility. There are several methods that may be used to study large groups including self-reporting instruments, direct observation, and motion sensors, each with their corresponding advantages and limitations. Of these, the self-reporting instruments (PA records and questionnaires) are easiest to administer and lowest in cost. They have the advantage of not influencing behavior, but possess the limitations that accompany self-reporting and recall (Valanou, Bamia, & Trichopoulou, 2006).

The Stanford 7-day physical activity recall tended to overestimate the energy expenditure of 24 male subjects by a mean amount of 30.6% when compared to the doubly labeled water method. There was also a high level of individual variability and the data indicated that the error was due to a misperception of exertion levels on behalf of the subjects. The authors suggested that the recall's usefulness was geared toward large epidemiological studies, not to estimate individual energy expenditures or for small groups (Conway, Seale, Jacobs Jr., Irwin, & Ainsworth, 2002).

The International Physical Activity Questionnaire (IPAQ) has been shown to be both a reliable and valid tool to determine physical activity in people ages 15-69 years (Craig et al., 2003). There are two versions of the questionnaire, a short and a long form, as well as the ability to self-administer either version. A person's physical activity reported in MET's can be obtained with the data from the IPAQ. The long version IPAQ was recently studied for validity against data from both accelerometers and

PA logs and shown to possess high concurrent validity. Total energy expenditure expressed as MET-h week $^{-1}$ was significantly correlated between the IPAQ and the log book (ρ = .067, P<0.0001), with the difference being -2.9 $\pm$ 44 MET-h week $^{-1}$ (*ns*). Total PA was significantly correlated between the IPAQ and the accelerometer (ρ = .055, P<0.0001). The results indicate that the long version IPAQ is a suitable tool to collect PA data derived from several domains where PA can occur (Hagströmer, Oja, & Sjöström, 2006).

Source of Review

The literature review was accomplished by searching the Scopus, Medline, and PsychInfo indexes using the following search terms: energy balance perception, college student, body weight, weight gain, nutrition knowledge, caloric intake, physical activity level, energy expenditure assessment.

Equipment & Measuring Techniques

The Omron handheld bioimpedance body fat analyzer was compared to hydrostatic weighing for predictive accuracy at the University of New Mexico. Participants included a total of 48 men and women between the ages of 18 and 55 years with a range of body fat percentage between 7 and 42.8. The accuracy rate for women was 65% and 72% for men $\pm$ 3.5% body fat. Based on this sample, the authors concluded that the

Omron body fat analyzer was a suitable tool to measure body fat in people with similar characteristics (Gibson, Heyward, & Mermier, 2000).

To measure stature, or height, the participant should remove foot wear and stand with heels together, legs straight, arms along sides with the head aligned in the Frankfort plane. The buttocks, heels, shoulder blades and back of head should touch the stadiometer, but may not be possible due to body composition. Get as many of the four points to touch in the event that not all can be achieved. Subject should then inhale, hold breath, and stand tall while measurer lowers headboard enough to compress hair. Measurement should be taken with eyes level to headboard to nearest 0.1 cm or 1/8 inch (Lee & Nieman, 2003, p.166).

The balance beam scale must be calibrated every time it is moved and before taking weights for research and it must rest on a flat, hard surface. The participant will remove shoes and coat and stand on the middle of platform. Two measurements should be taken and the weight recorded to the nearest 100 g or ¼ lb (Lee & Nieman, 2003, p. 167).

Prediction equations are taken from the *Dietary reference intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids* (NAS, IOM, FNB, 2005) and are as follows:

<u>BEE Equations</u>

BEE (kcal/d) for normal-weight, overweight, and obese men:

$$293-(3.8\times age[y]+456.4\times height(m)+10.12\times weight(kg)$$

BEE (kcal/d) for normal-weight, overweight, and obese women:

$$247-(2.67\times age[y]+401.5\times height(m)+8.60\times weight(kg)$$

PAL Equations

PAL for men: $(\#METs-1)\times 1.34\times(\min\div 1{,}440\min)$

Where $1.34 = 1.15 percent(EPOC)\div 0.9 percent(TEF)\div 0.95 percent$

PAL for women: $(\#METs-1)\times 1.42\times(\min\div 1{,}440\min)$

Where $1.42 = 1.15 percent(EPOC)\div 0.9 percent(TEF)\div 0.91 percent$

EER Equations

EER for normal-weight, overweight, and obese men ages 19 years and older: $864-(9.72\times age[y])+PA\times(14.2\times weight[kg]+503\times height[m])$

Where PA is the physical activity coefficient:

PA = 1.00 if PAL is estimated to be $\geq$1.0 <1.4 (sedentary)

PA = 1.12 if PAL is estimated to be $\geq$1.4 <1.6 (low active)

PA = 1.27 if PAL is estimated to be $\geq$1.6 <1.9 (active)

PA = 1.54 if PAL is estimated to be $\geq$1.9 <2.5 (very active)

EER for normal-weight, overweight, and obese women ages 19 years and older: $387-(7.31\times age[y])+PA\times(10.9\times weight[kg]+660.7\times height[m])$

Where PA is the physical activity coefficient:

PA = 1.00 if PAL is estimated to be $\geq$1.0 <1.4 (sedentary)

PA = 1.14 if PAL is estimated to be $\geq$1.4 <1.6 (low active)

PA = 1.27 if PAL is estimated to be $\geq$1.6 <1.9 (active)

PA = 1.45 if PAL is estimated to be $\geq$1.9 <2.5 (very active)

CHAPTER 3

METHODS

Research Questions

Research Question #1

Is there a significant difference between college students' self-estimated and predicted total daily energy requirements?

The dependent variable will be daily caloric need and the independent variable will have two levels, (1) self-reported estimated daily caloric needs and (2) calculated TEE based on gender, age, height, and weight. A 95% confidence interval (CI) will be used to determine the accuracy of each individual's estimate. The CI will be based on a standard deviation between 199 and 208 for males and 160 to 162 for females. The standard deviation used will be based on each participant's BMI (see Table 1).

Data from this question will be analyzed with a dependent t-test.

Research Question #2

Is there a significant difference between college students' self-estimated and predicted basal energy expenditure?

The dependent variable will be BEE and the independent variable will have two levels, (1) self-reported estimated BEE and (2) calculated BEE based on gender, age, height, and weight. A 95% CI will be used to determine the accuracy of each individual's estimate.

Data from this question will be analyzed with a dependent t-test.

Research Question #3

Is there a significant difference between college students' perceived height and weight and actual height and weight?

The dependent variables will be height and weight and the independent variable will have two levels, (1) self-reported height and weight and (2) actual height and weight. A 95% CI will be used to determine the accuracy of each individual's estimate.

Data from this question will be analyzed with a two dependent t-tests, one for each dependent variable.

Research Question #4

Is there an association between having taken a college nutrition class and one's ability to estimate total daily energy requirements?

Data will be analyzed with a Chi-square test for association as demonstrated below.

	EER Correct	EER Incorrect
Nutrition Class		
NO Nutr Class		

Research Question #5

Is there an association between gender and one's ability to estimate total daily energy requirements?

Data will be analyzed with a Chi-square test for association as demonstrated below.

	EER Correct	EER Incorrect
Males		
Females		

Subjects

A convenience sample will be taken from undergraduate students enrolled at UNLV. According to the National Center for Education Statistics, over 50% of traditional college students are under the age of 23 years old (2000), so data from students over the age of 23 will be excluded from the study. Human subject rights will be protected and IRB approval or exemption will be granted before proceeding with the study.

Equipment

A professional medical balance beam scale model 402LB manufactured by Health o meter, 700 West 100th Place, Bridgeview, IL 60455

A portable stadiometer model 214, manufactured by Seca Corp., 3401 Centrelake Drive Suite 320, Ontario, CA 91761

The HBF-306 Omron body fat analyzer manufactured by Omron Healthcare, Inc., 300 Lakeview Parkway, Vernon Hills, IL 60061

The Lange skinfold caliper manufactured by Beta Technology, 2841 Mission St., Santa Cruz, CA 95060

A measuring tape

Protocol

Participants will be informed of the study at the beginning of their class meeting and will be given informed consent forms to sign if willing to participate. Instructions on survey completion will be given to the class as a whole and read from a script. Participants will then be given an index card with a code and a corresponding coded survey. The code will be used to match anthropometric measurements to survey responses during analysis and is intended to provide confidentiality. During the class meeting, participants will be called out individually and taken to a private area where trained graduate students will take height, weight, and body fat measurements. The results will be recorded on the participant's coded index card, which will then be stored for future data entry and analysis, and completed surveys will be treated likewise. Upon completion of initial survey responses, the self-administered long version IPAQ will be given to each participant along with instructions read to the whole class from a script. The IPAQ's will also be coded, collected, and matched for data collection and analysis.

Data entry will be accomplished using an Excel spreadsheet which will automatically calculate the following: BMI, BEE, TEE, domain specific METs, and PAL. A standardized form explaining the participant's energy balance will be created for every participant after data entry is accomplished in an effort to provide education regarding energy balance.

Statistical Analysis

SPSS, version 15.0 will be used to analyze the data.

APPENDIX II

ADDITIONAL METHODS

Thesis Survey Script

Distribute Informed Consent Forms

"Good (morning/afternoon). My name is Aurora Buffington and I am a graduate student in the Kinesiology department here at UNLV. You are invited to participate in a research study. The purpose of this study is to determine if college students know their estimated energy requirements.

You are being asked to participate in this study because you are a student between the ages of 19 and 24 years enrolled in a college class. *If you are not between the ages of 19 and 24 years, you may still participate, however your data will be excluded from the study.*

If you volunteer to participate in this study, you will be asked to do the following during this initial contact: (1) fill out a brief survey about your estimated energy needs, (2) fill out a physical activity questionnaire; and during the following class meeting (3) have your height, weight, and body fat percentage measured. Your time commitment should be limited to approximately 25 minutes during this initial encounter to complete surveys and 5 minutes on the subsequent encounter to collect anthropometric data. *Since all information will be coded to ensure confidentiality, you will be assigned a code.* PLEASE REMEMBER YOUR CODE. YOU ARE ENCOURAGED TO WRITE IT DOWN IN YOUR NOTEBOOK WHEN YOU RECEIVE IT.

There *may* be direct benefits to you as a participant in this study. In approximately 2 weeks you will receive an explanation of your estimated energy requirements, your physical activity level, and your BMI. *This information will not have your name on it, only the code you are assigned.* PLEASE REMEMBER YOUR CODE if you would like to receive these results.

There are risks involved in all research studies. This study may include only minimal risks. You may become uncomfortable or embarrassed when answering some questions or being measured.
There *will not* be financial cost to you to participate in this study. The study will take 30 *minutes* of your time. You *will not* be compensated for your time. *The University of Nevada, Las Vegas may not provide*

compensation or free medical care for an unanticipated injury sustained as a result of participating in this research study.

If you have any questions or concerns about the study, you may contact Dr. Tandy at **702-895-5058** or Aurora Buffington at **702-895-4328.** For questions regarding the rights of research subjects, any complaints or comments regarding the manner in which the study is being conducted you may contact **the UNLV Office for the Protection of Research Subjects at 702-895-2794.**

Your participation in this study is voluntary and not a part of this class; however your instructor has permitted use of this classroom facility and a minimal amount of meeting time to accommodate this study. If you do not wish to participate you may leave the classroom when I am done reading this script. You may refuse to participate in this study or in any part of this study. You may withdraw at any time without prejudice to your relations with the university. You are encouraged to ask questions about this study at the beginning or any time during the research study. All information gathered in this study will be kept completely confidential. No reference will be made in written or oral materials that could link you to this study. All records will be stored in a locked facility at UNLV for at least 3 years after completion of the study. After the storage time the information gathered will be destroyed.

Please sign, date, and print your name if you agree to participate in this study. You also acknowledge that you are at least 18 years of age and that a copy of this form has been given to you. ***Do not sign this document if the Approval Stamp is missing or is expired."***

GIVE STUDENTS OPPORTUNITY TO ASK QUESTIONS OR LEAVE IF THEY DO NOT WISH TO PARTICIPATE. Collect completed consent forms and exchange for a survey, an IPAQ, and a copy of the informed consent for them to keep.

"Please COPY YOUR CODE somewhere in your notebook. You will need to remember this code for our next meeting AND you will need it to obtain the results of your energy balance estimation.

I would like to thank each of you for participating. Participating in this **survey** is voluntary and your grade in this class will not be affected by how you answer the questions. The answers you give are very important. I ask that you read each question carefully and answer it based on what you really know or do. I would like to emphasize that this is not a test of you or this school.

Throughout the entire **survey** process, I will maintain strict procedures to protect your privacy and allow for your anonymous participation. Please do not write your name on the survey or IPAQ questionnaire. Your answers are private. Results of this **survey** will never be reported by name or class. When you are done with the survey and the questionnaire, you can deposit them in this large box.

Now I would like you to look at the one page survey. You may use a pen or pencil to fill it out. Please answer each question with the best answer you can come up with. Even if you do not know the answer, give your best estimation.

When you are done with that survey, please read the directions and complete the IPAQ. We are allowed an additional 15 minutes to complete these surveys, which mean that the survey will end at approximately _______. If you finish before that time, you may deposit your survey and questionnaire in the box and leave quietly.

It is important that you answer the **surveys** based on what you really know or do. Do not pick a response just because you think that is what someone wants you to say.

Please make every attempt to be present for the next class meeting as I will be taking your height and weight measurements. These measurements will be taken privately, one participant at a time, and should take no more than 5 minutes per participant.

I would like to thank all of you for participating in this study. The information you provide will help us determine if college students know their estimated energy requirements."

Participant Survey

Survey ID: ____________________

Please take a few minutes to fill out this survey. Your answers will be kept confidential.

About You

1. **What is your gender?** O Male O Female

2. **What is your age?** ____________________

About Height and Weight

3. **With shoes removed, what is your height in feet and inches?** ________________

4. **With shoes removed, what is your current weight in pounds?** ________________

About Knowledge

5. **If you did absolutely nothing except lie quietly in bed all day, how many calories do you estimate your body would use?** __________calories

6. **How many calories do you need per day to *maintain* your weight?** __________calories

7. **Are you currently enrolled in a college nutrition class?**

   O Yes O No

8. **Have you ever taken a college nutrition class?**

   O Yes O No

Thank you for your participation. Your input is greatly appreciated.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE
(October 2002)

LONG LAST 7 DAYS SELF-ADMINISTERED FORMAT

FOR USE WITH YOUNG AND MIDDLE-AGED ADULTS (15-69 years)

The International Physical Activity Questionnaires (IPAQ) comprises a set of 4 questionnaires. Long (5 activity domains asked independently) and short (4 generic items) versions for use by either telephone or self-administered methods are available. The purpose of the questionnaires is to provide common instruments that can be used to obtain internationally comparable data on health–related physical activity.

Background on IPAQ
The development of an international measure for physical activity commenced in Geneva in 1998 and was followed by extensive reliability and validity testing undertaken across 12 countries (14 sites) during 2000. The final results suggest that these measures have acceptable measurement properties for use in many settings and in different languages, and are suitable for national population-based prevalence studies of participation in physical activity.

Using IPAQ
Use of the IPAQ instruments for monitoring and research purposes is encouraged. It is recommended that no changes be made to the order or wording of the questions as this will affect the psychometric properties of the instruments.

Translation from English and Cultural Adaptation
Translation from English is encouraged to facilitate worldwide use of IPAQ. Information on the availability of IPAQ in different languages can be obtained at www.ipaq.ki.se. If a new translation is undertaken we highly recommend using the prescribed back translation methods available on the IPAQ website. If possible please consider making your translated version of IPAQ available to others by contributing it to the IPAQ website. Further details on translation and cultural adaptation can be downloaded from the website.

Further Developments of IPAQ
International collaboration on IPAQ is on-going and an ***International Physical Activity Prevalence Study*** is in progress. For further information see the IPAQ website.

More Information
More detailed information on the IPAQ process and the research methods used in the development of IPAQ instruments is available at www.ipaq.ki.se and Booth, M.L. (2000). *Assessment of Physical Activity: An International Perspective.* Research Quarterly for Exercise and Sport, 71 (2): s114-20. Other scientific publications and presentations on the use of IPAQ are summarized on the website.

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?

   ☐ Yes

   ☐ No → ***Skip to PART 2: TRANSPORTATION***

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.

   _____ **days per week**

   ☐ No vigorous job-related physical activity → ***Skip to question 4***

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?

   _____ **hours per day**
   _____ **minutes per day**

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.

   _____ **days per week**

   ☐ No moderate job-related physical activity → ***Skip to question 6***

LONG LAST 7 DAYS SELF-ADMINISTERED version of the IPAQ. Revised October 2002.

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?

_____ **hours per day**
_____ **minutes per day**

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.

_____ **days per week**

☐ No job-related walking → ***Skip to PART 2: TRANSPORTATION***

7. How much time did you usually spend on one of those days **walking** as part of your work?

_____ **hours per day**
_____ **minutes per day**

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?

_____ **days per week**

☐ No traveling in a motor vehicle → ***Skip to question 10***

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?

_____ **hours per day**
_____ **minutes per day**

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

☐ No bicycling from place to place → ***Skip to question 12***

11. How much time did you usually spend on one of those days to **bicycle** from place to place?

_____ **hours per day**
_____ **minutes per day**

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?

_____ **days per week**

☐ No walking from place to place → ***Skip to PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY***

13. How much time did you usually spend on one of those days **walking** from place to place?

_____ **hours per day**
_____ **minutes per day**

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?

_____ **days per week**

☐ No vigorous activity in garden or yard → ***Skip to question 16***

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?

_____ **days per week**

☐ No moderate activity in garden or yard → ***Skip to question 18***

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?

_____ **hours per day**
_____ **minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?

_____ **days per week**

☐ No moderate activity inside home ➡ ***Skip to PART 4: RECREATION, SPORT AND LEISURE-TIME PHYSICAL ACTIVITY***

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?

_____ **hours per day**
_____ **minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?

_____ **days per week**

☐ No walking in leisure time ➡ ***Skip to question 22***

21. How much time did you usually spend on one of those days **walking** in your leisure time?

_____ **hours per day**
_____ **minutes per day**

22. Think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?

_____ **days per week**

☐ No vigorous activity in leisure time ➡ ***Skip to question 24***

LONG LAST 7 DAYS SELF-ADMINISTERED version of the IPAQ. Revised October 2002.

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?

_____ **hours per day**
_____ **minutes per day**

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?

_____ **days per week**

☐ No moderate activity in leisure time ➡ ***Skip to PART 5: TIME SPENT SITTING***

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?
_____ **hours per day**
_____ **minutes per day**

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?

_____ **hours per day**
_____ **minutes per day**

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?

_____ **hours per day**
_____ **minutes per day**

This is the end of the questionnaire, thank you for participating.

Coded Index Card

ID: ____________	
Height in Inches to closest ½ inch:	____________
Weight #1 in Pounds to closest pound:	____________
Weight #2 in Pounds to closest pound:	____________
Body Fat Percentage:	____________
Measurement taken by:	____________

Participant Form Letter

Dear Participant «Code»:

Thank you for participating in the research study titled "Knowledge of personal energy requirements in college students."

Your height was measured at «Ht_in_inches» inches and your weight at «Wt_in_lbs» pounds which results in a body mass index (BMI) of «BMI». *The BMI gives researchers a tool to assess the weight to height ratio for a group of people. The four classifications used in this study are: <18.5 underweight, 18.5 – 24.9 normal weight, 25 – 29.9 overweight, and >30 obese.* A limitation of the BMI is that it does not discern how much weight is attributable to lean body mass, so very muscular individuals may fall into an overweight or obese category. Your body fat was measured at «Body_Fat»% with an Omron HBF-300 body fat analyzer. *Body fat classification norms for average college students are as follows:* Unhealthy Low <5% (Males) <12% (Females); Athletic 5-13% (M), 12-22% (F); Recommended (<34 years of age) 10-22% (M), 20-32% (F); Unhealthy High >25% (M) >38% (F).

According to the answers you provided on the International Physical Activity Questionnaire (IPAQ), you spent an average of «PA_Mins» minutes daily doing something active. This translates to a physical activity level of «PAL_Cat». *Current ACSM and AHA physical activity recommendations for adults are to do moderately intense cardio 30 minutes a day, five days a week OR to do vigorously intense cardio 20 minutes a day, 3 days a week AND do eight to 10 strength-training exercises, eight to 12 repetitions of each exercise twice a week. Moderate-intensity physical activity means working hard enough to raise your heart rate and break a sweat, yet still being able to carry on a conversation. To lose weight or maintain weight loss, 60 to 90 minutes of physical activity may be necessary. The 30-minute recommendation is for the average healthy adult to maintain health and reduce the risk for chronic disease.* Your level of physical activity (beyond the normal activities of daily living) contributed an average «Kcals_PA»% of your daily estimated energy requirement. This can vary from day to day, but averages between 20 and 30% for most people. This is the most variable component of energy expenditure and can be raised by performing additional physical activity.

Basal energy expenditure (BEE) is an extrapolation of the rate of energy expenditure measured during rest after fasting. You estimated you would use «Est_BEE» calories if you lay in bed all day and did nothing; your BEE was calculated at «Calc_BEE» calories per day. BEE accounted for «Kcals_BEE»% of your daily estimated energy requirement. This is a highly stable component of energy expenditure.

Your estimated energy requirement (EER) was calculated based on your gender, age, height, weight and physical activity level. *The EER is an estimate of the amount of calories needed to maintain your current weight.* Your EER was calculated at «Calc_EER» calories per day compared to the estimate of «Est_EER» calories that you gave. Remember, this is only an estimate and actual needs may vary.

The difference between the EER calories and your BEE calories is mostly due to physical activity, although 10-15% of those calories may be attributed to the thermal effect of food and excess postexercise oxygen consumption. *The thermal effect of food (TEF) accounts for the energy required to digest food that is consumed. Excess postexercise oxygen consumption (EPOC) accounts for a slightly increased metabolic rate that exists after a bout of exercise.*

If you consume 100 more calories than you use, you could GAIN 10 pounds in one year. If you burn 100 more calories than you consume you could LOSE 10 pounds in one year. When you consume about the same calories as you use, you are in a state of ENERGY BALANCE and you will neither gain nor lose weight. **An extra 100 calories per day will make about 10 pounds difference over the period of a year.**

APPENDIX III

PARTICIPANT DATA

Please see enclosed CD-Rom for Excel data spreadsheet information.

VITA

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Degrees:
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Community College of the Air Force

Associate of Arts, 2003
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Special Honors and Awards:
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Thesis Title: Knowledge of Personal Energy Requirements in College Students

Thesis Examination Committee:
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Committee Member, Dr. John Young, Ph. D.
Committee Member, Dr. Lawrence Golding, Ph. D.
Graduate College Representative, Dr. Laura Kruskall, Ph. D.