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## Changes in Body Composition and Physical Activity Behavior in a Group of College Freshmen

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To the Graduate Council:

I am submitting herewith a thesis written by Tracy A. Swibas entitled "Changes in Body Composition and Physical Activity Behavior in a Group of College Freshmen." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Exercise Science.

Dixie L. Thompson, Major Professor

We have read this thesis and recommend its acceptance:

Eugene E. Fitzhugh, Edward T. Howley

Accepted for the Council:

Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

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CHANGES IN BODY COMPOSITION AND PHYSICAL ACTIVITY BEHAVIOR IN  
A GROUP OF COLLEGE FRESHMEN

A Thesis  
Presented for the  
Masters of Science Degree  
The University of Tennessee, Knoxville

Tracy Anne Swibas  
August 2007

## **DEDICATION**

This master thesis is dedicated to my family, Charlene, Ed, and Carie Swibas, whom I admire tremendously. I thank you for always believing in me, supporting me, and encouraging me to accomplish goals I never thought were in reach. Without all of you this would have never been possible. Thank you for everything, and I love you very much.

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## ABSTRACT

**PURPOSE:** To compare: 1-the physiological profile of former athletes (Ath) and non-athletes (Non-Ath) upon college entrance, 2-PA levels in these groups, and 3-changes in physiological profile and PA level of former Ath and Non-Ath and females and males over the course of freshman year. Sixty-two college freshmen were tested during the initial weeks of the school year and again during the final weeks of the school year; the sample consisted of 32 former Ath (18 females and 14 males) and 30 Non-Ath (19 females and 11 males). **METHODS:** Body composition (BC) was assessed using the Bod Pod with a conversion of body density to body fat percentage (%BF) using the Siri equation. PA was assessed using the International Physical Activity Questionnaire (IPAQ), and 7 days of steps were counted using a pedometer. **RESULTS:** Upon entrance into college, Ath and Non-Ath had similar BC. Daily average number of steps was similar among the groups (Ath:  $11212 \pm 2729$  steps; Non-Ath  $11191 \pm 3735$ ). However, median MET-minutes of weekly total PA (TPA) was higher in Ath (2737 METmin/wk) than Non-Ath (1613 METmin/wk). Over the course of freshmen year, there was a significantly larger drop in TPA for Ath ( $-1006 \pm 2126$  MET-min/wk) than Non-Ath ( $140 \pm 2458$  MET-min/wk). Overall, Ath had a higher fat free mass ( $p=0.046$ ). The overall sample experienced unhealthy changes in BC, with a significant average weight gain of  $1.81 \text{ kg} \pm 2.59 \text{ kg}$  and a significant decline in daily steps. Males had a significantly larger decline in steps than females ( $-2374 \pm 3720$  steps/day vs.  $-929 \pm 2596$  steps/day). The overall sample also had a significant decrease in median TPA ( $2134$  MET-min/wk to  $1725$  MET-min/wk). However there was a wide variation of changes in BC and PA;

some had large changes while others had small or none. CONCLUSION: Generally, there were small but unhealthy changes in BC and decreases in PA during freshman year. Former athletes enter college with initially higher activity level when compared to Non-Ath; however this difference disappears by the end of freshmen year. The key is to determine factors that contribute to the large changes in certain individuals and to pinpoint factors that influence college students' PA behavior.



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## CHAPTER 1: INTRODUCTION

The prevalence of obesity and overweight is at an all-time high in the United States, and there is no evidence that it is improving [1-5]. Data from NHANES shows from 1976 to 1980, 11.5% of children and adolescents were overweight and 14.5% of adults were obese (BMI greater than or equal to 30.0) [1, 5, 6]. From 2003 to 2004, 36.2% of children and adolescents were overweight and 32.3% of adults were obese [5]. There has been a 24.7% increase in overweight children and adolescents and a 17.8% increase in obese adults from 1976 to 2004 [5].

Obesity is a serious health problem. It increases the risk of diseases and health conditions including type 2 diabetes mellitus, cardiovascular disease, hypertension, stroke, dyslipidemia and osteoarthritis as well as some cancers [7, 8]. Specifically, centrally located excess weight is a stronger predictor of health problems [9, 10]. Regular physical activity helps control weight, reduces risk of disease, and strengthens muscles, bones and joints [11]. Participation in regular physical activity is inversely associated with obesity [12], and amount of physical activity is negatively associated with central obesity and total body fat mass [13, 14].

Research has shown that the transition from high school to college is a period when an individual becomes susceptible to unhealthy weight gain [15]. This period is a critical time in an individual's life as the young adult moves away from home and gains a new-found independence. There has been no research comparing groups such as former athletes and non-athletes during the transition from high school to college, however there have been numerous studies that have shown that it is very common for freshmen as a

whole to gain weight during the first year of college [15-19]. For instance, Anderson et al. [16] reported that most weight was gained during the first semester, while other studies have shown that an increase in weight as well as an increase in Body Mass Index (BMI) occurred from the beginning of freshman year to the end of sophomore year [18]. Also comparing women in a college setting (living on campus) to women in a community college setting (not living on campus), it was found that women in the college setting gained significantly more weight [17].

During the high school/college transition certain lifestyle behaviors such as a decrease in physical activity levels can develop, contributing to this observed excess weight gain. Research shows that 66.2% of students reported regular vigorous physical activity (VPA) in high school, however during the first 8 weeks in college the percentage of VPA was found to decrease to 44.1% [20]. According to the American College Health Association-National College Health Assessment [21], only 42.2% of college students reported participating in vigorous physical activity for at least 20 minutes or participating in moderate physical activity (MPA) for at least 30 minutes on at least 3 out of the past 7 days, and less than one-half of students reported participating in strength training at least 2 out of the 7 days. Taken together, these data demonstrate that the majority of college students do not engage in even the minimal amount of physical activity needed to promote good health which likely contributes to unhealthy weight gain.

Data from the U.S. Department of Health and Human Services suggest that participation in physical activity declines with age [11], and it has been reported that the steepest decline in physical activity occurs during adolescence and young adulthood [22, 23]. During the transition from adolescence into adulthood, low levels of physical

activity contribute to overall obesity in adult males and overall obesity as well as abdominal obesity in adult females [24, 25]. The American College of Sports Medicine (ACSM), and the Centers for Disease Control and prevention (CDC) recommend that every adult should accumulate 30 minutes or more of moderate-intensity physical activity on most, preferably all, days of the week [26] or vigorous physical activity 3 or more days per week for at least 20 minutes per occasion [11]. Also, the U.S. Department of Health and Human Services (HHS) and the Department of Agriculture (USDA) published the *Dietary Guidelines for Americans 2005*, which recommended that children and adolescents should engage in at least 60 minutes of physical activity on most, preferably all, days of the week to manage body weight and prevent gradual, unhealthy weight gain; and that adults engage in at least 30 minutes of moderate-intensity physical activity on most, preferably all, days of the week to reduce the risk of chronic disease. To help manage body weight and prevent gradual, unhealthy body weight gain adults need to engage in 60 minutes of moderate-to-vigorous intensity physical activity (MVPA) on most days of the week while not exceeding daily caloric intake requirements, and to sustain weight loss adults need to engage in 60 to 90 minutes of daily MVPA while not exceeding daily caloric intake requirements to sustain weight loss [27].

Most research has focused on freshmen as a whole, however little research has been done comparing weight changes, physical activity patterns, or dietary patterns of former athletes to non-athletes once they enter college. Comparing these groups might give us insight into whether or not behavior patterns differ, and help determine if these groups are equally susceptible to excess weight gain during the transition from high school to college. Former athletes come to college with a history of regular physical activity, but in

a less structured environment, it is unclear whether or not they will continue with these exercise patterns.

There is some evidence that youth physical activity patterns predict adult behavior. Adolescent sport participation, specifically in endurance sports, has been associated with higher levels of physical activity in adulthood [28]. Exposure to sports during adolescence as well as the development of sport skills may be good preparation for lifelong physical activity.

Therefore, the purpose of this study was to examine a group of college freshman by comparing:

- 1) Initial body composition of former athletes to that of non-athletes.
- 2) Initial activity patterns of former athletes to that of non-athletes.
- 3) Changes in body composition and physical activity behavior over the course of freshman year of former athletes to that of non-athletes.

Based on previous research it is hypothesized that:

- 1) Upon entering college former athletes will have more lean and less fat mass when compared to non-athletes.
- 2) Upon entering college, former athletes will engage in more physical activity when compared to non-athletes
- 3) Over the course of freshman year in college there will be no difference in changes in body composition and physical activity behavior between former athletes and non-athletes; however students who remain more physically active will have less unhealthy changes in body composition during freshmen year.



## CHAPTER 2: REVIEW OF LITERATURE

### Physical activity behavior during adolescence and young adulthood

Research has shown that physical activity declines with age [29, 30] with the steepest decline during adolescence [31, 32] and young adulthood [33]. The Cardiovascular Risk in Young Finns (CRYF), a longitudinal study, focused on the age-related decline in physical activity. Physical activity was assessed by a questionnaire focusing on frequency of leisure time physical activities, intensity of activities, rating of participation in sports club training, participation in sports competition, and questions on how individuals spend their leisure time. Baseline data were taken on children and adolescents aged 9, 12, 15, and 18 years in 1980; they were followed up 3, 6, and 9 years later. Telama et al. [29] found that self-reported physical activity declined from age 12 to 27 years. The percentage decline per year shown by a physical activity index, (accounts for organized and non-organized activities, as well as frequency and intensity of activities) was 2.2% for males and 1.4% for females. Most of the overall decline occurred between the ages of 12-18 years for males and 12-15 years for females. Between the ages of 18-21 years males had a decline of 1.7% while females had a decline of 1.2%, with almost a leveling off in activity between 21-24 years of age. Another longitudinal study, The Amsterdam Longitudinal Growth and Health Study assessed physical activity over a 15-year period in Dutch males and females between the ages of 13-27 years. A structured interview was used to assess activities at work, school, during leisure, organized and non-organized sports, and active transportation that was above the 4 MET value. Van Mechelen et al. [30] found a significant drop in habitual physical

activity in males but not in females over the 15-year period. Dovey et al. [32] analyzed data from the Dunedin Multidisciplinary Health and Development Study (DMHDS) cohort from New Zealand. Physical activity was assessed by The Minnesota Leisure Time Physical Activity Questionnaire, which asked participants to recall the type, frequency, and duration in each activity. There was a significant drop in overall mean time of physical activity, from 9.7 hours per week at age 15 to 6.1 hours per week at age 18. A cross-sectional study done by Trost et al. [31] in Massachusetts objectively measured elementary school, junior high school, and senior high school children's physical activity with an accelerometer. Physical activity levels were compared by grade and gender, and it was found that daily moderate-to-vigorous physical activity and vigorous physical activity for both males and females declined with increasing grade level.

### **Activity behavior during college (specifically freshman year)**

Currently the ACSM/CDC recommends that adults engage in 30 minutes of moderate physical activity (MVP) on most, preferably all, days of the week, or vigorous physical activity (VPA) on 3 or more days per week for at least 20 minutes per occasion[11]. The U.S. Department of Health and Human Services (HHS) and the Department of Agriculture (USDA) published the *Dietary Guidelines for Americans 2005*, which recommends that children and adolescents participate in at least 60 minutes of MPA most preferably all days of the week [27]. Large portions of college students have failed to meet any physical activity recommendations throughout the years. Results from the 1995 National College Health Risk Behavior Survey found that few college

students participated in vigorous (37.6%) or moderate (19.5%) physical activity at recommended levels [34].

Dinger et al. [35] examined physical activity among 245 female and 209 male undergraduate students between 18 and 30 years of age. Physical activity was objectively monitored using an accelerometer, which was worn for 7 days. Physical activity was examined two different ways; accumulation of all daily activity no matter the duration, and accumulation of daily activity in bouts that lasted  $\geq 10$  minutes in duration. When all accumulated physical activity (counts per day  $\times 100$ ) was examined approximately half, 53%, of the participants met the moderate physical activity recommendation of 30 minutes or more on most days of the week, however, very few, 4.6%, met the vigorous physical activity recommendations. Also, students were less likely to be physically active on the weekends (Saturday and Sunday) than on the weekdays (Monday–Friday). When accumulated daily activity required bouts that lasted  $\geq 10$  minutes in duration, results were different. Only 4% met the current physical activity recommendations for moderate or vigorous activity. In conclusion, when activity was accumulated throughout the day more students met the recommendations, however very few students accumulated activity in  $\geq 10$  min bouts.

Huang et al. [19] assessed BMI, dietary habits, and physical activity in 738 college students 18-27 years of age. Three questions focusing on sports, strengthening exercises, and participation in physical education classes were taken from the Youth Risk Behavior Survey to assess physical activity. BMI was calculated using self-reported height and weight. Fruit, vegetable and fiber consumption was the main focus for assessing dietary habits. When BMI was used directly, instead of BMI percentiles, the

prevalence of overweight and obesity was 21.6% and 4.9%. Males were more likely to be overweight than females, and students  $\geq 20$  years were more likely to be overweight and obese than students who were  $\leq 19$  years. Students reported engaging in  $2.8 \pm 2.1$  days of aerobic activity (with males reporting significantly more days than females),  $2.2 \pm 2.1$  days of strength training and  $0.9 \pm 1.8$  days of physical education classes in the last 7 days, suggesting that students fall short of meeting the physical activity recommendations. Students  $\leq 19$  years reported significantly more days of aerobic exercise and strength training than those  $\geq 20$  years, however the mean number of days students participated in aerobic exercise was not different between groups. Physical activity levels may decrease with age, which may be the contributing factor to the significantly higher BMI in students  $\geq 20$  years.

Many college students fail to meet recommended levels of physical activity, but is there actually a decline in physical activity during college or a continuation of inadequate activity from adolescence and young adulthood? Bray et al. [20] examined changes in self-reported VPA in 145 Canadian undergraduates and found a significant decline in physical activity during the transition from high school to college [20]. Activity was assessed during the last 2 months of high school and again during the first 2 months of college. VPA was defined as ‘activities requiring moderate to strenuous effort that are sustained long enough to cause one to break a sweat or to breathe heavily’. Students were then classified as either ‘active’ or ‘sedentary’ based on the average number of vigorous sessions, and the average duration per session they engaged in per week. 66.2% of the students were classified as active during the last 2 months of high school, while only 44.1% of students were classified as active during the first 2 months at college. This

means that 33.8% of the sample was insufficiently active during high school while 55.9% were insufficiently active during the transition from high school to college.

Butler et al. [36] examined body composition, dietary intake, fitness/physical activity and physical self-efficacy in 82 college female freshman upon entrance into college and again 5 months later. At baseline body fat % was in the healthy range at  $21.87 \pm 5.59 \text{ kg} \cdot \text{m}^{-2}$ . 54 of the 82 females returned, and when examining the data on 54 subjects at baseline and after 5 months there was a significant increase in body mass, BMI, % body fat, fat mass, and a significant decrease in lean mass. Also, significant decreases were found in total, work, and sport physical activity, while there was an increase in leisure time physical activity [36]. Total caloric intake decreased significantly, with a decrease in grams of fat and carbohydrate consumed, suggesting that the decrease in physical activity led to the unhealthy weight changes seen after 5 months.

Pinto et al. [37] examined changes in physical activity in college students. At baseline (T1) during freshman year of college, 332 students' physical activity was assessed using a questionnaire (i.e. 'how many times in the past 7 days did you engage in moderate and vigorous activity'). Out of the 332 with baseline data, 242 students participated in the follow-up one year later (T2). At baseline, the mean BMI was in the healthy range with a mean of  $21.9 \text{ kg} \cdot \text{m}^{-2}$ , and one year later, BMI remained unchanged at a mean of  $21.8 \text{ kg} \cdot \text{m}^{-2}$ . There was no overall change in students' physical activity from the 1<sup>st</sup> year of college to the 2<sup>nd</sup> year. Even though there was no overall change it was reported that 42% at T1 and 36% at T2 did not meet ACSM and CDC recommended levels of physical activity.

Two studies examined weight changes, including BMI, during freshman year of college. Both found a significant gain in weight. Anderson et al. [16] examined weight changes in 135 college freshman  $\leq 19$  years of age. Students were weighed in September and December and a sub-sample ( $n=46$ ) from this group was also weighed in May. At baseline, in September, the mean BMI for the group was  $23.3 \pm 3.7 \text{ kg}\cdot\text{m}^{-2}$  with 79.3% in the normal range, 15.6% in the overweight range, and 5.2% in the obese range. In December the same sample of 135 had a mean BMI range of  $23.9 \pm 3.6 \text{ kg}\cdot\text{m}^{-2}$  with 68.1% in the normal range, 25.2% in the overweight range, and 6.7% in the obese range. There was an overall significant mean weight gain of 1.3 kg from September to December, with no gender difference. The sub-sample of 46 who also came back in May had a mean BMI of  $23.8 \pm 3.3 \text{ kg}\cdot\text{m}^{-2}$  with 78.3% in the normal range, 17.4% in the overweight range, and 4.3% in the obese range. There was an overall significant mean weight gain of 1.7 kg from September to May. Most weight gain tended to occur during the beginning of freshmen year, from September to December, while weight gain from December to May was not significant. Levitsky et al. [15] also examined weight gain in college freshman. A total of 60 college students were weighed at the beginning of their freshman year and again 12 weeks later. The mean weight gain was significant at  $1.9 \pm 2.4 \text{ kg}$ . Mean BMI increased significantly from  $20.8 \pm 2.1$  to  $21.5 \pm 2.3 \text{ kg}\cdot\text{m}^{-2}$  as well.

Racette et al. [18] examined weight changes, exercise and dietary patterns during freshman and sophomore year in 764 college students. Amount of aerobic exercise, strength training, and stretching was assessed using a questionnaire. Questions were based on the definition for each type of exercise as well as the recommended level taken from the ACSM (aerobic – 3-5 days per week for 20-60 min/day, strength – 2 to 3 days

per week with one set of 8 to 10 reps, and stretching – 2 to 3 days per week).

Approximately 18% of the incoming freshmen were classified as overweight. At the end of sophomore year, 290 of the 764 students remained in the study. Body weight increased in 70% of the 290 students from beginning of freshman to the end of sophomore year, and for those who gained weight, the mean increase was  $4.1 \pm 3.6$  kg. BMI also increased over time in 69% of students. Aerobic exercise significantly decreased from freshman (62%) to sophomore year (55%), while stretching (30% vs. 38%) significantly increased. Also important to mention, was that 30% of students did not engage in any exercise. Only 30% of students consumed 5 fruits and vegetables per day, and about 50% consumed high-fat foods per day. Their percentages did not change much from freshman to sophomore year. However, a significant decrease in fried food consumption occurred from freshman to sophomore year (54% vs. 47%). Weight gain, lack of regular exercise and unhealthy eating patterns were common among these students during the first 2 years of college [18].

A cross-sectional study done by Suminski et al. [38] examined 2,836 American college students between the ages of 18 – 25 years of age. The Self-Report of Physical Activity (SRPA) Questionnaire assessed physical activity during the past month. The Physical Activity Readiness Questionnaire contained questions relating to how many hours per week an individual engaged in weight lifting activities, how many hours per day did an individual watch TV, use a computer or play video games, and whether individuals were active in sports or organized physical activity during elementary, middle and high school. Approximately 47% of the total sample had not engaged in VPA during the past month and 17% did not engage in any physical activity during the past month.

Female and minorities seemed to have higher inactivity levels, 28.1% Asian, 23.5% of African American, 17.4% of White, and 20.3% of Hispanic women reported no activity during the past month. These studies taken together provide evidence that during the transition into college, activity patterns may have a tendency to decrease slightly, which may contribute to the increase in weight and the failure to meet recommended levels of physical activity.

### **Habitual physical activity and the association with current physical activity behavior**

Decline in physical activity with age has been supported by many studies; however, research has also found that past physical activity behavior is associated with current physical activity patterns. From the CRYF study, Telama et al. [39] found that high levels of continuous physical activity from ages 9 – 18 were associated with higher levels of adult physical activity. Sparling et al. [40] surveyed college alumni regarding their level of physical activity as college seniors as well as their current physical activity. Physical activity questions were taken from the 1995 National College Health Risk Behavior Survey, which included questions on the number of days in the past week they participated in vigorous, moderate and strength activities. Additional questions on involvement in college sports, comparing current and college physical activity, attitudes towards exercise, and if they were aware of the current recommendations for MPA. Past physical activity was positively associated with current physical activity.

The following 6 studies provide evidence that participation in sports seems to play an important role in keeping adolescents habitually active as well as influencing lifelong



physical activity behavior. A longitudinal study done by Pfeiffer et al. [41] examined self-reported physical activity and sports participation in grade school girls during 8<sup>th</sup>, 9<sup>th</sup> and 12<sup>th</sup> grade. Physical activity was assessed using the 3-Day Physical Activity Recall (3DPAR), which was then examined in blocks of vigorous, moderate and strength activities. Sports participation was assessed using two questions from the Youth Risk Behavior Surveillance Survey. Girls who were active in sports during 8<sup>th</sup> and 9<sup>th</sup> grade were more physically active during 12<sup>th</sup> grade when compared to girls not active in sports at any age. Dovey et al. [32] found that higher levels of fitness at age 15 years and higher levels of self assessed health for males and females were predictors of maintaining physical activity behavior at age 18 years. This study also found that participation in school sports for males was also a predictor of maintaining a reasonable level of PA at age 18 years. Telama et al. [42] found that physical activity and sports participation at age 9, 12, 15, and 18 had significant but weak correlations with physical activity measured 9 and 12 years later. Also, children engaging in organized sports for at least 3 years were more likely to have a higher physical activity level in young adulthood. This study suggested that experience and skills that develop from childhood sports participation may be important for continuation in later life physical activity.

Tammelin et al. [24] examined the North Finland 1996 cohort. Self-reported physical activity was assessed at age 14 and age 31 years. Participants, at age 14 years received a mailed questionnaire that focused on frequency of participation in sports after school hours. Participants, at age 31 years were asked questions on frequency of participation in light and brisk physical activities. Male adolescents who were active in sports at least twice a week and female adolescents who were active in sports at least

once a week at age 14 years were more physically active as adults at age 31 years, when compared to those who participated in sports less than once a week. Participation in endurance sports such as cross-country skiing, running, swimming, or cycling [28] corresponded with the highest level of physical activity in adults. A retrospective study done by Alfano et al. [43] examined women ages 18-39 years involved in the Women's Health Project. Two questionnaires assessed past sports participation and current habitual physical activity (work, sport and leisure, excluding sport). Participation in sports during junior high, high school, and/or college was associated with greater levels of physical activity in adulthood.

Although research has shown a decline in physical activity with age, there is evidence that habitual activity during adolescence is a good predictor of future activity patterns, however the strength of physical activity tracking from adolescence to adulthood is only moderate, with closer time spans between measurements resulting in higher correlations. This suggests that other periods in life, besides adolescent activity, as shown in Alfano et al. [43] and Sparling et al. study [40], can influence current physical activity patterns as well. However, it is important to note that children and adolescents participating in physical activity, including sports gain knowledge, skills and confidence that may ensure lifelong physical activity patterns.

### **Comparing body composition in inactive and active people**

There is an inverse relationship between physical activity and body fat, suggesting that physical activity may prevent and/or decrease obesity [12]. Studies done at the University of Tennessee have shown that there is an inverse relationship between steps

taken per day, body fat percentage, BMI, waist circumference and hip circumference in middle-aged women [44], African-American women [45], and in postmenopausal women[46].

Thompson et al. [44] examined accumulated walking and body composition in 80 middle-aged women between 40 and 66 years of age. Body composition variables including height, weight, BMI, waist circumference, hip circumference, and body fat were assessed. Physical activity was monitored for 7 days using a pedometer. A significant inverse correlation was found between average steps per day and body fat percentage ( $r=-0.713$ ), BMI ( $r=-0.417$ ), waist circumference ( $r=-0.616$ ), hip circumference ( $r=-0.278$ ), and waist-to-hip ratio ( $r=-0.652$ ).

Krumm et al. [46] examined the relationship between daily steps and body composition among 93 postmenopausal women between the ages of 50-75 years. Body composition variables including height, weight, BMI, waist circumference, hip circumference, and body fat percentage were assessed. Physical activity was monitored for 14 days using a pedometer, while energy intake was assessed using a 3-day food log. There was a significant negative correlation between average steps per day and BMI ( $r=-0.422$ ), percent body fat ( $r=-0.368$ ), waist circumference ( $r=-0.487$ ), hip circumference ( $r=-0.435$ ), waist-to-hip ratio ( $r=-0.296$ ), and trunk fat ( $r=-0.393$ ), while there was no significant correlation between daily kcal consumed and any body composition variables.

Hornbuckle et al. [45] examined daily steps and body composition among 69 African-American women between the ages of 40-64 years. Body composition variables including height, weight, BMI, waist circumference, hip circumference, and body fat percentage were assessed. Physical activity was monitored for 7 days using a pedometer,

while energy intake was assessed using a 3-day food log. There were significant inverse correlations between walking volume and BMI ( $r=-0.479$ ) and body fat ( $r=-0.506$ ).

When women were divided into groups defined by amount of steps taken per day (<5,000 steps/d, 5,000-7,499 steps/d or  $\geq 7,500$  steps/d), significant differences were found for all variables except waist-to-hip ratio when comparing the least active (<5,000 steps/d) to the most active group ( $\geq 7,500$  steps/d), while there was no significant difference in caloric intake among the three activity groups.

STRRIDE (studies of targeted risk reduction interventions through defined exercise) [13, 14], a randomized, controlled study of exercise intensity and amount, reported a dose-response relationship between the amount of exercise and change in central obesity [13, 14] and total body fat [14], suggesting that the more exercise one engaged in, the greater decrease in central obesity as well as total body fat he/she experienced. Slentz et al. [14] examined 120 sedentary, overweight men and women between the ages of 40-65 years with mild to moderate dyslipidemia. They were divided into one of three groups; high amount/vigorous intensity, low amount/vigorous intensity, or low amount/moderate intensity. Participants were encouraged to keep the same diet and maintain body weight. With no significant changes in daily caloric intake or percentage change in macronutrient intake, sedentary individuals who continued to lead physically inactive lives tended to gain weight, however, weight maintenance could be achieved by adding a small amount of exercise to a sedentary lifestyle.

As mentioned earlier, past habitual activity is important in predicting an active lifestyle as well as a healthy profile in the future. The study done by Tammelin et al. [24] not only found that past sports participation plays a role in current physical activity

patterns, but also found that being inactive throughout the transition from adolescence to adulthood was associated with overall obesity in males, and overall obesity as well as severe abdominal obesity in females at the age of 31 years. Consistent with these findings, Yang et al. [25] examined data from the longitudinal CRYF study. Children, adolescents and young adults aged 9, 12, 15, and 18 years were followed for 21 years. At baseline during youth, frequency and intensity of leisure-time physical activity, participation in sports-club training, participation in sports competitions, usual way of spending leisure time and the way of commuting to school was assessed using a self-report questionnaire. During adulthood, frequency, duration and intensity of vigorous activity, average duration of a physical activity session and participation in organized physical activity was assessed. Youth were classified as either 'inactive', 'moderately active', or 'active'. During adulthood individuals were also classified as either 'inactive', 'moderately active', or 'active'. Also, to examine the change in activity level from youth to adulthood individuals were divided into one of four categories based on activity level in youth and activity level in adulthood; 'persistently active', 'increasingly active', 'decreasingly active', or 'persistently inactive'. After adjusting for potential confounding factors no significance was found for men however, women who had been 'decreasingly active' from youth to adulthood had a significantly higher probability of being overweight (OR=1.79) and obese (OR=2.09), and women who were 'persistently inactive' had a significantly higher probability of being overweight (OR=2.18) than women who had been 'persistently active'. Also, women who had been 'decreasingly active' had a significantly higher probability of developing mild (OR=2.21) and severe (OR=2.19) abdominal obesity in adulthood than those who had been 'persistently active'.

This suggests that low levels of physical activity from adolescence to adulthood were associated with an increased risk of abdominal fat in women.

Sparling et al. [40], mentioned above, found that based on current physical activity, alumni who engaged in regular physical activity had a significantly lower weight gain (3.0kg vs. 6.1kg), however, there was no mention whether lean and/or fat mass was the contributor to weight gain. Alfano et al. [43], also mentioned above, examined data from the Women's Health Project which surveyed women on past sport participation and found that participation in sports during junior high, high school, and/or college was associated with lower assessed BMI values.

### **Association of athletic participation on Leisure Time Physical Activity (LTPA)**

As previous noted habitual physical activity has been associated with current physical activity patterns [28, 47]. Sport participation may have an influence on LTPA, however only a few studies have examined the association of athletic participation on LTPA. Aarnio et al. [48] examined the changes in LTPA during a three-year period among Finnish adolescent twins. They also examined whether the type of sport played had an influence on the amount of LTPA. Three questionnaires with the same physical activity questions were mailed to the twins within two months of their 16<sup>th</sup> birthday, a month after their 17<sup>th</sup> birthday, and after their 18<sup>th</sup> birthday. The physical activity questions were based on frequency and perception of own physical fitness. Two variables were created; stability of physical activity and self-reported fitness.

Adolescents who participated in several different types of sports had the highest stability

of LTPA, and those who participated in organized sports were more often persistent exercisers and persistently fit than those who did not [48].

There also have been two studies that found no association between LTPA and athletic participation [43, 49], however these studies did not classify sport as a leisure activity. Alfano et al. [43] examined history of sport participation and health and physical activity among 486 women between the ages of 18-39 years. A brief questionnaire assessed past sport participation, and current physical activity level, while diet records were used to assess dietary intake. Women who had a history of sport participation had lower adult BMI and higher current sport, work-related, and total activity level. However, there was no association between past sport participation and current levels of LTPA (excluding sport). Also, past sports participation did not significantly relate to the number of total calories per day. The physical activity questions focused on work, sport, leisure (excluding sport) and total physical activity and found that most women who engaged in sports as children currently spend their leisure time engaged in sport rather than walking or bicycling. Since sport was taken out of leisure this might explain why there was no association between past sport participation and current LTPA, suggesting that many who have history of sport participation are likely to engage in sport in their leisure time. Another study done by Deforche et al. [49] examined physical activity among 90 adolescent boys and girls who were divided into three groups based on weight: obese, overweight, or normal weight. Physical activity was assessed using the Baeche Questionnaire which focused on physical activity during sport and during leisure time (excluding sport). Even though the sport index was highest in the normal weight group there was no difference in LTPA. Depending on how the

author classifies leisure time appears to affect the results and the conclusions drawn from previous research.

## **Summary**

Engaging in regular physical activity has numerous health benefits including a healthier body composition. However, research has shown that physical activity declines with age, especially during adolescence and young adulthood. This decline in activity continues during the transition into college leading to weight gain. Much of the past research has focused on BMI as an indicator of weight gain, which does not take into account body fat percentage and may over predict in individuals, such as athletes, with higher lean mass. Since past activity behavior is associated with current activity behavior, it is important to examine individuals with a history of regular activity to see if they may be less susceptible to unhealthy changes during freshmen year of college.



## CHAPTER 3: METHODS

### Sample

This project was a part of the “Freshman Experience: Life in Motion” study, which was a quasi-randomized sample that recruited participants from a larger study, “Promoting Happy Healthy UT Undergraduates”, a web-based survey focusing on student’s health habits. The sample we used for analyses went through two sampling procedures; first, individuals from the “Promoting Happy Healthy UT Undergraduates” who indicated interest in further research were considered for our study. Second, the interested individuals went through a randomization process which allowed us to purposely recruit a sample with half former athletes and half non-athletes. Also, within each athlete and non-athlete strata, the sample was purposely randomized to equal the proportion of UT freshmen in 2005 based upon gender and ethnicity. The overall goal was to recruit at least 100 subjects. However, an insufficient number of participants were identified from this sampling design, so additional subjects were recruited via flyers posted in dormitories. The Institutional Review Board (IRB) approved all procedures before the study began (IRB #7119B).

Overall, a sample of 111 University of Tennessee first year students participated in the study. Participants had to be at least 18 years of age, healthy and having graduated from high school within the last year. Out of the 111 students who began the study, 104 (94%) had complete data for fall testing, 66 (59%) returned for spring testing and 62 (56%) had complete data for both fall and spring testing. The sample consisted of two groups; individuals who participated in a varsity sport senior year in high school and

individuals who did not participate in a varsity sport senior year in high school.

Collegiate athletes were excluded from the study, because the focus was on those who were former athletes in high school.

## **Procedures**

During the first visit to the laboratory, researchers reviewed all procedures with participants and asked them to sign informed consent forms (Appendix B). Participants also completed questionnaires consisting of demographics, medical history, personal/family history, and athletic participation history.

In a body composition lab, participants were asked to remove shoes while height was measured to the nearest 0.1 cm using a stadiometer (Seca Corporation, Columbia MD). Waist and hip circumference were then measured to the nearest 0.1 cm using a Gulick fiberglass measuring tape with tension handle (Creative Health Products, Inc., Plymouth MI). Waist measurement was taken at the narrowest portion of the torso between the rib cage and iliac crest, after normal expiration. Hip circumference was taken at the greatest gluteal protuberance while the subject stood with feet together.

Body composition was assessed using the BodPod (Life Measurement Instruments, Concord, CA). This provided the criterion for body mass and body density. The BodPod estimates the amount of volume displaced by the body, by applying Boyle's Law which states that as volume of air increases, pressure decreases and vice versa. Body volume was measured by taking the difference in volume of air in the BodPod chamber with and without the subject inside. Participants were provided with a lycra swimsuit and swim cap, all jewelry was removed, and subjects were weighed on a

calibrated scale before entering the BodPod. After body volume and body weight were estimated, body density ( $\text{kg}\cdot\text{l}^{-1}$ ) was calculated. Once overall body density was known, percentage of body fat was calculated using the Siri equation. A higher density reflects a higher proportion of lean tissue since lean tissue is denser than fat tissue. Body mass was measured to the nearest 0.01 kg and body density to the nearest  $0.001 \text{ kg}\cdot\text{l}^{-1}$ . BMI was calculated by dividing weight in kilograms by height in meters squared ( $\text{kg}\cdot\text{m}^{-2}$ ).

Before leaving the laboratory, participants were assigned a sealed New Lifestyles NL-2000 pedometer (New Lifestyles Inc., Lees Summit, MO), to wear every day for 7 consecutive days. Participants were instructed to wear the device all day except when sleeping or in water.

Eight days later each participant came back to the laboratory to return his/her NL-2000 pedometer. The steps from the pedometer were recorded by the researcher. When the pedometer was returned, participants were asked to complete the International Physical Activity Questionnaire (IPAQ) (Appendix D). After completing the IPAQ, the participants received a \$50 gift certificate to the UT Bookstore/computer store and were told that they would be contacted during spring semester 2007 for a repeat of testing.

In spring 2007, participants were invited to repeat the same series of tests. After the completion of the two days of testing, another \$50 gift certificate to the UT Bookstore/computer store was rewarded to participants who completed spring 2007 procedures.

## Statistical analyses

Statistical analyses were performed using the SPSS statistical program for Windows, version 15.0 (SPSS Inc., Chicago, IL). Descriptive statistics were calculated for all physical characteristics (e.g. age, height, weight). Measures consisted of initial body composition and physical activity, as well as changes in body composition and physical activity. Athletic status and gender were both examined. Firstly, comparisons of body composition and physical activity between former athletes and non-athletes and females and males during the initial weeks of freshmen fall semester were analyzed. Gender was analyzed separately, athletic status was analyzed separately, and gender and athletic status were analyzed together. If the data were normal, independent samples t-test was used and means and standard deviations were reported, if the data were non-normal the Mann-Whitney test was used, and medians and ranges were reported.

Secondly, changes over the course of freshmen year in body composition and physical activity were analyzed as well and whether or not these changes were different across gender and athletic status. All data were examined using a change score that was computed by subtracting the raw scores in the fall from the raw scores in the spring. All change scores except one were normally distributed so means and standard deviations were reported. For the one variable (fat free mass) where the change score was non-normal a repeated measures ANOVA was run on raw scores to explore time, time by group, time by gender, time by gender by group, group, gender and group by gender effects. For the rest of the variables, a Univariate ANOVA was used to explore group,

gender and group by gender effects. Raw scores from fall and spring were examined to look for time effect and specific differences in fall and spring.

If there was a gender effect then an independent samples t-test examined the body composition and physical activity change score to determine if males and females were changing differently over time. Then an independent samples t-test (for normal data) or a Mann-Whitney test (for non-normal data) examined raw scores to determine if there was a difference in females and males in fall or spring. Then a paired samples t-test (for normal data) or a Wilcoxon signed rank test (for non-normal) examined whether or not females and males had a significant change over the course of freshmen year using raw scores from fall and spring.

If there was a group effect an independent samples t-test was used to examine body composition and physical activity change scores to determine if athletes and non-athletes were changing differently over time. Then an independent samples t-test (for normal data) or a Mann-Whitney test (for non-normal data) examined raw scores to determine if there was a difference in athletes and non-athletes in fall or spring. Then a paired samples t-test (for normal data) or a Wilcoxon signed rank test (for non-normal) examined whether or not athletes and non-athletes had a significant change over the course of freshmen year using raw scores from fall and spring.

If there was a gender by group effect an independent samples t-test examined the change scores to determine if there was a difference in change between female athletes and non-athletes as well as male athletes and non-athletes. If there were no differences between female/male athletes and female/male non-athletes then 'group' (i.e. athletes and non-athletes) was taken out of the equation and females/males were clumped as a group.

Then a paired samples t-test (for normal data) or a Wilcoxon signed rank test (for non-normal) examined whether or not females/males as a group had a significant change over the course of freshmen year using raw scores from fall and spring.

If there was a difference in female/male athletes and female/male non-athletes an independent samples t-test (for normal data) or a Mann-Whitney test (for non-normal data) examined raw scores to determine if there was a difference in female/male athletes and female/male non-athletes in fall or spring. Then a paired samples t-test (for normal data) or a Wilcoxon signed rank test (for non-normal) examined whether or not female/male athletes and female/male non-athletes had a significant change over the course of freshmen year using raw scores from fall and spring.

If change scores were not significant, gender effect was still examined for fall and spring. An independent samples t-test (for normal data) or Wilcoxon signed rank test (for non-normal data) was used to determine if males or females significantly differed among any variables in fall and spring, using raw data.

If change scores were not significant, group effect was still examined for fall and spring. An independent samples t-test (for normal data) or Wilcoxon signed rank test (for non-normal data) was used to determine if athletes and non-athletes significantly differed among any variables in fall and spring, using raw scores.

To determine if there was a time effect for the overall sample a paired samples t-test (for normal data) or Wilcoxon signed rank test (for non-normal data) was used to examine raw scores from fall and spring.

To examine the relationship between physical activity (average total physical activity, change in total physical activity, average daily steps, and change in daily steps)

and body composition a bivariate correlation was run. To determine if those who returned for spring testing differed from those who did not return in the spring a chi square was run. For all tests, significance was set a priori at  $p < 0.05$ .

## CHAPTER 4: RESULTS

The initial fall sample consisted of 111 freshmen, 64% were females, 82% were white, and 50.5% were former athletes. 66 freshmen returned in the spring (response rate=59%), and 4 were excluded from the analyses due to failure to complete all days of testing, leaving a final sample of 62 freshmen; 59.7% were females, 82.3% were white, and 51.6% were former athletes (Table 1). When comparing the sample of 66 to the 2006 UT freshmen population our sample had a slightly higher percentage of females (51.5% vs. 59.7%) and blacks (9.9% vs. 14.5%) and a slightly lower percentage of whites (84.2% vs. 82.3%) and other races (5.4% vs. 3.2%). There were no significant differences in gender, race/ethnicity, or athletic status between those who returned in the spring and those who did not.

### Upon entrance into college

#### Females vs. Males

Upon entrance into college, when comparing females and males; males were significantly taller ( $p<0.001$ ), weighed more ( $p=0.002$ ), had a larger waist circumference ( $p<0.001$ ), waist-to-hip ratio ( $p<0.001$ ), less body fat % ( $p<0.001$ ), fat mass ( $p<0.001$ ), more fat free mass ( $p<0.001$ ), and reported higher amount of leisure time physical activity (LTPA) ( $p=0.014$ ) than females. There were no gender differences in daily steps.



**Table 1. Sample breakdown**

	<b>2006 UT Freshmen (n=4244)</b>	<b>Initial Fall Sample (n=111)</b>	<b>Final Fall Sample (n=104)</b>	<b>Initial Spring Sample (n=66)</b>	<b>Final Spring Sample (n=62)</b>
	<b>Number (%)</b>				
<b>Gender</b>					
Females	2186 (51.5)	64 (57.7)	61 (58.7)	40 (60.6)	37 (59.7)
<b>Race/Ethnicity</b>					
White	3575 (84.2)	91 (82.0)	85 (81.7)	54 (81.8)	51 (82.3)
Black	419 (9.9)	16 (14.4)	15 (14.4)	10 (15.2)	9 (14.5)
Other	231 (5.4)	4 (3.6)	5 (3.9)	2 (3.0)	2 (3.2)
<b>Former Athlete</b>					
Yes	NA	56 (50.5)	53 (51.0)	35 (53.0)	32 (51.6)
<b>Response Rate</b>	NA	NA	94%	59%	56%

**Athletes vs. Non-Athletes**

Upon entrance into college, when comparing athletes and non-athletes; there were no differences in body composition or daily steps. Athletes reported significantly higher median weekly total physical activity (TPA) ( $p=0.013$ ) than non-athletes (2737 MET-min/wk vs. 1613 MET-min/wk). Gender and athletic status was then explored, and male athletes had significantly higher median TPA ( $p<0.001$ ) than male non-athletes (3421 MET-min/wk vs. 1236 MET-min/wk).

TPA consists of LTPA, transportation physical activity (TRAN PA), and work physical activity (WORK PA). WORK PA was excluded for all analyses because so few individuals participated in WORK PA. TRAN PA did not differ between athletes and non-athletes upon entrance into college; however LTPA was significantly different between the two groups. Athletes had a significantly higher median MET-min/wk of LTPA ( $p=0.008$ ) than non-athletes (1677 MET-min/wk for athletes vs. 650 MET-min/wk

for non-athletes). When exploring gender and athletic status we found that male athletes had significantly higher LTPA ( $p=0.005$ ) than male non-athletes (1999 MET-min/wk vs. 868 MET-min/wk), while female athletes and female non-athletes did not differ.

## **Comparing body composition and physical activity changes over the course of freshmen year**

### **Overall Sample**

In the overall sample, many of the body composition variables increased over freshmen year; height ( $p<0.001$ ), FFM ( $p<0.001$ ), WHR ( $p<0.001$ ), weight ( $p<0.001$ ), FM ( $p=0.013$ ), WC ( $p=0.003$ ), and BMI ( $p<0.001$ ), while steps significantly decreased ( $p<0.001$ ). Body fat had a tendency to increase over time however it was not significant ( $p=0.091$ ) (Table 2). Activity level decreased over freshmen year; freshmen reported a significant decrease in TPA ( $p=0.021$ ) and TRAN PA (0.008), while freshmen reported no change in LTPA (Table 3). An outlier for weight, hip circumference and BMI was excluded from the analyses. This exclusion resulted in the change scores being normally distributed

### **Females vs. Males**

There was no difference in change between females and males for most body composition variables. There was a trend for body fat to remain stable for females while body fat tended to increase for males over freshmen year ( $p=0.058$ ). The only significant difference in change for females and males was that males had a significantly larger drop in daily steps than females ( $p=0.037$ ); males dropped 2374 steps/day while females dropped 929 steps/day (Table 4). There were no differences in change between females and males in TPA, LTPA, or TRAN PA (Table 5).

**Table 2. Means, standard deviations, medians and inter-quartile ranges for body composition variables and daily steps for the overall sample**

	Fall N=62	Spring N=62	
	Mean (SD)		p for change
<b>Height (m)</b>	1.705 (0.080)	1.712 (0.080)	<b>&lt;0.001</b>
<b>FFM (kg)</b>	50.7 (10.1)	51.4 (10.0)	<b>&lt;0.001</b>
<b>WHR</b>	0.79 (0.05)	0.81 (0.05)	<b>&lt;0.001</b>
<b>BF (%)</b>	23.4 (10.6)	24.1 (10.1)	0.091
<b>Steps</b>	11202 (3228)	9690 (3112)	<b>&lt;0.001</b>
	Median (IQR)		
<b>Weight (kg)</b>	62.5 (56.9-73.0)	64.5 (57.9-75.5)	<b>&lt;0.001</b>
<b>FM (kg)</b>	13.7 (10.7-18.8)	15.3 (11.3-21.0)	<b>0.013</b>
<b>WC (cm)</b>	74.0 (69.4-80.1)	74.5 (69.7-81.4)	<b>0.003</b>
<b>HC (cm)</b>	93.8 (90.0-99.6)	94.6 (90.4-99.4)	0.982
<b>BMI (kg·m<sup>-2</sup>)</b>	22.2 (19.7-24.6)	22.6 (19.9-25.0)	<b>&lt;0.001</b>

**Table 3. Medians and inter-quartile ranges for total, leisure and transportation physical activity for the overall sample**

	Fall N=62	Spring N=62	
	Median (IQR)		p for change
<b>TPA MET-min/wk)</b>	2134 (1014-3245)	1725 (984-2655)	<b>0.021</b>
<b>LTPA (MET-min/wk)</b>	854 (322-1866)	724 (190-1985)	NS
<b>TRAN PA (MET-min/wk)</b>	742 (408-1153)	536 (260-1039)	<b>0.008</b>

**Table 4. Means, standard deviations, medians and inter-quartile ranges for body composition variables and daily steps comparing males and females**

	Fall N=62		Spring N=62		
	Female n=37	Male n=25	Female n=37	Male n=25	
	<b>Mean (SD)</b>				<b>p for change</b>
<b>Height (m)</b>	1.657±0.054	1.777±0.053	1.662±0.053	1.786±0.049	NS
<b>FFM (kg)</b>	44.0±5.5	60.5±6.8	44.9±5.3	61.0±7.2	NS
<b>WHR</b>	0.77±0.04	0.83±0.05	0.78±0.05	0.84±0.05	NS
<b>BF (%)</b>	29.6±7.4	14.1±7.3	29.7±7.7	15.8±7.0	0.058
<b>Steps</b>	10762±2884	11852±3641	9833±2882	9479±3475	<b>0.037</b>
	<b>Median (IQR)</b>				
<b>Weight (kg)</b>	59.7 (54.5-68.1)	72.1 (60.0-79.1)	60.9 (57.0-69.7)	74.4 (62.6-80.8)	NS
<b>FM (kg)</b>	17.6 (13.3-21.0)	9.1 (4.9-14.3)	18.1 (14.0-22.3)	11.1 (7.4-15.5)	NS
<b>WC (cm)</b>	72.4 (67.9-78.3)	78.8 (70.6-82.4)	73.5 (68.7-78.3)	78.8 (71.7-85.0)	NS
<b>HC (cm)</b>	93.8 (90.2-99.8)	93.1 (88.6-98.4)	94.5 (90.6-99.5)	95.1 (87.5-99.2)	NS
<b>BMI (kg·m<sup>-2</sup>)</b>	22.2 (19.9-24.4)	21.9 (19.1-25.0)	23.4 (20.3-24.8)	23.0 (19.8-25.8)	NS

## Athletes vs. Non-Athletes

When comparing the difference in change between athletes and non-athletes there was a significant difference in change in daily steps, TPA and TRAN PA and a trend for difference in change in WC and LTPA. Non-athletes had a significantly larger drop in steps than athletes ( $p=0.032$ ) (Table 6), while male non-athletes had a significantly larger drop in steps than male athletes ( $p=0.024$ ) (Table 7). There was no difference in change between athletes and non-athletes in any body composition variables, however there was a trend for male non-athletes to have a larger increase in WC than male athletes ( $p=0.096$ ) (Table 8), however this was not significant.

Athletes had a significantly larger drop in TPA ( $p=0.044$ ) than non-athletes (Table 9), while male athletes had a significantly larger drop in TRAN PA ( $P=0.034$ ) than male non-athletes (Table 10). There was a trend for athletes to have a larger drop in LTPA ( $p=0.096$ ) than non-athletes (Table 11), however this was not significant.

**Table 5. Medians and inter-quartile ranges for total, leisure and transportation physical activity comparing males and females**

	Fall N=62		Spring N=62		p for change
	Female n=37	Male n=25	Female n=37	Male n=25	
	<b>Median (IQR)</b>				
<b>TPA</b> (MET-min/wk)	1777 (985-2961)	2466 (1187-4357)	1683 (970-2205)	1940 (931-4196)	NS
<b>LTPA</b> (MET-min/wk)	594 (261-1477)	1398 (829-2165)	495 (159-1440)	870 (469-2518)	NS
<b>TRAN PA</b> (MET-min/wk)	693 (421-1039)	825 (404-1312)	495 (330-1039)	660 (190-1170)	NS

**Table 6. Means and standard deviations for change in daily steps comparing athletes and non-athletes**

	Change Score		p for change
	Athletes n=32	Non-Athletes n=30	
Steps/day	-906 (2817)	-2158 (3402)	<b>0.032</b>

**Table 7. Means and standard deviations for change in daily steps comparing male athletes and male non-athletes**

	Change Score		p for change
	Male Athletes n=14	Male Non-Athletes n=11	
Steps/day	-920 (3185)	-4224 (3687)	<b>0.024</b>

**Table 8. Means and standard deviations for change in WC comparing male athletes and male non-athletes**

	Change Score		p for change
	Male Athletes n=14	Male Non-Athletes n=11	
WC (cm)	0.4 (2.9)	2.6 (3.3)	0.096

**Table 9. Means and standard deviations for change in TPA comparing athletes and non-athletes**

	Change Score		p for change
	Athletes n=32	Non-Athletes n=30	
TPA (MET-min/wk)	-1006 (2126)	140 (2458)	<b>0.044</b>

**Table 10. Means and standard deviations for change in TRAN PA comparing male athletes and male non-athletes**

	Change Score		p for change
	Male Athletes n=14	Male Non-Athletes n=11	
TRAN PA (MET-min/wk)	-834 (1486)	499 (1432)	<b>0.034</b>

**Table 11. Means and standard deviations for change in LTPA comparing athletes and non-athletes**

	Change Score		p for change
	Athletes n=32	Non-Athletes n=30	
LTPA (MET-min/wk)	-541 (1692)	357 (1873)	0.096

Raw scores from fall and spring were examined to determine if athletes were significantly changing over time and if non-athletes were significantly changing over time. There were decreases in steps for non-athletes, increases in WC for athletes and decreases in TPA and TRAN PA for athletes. Male non-athletes significantly decreased in daily steps from fall to spring ( $p=0.003$ ) (Table 12). Females athletes significantly increased in WC from fall to spring ( $p=0.003$ ) (Table 13). Athletes reported a significant decrease in TPA from fall to spring ( $p=0.012$ ) (Table 14). Male athletes reported a significant decrease in TRAN PA from fall to spring ( $p=0.021$ ) (Table 15).

### **Relationship between change in physical activity and body composition**

Table 16 shows the relationship between change in body composition and average TPA, change in TPA, average steps and change in daily steps. There were no significant

**Table 12. Male non-athletes means and standard deviations for daily steps in fall and spring**

	Raw scores		p for change
	Fall	Spring	
	<b>Male Non-Athletes n=11</b>	<b>Male Non-Athletes n=11</b>	
<b>Steps/day</b>	12933 (4486)	8709 (2907)	<b>0.003</b>

**Table 13. Female athletes medians and inter-quartile ranges for WC in fall and spring**

	Raw scores		p for change
	Fall	Spring	
	<b>Female Athletes n=18</b>	<b>Female Athletes n=18</b>	
<b>WC (cm)</b>	72.9 (68.6-76.0)	73.7 (69.4-77.7)	<b>0.003</b>

**Table 14. Athletes medians and inter-quartile ranges for TPA in fall and spring**

	<b>Raw scores</b>		
	<b>Fall</b>	<b>Spring</b>	
	<b>Athletes n=32</b>	<b>Athletes n=32</b>	<b>p for change</b>
<b>TPA (MET-min/wk)</b>	2737 (1083-5116)	1962 (1232-3035)	<b>0.012</b>

**Table 15. Male athletes medians and inter-quartile ranges for TRAN PA in fall and spring**

	<b>Raw scores</b>		
	<b>Fall</b>	<b>Spring</b>	
	<b>Male Athletes n=14</b>	<b>Male Athletes n=14</b>	<b>p for change</b>
<b>TRAN PA (MET-min/wk)</b>	1082 (577-2266)	676 (132-1095)	<b>0.021</b>



**Table 16. Correlations between average TPA, change in TPA, average steps, and change in daily steps and changes in body composition**

	<b>ATPA<sup>1</sup></b>	<b>Δ TPA<sup>2</sup></b>	<b>Average steps<sup>3</sup></b>	<b>Δ Daily steps<sup>4</sup></b>
<b>Δ Height</b>	r = -0.028 (p=0.826)	r = 0.136 (p=0.297)	r = 0.131 (p=0.311)	r = -0.186 (p=0.147)
<b>Δ Weight</b>	r = -0.027 (p=0.839)	r = 0.095 (p=0.464)	r = -0.076 (p=0.558)	r = 0.076 (p=0.555)
<b>Δ WC</b>	r = -0.089 (p=0.433)	r = 0.215 (p=0.093)	r = 0.022 (p=0.866)	r = 0.123 (p=0.341)
<b>Δ HC</b>	r = -0.014 (p=0.912)	r = 0.136 (p=0.297)	r = -0.034 (p=0.795)	r = -0.055 (p=0.672)
<b>Δ WHR</b>	r = -0.107 (p=0.406)	r = 0.159 (p=0.216)	r = 0.049 (p=0.708)	r = 0.187 (p=0.145)
<b>Δ BF</b>	r = -0.107 (p=0.407)	r = 0.083 (p=0.524)	r = -0.221 (p=0.085)	r = -0.001 (p=0.993)
<b>Δ BMI</b>	r = -0.029 (p=0.822)	r = 0.137 (p=0.292)	r = -0.118 (p=0.362)	r = 0.116 (p=0.370)
<b>Δ FM</b>	r = -0.104 (p=0.442)	r = 0.075 (p=0.564)	r = 0.228 (p=0.074)	r = 0.089 (p=0.493)
<b>Δ FFM</b>	r = 0.173 (p=0.179)	r = -0.013 (p=0.918)	r = -0.042 (p=0.743)	r = 0.024 (p=0.852)

WC – waist circumference, HC – hip circumference, WHR – waist-to-hip ratio, BF – body fat, BMI – body mass index, FM – fat mass, FFM – fat free mass

<sup>1</sup> Average totally physical activity (weekly total activity in fall + weekly total activity in spring)/2

<sup>2</sup> Change in total weekly physical activity (total weekly physical activity in the spring – total weekly activity in the fall)

<sup>3</sup> Average steps (daily steps in fall + daily steps in spring)/2

<sup>4</sup> Change in daily steps (daily steps in spring – daily steps in fall)

correlations between changes in any body composition variables and average TPA. There were also no significant correlations between changes in any body composition variables or change in daily steps and change in TPA. There were no significant correlations between changes in any body composition variables and average steps. There were also no significant correlations between changes in any body composition variables or change in daily steps and change in daily steps.

## CHAPTER 5: DISCUSSION

The purpose of this study was to determine differences in body composition and physical activity in former athletes and non-athletes as well as females and males upon entrance into college, and to determine if the changes in body composition and physical activity over the course of freshmen year were different in athletes and non-athletes as well as females and males.

### **Body composition**

Freshmen are young adults and are still continuing to grow, so it makes sense that for the overall sample there was a small but significant increase in height. However, there were also unhealthy changes in body composition. Weight, BMI, waist circumference, and waist-to-hip ratio significantly increased over the course of freshmen year, which suggests that college is a time when unhealthy changes do occur, however these changes were small. There was a significant mean weight gain of  $1.8 \pm 2.6$  kg, one half of which was fat mass; however these changes were nowhere near the well known 'Freshmen 15'.

There was also a significant mean increase in BMI of  $0.4 \pm 0.9$   $\text{kg} \cdot \text{m}^{-2}$ . In fall 80.3% of freshmen fell within the healthy BMI range, 14.9% fell within in the overweight range and 4.9% fell within the obese range; in spring 75.4% fell within the healthy range, 19.7% fell within the overweight range and 4.9% fell within the obese range. In other words, the percentage of obese individuals remained constant, but some normal weight persons moved to the overweight category. This is consistent with past literature. Anderson et al.[16] found that freshmen had a mean weight gain of 1.7 kg

from September to May. In May, 78.3% of the sample fell within the normal BMI range, 17.4% fell within the overweight range, and 4.3% fell within the obese range. Levitsky et al. [15] also found similar results in a group of 60 freshmen. Freshmen had a significant mean weight gain of  $1.9 \pm 2.4$  kg after 12 weeks in college. Racette et al. [18] found that from beginning of freshmen year to the end of sophomore those who gained weight had a mean increased of  $4.1 \pm 3.6$  kg, suggesting that the mean increase of  $1.8 \pm 2.6$  kg found in our study over one year may double over the sophomore year. Butler et al. [36] examined 82 female freshmen upon entrance into college and again 5 months later and found significant increases in body mass ( $63.84 \pm 11.37$  kg to  $64.55 \pm 11.42$  kg), BMI ( $23.64 \pm 3.86$  kg·m<sup>-2</sup> to  $23.91 \pm 3.88$  kg·m<sup>-2</sup>), % body fat ( $21.96 \pm 5.65\%$  to  $23.75 \pm 5.41\%$ ), fat mass ( $14.53 \pm 6.55$  kg to  $15.84 \pm 6.4$  kg) and decrease in lean mass ( $49.47 \pm 5.98$  kg to  $48.86 \pm 5.74$  kg). Consistent with Butler, females in our study had a significant increase in body mass, fat mass and BMI, however, there were no changes in % body fat, and instead of a decrease in lean mass, we found a significant increase.

It was not a surprise that males were significantly leaner, with significantly less fat mass and body fat % and significantly more lean mass than females. Overall, the change in body fat % was  $+0.74 \pm 3.42$  % between fall and spring. There was no difference in change between males and females in fat mass, lean mass, or body fat % over the course of freshmen year, however there was a trend ( $p=0.058$ ) for body fat to remain stable in females, while body fat tended to increase in males.

Former athletes and non-athletes came into college with similar body composition. Over the course of freshmen year there was an increase in waist circumference female athletes ( $p=0.003$ ), while there was no significant change for male

athletes and females non-athletes. Overall athletes had significantly higher fat free mass than non-athletes ( $p=0.046$ ).

Important to mention was the large variation in body composition change. Some individuals had large increases or decreases, while others had no change in body composition. Figure 1 shows the variation in weight change. 73.8% of the sample ( $n=45$ ) gained weight with a mean gain of  $2.9\pm 2.0$  kg. Only 26.2% of the sample ( $n=16$ ) lost weight with a mean loss of  $1.3\pm 0.9$  kg. Most of the sample gained weight which makes sense since these are young adults who are still growing. However, weight does not indicate what kind of mass was gained (i.e., body fat or fat free mass).

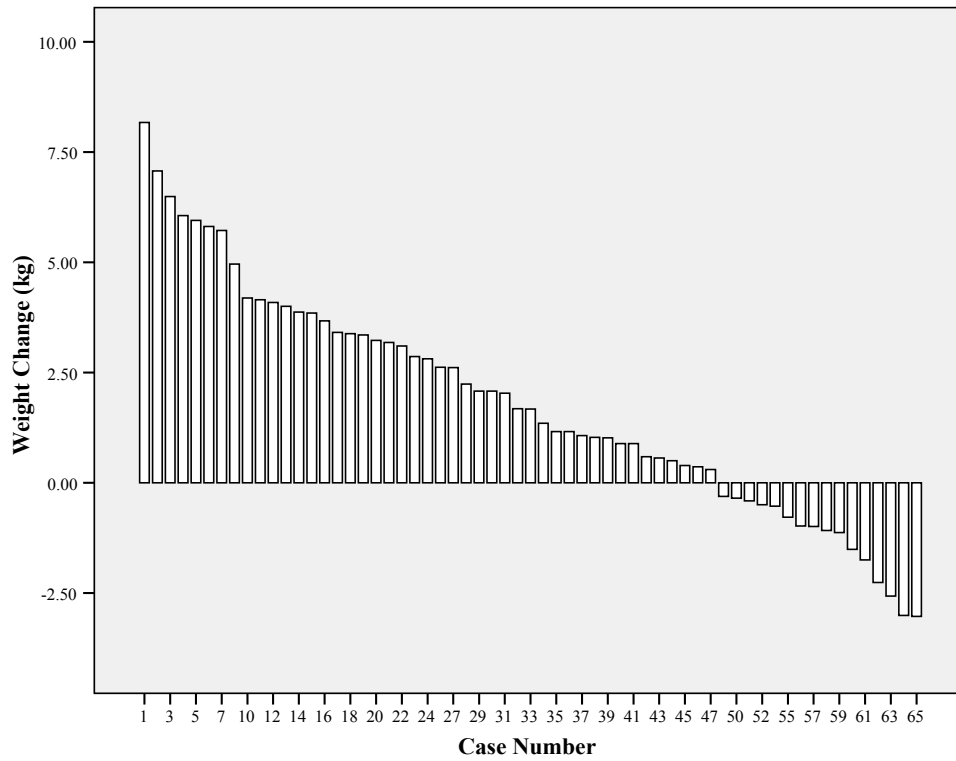
Figure 2 shows the variation in change in body fat %. 58.1% of the sample ( $n=36$ ) gained body fat with a mean gain of  $3.0\pm 2.4$ . 41.9% of the sample ( $n=26$ ) lost body fat with a mean loss of  $2.4\pm 1.7$ . Figure 3 shows the variation for change in hip circumference. 49.2% of the sample ( $n=30$ ) gained in hip circumference with a mean gain of  $2.3\pm 1.8$ . 49.2% of the sample ( $n=30$ ) lost in hip circumference with a mean loss of  $2.3\pm 1.6$ , while 1.6% ( $n=1$ ) remained unchanged.

If researchers could pinpoint what factors contribute to those individuals with large changes then it may give us insight into what is actually happening to these individuals and why it is occurring.

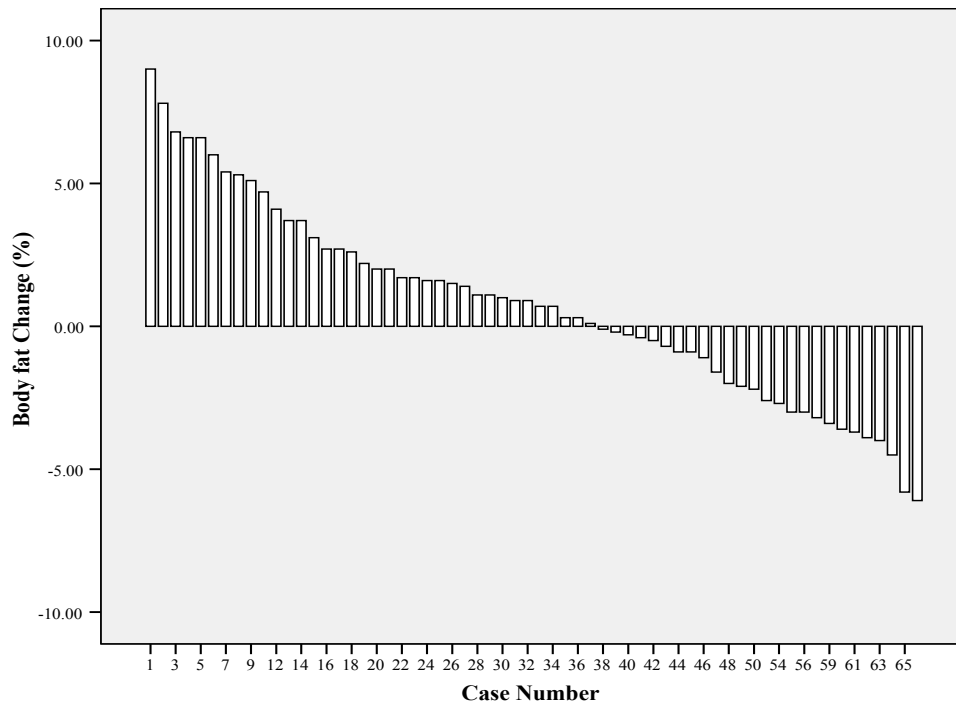
### **Physical activity**

At the beginning of freshmen year the average step count was  $11202\pm 3228$  steps/day which significantly decreased over the year to  $9690\pm 3112$  steps/day a mean decrease of  $1512\pm 3152$  steps/day.

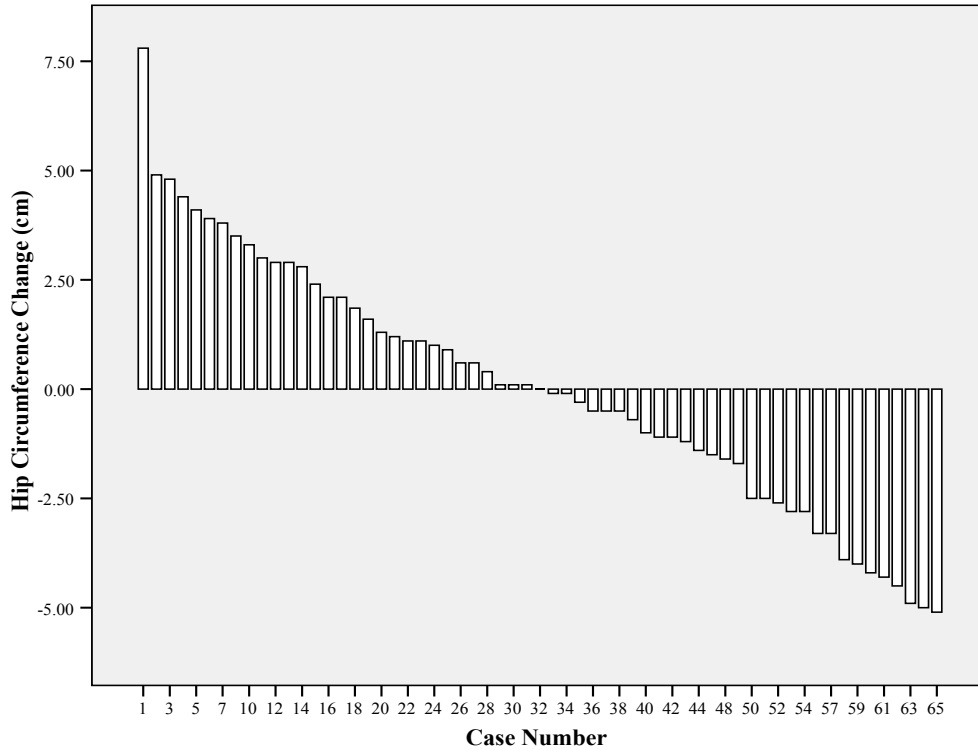
**Figure 1. Variation in individual cases of weight change**



**Figure 2. Variation in individual cases of body fat change**



**Figure 3. Variation in individual cases of hip circumference change**



Freshmen also significantly decreased TPA ( $p=0.021$ ) and transportation activity ( $p=0.008$ ).

When looking at differences across gender upon entrance into college, males had significantly higher LTPA ( $p=0.014$ ) than females, while there were no differences in males and females daily steps, however males had a significantly larger drop ( $p=0.037$ ) than females ( $-2374\pm3720$  steps/day vs.  $-929\pm2596$  steps/day). There were no differences in changes in TPA, LTPA, or TRAN PA for females and males. There was no change in TPA or LTPA in females, however this was inconsistent with the findings of Butler et al. [36] who found that over the course of 5 months females had a significant decrease in total, work, and sport physical activity, while there was an increase in leisure time physical activity.

Athletes came into college with higher LTPA ( $p=0.008$ ) and TPA ( $p=0.013$ ), while TRAN PA and steps did not differ between the groups. This makes sense because most of college freshmen's transportation activity requires walking or riding a bike to class. Changes over the year were different among athletes and non-athletes. Non-athletes had a significantly larger drop in steps from fall to spring when compared to athletes ( $p=0.032$ ), and when breaking it down by gender, male non-athletes had a significantly larger drop in steps from fall to spring than male athletes ( $p=0.024$ ), while females athletes and non-athletes did not differ. Athletes came into college with higher LTPA and TPA; however these significances disappeared in the spring. Athletes had a significant drop in TPA ( $p=0.012$ ), which was significantly larger drop ( $p=0.044$ ) than non-athletes. TRAN PA was similar for athletes and non-athletes in the fall, however there was a trend ( $p=0.098$ ) for athletes to drop more than non-athletes over the year. Male athletes had a significantly larger drop in TRAN PA than male non-athletes ( $p=0.034$ ). Overall we can see that upon entrance into college athletes start off with a higher activity level than non-athletes; however over the course of freshmen year these differences disappear, leading us to believe that athletes are decreasing their activity more than non-athletes. However, when examining objectively measured daily steps, non-athletes are significantly decreasing in activity as well. The accuracy of self-reported activity from the IPAQ is questionable and in this study it was not consistent with objectively measured activity from the pedometers. There are no published studies indicating that the IPAQ can be useful in detecting change in PA behavior over time.



## **Relationship between change in physical activity and body composition**

When the associations between physical activity and change in body composition were examined, essentially no significant correlations were found (Table 14 and 15). This may be due to the large variation in body composition and physical activity. For example, one subject has a 5.72 kg gain in weight, a 1.6% gain in fat, while daily steps decreased by 4260, and TPA decreased by 3351 MET-min/wk. Another subject had a 3.01 kg loss in weight, a 3% decrease in body fat, while daily steps decreased by 3033 steps and TPA decreased by 1500 MET-min/wk. Since there were numerous individuals who had small changes in body composition and activity this limits the ability to draw conclusions. If those with large changes are grouped with those with small changes the effect of the large change is reduced. Therefore, having a sample with such a large variation in data may hide differences that may really be occurring.

## **Limitations**

Diet was not included in the analyses. Since there was no correlation between changes in body composition and physical activity, an examination of subjects' diet habits may have given us an explanation to the lack in association.

The length of the study may have been too short to really find significant associations in body composition and physical activity. There tends to be negative changes in body composition and physical activity in freshmen, but one school year (August – April) gives only a snapshot of the overall college experience.

The sample was not a random sample, but a convenience sample of college students. We were limited to those individuals who responded to the web-based health survey. Individuals who were more conscious about their health may have been more likely to participate, and individuals from lower socioeconomic class who did not own a home computer did not have the opportunity to participate. Also, it was not a large sample. A larger, representative sample would be preferred for making general statements about changes in college freshmen.

The definition of ‘athletes’ for this study is a limitation. Athletes were grouped together no matter what sport they played, whether it be a very low intensity/low aerobic sport such as bowling to a very high intensity/high aerobic sport such as cross country. This may not have given us the best picture of how athletes differ from non-athletes. Athletes were defined as individuals who participated in a varsity sport senior year in high school. Varsity sports are not the only determination of athletic status; it does not take into account individuals who participated in competitive sports outside of high school or those who were regularly physically active.

## **Summary**

Overall there were slight increases in body mass and body fat and decreases in activity level; however changes that occur during freshmen year in college are not the same for all individuals. Some have unhealthy or healthy changes while others may not experience much of a change. These changes may be due to factors such as intent to change, what types of activities they become involved in, or how active they were before entering college. In this study athletes come into college with higher activity level,

however over the course of freshmen year the differences disappear, suggesting that a history of activity, by the definition of varsity athlete senior year in high school does not mean they are less susceptible to unhealthy changes during freshmen year. The key for future research is to focus on individuals with large changes in body composition and activity and determine what factors are contributing to these large changes. It will also be important to learn what factors are most influential in keeping students active during their college years.

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## APPENDICES



## **Appendix A: Psychological variables**

## Introduction

Because psychological variables influence exercise behavior, examining an individual's motivation for physical activity is important. Physical self-perception is one of the determinants of physical activity behavior [1]. The Physical Self-Perception Profile (PSPP) is a questionnaire specific to a young college population that allows individuals to rate themselves on five factors: sports competence, physical condition, body attractiveness, strength, and over-all physical self-worth. In order to give an idea of how important each factor is to each individual the Perceived Importance Profile (PIP) is also incorporated in the PSPP [1]. Research has shown that physically active individuals score higher on physical self-perception when compared to less active individuals, specifically athletes seemed to score higher on aspects of self-concept such as social acceptance, physical appearance [2, 3] as well as athletic competence [2-4] when compared to non-athletes. Gender differences in self-perception also seem to be common, males have shown to score higher on athletic competence [5], as well as all sub-scales of physical self-perception when compared to females [1, 6]. It is unknown how these psychological variables are impacted during the transition from high school into college, especially for former athletes. It is also unknown whether there is any connection between changes in physical activity patterns and changes in physical self-perception during this period.

## Review of literature

### Comparing psychological variables in inactive and active people

Physical activity has been shown to have positive effects on psychological health such as decreased anxiety and depression, and enhanced feelings of well being, while physical self-perception has been positively associated with participation in physical activity[2, 7]. Fox created a Physical Self-Perception Profile (PSPP) along with a Physical Importance Profile (PIP) to help explain the aspects of the physical self [1]. The PSPP assesses four sub-domains including sport competence, physical condition, body attractiveness, and physical strength, with an overall physical self-worth domain. The PIP was created to accompany the PSPP because, not only are the PSPP sub-domains essential to the physical self, but it is also necessary to understand the importance individuals place on each of these sub-domains. If an individual perceives sport competence as unimportant, then a low sport competence score would not be likely to impact overall physical self-worth.

Fox's PSPP has been used among adolescents, high school, and college students, while Fox's PIP has been used among college students. The PSPP and PIP have been used to examine the relationship between physical activity and physical self-perception among active and sedentary individuals as well as males and females. Individuals active in sports score higher on all five sub-domains of physical self-perception; sport competence, physical condition, body attractiveness, physical strength and physical self-worth when compared to their sedentary counterparts [8]. Research has also found

significant differences between males and females. Males consistently scored higher on all sub-domains of physical self-perception when compared to females[6, 9].

Crocker et al. [7] examined physical activity and self-perception in 220 boys and 246 girls aged 10-14 years. Self-perception was assessed using the PSPP and physical activity was assessed using the Physical Activity Questionnaire for Older Children (PAQ-C) which measures moderate to vigorous physical activity during the past 7 days. Sport competence (0.528), physical conditioning (0.508), body attractiveness (0.315), strength competence (0.397) and physical self-worth (0.450) were positively correlated with physical activity. Although boys had significantly higher physical activity scores, and sport and strength competence scores, the relationship between physical activity and physical self-perception was similar in both boys and girls. Physical self-perception was shown to be a moderate correlate of physical activity in older children.

Asci et al. [2] examined self-concept and body image in Turkish high school male athletes (n=174) and non-athletes (n=174). The Harter Self-Perception Profile for Adolescents assessed self-concept. The Berscheid, Walster and Bohrnstedt Body Image Questionnaire assessed satisfaction with specific body parts. Athletes scored higher on social acceptance, athletic competence, and physical appearance. Also, athletes scored significantly higher on muscle power, shoulders, chest/upper extremities, and mean body image satisfaction. Participation in physical activity was significantly related to higher self-concept and body-image in high school males.

Physical self-perception has been associated with sport participation. Another study done by Asci et al. [8] examined self-perception in 329 elite Turkish athletes and compared them to 469 non-athletes between the ages of 18-21 years. Physical self-

perception was assessed using the PSPP. Elite athletes scored higher on sport competence, physical conditioning, and physical strength. When examining gender effects; males scored higher than females on sport competence and physical conditioning. Also, female athletes scored higher on sport competence, physical conditioning, and strength competence when compared to male and female non-athletes. Changes in sports participation might influence the perception of competence in the physical domain.

Hayes et al. [6] examined gender differences in physical self-perceptions, global self-esteem and physical activity among Canadian college students (94 females and 89 males). PSPP was used to assess physical-self perception. The What I Am Like scale (GSE) assessed global-self esteem, and The Leisure Time Exercise Questionnaire (LTEQ) assessed leisure time activity over a 7-day period. Men scored significantly higher on body, sport, conditioning and physical self worth, while there were no gender differences for strength, global self-esteem, and physical activity measures. When measures on self-esteem and physical activity were examined, men's physical activity was positively correlated with global self-esteem (0.22), physical self-worth (0.36), as well as all PSPP sub-domains; body (0.41), physical conditioning (0.49), sport (0.38), and strength (0.28). Females' physical activity was related to only one PSPP sub-domain; physical conditioning (0.48). For both males and females physical conditioning had the highest correlation with physical activity level.

A study done by Lindwall et al. [9] examined the relationship between exercise frequency and duration and PSPP scores and PIP importance ratings of physical self-perception in 164 Swedish college students during their first weeks as freshman. PSPP was used to assess physical self-perception, PIP was used to assess the importance an

individual places on the PSPP sub-domains (sport, condition, body, strength) Exercise frequency and duration was assessed by a questionnaire asking students how often and how long they participated in planned, structured, repetitive bodily movements for the purpose of improving or maintaining physical fitness and health. About 65% of men and 56% of women reported exercising two to three times per week, while about 58% of men and 67% of women reported exercising for 45-90 min. Exercise frequency and duration were both positively associated with all PSPP and PIP sub-domains. Individuals who exercised more frequently and for longer durations had higher PSPP scores than individuals who did not exercise regularly. The relationship between frequency and PSPP and PIP scores were strong, with four out of the five PSPP sub-domain scores (sport competence, physical conditioning, strength competence, and physical self-worth) and all 4 PIP sub-domain scores (sport imp., condition imp., body imp., and strength imp.) showing significant positive associations. The relationship between duration and PSPP and PIP scores were weaker with three out of the five PSPP sub-domains (sport, condition, and physical self-worth), and only one of the four PIP sub-domains (sport imp.) showing significant positive associations. This suggests that frequency rather than duration of exercise was associated with a more positive perception of the physical self. When differences in gender were examined males scored higher on 4 out of the 5 PSPP sub-domains (sport, condition, body and physical self-worth) as well as 2 out of the 4 PIP sub-domains (sport imp., and strength imp.). In conclusion, physical self-perception is positively associated with activity level, however it cannot be concluded that higher activity levels cause higher physical self-perception scores.

## Results

Freshmen as a group had a significant decrease in perceived physical conditioning ( $p=0.012$ ) over the year, while there was a trend for perceived body attractiveness ( $p=0.083$ ) and physical self-worth ( $p=0.090$ ) to decrease over time (Table 17).

Males scored significantly higher on perceived sport competence ( $p=0.004$ ), physical conditioning ( $p=0.013$ ), and physical self-worth ( $p=0.031$ ) when compared to females. There was no difference in change between females and males

Athletes scored significantly higher on perceived sport competence ( $p=0.001$ ), physical conditioning ( $p=0.015$ ), and strength ( $0.012$ ) when compared to non-athletes. There was no difference in change between athletes and non-athletes.

**Table 17. Means and standard deviations in fall and spring for Physical Self-Worth and PSPP subdomains for the overall sample.**

	Fall N=62	Spring N=62	
	Mean (SD)		p for change
Physical Self-Worth	15.61 (4.40)	15.69 (4.73)	0.090
Sport Competence	15.79 (4.28)	14.92 (4.31)	NS
Physical Condition	16.00 (3.55)	15.47 (3.96)	0.012
Body Attractiveness	15.68 (3.07)	15.52 (3.48)	0.083
Strength Competence	17.13 (4.32)	16.52 (4.06)	NS

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## Appendix B: Informed Consent

## FRESHMAN EXPERIENCE: LIFE IN MOTION

**Student Investigators:** Tracy Swibas and Amber McMahon

**Address:** Exercise, Sport, and Leisure Studies  
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1914 Andy Holt Ave., 340 HPER  
Knoxville, TN 37914-2700

**Phone:** (865) 974-5051

**Purpose:** College freshmen face many challenges. Among the decisions that individuals must make are choices about exercise and eating habits. This study is designed to gather information about eating and exercise patterns of college freshmen. We plan to gather this information early in the freshman year 2006 and then again late in spring 2007. *If you choose to participate in this study, you will make a total of 4 visits to the Applied Physiology Laboratory (HPER Building, keep records of what you eat, and wear an activity monitor to measure your activity. You must be at least 18 years old to participate in this research study.* The details are described below.

**Testing Procedures:** During fall 2006 you will make 2 visits to the Applied Physiology Laboratory (HPER 314). *The first visit will take about 1 hour and will consist of filling out 2 questionnaires and having your blood pressure and body composition measured.* During this first visit you will *complete a survey* that asks basic demographic questions (sex, age, race, etc.) as well as questions about tobacco use, weight history, family history of major illness, and athletic history. You will also *complete a questionnaire* that gathers physical activity information on the previous 7 days. Next we will *measure your blood pressure*. The procedure will be like what you might have experienced in a physician's office. We will put an inflatable cuff around your upper arm, inflate the cuff, and use a stethoscope to listen for sounds in an artery that is located in your elbow. Next we will use 2 techniques to *estimate your body composition* (i.e., your body fat percentage). For these procedures you will wear a swimming suit. We will use a tape measure to measure the distance around your waist and hips. We will also measure your height with a scale on the wall. You will then stand on a machine that estimates body fatness by measuring electrical currents in your body. Next, you will sit in a chamber that measures the size of your body. You will sit in this machine for 2-3, one-minute trials. During the time that the chamber is closed, you will be able to see your surroundings and breathe normally. Before leaving the laboratory, you will be given an activity monitor (some people will be given 2 monitors to wear – one on each hip) and instructions for completing a food diary. For 7 days following this session, you will wear the activity monitor(s) and record all that you eat and drink. The activity monitors are small devices that fit onto the waist band of your clothing. These will be worn continuously except when sleeping or when in water.

*Your second visit to the Applied Physiology Laboratory will occur immediately following the completion of 7-day eating record. This visit will take about 45 minutes. You will return the activity monitor(s). You will complete a physical activity questionnaire that asks about your exercise for the previous week. You will also complete*

*a survey that asks questions about your opinion of exercise (e.g., your comfort level with exercise, how much you value exercise). An investigator will review your food diary with you and ask questions so that we can accurately interpret your responses. Once you have completed all aspects of this second visit, including returning all equipment, you will be given a \$50 gift certificate that can be used in the UT Bookstore and/or UT Computer Store.*

In spring 2007, you will be contacted to repeat this series of tests. Again the compensation will be a \$50 gift certificate to the UT Bookstore.

**Potential Risks:** There are no known risks to any of the tests you will complete as a part of this project. The major risk is loss of confidentiality, but your identity will be protected. Your test results will be labeled with a subject identification number, and your name will not be linked with your test results. All data will be secured in computers that are password protected and accessible only to study investigators. Hard copies of data and signed consent forms will be stored separately in locking file cabinets.

**Benefits of Participation:** You will be given information about your body composition, blood pressure, and physical activity pattern. Your participation will provide researchers with greater insight into the choices that freshmen make about eating and exercise.

**Confidentiality:** As described above, your identity will be protected by investigators. No information will be provided to others without your written consent. Although researchers intend to publish the overall results of this study, you will not be identified as a participant in this project.

**Compensation:** As described above, you will be given a \$50 gift certificate to the UT Bookstore upon completion of all aspects of visits 1 and 2. *Equipment and fully completed food and activity diaries must be returned in order to receive compensation. No partial compensation will be given.* Upon completion of visits 3 and 4 in spring 2007, another \$50 gift certificate to the UT Bookstore will be given. Again, no partial compensation will be given.

**Emergency Medical Treatment:** The University of Tennessee does not automatically reimburse subjects for medical claims or other compensation.

**Contact Information:** If you have questions or concerns at any time about your participation in this project, you may contact Dr. Dixie Thompson at (865) 974-8883 (office – 340 HPER, University of Tennessee). If you have questions about your rights as a research participant, contact the University of Tennessee Office of Research Compliance Officer at (865) 974-3466.

**Voluntary Participation:** Your participation is voluntary, and you may stop your participation at any point. If you stop participation prior to completing the data collection,

your data will be destroyed. If you stop participation before completing the requirements of the study, you will not receive the compensation. If you stop participation, you will be expected to return all equipment.

**Consent:** I have read the above information. I have received a copy of this form. I agree to participate in this study. Researchers may keep my confidential contact information in the event that follow-up studies are conducted in subsequent years.

Participant's Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Investigator's Signature: \_\_\_\_\_ Date: \_\_\_\_\_



## Appendix C: Health History Questionnaire

**“Freshman Experience: Life in Motion”  
Demographic Questions**

- 1) What is your date of birth? Month \_\_\_\_ / Day \_\_\_\_ /Year \_\_\_\_
- 2) What is your sex?
  - Female
  - Male
- 3) Are you Hispanic or Latino?
  - Yes
  - No
  - Don't Know/Not Sure
- 4) Which one of these groups would you say best represents your race?
  - White
  - Black
  - Asian
  - Native Hawaiian or Other Pacific Islander
  - American Indian or Alaska Native
  - Multi-racial
  - Other (please specific) \_\_\_\_\_
  - Don't Know/Not Sure
- 5) Are you a full-time student?
  - Yes
  - No
- 6) Are you an international student?
  - Yes
  - No
- 7) Where do you currently live?
  - Campus residence hall
  - Off-campus housing
  - Fraternity or sorority house
  - Other university housing
  - Parent/guardian's home
  - Other
- 8) Have you or do you plan to become a member of a social fraternity or sorority?
  - Yes
  - No

## Medical History/Family History

- 9) Has a doctor or other health professional ever told you had any of the following medical conditions? (Please check all that apply)
- Arthritis (joint problems)
  - Heart disease (heart attack or cardiovascular disease)
  - Stroke
  - Hypertension (high blood pressure)
  - Diabetes (high blood sugar)
  - Weight problem (overweight or obese)
  - Cancer – if so, what type? \_\_\_\_\_
- 10) Including living and deceased, were any of your blood relatives (i.e., grandparents, parents, brothers, and sisters) ever told by a health professional that they had any of the following? (Please check all that apply)
- Arthritis (joint problems)
  - Heart disease (heart attack or cardiovascular disease)
  - Stroke
  - Hypertension (high blood pressure)
  - Diabetes (high blood sugar)
  - Weight problem (overweight or obese)
  - Cancer – if so, what type? \_\_\_\_\_
- 11) Have you smoked at least 100 cigarettes (5 packs) in your entire life?
- Yes
  - No (Skip to question 14)
  - Don't know / Not sure (Skip to question 14)
- 12) Do you now smoke cigarettes every day, some days, or not at all?
- Every day
  - Some days
  - Not at all (Skip to question 14)
  - Don't know/Not sure (Skip to question 14)
- 13) During the past 12 months, have you stopped smoking for one day or longer because you were trying to quit smoking?
- Yes
  - No
  - Don't know / Not sure
- 14) Do you consider yourself now to be...
- Overweight
  - Underweight
  - About the right weight
  - Don't know

- 15) Would you like to weigh...
- More
  - Less
  - Stay about the same
  - Don't know
- 16) How much did you weigh a year ago? \_\_\_\_\_ pounds
- 17) Was the change between your current weight and your weight a year ago intentional?
- Yes
  - No
  - Don't know
- 18) During the past 12 months, have you tried to lose or keep from gaining weight?
- Yes
  - No  **Skip to question 20 below**
  - Don't know
- 19) If yes to number 18 above, how did you try to lose or keep from gaining weight?  
(Check all that apply)
- Switched to foods with lower calories
  - Ate less fat
  - Exercised
  - Skipped meals
  - Ate diet foods or products
  - Used a liquid diet formula such as Slimfast or Optifast
  - Joined a weight loss program such as Weight Watchers, Jenny Craig, Tops, or Overeaters Anonymous
  - Took diet pills prescribed by a doctor
  - Took other pills, medicines, herbs, or supplements not needing a prescription
  - Took laxatives or vomited
  - Drank a lot of water
  - Followed a special diet such as Dr. Atkins, other high protein or low carbohydrate diet
  - Other
- 20) During the past 12 months, have you tried to gain weight?
- Yes
  - No  **Skip to question 22 on next page**
  - Don't know



- 21) If yes to number 20 above, how did you try to gain weight?  
(Check all that apply)
- Weight or Strength Training
  - Eating More Food
  - Supplement Use
  - Other

### **Athletic Participation History**

- 22) During your senior year of high school, did you participate in a varsity-level sport?
- Yes
  - No
- 20) In which high school varsity sports did you participate? (Mark all that apply)
- Archery
  - Badminton
  - Baseball
  - Basketball
  - Bowling
  - Cheer squad
  - Crew
  - Cross country
  - Cycling
  - Dance line
  - Diving
  - Fencing
  - Field hockey
  - Football
  - Golf
  - Gymnastics
  - Ice hockey
  - Lacrosse
  - Martial arts
  - Pom Poms
  - Rifle
  - Skiing
  - Soccer
  - Softball
  - Squash
  - Swimming
  - Synchronized swimming
  - Team handball
  - Tennis
  - Track, Indoor

- Track, Outdoor
- Volleyball
- Water polo
- Weight lifting
- Wrestling
- Other \_\_\_\_\_

## **Appendix D: International Physical Activity Questionnaire (IPAQ)**

## PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that college freshmen 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, 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: 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.

1. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**? (Please do not count any walking you do to go to school, work, or between classes.)

\_\_\_\_\_ **days per week**

No walking in leisure time



**Skip to question 3**

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

\_\_\_\_\_ **hours per day**

\_\_\_\_\_ **minutes per day**

3. 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 5**

4. 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**

5. 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 question 7 on next page**

6. 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 2: TRANSPORTATION PHYSICAL ACTIVITY***

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

7. 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 9**

8. 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 campus, work, to do errands, or to go from place to place. Please don't count any walking you have already mentioned in Part I above.

9. 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 (e.g., between classes)**?

\_\_\_\_\_ **days per week**

No bicycling from place to place → **Skip to question 11**

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

\_\_\_\_\_ hours per day  
\_\_\_\_\_ minutes per day

11. 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 (e.g. between classes)**?

\_\_\_\_\_ days per week

No walking from place to place **→ Skip to question 13 on next page**

12. 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: JOB- RELATED PHYSICAL ACTIVITY**

The section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work. Do not include unpaid work you might do around your dorm room or home (e.g., cleaning your dorm room, yard work, general maintenance, or caring for your family).

13. Do you currently have a job or do any unpaid work outside where you live in Knoxville?

Yes

No



**Skip to question 20 on next page**

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.

14. 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 16**

15. 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**

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** 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 18**

17. 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**

18. 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 or school**? Please do not count any walking you did to travel to or from work or school.

\_\_\_\_\_ **days per week**

No job or school-related walking



**Skip to question 20 on next page**

19. How much time did you usually spend on one of those days **walking** as part of your work or school? (Do not include any walking you reported earlier in the survey).

\_\_\_\_\_ **hours per day**

\_\_\_\_\_ **minutes per day**

#### **PART 4: TIME SPENT SITTING**

The last questions are about the time you spend sitting while in class at school, doing homework, work, in the dorm or at home, 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.

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

\_\_\_\_\_ **hours per day**  
\_\_\_\_\_ **minutes per day**

21. 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.**



## **Appendix E: IPAQ Scoring Protocol**



# **Guidelines for Data Processing and Analysis of the International Physical Activity Questionnaire (IPAQ)**

– Short and Long Forms

**November 2005**

## **Contents**

- 1 **Introduction**
- 2 **Uses of IPAQ Instruments**
- 3 **Summary Characteristics of Short and Long Forms**
- 4 **Overview of Continuous and Categorical Analyses of IPAQ**
- 5 **Protocol for Short Form**
- 6 **Protocol for Long Form**
- 7 **Data Processing Rules**
- 8 **Summary Algorithms**

**Appendix 1. At A Glance IPAQ Scoring Protocol – Short Forms**

**Appendix 2. At A Glance IPAQ Scoring Protocol – Long Forms**

## 1. Introduction

This document describes recommended methods of scoring the data derived from the telephone / interview administered and self-administered IPAQ short and long form instruments. The methods outlined provide a revision to earlier scoring protocols for the IPAQ short form and provide for the first time a comparable scoring method for IPAQ long form. Latest versions of IPAQ instruments are available from [www.ipaq.ki.se](http://www.ipaq.ki.se).

Although there are many different ways to analyse physical activity data, to date there is no formal consensus on a 'correct' method for defining or describing levels of physical activity based on self-report population surveys. The use of different scoring protocols makes it very difficult to compare within and between countries, even when the same instrument has been used. Use of these scoring methods will enhance the comparability between surveys, provided identical sampling and survey methods have been used.

## 2. Uses of IPAQ Instruments

IPAQ short form is an instrument designed primarily for population surveillance of physical activity among adults. It has been developed and tested for use in adults (age range of 15-69 years) and until further development and testing is undertaken the use of IPAQ with older and younger age groups is not recommended.

IPAQ short and long forms are sometimes being used as an evaluation tool in intervention studies, but this was not the intended purpose of IPAQ. Users should carefully note the range of domains and types of activities included in IPAQ before using it in this context. Use as an outcome measure in small scale intervention studies is not recommended.

## 3. Summary Characteristics of IPAQ Short and Long Forms

1. IPAQ assesses physical activity undertaken across a comprehensive set of domains including:
  - a. leisure time physical activity
  - b. domestic and gardening (yard) activities
  - c. work-related physical activity
  - d. transport-related physical activity;
  
- 1 The IPAQ **short** form asks about three specific types of activity undertaken in the four domains introduced above. The specific types of activity

that are assessed are walking, moderate-intensity activities and vigorous-intensity activities.

2 The items in the **short** IPAQ form were structured to provide separate scores on walking, moderate-intensity and vigorous-intensity activity.

Computation of the total score for the short form requires summation of the duration (in minutes) and frequency (days) of walking, moderate-intensity and vigorous-intensity activities. Domain specific estimates cannot be estimated.

3 The IPAQ **long** form asks details about the specific types of activities undertaken within each of the four domains. Examples include walking for transportation and moderate-intensity leisure-time activity.

4 The items in the **long** IPAQ form were structured to provide separate domain specific scores for walking, moderate-intensity and vigorous-intensity activity within each of the work, transportation, domestic chores and gardening (yard) and leisure-time domains. Computation of the total scores for the long form requires summation of the duration (in minutes) and frequency (days) for all the types of activities in all domains. Domain specific scores or activity specific sub-scores may be calculated. Domain specific scores require summation of the scores for walking, moderate-intensity and vigorous-intensity activities within the specific domain, whereas activity-specific scores require summation of the scores for the specific type of activity across domains.

#### **4. Overview of Continuous and Categorical Analyses of IPAQ**

Both categorical and continuous indicators of physical activity are possible from both IPAQ forms. However, given the non-normal distribution of energy expenditure in many populations, it is suggested that the continuous indicator be presented as median minutes/week or median MET–minutes/week rather than means (such as mean minutes/week or mean MET-minutes/week).

##### **4.1 Continuous Variables**

Data collected with IPAQ can be reported as a continuous measure. One measure of the volume of activity can be computed by weighting each type of activity by its energy requirements defined in METs to yield a score in MET–minutes. METs are multiples of the resting metabolic rate and a MET-minute is computed by multiplying the MET score of an activity by the minutes performed. MET-minute scores are equivalent to kilocalories for a 60 kilogram person. Kilocalories may be computed from MET-minutes using the following equation: MET-min x (weight in kilograms/60 kilograms). MET-minutes/day or MET-minutes/week can be presented although the latter is more frequently used and is thus suggested.

Details for the computation for summary variables from IPAQ short and long forms are detailed below. As there are no established thresholds for

presenting MET-minutes, the IPAQ Research Committee propose that these data are reported as comparisons of median values and interquartile ranges for different populations.

#### 4.2 Categorical Variable: Rationale for Cut Point Values

There are three levels of physical activity proposed to classify populations:

- 1 Low
- 2 Moderate
- 3 High

The algorithms for the short and long forms are defined in more detail in Sections 5.3 and 6.3, respectively. Rules for data cleaning and processing prior to computing the algorithms appear in Section 7.

Regular participation is a key concept included in current public health guidelines for physical activity.<sup>1</sup> Therefore, both the total volume and the number of days/sessions are included in the IPAQ analysis algorithms.

The criteria for these levels have been set taking into account that IPAQ asks questions in all domains of daily life, resulting in higher median MET-minutes estimates than would have been estimated from leisure-time participation alone. The criteria for these three levels are shown below.

Given that measures such as IPAQ assess total physical activity in all domains, the “leisure time physical activity” based public health recommendation of 30 minutes on most days will be achieved by most adults in a population. Although widely accepted as a goal, in absolute terms 30 minutes of moderate-intensity activity is low and broadly equivalent to the background or basal levels of activity adult individuals would accumulate in a day. Therefore a new, higher cutpoint is needed to describe the levels of physical activity associated with health benefits for measures such as IPAQ, which report on a broad range of domains of physical activity.

##### **‘High’**

This category was developed to describe higher levels of participation. Although it is known that greater health benefits are associated with increased levels of activity there is no consensus on the exact amount of activity for maximal benefit. In the absence of any established criteria, the IPAQ Research Committee proposes a measure which equates to approximately at least one hour per day or more, of at least moderate-intensity activity above the basal level of physical activity. Considering that basal activity may be considered to be equivalent to approximately 5000 steps per day, it is proposed that “high active” category be considered as those who move at least 12,500 steps per day, or the equivalent in

moderate and vigorous activities. This represents at least an hour more moderate-intensity activity over and above the basal level of activity, or half an hour of vigorous-intensity activity over and above basal levels daily. These calculations were based on emerging results of pedometers studies.<sup>2</sup>

This category provides a higher threshold of measures of total physical activity and is a useful mechanism to distinguish variation in population groups. Also it could be used to set population targets for health-enhancing physical activity when multi-domain instruments, such as IPAQ are used.

Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of American Medical Association* 1995; 273(5):402-7. and U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, The Presidents' Council on Physical Fitness and Sports: Atlanta, GA:USA. 1996. <sup>2</sup> Tudor-Locke C, Bassett DR Jr. How many steps/day are enough? Preliminary pedometer indices for public health. *Sports Med.* 2004;34(1):1-8.

### **'Moderate'**

This category is defined as doing some activity, more than the low active category. It is proposed that it is a level of activity equivalent to "half an hour of at least moderate-intensity PA on most days", the former leisure time-based physical activity population health recommendation.

### **'Low'**

This category is simply defined as not meeting any of the criteria for either of the previous categories.

## **5. Protocol for IPAQ Short Form**

### **5.1 Continuous Scores**

Median values and interquartile ranges can be computed for walking (W), moderate-intensity activities (M), vigorous-intensity activities (V) and a combined total physical activity score. All continuous scores are expressed in MET-minutes/week as defined below.

### **5.2 MET Values and Formula for Computation of MET-minutes/week**

The selected MET values were derived from work undertaken during the IPAQ Reliability Study undertaken in 2000-2001<sup>3</sup>. Using the Ainsworth et al.

Compendium (*Med Sci Sports Med* 2000) an average MET score was derived for each type of activity. For example; all types of walking were included and an average MET value for walking was created. The same procedure was undertaken for moderate-intensity activities and vigorous-intensity activities. The following values continue to be used for the analysis of IPAQ data: Walking = 3.3 METs, Moderate PA = 4.0 METs and Vigorous PA = 8.0 METs. Using these values, four continuous scores are defined:

Walking MET-minutes/week = 3.3 \* walking minutes \* walking days  
Moderate MET-minutes/week = 4.0 \* moderate-intensity activity minutes \* moderate days  
Vigorous MET-minutes/week = 8.0 \* vigorous-intensity activity minutes \* vigorous-intensity days  
Total physical activity MET-minutes/week = sum of Walking + Moderate + Vigorous MET-minutes/week scores.

### 5.3 Categorical Score

#### Category 1 Low

This is the lowest level of physical activity. Those individuals who not meet criteria for Categories 2 or 3 are considered to have a 'low' physical activity level.

<sup>3</sup> Craig CL, Marshall A, Sjostrom M et al. International Physical Activity Questionnaire: 12 country reliability and validity *Med Sci Sports Exerc* 2003; August

#### Category 2 Moderate

The pattern of activity to be classified as 'moderate' is either of the following criteria: a) 3 or more days of vigorous-intensity activity of at least 20 minutes per day

**OR**

b) 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day

**OR**

c) 5 or more days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum Total physical activity of at least 600 MET-minutes/week.

Individuals meeting at least one of the above criteria would be defined as accumulating a minimum level of activity and therefore be classified as 'moderate'. See Section 7.5 for information about combining days across categories.

### Category 3 High

A separate category labelled 'high' can be computed to describe higher levels of participation.

The two criteria for classification as 'high' are:

- a) vigorous-intensity activity on at least 3 days achieving a minimum Total physical activity of at least 1500 MET-minutes/week
- OR**
- b) 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum Total physical activity of at least 3000 MET-minutes/week.

See Section 7.5 for information about combining days across categories.

#### 5.4 Sitting Question in IPAQ Short Form

The IPAQ sitting question is an additional indicator variable of time spent in sedentary activity and is not included as part of any summary score of physical activity. Data on sitting should be reported as median values and interquartile ranges. To-date there are few data on sedentary (sitting) behaviours and no well-accepted thresholds for data presented as categorical levels.

## 6. Protocol for IPAQ Long Form

The long form of IPAQ asks in detail about walking, moderate-intensity and vigorous-intensity physical activity in each of the four domains. Note: asking more detailed questions regarding physical activity within domains is likely to produce higher prevalence estimates than the more generic IPAQ short form.

### 6.1 Continuous Score

Data collected with the IPAQ long form can be reported as a continuous measure and reported as median MET-minutes. Median values and interquartile ranges can be computed for walking (W), moderate-intensity activities (M), and vigorous-intensity activities (V) within each domain using the formulas below. Total scores may also be calculated for walking (W), moderate-intensity activities (M), and vigorous-intensity activities (V); for each domain (work, transport, domestic and garden, and leisure) and for an overall grand total.

### 6.2 MET Values and Formula for Computation of MET-minutes



## **Work Domain**

Walking MET-minutes/week at work = 3.3 \* walking minutes \* walking days at work  
Moderate MET-minutes/week at work= 4.0 \* moderate-intensity activity minutes \* moderate-intensity days at work  
Vigorous MET-minutes/week at work= 8.0 \* vigorous-intensity activity minutes \* vigorous-intensity days at work  
Total Work MET-minutes/week =sum of Walking + Moderate + Vigorous MET-minutes/week scores at work.

## **Active Transportation Domain**

Walking MET-minutes/week for transport = 3.3 \* walking minutes \* walking days for transportation  
Cycle MET-minutes/week for transport= 6.0 \* cycling minutes \* cycle days for transportation  
Total Transport MET-minutes/week = sum of Walking + Cycling MET-minutes/week scores for transportation.

## **Domestic and Garden [Yard Work] Domain**

Vigorous MET-minutes/week yard chores= 5.5 \* vigorous-intensity activity minutes \* vigorous-intensity days doing yard work (**Note:** the MET value of 5.5 indicates that vigorous garden/yard work should be considered a moderate-intensity activity for scoring and computing total moderate intensity activities.)  
Moderate MET-minutes/week yard chores= 4.0 \* moderate-intensity activity minutes \* moderate-intensity days doing yard work  
Moderate MET-minutes/week inside chores= 3.0\* moderate-intensity activity minutes \* moderate-intensity days doing inside chores.  
Total Domestic and Garden MET-minutes/week =sum of Vigorous yard + Moderate yard + Moderate inside chores MET-minutes/week scores.

## **Leisure-Time Domain**

Walking MET-minutes/week leisure = 3.3 \* walking minutes \* walking days in leisure  
Moderate MET-minutes/week leisure = 4.0 \* moderate-intensity activity minutes \* moderate-intensity days in leisure  
Vigorous MET-minutes/week leisure = 8.0 \* vigorous-intensity activity minutes \* vigorous-intensity days in leisure  
Total Leisure-Time MET-minutes/week = sum of Walking + Moderate + Vigorous MET-minutes/week scores in leisure.

## **Total Scores for all Walking, Moderate and Vigorous Physical Activities**

Total Walking MET-minutes/week = Walking MET-minutes/week (at Work + for Transport + in Leisure)  
Total Moderate MET-minutes/week total = Moderate MET-minutes/week (at Work + Yard chores + inside chores + in Leisure time) + Cycling Met-minutes/week for Transport + Vigorous Yard chores MET-minutes/week  
Total Vigorous MET-minutes/week = Vigorous MET-minutes/week (at Work + in Leisure)

**Note:** Cycling MET value and Vigorous garden/yard work MET value fall within the coding range of moderate-intensity activities.

## **Total Physical Activity Scores**

An overall total physical activity MET-minutes/week score can be computed

as: Total physical activity MET-minutes/week = sum of Total (Walking + Moderate + Vigorous) MET-

minutes/week scores. This is equivalent to computing: Total physical activity MET-minutes/week = sum of Total Work + Total Transport + Total Domestic and Garden + Total Leisure-Time MET-minutes/week scores.

As there are no established thresholds for presenting MET-minutes, the IPAQ Research Committee proposes that these data are reported as comparisons of median values and interquartile ranges for different populations.

### **6.3 Categorical Score**

As noted earlier, regular participation is a key concept included in current public health guidelines for physical activity.<sup>4</sup> Therefore, both the total volume and the number of day/sessions are included in the IPAQ analysis algorithms. There are three levels of physical activity proposed to classify populations – ‘low’, ‘moderate’, and ‘high’. The criteria for these levels are the same as for the IPAQ short [described earlier in Section 4.2]

#### **Category 1 Low**

This is the lowest level of physical activity. Those individuals who not meet criteria for Categories 2 or 3 are considered ‘low’.

#### **Category 2 Moderate**

The pattern of activity to be classified as ‘moderate’ is either of the following criteria:

d) 3 or more days of vigorous-intensity activity of at least 20 minutes per day

**OR**

e) 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day

**OR**

<sup>4</sup>

Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C et al. Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of American Medical Association* 1995; 273(5):402-7. and U.S. Department of Health and Human Services. *Physical Activity and Health: A Report of the Surgeon General*. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, The Presidents' Council on Physical Fitness and Sports: Atlanta, GA:USA. 1996.

- f) 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum Total physical activity of at least 600 MET-minutes/week.

Individuals meeting at least one of the above criteria would be defined as accumulating a moderate level of activity. See Section 7.5 for information about combining days across categories.

### Category 3 High

A separate category labelled 'high' can be computed to describe higher levels of participation.

The two criteria for classification as 'high' are:

- a) vigorous-intensity activity on at least 3 days achieving a minimum Total physical activity of at least 1500 MET-minutes/week

**OR**

- b) 7 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum Total physical activity of at least 3000 MET-minutes/week.

See Section 7.5 for information about combining days across categories.

## 6.4 IPAQ Sitting Question IPAQ Long Form

The IPAQ sitting question is an additional indicator variable and is not included as part of any summary score of physical activity. To-date there are few data on sedentary (sitting) behaviours and no well-accepted thresholds for data presented as categorical levels. For the sitting question 'Minutes' is used as the indicator to reflect time spent in sitting rather than MET-minutes which would suggest an estimate of energy expenditure.

IPAQ long assesses an estimate of sitting on a typical weekday, weekend day and time spent sitting during travel (see transport domain questions).

### Summary sitting variables include

Sitting Total Minutes/week = weekday sitting minutes\* 5 weekdays + weekend day sitting minutes\* 2 weekend days

Average Sitting Total Minutes/day = (weekday sitting minutes\* 5 weekdays + weekend day sitting minutes\* 2 weekend days) / 7

**Note:** The above calculation of 'Sitting Total' excludes time spent sitting during travel because the introduction in IPAQ long directs the responder to NOT include this component as it would have already been captured under the Transport section. If a summary sitting variable including time

spent sitting for transport is required, it should be calculated by adding the time reported (travelling in a motor vehicle) under transport to the above formula. Care should be taken in reporting these alternate data to clearly distinguish the 'total sitting' variable from a 'total sitting – including transport' variable.

## 7. Data Processing Rules

In addition to a standardized approach to computing categorical and continuous measures of physical activity, it is necessary to undertake standard methods for the cleaning and treatment of IPAQ datasets. The use of different approaches and rules would introduce variability and reduce the comparability of data.

There are no established rules for data cleaning and processing on physical activity. Thus, to allow more accurate comparisons across studies IPAQ Research Committee has established and recommends the following guidelines:

### 7.1 Data Cleaning

- I. Any responses to duration (time) provided in the hours and minutes response option should be converted from hours and minutes into minutes.
- II. To ensure that responses in 'minutes' were not entered in the 'hours' column by mistake during self-completion or during data entry process, values of '15', '30', '45', '60' and '90' in the 'hours' column should be converted to '15', '30', '45', '60' and '90' minutes, respectively, in the minutes column.
- III. In some cases duration (time) will be reported as weekly (not daily) e.g., VWHRS, VWMINS. These data should be converted into an average daily time by dividing by 7.
- IV. If 'don't know' or 'refused' or data are missing for time or days then that case is removed from analysis.

**Note:** Both the number of days *and* daily time are required for the creation of categorical and continuous summary variables

### 7.2 Maximum Values for Excluding Outliers

This rule is to exclude data which are unreasonably high; these data are to be considered outliers and thus are excluded from analysis. All cases in which the sum total of all Walking, Moderate and Vigorous time variables is greater than 960 minutes (16 hours) should be excluded from the analysis. This assumes that on average an individual of 8 hours per day is spent sleeping.

The 'days' variables can take the range 0-7 days, or 8, 9 (don't know or refused); values greater than 9 should not be allowed and those cases excluded from analysis.

### **7.3 Minimum Values for Duration of Activity**

Only values of 10 or more minutes of activity should be included in the calculation of summary scores. The rationale being that the scientific evidence indicates that episodes or bouts of at least 10 minutes are required to achieve health benefits. Responses of less than 10 minutes [and their associated days] should be re-coded to 'zero'.

### **7.4 Truncation of Data Rules**

This rule attempts to normalize the distribution of levels of activity which are usually skewed in national or large population data sets.

In IPAQ short - it is recommended that all Walking, Moderate and Vigorous time variables exceeding '3 hours' or '180 minutes' are truncated (that is re-coded) to be equal to '180 minutes' in a new variable. This rule permits a maximum of 21 hours of activity in a week to be reported for each category (3 hours \* 7 days).

In IPAQ long – the truncation process is more complicated, but to be consistent with the approach for IPAQ short requires that the variables total Walking, total Moderate-intensity and total Vigorous-intensity activity are calculated and then, for each of these summed behaviours, the total value should be truncated to 3 hours (180 minutes).

When analysing the data as categorical variable or presenting median and interquartile ranges of the MET-minute scores, the application of the truncation rule will not affect the results. This rule does have the important effect of preventing misclassification in the 'high' category. For example, an individual who reports walking for 10 minutes on 6 days and 12 hours of moderate activity on one day could be coded as 'high' because this pattern meets the '7 day' and "3000 MET-min" criteria for 'high'. However, this uncommon pattern of activity is unlikely to yield the health benefits that the 'high' category is intended to represent.

Although using median is recommended due to the skewed distribution of scores,

if IPAQ data are analysed and presented as a continuous variable using mean values, the application of the truncation rule will produce slightly lower mean values than would otherwise be obtained.

## 7.5 Calculating MET-minute/week Scores

Data processing rules 7.2, 7.3, and 7.4 deals first with excluding outlier data, then secondly, with recoding minimum values and then finally dealing with high values. These rules will ensure that highly active people remain classified as 'high', while decreasing the chances that less active individuals are misclassified and coded as 'high'.

Using the resulting variables, convert time and days to MET-minute/week scores [see above Sections 5.2 and 6.2; METS x days x daily time].

## 7.6 Calculating Total Days for Presenting Categorical Data on Moderate and High Levels

Presenting IPAQ data using categorical variables requires the total number of 'days' on which all physical activity was undertaken to be assessed. This is difficult because frequency in 'days' is asked separately for walking, moderate-intensity and vigorous-intensity activities, thus allowing the total number of 'days' to range from a minimum of 0 to a maximum of 21 'days' per week in IPAQ short and higher in IPAQ long. The IPAQ instrument does not record if different types of activity are undertaken on the same day.

In calculating 'moderately active', the primary requirement is to identify those individuals who undertake activity on at least '5 days'/week [see Sections 4.2 and 5.3]. Individuals who meet this criterion should be coded in a new variable called "*at least five days*" and this variable should be used to identify those meeting criterion b) at least 30 minutes of moderate-intensity activity and/or walking; and those meeting criterion c) any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of 600 MET-minutes/week.

- Below are two examples showing this coding in practice: i) an individual who reports '2 days of moderate-intensity' and '3 days of walking' should be coded as a value indicating "*at least five days*";
- ii) an individual reporting '2 days of vigorous-intensity', '2 days of moderate-intensity' and '2 days of walking' should be coded as a value to indicate "*at least five days*" [even though the actual total is 6].

The original frequency of 'days' for each type of activity should remain in the data file for use in the other calculations.

The same approach as described above is used to calculate total days for computing the 'high' category. The primary requirement according to the stated criteria is to identify those individuals who undertake a combination of walking, moderate-intensity and or vigorous-intensity activity on at least 7 days/week [See section 4.2]. Individuals who meet this criterion should be coded as a value in a new variable to reflect "*at least 7 days*".

- Below are two examples showing this coding in practice: i) an individual who reports '4 days of moderate-intensity' and '3 days of walking' should be coded as the new variable "*at least 7 days*".
- ii) an individual reporting '3 days of vigorous-intensity', '3 days moderate-intensity' and '3 days walking' should be coded as "*at least 7 days*" [even though the total adds to 9] .

## 8. Summary algorithms

The algorithms in Appendix 1 and Appendix 2 to this document show how these rules work in an analysis plan, to develop the categories 1 [Low], 2 [Moderate], and 3 [High] levels of activity.

IPAQ Research Committee  
November 2005

## APPENDIX 1

### At A Glance IPAQ Scoring Protocol (Short Forms)

#### Continuous Score

Expressed as MET-min per week: MET level x minutes of activity/day x days per week

*Sample Calculation*

**MET levels**

**MET-minutes/week for 30 min/day,**

### 5 days

Walking = 3.3 METs  $3.3 \times 30 \times 5 = 495$  MET-minutes/week  
Moderate Intensity = 4.0 METs  $4.0 \times 30 \times 5 = 600$  MET-minutes/week  
Vigorous Intensity = 8.0 METs  $8.0 \times 30 \times 5 = 1,200$  MET-minutes/week

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TOTAL = 2,295 MET-minutes/week

Total MET-minutes/week = Walk (METs\*min\*days) + Mod (METs\*min\*days)  
+ Vig (METs\*min\*days)

### Categorical Score- three levels of physical activity are proposed

#### 1. Low

No activity is reported **OR**  
Some activity is reported but not enough to meet Categories 2 or 3.

#### 2. Moderate

Either of the following 3 criteria  
3 or more days of vigorous activity of at least 20 minutes per day **OR**  
5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day **OR**  
5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-minutes/week.

#### 3. High

Any one of the following 2 criteria  
Vigorous-intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week **OR**  
7 or more days of any combination of walking, moderate- or vigorous-intensity activities accumulating at least 3000 MET-minutes/week

Please review the full document “Guidelines for the data processing and analysis of the International Physical Activity Questionnaire” for more detailed description of IPAQ analysis and recommendations for data cleaning and processing [[www.ipaq.ki.se](http://www.ipaq.ki.se)].



## APPENDIX 2

### At A Glance IPAQ Scoring Protocol (Long Forms)

#### Continuous Score

Expressed as MET-minutes per week: MET level x minutes of activity/day x days per week

#### Sample Calculation

#### MET levels MET-minutes/week for 30 min/day, 5 days

Walking at work= 3.3 METs  $3.3 \times 30 \times 5 = 495$  MET-minutes/week  
Cycling for transportation= 6.0 METs  $6.0 \times 30 \times 5 = 900$  MET-minutes/week  
Moderate yard work= 4.0 METs  $4.0 \times 30 \times 5 = 600$  MET-minutes/week  
Vigorous intensity in leisure= 8.0 METs  $8.0 \times 30 \times 5 = 1,200$  MET-minutes/week

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TOTAL = 3,195 MET-minutes/week

Domain Sub Scores Total MET-minutes/week at **work** = Walk (METs\*min\*days) + Mod (METs\*min\*days) + Vig (METs\*min\*days) at work

Total MET-minutes/week for **transportation** = Walk (METs\*min\*days) + Cycle (METs\*min\*days) for transportation

Total MET-minutes/week from **domestic and garden** = Vig (METs\*min\*days) yard work + Mod (METs\*min\*days) yard work + Mod (METs\*min\*days) inside chores

Total MET-minutes/week in **leisure-time** = Walk (METs\*min\*days) + Mod (METs\*min\*days) + Vig (METs\*min\*days) in leisure-time

#### Walking, Moderate-Intensity and Vigorous-Intensity Sub Scores

Total **Walking** MET-minutes/week = Walk MET-minutes/week (at Work + for Transport + in Leisure)

Total **Moderate** MET-minutes/week = Cycle MET-minutes/week for Transport + Mod MET-minutes/week (Work + Yard chores + Inside chores + Leisure) + Vigorous Yard chores MET-minutes

**Note:** The above is a total moderate activities only score. If you require a total of all moderate-intensity physical activities you would sum Total Walking and Total Moderate

Total **Vigorous** MET-minutes/week = Vig MET-minutes/week (at Work + in Leisure)

Total Physical Activity Score **Total** Physical Activity MET-minutes/week = **Walking** MET-minutes/week + **Moderate** MET-minutes/week + Total **Vigorous** MET-minutes/week

Continued.....

**Also**

**Total** Physical Activity MET-minutes/week = Total MET-minutes/week (at Work + for Transport + in Chores + in Leisure)

### **Categorical Score- three levels of physical activity are proposed**

#### **1. Low**

No activity is reported **OR**

- a. Some activity is reported but not enough to meet Categories 2 or 3.

#### **2. Moderate**

Either of the following 3 criteria

- a. 3 or more days of vigorous-intensity activity of at least 20 minutes per day **OR**
- b. 5 or more days of moderate-intensity activity and/or walking of at least 30 minutes per day **OR**
- c. 5 or more days of any combination of walking, moderate-intensity or vigorous-intensity activities achieving a minimum of at least 600 MET-min/week.

#### **3. High**

Any one of the following 2 criteria

Vigorous-intensity activity on at least 3 days and accumulating at least 1500 MET-minutes/week **OR**

7 or more days of any combination of walking, moderate- or vigorous- intensity activities accumulating at least 3000 MET-minutes/week

**Please review the full document “Guidelines for the data processing and analysis of the International Physical Activity Questionnaire” for more detailed description of IPAQ analysis and recommendations for data cleaning and processing [www.ipaq.ki.se].**

## VITA

Tracy Swibas was born on July 2<sup>nd</sup>, 1982 in Denver, Colorado. On that same day just 5 minutes later, her twin sister Carie was born. Tracy grew up in Golden and Lakewood Colorado and currently resides in Lakewood, Colorado. At the age of 6 she began her soccer career. She played for The Rush soccer club and won 3 National titles during this time. She attended Kyffin Elementary school, Bear Creek middle school and graduated from Bear Creek High School in 2000. Continuing her soccer career, she was awarded a soccer scholarship to the University of Tennessee, Knoxville where she played for 4 years. She graduated from the University of Tennessee with a Bachelor of Science degree in psychology and sociology in 2005. She ended her soccer career as an undergraduate and gave back to the sport through coaching and training younger athletes. Tracy went on to obtain her Masters of Science degree from the University of Tennessee in exercise physiology. While Tracy was a master's student she served as a research assistant, collaborating with professors and students from the exercise science department as well as the nutrition department on the 'Life in Motion' freshman study.