The influence of growth on body composition, physical activity, and fitness in overweight and obese children

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The influence of growth on body composition, physical activity, and fitness in overweight and obese children

by

Jennifer D. Smith

A thesis submitted to the graduate faculty
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Kinesiology
(Behavioral Basis of Physical Activity)

Program of Study Committee:
Katherine T. Thomas, Major Professor
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Iowa State University
Ames, Iowa
2009

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ABSTRACT

Twenty-seven pairs of children matched on age, gender and ethnicity, ages 5-to-9 years were recruited from a sample of 115 children. One child in each pair was overweight (at or above the 85th percentile for BMI) and one was normal weight (between 20th and 70th percentile for BMI) at the beginning of the study. Anthropometric measurements (waist, hip, upper arm and calf circumference; femur and humerus breadth; triceps, calf, suprailiac, etc. skinfolds; stature and mass), percent fat (Bod Pod); physical fitness (Fitnessgram and submaximal cycle ergometer) and physical activity (self-report) were measured at baseline and nine months later at the end point of the study to track growth, fitness and physical activity across time. Fifty-three of the participants completed the study. Six (20%) of the overweight participants were no longer overweight at the end of the study (e.g., above 85th percentile for BMI); no normal weight participants reached the 85th percentile during the study time. All of the overweight participants with significant changes in BMI percentile were at or below the 90th percentile.

Group comparisons (overweight and normal weight) based on BMI produced large differences in mass, lean body mass, waist circumference, femur & humerus breadth, percent fatness, and subcutaneous fat. On variables that are important measures of growth both groups increased significantly in stature, mass, lean body mass, humerus breadth, and subcutaneous fat. Thus, the growth measures not associated with fatness followed the same pattern in overweight and normal weight groups. For measures of fatness, both groups regressed toward the mean over time. Somatotype revealed that overweight participants were more mesomorphic (increased muscle and bone) as well as
endomorph (increased fat) when compared to normal weight participants. Mesomorphy increased over time and endomorphy decreased, and the trend was for all participants to shift toward a balanced somatotype.

Using percent body fat (estimated from Bod Pod) to group participants into normal (below 20 and 30% for males and females respectively) and overweight (at or above 20 and 30% body fat) produced different classifications than those created using BMI in 35% of the participants and agreement with BMI in 65% of the sample. Percent body fat changed in 13.5% of the participants from baseline to endpoint, with 5 no longer too fat and 2 becoming too fat. Fewer participants were classified as overweight using percent fat than BMI.

Considering the participants where BMI and percent fat agreed (n=34), differences between the normal weight and obese groups were identified for Pacer laps (moderate effect size) and push-ups (large effect size) with small or no differences for curl-ups, self-reported physical activity, k joules (work), and heart rate. The obese participants were equally fit based on total work output, exercise heart rate, and curl-ups at baseline and endpoint. The overweight group did not complete as many push-ups, had an 80-83% of participants in the healthy zone for Pacer while the number of laps was fewer on average, reported similar amounts of organized physical activity and generally lost the ground over time when compared with the normal weight group. These findings were generally consistent when comparing the entire sample (n=53).

Based on BMI groups overweight and normal weight children demonstrated the similar growth patterns across time (7 months) with the exception of mass. Body fat groupings suggested that BMI may misclassify some participants who have greater lean body mass
and are mesomorphic. Running tests result in more difference between overweight and normal weight participants than cycle ergometer exercise tests. Overweight and normal weight children are more alike than different for growth and physical activity parameters.
INTRODUCTION

The prevalence of obesity in children, ages 6-11 years, has risen from 6.5% to 17% in two decades (USDHHS, 2001). Particularly troubling is the finding that children who are overweight tend to remain overweight (Thompson, Obarzanek, Franko, Barton, Morrison, Biro, et al., 2007). The amount of physical activity, from sedentary to physically active, influences weight and fat because energy expenditure is half of the energy balance equation (Dietz, 2004). Further, physical inactivity is an independent health risk (United States Department of Health and Human Services, 2001). Physical fitness has been identified as a positive outcome of a physically active lifestyle. Unfortunately, children and adolescents are increasingly sedentary (Thomas, Lee, & Thomas, 2003). Childhood obesity has been associated with increased risk for disease (Wang & Dietz, 2002). Growth is a complicating factor in childhood obesity, because children typically undergo alternating periods of steady and rapid growth (Malina, 1984). Thus, understanding both physical activity and growth in overweight children is an important problem to address.

Normal growth in children includes the acquisition of lean body mass (muscle, bone and organ growth) and absolute fat. Physical activity has a positive influence on several growth parameters, including stature, lean body mass, bone density, skeletal breadths and relative fatness (Malina, 1984). Bones typically grow in length, then breadth and density, then length and so forth, producing a cyclical profile of increasing and decreasing linearity. Girls and boys follow similar growth patterns prior to puberty. Although both genders gain lean body mass, boys tend to have more fat-free mass than girls. On average, girls exceed boys in both relative and absolute fat during childhood
growth. The differences between girls and boys are not great until adolescence and the onset of sexual maturation (Malina, 1984).

Accelerated growth and development due to increased fatness during childhood has caused overweight/obese children to exhibit advanced bone age and led to early sexual maturation (Frisch & Revelle, 1971). The relationship between fatness and early maturation is still controversial because the direction of causation has not been determined. Evidence from the Newton Girls Study suggested that weight status prior to menarche was influential on the start of sexual maturation. Not only is the theory of advanced bone age a possible explanatory factory but the possibility of increased leptin levels affecting the development of the reproductive system may also be related to obesity and early maturation (Must, Naumova, Phillips, Blum, Dawson-Hughes, & Rand, 2005). What remains unknown is the influence of physical activity and fitness in overweight, growing children.

Body mass index (BMI) has been used for screening and population monitoring of obesity. However, BMI does not separate fat from lean and may overestimate obesity in individuals with significant lean body mass (Sardinha, Going, Teixeira & Lohman, 1999). BMI increases during infancy, childhood and adolescence so BMI percentile for age and gender has been used to determine whether or not an individual child was overweight, underweight or healthy weight (CDC, 2008). BMI has been useful in public health, particularly with adults, and more practical than using a two component (lean and fat) measurement to assess obesity. Body fat above 20 and 30% for males and females, respectively, has been used to determine healthy versus too fat (e.g., obese), with fat
assessed through skinfolds in adults, hydrostatic weighing and other methods (Morrow, Jackson, Disch, & Mood, 2005).

Energy balance is the key factor in body composition (Dietz, 2004). When the calories consumed match the calories expended body weight and fat are stable. To reduce fat and weight, one must expend more calories than consumed, generally by a combination of increasing physical activity and decreasing caloric intake. Clearly, most obesity is a result of energy imbalance where more activity could reduce excess fat (Dietz, 2004). However, growth during childhood and adolescence also demands energy and has the potential for a positive influence on body composition, specifically body mass index and relative fat.

Physical activity and physical fitness are different by definition but related, and both are important factors influencing growth and development of children. Physical fitness is an outcome of a physically active lifestyle. Physical fitness is a specific set of performance markers related to important aspects of health including cardio-respiratory endurance (aerobic capacity), flexibility, body composition, muscular endurance, and muscular strength. Fitness is evaluated with field and laboratory tests. FITNESSGRAM, the Presidential Physical Fitness Test, and the AAHPERD Youth Fitness Test have been developed to assess the fitness of children (Morrow, Jackson, Disch, & Mood, 2002). Some fitness batteries include a body composition component. Too much fat or weight produces a poor score on that component. This suggests that an individual who is too fat can not be physically fit. Sub-maximal exercise testing is conducted in the lab setting with the use of cycle ergometry or a treadmill to evaluate aerobic capacity.
Physical activity is associated with loss of adipose tissue (Welk & Blair, 2000). Research has shown that children that participate in regular physical activity are more likely to be fit and have less body fat (Ara, Vicente-Rodriguez, Jimenez-Ramirez, Dorado, Serrano-Sanchez, & Calbet, 2004). Adiposity, fitness, and obesity have been deemed important when evaluating health risks in adults and children (Lee, Blair, & Jackson, 1999; Sallis, McKenzie, & Alcaraz, 1993; Christou, Gentile, DeSouza, Seals, & Gates, 2005).

Statement of the Problem and Hypotheses

It is unknown whether overweight and/or obese children follow the same growth pattern as a normal weight child in the acquisition of stature, lean body mass, absolute fat, and relative fat. Further, there are no longitudinal data on the fitness or physical activity of overweight and obese children. Both physical activity/fitness and obesity are important factors to understand because of the relationship among these and the impact of these on health. Unfortunately, the population datum on children suggests that, once overweight or overly fat, children tend to remain overweight or overly fat (Wang, Ge, & Popkin, 2003). Physical activity during childhood is associated with increased lean body mass. What is unknown is whether or how much of overweight or obesity can be “outgrown”, how physical activity moderates the growth of lean body mass in overweight children, and whether overweight children follow the same growth pattern as normal weight children. The purpose of this study is to address those three questions.

The working hypothesis was that overweight children follow the same growth pattern as normal weight children. Further, overweight/obese children that were physically active would acquire lean body mass and relative fat would decrease. Non-active overweight
and obese children would increase fat, both absolute and relative, along with modest gains in lean body mass. Finally, active/fit children were more likely to outgrow overweight than inactive/unfit children. A third hypothesis was developed further into the study when discrepancies between BMI and percent body fat percentage became evident. Body mass index (BMI) and percent body fat will not have complete agreement when group placements are compared between separate measures. BMI will categorize more children as overweight as it does not utilize body composition.
METHOD

Participants

A sample of children ranging from five-to-nine years of age from central Iowa was recruited to form gender- and age-matched pairs, in which one was overweight based on BMI and the other was normal-weight. Participants were recruited with flyers and word-of-mouth. Contact with most of the children originated from an elementary school, a home-school physical education program, or an after-school program at Iowa State University. Potential participants were screened for BMI during phone interviews. For those meeting the criteria, an initial meeting was scheduled to measure stature and mass in the laboratory. The CDC BMI calculator was used to determine BMI percentile from the direct measurement of stature and mass. Ideally, children placed into the healthy-weight categorization would be close to the 50th percentile, with a goal of all normal-weight participants being between the 40th and 60th percentile. Due to difficulty with recruitment, the percentile range was extended from the 20th to 60th percentile. Overweight was defined as being between the 85th and the 99th percentile at baseline.

BMI Z-scores from the CDC study population were used to calculate power for the study. Growth based on BMI change was approximated for a six-month period for both male and female children. Effect sizes of 0.8 were calculated for both genders at several ages with the target age range. With power of .8 and alpha at 0.05, 25 participants per group were deemed necessary. An equal number of boys and girls was a goal; twenty-two females (11 pairs) and thirty-two males (16 pairs) entered the study. The two groups were similar for stature (es=-0.19) and different for mass (es=-1.76) at
the beginning of the study. Measurements were taken at two times during the study. Baseline measurements were taken immediately after recruitment and end line measurements were taken 5-7 months following baseline.

Parental consent and child assent was obtained prior to the beginning of the study. Age-appropriate instructions were designed and delivered to each child. The study was approved by the Institutional Review Board at Iowa State University. Participants were encouraged to wear clothing appropriate for physical activity and anthropometric measurements and a swimsuit for measurement of body fat.

Subjects were compensated for their participation at the conclusion of both the baseline and the end line measurements. Each child was provided with gift cards to businesses in Central Iowa. Gift cards were provided for the local movie theater, book store, and bowling alley. Each child was entitled to a free semester of an after-school physical activity program at Iowa State University.

Instrumentation

Physique (somatotype), body mass index (BMI), body composition (body fat), physical activity (recall) and physical fitness (Fitnessgram and cycle ergometer) were assessed using methods outlined in the following sections.

Anthropometric Measurements

Anthropometric measurements were taken on each child. Stature and mass were measured to calculate the BMI. All anthropometric measurements (e.g., stature, mass, circumferences, breadths, and skinfolds) were completed using the methods in The Anthropometric Standardization Guide (Lohman, Roche, & Martorell, 1988). Circumferences included waist, hip, calf and upper arm. Waist and hip circumferences
were repeated three times to ensure measurement reliability. A waist-to-hip ratio was calculated from these measurements.

**Body Composition Measurements**

The measurement of BMI was done with clothing on and no shoes. Children participated in the study while wearing athletic apparel. Height, weight, birth date, and date of measurement were entered into a BMI calculator provided by the Centers for Disease Control and Prevention (CDC). Results provided each child’s BMI and BMI percentile. The same information was used to determine a BMI z-score.

Skinfold measurement was taken at five skinfold sites using Lange calipers as outlined by Lohman et al. (1988). The calipers were calibrated, using the calibration stone prior to measuring a participant and immediately after to ensure accuracy. Measurements were taken at the following skinfold sites: triceps, subscapular, suprailiac, abdominal, and medial calf. Measurement was repeated three times at each site to ensure reliability.

Air-displacement plethysmography was conducted using the 2000A model of the BOD POD, which utilizes 2.0 software. Children wore swim suits for this measurement. Swimsuits could not contain any metal. If male swim trunks were too long and bulky, smaller athletic shorts were worn to prevent errors due to excess clothing. Earrings, hair clips, jewelry, etc. were removed prior to measurement. Each child wore a swim cap into the chamber as hair needed to be contained and compressed to the scalp. Each participant was allowed to investigate and sit in the chamber prior to measurement so that he or she could become familiar with the equipment. The BOD POD was referred to as a
spaceship or egg so each child understood that he or she would sit inside it for a period of
time.

Prior to measurement, the BOD POD was calibrated. Age and height were
entered into the software program. A scale was attached to the system and mass was
measured twice to ensure reliability. Each child had to be measured by the BOD POD at
least twice; many children were measured three times. Measurement was repeated a third
time if children were unable to remain still while sitting in the chamber. Each
measurement lasted about 30 seconds. Thoracic volume was estimated by the BOD POD
software as the children were unable to complete the actual measurement of thoracic
volume.

Somatotype Measurement

Somatotype was determined using the method outlined by Heath and Carter
(Johnson & Nelson, 1967). Bone breadth was measured using the method outlined in
Lohman et al (1988). Calipers were used to measure the humerus and femur breadths.
Stature, mass, skinfolds, bone breadths, age, birth date, and circumferences were entered
into a somatotype calculator developed by Sweat Technologies. The program provided
values for each of the three somatotype components; endomorphy, ectomorphy, and
mesomorphy. The two somatotypes with the largest values provided the child’s
somatotype identity. If one somatotype value prevailed over the remaining two, the child
was only labeled with a singular identity.

Physical Activity Measurement

Activity levels were measured using the retrospective method of Cote (Cote,
Baker, & Abernathy 2001). The parent and/or guardian and child reflected on the
frequency of physical activity over two separate periods of time that spanned a year in length. Specifically, activity was recalled from August 2006 through August 2008. Parents and children recalled participation in specific, structured physical activities each month, as well as the frequency of those activities per week. During baseline measurements, families recalled activity from August 2006 until August 2007. At end line measurements, families recalled activity from August 2007 until August 2008. The instrument was determined to be valid and reliable (Cote, Ericsson, & Law, 2005). Validity was established by correlation of parent to child reports. All correlations were significant at all ages from 5 – 30 years. Participants were consistent with parents when reporting time in deliberate practice, deliberate play, and organized play. Reliability was .99, .70, and .88 respectively.

**Physical Fitness Measurement**

The field test of physical fitness was the FITNESSGRAM test battery. Specific subtests were the PACER, the curl-up, and push-up. Directions were provided verbally on a compact disc to ensure that all participants would receive identical instructions. The compact disc also provided a cadence for the sit-up and push-up subtests. Cues and beeps were provided during the PACER test so that students would know when to run and rest. Detailed instructions and test protocol are provided in a separate reference (Meredith & Welk, 2005). The FITNESSGRAM software was used to assign zones to each performance.

The Physical Work Capacity 170 (PWC 170), a submaximal cycle ergometer test, was also used to assess cardiovascular fitness. The PWC 170 uses a multi-stage cycle ergometry procedure to predict work capacity at a heart rate of 170 beats per minute.
Children were fitted with Polar heart rate monitors prior to starting the test. Children were encouraged to rest prior to the test to ensure the starting pulse would be representative of a non-exercising heart rate. Children were allowed to practice pedaling the cycle ergometer while listening to a cadence of 60 rpm with no tension on the cycle ergometer. A stopwatch was used to accurately record heart rates each minute and increase tension appropriately every two minutes. Participants were frequently asked about comfort levels and heart rate was verbally reported every minute. When the child reached a heart rate of 165 bpm, the test was ended. The child then pedaled at a lower tension to cool down the body and return heart rate to a pre-exercise state.

Procedures

Children were recruited for the overweight/obese group. A screening BMI was obtained from direct measurement. Age and gender matches in the healthy weight category were recruited and paired with those in the overweight/obese group. Prior to laboratory testing and measurement, research procedures were explained to each child and a parent/guardian. The directions were simple, age-appropriate and ensured that each test was described in a consistent manner to all participants. Before initial measurements, all parties were informed of the goals, benefits, and possible risks associated with participation. Written informed consent was acquired from the parent or guardian. Written informed assent was acquired from the participating child. Instructions about proper clothing and footwear were given and the reimbursement procedures explained. Paperwork was disseminated for mileage and payment for participation. Payment was received after the participant attended baseline measurement.
appointments and once again at end line measurement. Mileage costs were reimbursed at the conclusion of each session.

Stature and mass were measured in the laboratory while the children were wearing athletic apparel and no shoes. Participants attended two separate appointments within the same week during the baseline measurement portion of the study. One appointment was devoted to laboratory testing; the other to field-testing. Each participant attended two separate appointments five to seven months after the start of the study, to repeat the final laboratory and field measurements. The measurement order, laboratory versus field, was counter-balanced across pairs of participants. Laboratory testing included the PWC-170 cycle ergometer test, skin fold measurements, bone breadths, and body circumferences. Field testing included fitness testing and physical activity recall. Height and weight were measured at the first measurement appointment, which could have taken place in the laboratory or field setting. Participants were prepared to use the BOD POD at both appointments in the event datum could not be retrieved successfully at the first appointment.
DESIGN AND ANALYSIS

The study was a longitudinal descriptive study with matched pairs of participants based on body mass index (BMI) in a 2 by 2 design (group by time) with repeated measures on the second factor. Participants were re-organized into groups based on percent body fat at baseline, regardless of the recruitment BMI category.

To test the first hypothesis, that overweight children follow the same growth pattern as normal weight children, a 2 by 2 (time by group) Manova was computed with seven dependent variables (stature, mass, lean body mass, waist circumference, femur and humerus breadths, and subcutaneous fat). Alpha was set at 0.05, effect sizes were calculated for significant main effects and interactions.

To test the second hypothesis, that obese children that were physically active would acquire lean body mass and relative fat would decrease while non-active overweight and obese children would increase fat, both absolute and relative, along with modest gains in lean body mass, five independent t-tests were computed. Groups were formed based on obese participants who lost body fat or gained body fat during the study. The dependent variables were kjoules, push-ups, physical activity, Pacer and heart rate.

To test the third hypothesis, body mass index (BMI) and percent body fat will not have complete agreement when group placements are compared between separate measures, consistency of classification was calculated and agreement reported.
RESULTS

While participants were recruited and initially categorized based on BMI status, the groups formed for analyses were based on percent body fat. Body fat at and below 20 and 30 percent for males and females respectively were considered normal-weight, while percentages above these were considered obese. Eighty-seven percent (45 of 53) of participants had the same weight status from baseline to end point. Descriptive data for the two weight groups by gender at baseline and endpoint are presented in Table 1. The remaining eight participants were not used in these analyses because their weight status changed. One male and one female increased body fat percentage during the seven months of the study and thus went from the normal-weight group to the obese group. Five males and one female decreased in percentage of body fat, thus changing their status from the obese group to the normal-weight group.

Hypothesis One.

To address the question, do obese children follow the same growth pattern as children of normal weight, a repeated-measures MANOVA with group (weight category) and time (growth) as independent variables and stature, mass, lean body mass (LBM), waist circumference, sum of skinfolds, and femur and humerus breadth as dependent variables was completed. The dependent variables used in this analysis were deemed normally distributed after examining the skewness, kurtosis and Q-Q plots within each group (e.g., normal-weight and overweight. The multivariate tests produced three significant results for group \( F(7,37) = 11.89, p = .0001 \), time \( F(7,37) = 56.25, p = .0001 \) and the group by time interaction \( F(7,37) = 4.63, p = .001 \). The interaction of growth
(baseline and endpoint) and group (overweight and normal weight) was the effect of primary interest to answer the question.

After a Bonferroni correction (.05/7), alpha was set at .007 for the follow-up tests. The univariate ANOVAs produced one significant interaction for mass \( F(1,43)=28.77, p=.0001 \) (see Figure 1). The remaining interactions were not significant. The normal-weight group gained 6% mass over the seven months, while the overweight group gained over 10% during the same time. During this time, the percent of fat for the overweight group was stable (effect size=0.06) and the normal-weight group registered a moderate loss (effect size=-0.54).

Significant within-subjects effects were found for increases in stature \( F(1,43)=48.2, p=.0001 \), mass \( F(1,43)=135.2, p=.0001 \), lean body mass \( F(1,43)=51.79, p=.0001 \), femur breadth \( F(1,43)=139.0, p=.0001 \) and humerus breadth \( F(1,43)=125.9, p=.0001 \). These results were consistent with growth expectations for children in this age range (Table 2). Waist circumference and subcutaneous fat (sum of skinfolds) did not change significantly during this time period. Based on the confidence intervals, waist circumference was both not significant and was declared the same because the baseline and end point confidence interval completely overlapped. Subcutaneous fat (sum of skinfolds) and percent fat were not different nor did these meet the criteria to be declared the same.

The between-subjects tests produced six significant effects indicating differences between the two groups; mass \( F(1,43)=26.34, p=.0001 \), waist circumference \( F(1,43)=38.17, p=.0001 \), subcutaneous fat \( F(1,43)=68.03, p=.0001 \), lean body mass \( F(1,43)=9.45, p=.004 \), femur breadth \( F(1,43)=16.75, p=.0001 \), and humerus breadth
were significant (Table 2), and stature [$F(1,43)=6.9$, $p=.012$] was not significant. The obese group was larger on both lean (lean body mass, femur and humerus breadth) and fat (mass, subcutaneous fat and waist circumference) measures. The average effect size for three lean measures was 1.5 as compared to 4.8 for the three fat measures.

The five male participants who changed weight status had body fat percentages between 21-and-24% at baseline and displayed an average loss of 5% body fat at the end point. At baseline, the mean stature and lean body mass were no different (effect size of zero) from the normal males. Humerus breadth and mass were moderately greater at baseline from the normal boys (effect sizes of 0.5 and 0.6). A small difference was noted (es.=0.2) for femur breadth. Those five males had less mass (es=0.61), and moderately less stature, humerus and femur breadths and lean body mass (mean es=0.36) when compared to the overweight males at baseline. The waist circumference (m=59.69, S.D=7.1) was closer to the normal males (m=56.8, s=3.5) than the obese males (m=68.4, s=12.9).

Hypothesis Two

In order to test the second hypothesis, physical activity was assessed to determine if overweight children that were physically active acquired lean body mass and relative fat decreased. Non-active overweight children would increase fat, both absolute and relative, along with modest gains in lean body mass. Self-reported recall of physical activity was more susceptible to error than direct measures of physical activity. An outcome of being physically active is physical fitness, so fitness and activity are generally related. Therefore, it was important to assess both the reliability of the self-reported data
and to determine whether physical activity recall was consistent with physical fitness. Further, field measures of physical fitness and laboratory measures should be related. In the case of overweight participants, a cycle ergometer test was more likely to reduce performance differences when compared to a running test. Thus, three methods of defining physical activity were used; self-reported physical activity recall, a field measure of physical fitness, and a laboratory measure of physical fitness.

Physical activity and fitness

Intraclass reliability (normal-weight R=0.73; overweight R=0.78) for minutes of physical activity was similar to the Fitnessgram data for PACER (R=0.67 & 0.80), curl-ups (R=0.75 & 0.83) and pushups (R=0.79 & 0.90). Data in this study for curl-ups and push-ups did not meet the assumption of normality. Fitnessgram provides performance categories including “healthy zone” for each component. Most participants (96% and 93%) were in the healthy zone for curl-ups at both baseline and endpoint and most were in the healthy zone for at least one of the components (Table 3). Approximately one third of the participants were in the healthy zone for all three measures of fitness.

Two measures from sub-maximal exercise were calculated based on the cycle ergometer test. First, total work in joules was calculated (workload in watts * 60) for each minute of exercise and, if necessary, watts for the partial last minute of exercise then summed across the entire test. This was converted to kJoules (joules/1000). Second, the heart rate for participants at workload 14.71 in minute 2 of exercise was identified. This timeframe and workload was selected because at baseline and endpoint this included the greatest number of participants. These data were determined to be normal based on skewness, kurtosis and stem-and-leaf plots. At baseline, some children did not complete
the cycle test because of equipment issues or because some younger children could not complete the test. At the end point, all but one participant completed the test. Therefore, baseline to end point comparisons had less power for this test than for other measurements. Thus, reliability was estimated using measures at the end point. The number of laps completed for PACER and the kJoules at the end point were modestly correlated at $r(30)=0.39$, $p=0.04$. Similarly, kJoules and heart rate for minute 2 at workload 14.71 were also correlated $r(31)=-0.64$, $p=0.0001$. The reliability of heart rate minute 2 (workload 14.71) comparing the two time points was $R=0.63$.

To test this hypothesis, the obese participants ($n=15$) were divided into two groups, those who gained fat ($n=7$) and those who lost fat ($n=8$) between baseline and endpoint. The gain group increased by an average of 6% body fat and the lost group by about 4% over time. None of the four independent $t$-tests were significant for PACER [$t(13)=1.49$, $p=0.16$], push-ups [$t(13)=2.30$, $p=0.04$], physical activity [$t(13)=-1.08$, $p=0.30$], heart rate [$t(13)=0.96$, $p=0.35$] and total work output in kJoules [$t(13)=-0.63$, $p=0.55$]. While not significant, exercise heart rate, total work output and physical activity were higher in the fat gain group, while PACER and push-ups were higher in the fat loss group.

Hypothesis Three

To test the hypothesis, body mass index (BMI) and percent body fat will not have complete agreement when group placements are compared between separate measures, participants were grouped by body mass index (BMI) percentile for age and gender into obese (at and above the 85th percentile) and normal-weight (below the 70th percentile) at baseline and the end point. These groupings were compared to the groups formed using
percentage of body fat. The two methods of classification, percentage of body fat and BMI percentile, agreed on 66% of the participants, while classifying 42% (n=22) as normal fat/weight and 23% as overweight and overly fat (n=12). These participants were in the same group at both the baseline and end point. The two methods of assessing weight status agreed on one additional participant, who began the study obese but ended in the normal-weight classification. The remaining third of the participants (n=17) were classified differently depending upon the measure used and the time period.

The two measures of body composition that were independent of BMI (e.g., did not use mass or stature) and percentage of fat were waist circumference and sum of skinfolds (Table 3). Means for the normal-weight group and a group formed from the participants where BMI and percentage of fat disagreed on status indicated that the disagree group was closer to the normal-weight group than to the obese group. The subcutaneous fat (sum of skinfolds) for the obese group did not overlap with either of the other groups at either point in time. For waist circumference, the obese group did not overlap with either group at the end point.
TABLES AND FIGURES

Figure 1. Group (overly fat and normal fat) by time (baseline and endpoint) interaction for mass (kg).
Table 1. Descriptive data for stature, mass, percent fat, lean body mass, BMI and BMI percentile at baseline and end point with groups that remained normal or obese based on percent body fat by gender.

<table>
<thead>
<tr>
<th>Normal Fat</th>
<th>Baseline</th>
<th>Overall</th>
<th>End point</th>
<th>Overall</th>
</tr>
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<tr>
<td></td>
<td>Male n=13</td>
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<td>Male n=13</td>
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<td>Age</td>
<td>7.6 1.1</td>
<td>7.2 1.2</td>
<td>7.4 1.1</td>
<td>136.8 12.2</td>
</tr>
<tr>
<td>Stature (cm)</td>
<td>130.5 11.2</td>
<td>125.4 8.1</td>
<td>127.6 9.7</td>
<td>136.8 12.2</td>
</tr>
<tr>
<td>Mass (kg)</td>
<td>25.7 5.0</td>
<td>24.0 3.9</td>
<td>24.7 4.5</td>
<td>27.0 5.5</td>
</tr>
<tr>
<td>Body Fat %</td>
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<td>20.4 4.5</td>
<td>17.6 5.4</td>
<td>10.5 4.0</td>
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<tr>
<td>Lean Body</td>
<td>22.0 4.0</td>
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<td>20.0 3.8</td>
<td>23.5 4.3</td>
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<td>BMI percentile</td>
<td>57 19</td>
<td>58 26</td>
<td>58 23</td>
<td>46 20</td>
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<table>
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<th>Male n=12</th>
<th>Female n=3</th>
<th>Overall n=15</th>
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<td>8.6 .53</td>
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<td>148.5 11.4</td>
<td>140.7 11.0</td>
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<tr>
<td>Stature (cm)</td>
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<td>144.8 10.1</td>
<td>136.4 10.9</td>
<td>138.7 10.4</td>
<td>148.5 11.4</td>
<td>140.7 11.0</td>
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<tr>
<td>Mass (kg)</td>
<td>35.8 11.9</td>
<td>53.3 22.1</td>
<td>39.3 15.3</td>
<td>39.3 12.7</td>
<td>59.0 22.8</td>
<td>43.3 16.4</td>
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<tr>
<td>Body Fat %</td>
<td>30.9 7.5</td>
<td>40.6 5.7</td>
<td>32.9 8.1</td>
<td>31.1 8.3</td>
<td>42.6 7.7</td>
<td>33.4 9.3</td>
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<tr>
<td>Lean Body</td>
<td>24.1 6.4</td>
<td>31.0 11.1</td>
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<td>26.3 6.3</td>
<td>33.9 14.7</td>
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<tr>
<td>Mass (kg)</td>
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<td>26.7 7.2</td>
<td>22.2 5.3</td>
<td>21.5 4.4</td>
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<td>97 3</td>
<td>92 10</td>
<td>90 13</td>
<td>98 2</td>
<td>91 12</td>
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Table 2. Descriptive data for significant within subjects effects (baseline and end points) for stature, mass, LBM, humerus breadth, and subcutaneous fat, and between subjects (body fat group effects; normal fat and overly fat) for mass, lean body mass (LBM), waist circumference, femur and humerus breadths, percent fat, and subcutaneous fat.

<table>
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<th>Dependent Variable</th>
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<th>Within Subjects Effects (time)</th>
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<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>Stature</td>
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<tr>
<td>Mass (kg)</td>
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<td>4.7</td>
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<tr>
<td>lbm (kg)</td>
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<td>3.9</td>
</tr>
<tr>
<td>Waist c (cm)</td>
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</tr>
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<td>Femur (cm)</td>
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<tr>
<td>Humerus (cm)</td>
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<td>0.4</td>
</tr>
<tr>
<td>Subcutaneous fat (mm)</td>
<td>39.3</td>
<td>12.3</td>
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Table 3. Percentage of participants within healthy zone for three Fitnessgram components (body fat group effects; normal fat and overly fat) and percentage of participants passing 0-3 fitness test components at baseline and end point.

<table>
<thead>
<tr>
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<th>Obese (n=20)</th>
<th>Overall (n=53)</th>
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</thead>
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<tr>
<td>Curl-ups</td>
<td>32 (97.0%)</td>
<td>19 (95.0%)</td>
<td>51 (96.2%)</td>
</tr>
<tr>
<td>Push-ups</td>
<td>23 (69.7%)</td>
<td>9 (45.0%)</td>
<td>32 (60.4%)</td>
</tr>
<tr>
<td>Pacer</td>
<td>15 (45.5%)</td>
<td>7 (35.0%)</td>
<td>22 (41.5%)</td>
</tr>
<tr>
<td>Pass 0</td>
<td>1 (3.0%)</td>
<td>0 (0%)</td>
<td>1 (1.9%)</td>
</tr>
<tr>
<td>Pass 1</td>
<td>7 (21.2%)</td>
<td>9 (45.0%)</td>
<td>16 (30.2%)</td>
</tr>
<tr>
<td>Pass 2</td>
<td>12 (36.4%)</td>
<td>7 (35.0%)</td>
<td>19 (35.8%)</td>
</tr>
<tr>
<td>Pass 3</td>
<td>13 (39.4%)</td>
<td>4 (20.0%)</td>
<td>17 (32.1%)</td>
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</table>

<table>
<thead>
<tr>
<th>End Point</th>
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<th>Fat (n=15)</th>
<th>Overall (n=45)</th>
</tr>
</thead>
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<tr>
<td>Curl-ups</td>
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<td>13 (86.7%)</td>
<td>42 (93.3%)</td>
</tr>
<tr>
<td>Push-ups</td>
<td>18 (60.0%)</td>
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<td>Pacer</td>
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<td>3 (20.0%)</td>
<td>21 (46.7%)</td>
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<tr>
<td>Pass 0</td>
<td>1 (3.3%)</td>
<td>1 (6.7%)</td>
<td>2 (4.4%)</td>
</tr>
<tr>
<td>Pass 1</td>
<td>7 (23.3%)</td>
<td>9 (60.0%)</td>
<td>16 (35.6%)</td>
</tr>
<tr>
<td>Pass 2</td>
<td>8 (26.7%)</td>
<td>4 (26.7%)</td>
<td>12 (26.7%)</td>
</tr>
<tr>
<td>Pass 3</td>
<td>14 (46.7%)</td>
<td>1 (6.7%)</td>
<td>15 (33.3%)</td>
</tr>
</tbody>
</table>

Healthy on all
DISCUSSION

The discussion focuses on three findings; the similarity in growth between weight groups and the potential for out-growing overweight based on body fat percent, (hypothesis 1); the unexpectedly small differences in physical activity parameters between obese and normal-weight participants (hypothesis 2) and the areas of agreement and disagreement between percentage of body fat and BMI (hypothesis 3). Of particular note was that only one participant dropped out of the study.

Growth patterns of obese children

Stature, bone breadths, and lean body mass are known to increase over time as a natural part of growth and maturation. The within-subjects effects were consistent with typical growth expectations, including increases in stature, mass, lean body mass, humerus breadth, and subcutaneous fat (Malina, 1986). The only variable that changed differently between normal-weight and overweight groups across time was mass, based on the significant interaction. This suggested that overweight children are more like children of normal weight than the groups are different in pattern of change. The groups were different in absolute terms for fat-related variables (e.g., waist circumference, percent body fat and subcutaneous fat) and other anthropometric measures (mass, lean body mass, femur and humerus breadth). Stature was not different among groups.

Bearing more weight is associated with greater bone breadths, so greater lean body mass and femur breadths could be a result of greater body mass (Malina, 1986). The reverse is also possible; that is, greater body mass has been related to larger bones. The groups were not statistically different for stature. However, the confidence intervals indicated that the groups were not the same. The large differences in stature might
suggest early maturation which has been associated with obesity (Frisch & Revelle, 1971). Alternatively, the large difference in stature could be due to familial influence, since stature is heritable (CDC, 2009). Thus, these data do not support an early maturation hypothesis.

Physical activity and fitness in overweight children

Generally, overweight/obese children were not less active than normal-weight children in this study. Unfortunately, both classifications of children may be less active than what has been recommended by health professionals and may fall short of physical activity recommendations. Sedentary patterns were not found within either group, so it may be incorrect to assume that one group’s inactivity had an impact on the findings within the study. In addition, overweight/obese children do not seem less fit than their normal-weight counterparts. Based on normative criterion (FITNESSGRAM), most children were in the “healthy zone” at both baseline and end point. Small effect sizes revealed physical activity and fitness may not be a strong contributing factor to overweight/obesity in this sample of children. The use of submaximal cycle ergometer testing also revealed no difference between groups for total work (Kjoules) and heart rate. Heart rate, which was lower in the obese children, may have been affected by growth and development as heart rate slows as children age and approach puberty (Nugent & Finley, 1990).

Agreement of percent fat and BMI

The two methods of weight classification produced a moderate agreement (66%). BMI may overestimate the number of participants that are overweight, especially those children close to the 85-90th percentile. Because BMI does not separate fat from lean
mass, those children with significant lean body mass may not have too much fat but may have higher BMI due to increased lean body mass. Thus, disagreement between the two different methods of classification may occur (Sardinha, Going, Teixeira & Lohman, 1999). Body fat presents challenges to accurate measurement but was consistent with other measures of fat (waist and skinfolds) in this study. For children with BMIs of 85-90 percentile, a second measure such as waist circumference or skinfolds has the potential to more accurately identify overly fat children than BMI alone.

Limitations

Recruitment for the study was not random due to the need for age- and gender-matched pairs that were categorized into groups based on BMI percentile (20-60th percentile for normal-weight; 85th and above percentile for overweight/obese). The use of self-report for physical activity recall was susceptible to error. In addition, only structured physical activity was recalled in the self-report of physical activity. Free play and non-structured physical activity was not included since the period of recall was long in duration (the previous one year at baseline and end point). The use of doubly labeled water or accelerometers may be useful in future research to more accurately track the activity patterns in a study of this nature. Sub-maximal testing on the cycle ergometer was difficult for the youngest children in the study and prevented several participants from completing the test at baseline data collection.
REFERENCES


REVIEW OF LITERATURE

Physical Activity

Physical activity is assumed to cause greater lean body mass and less fat in young and adult populations (Welk & Blair, 2000). Physical activity may also lead to fitness, which is associated with additional lean body mass. Normal growth in children includes the acquisition of lean body mass and fat. However, no data are available describing the growth of overweight children. It is known that physical activity has a positive influence on several growth parameters, including stature, lean body mass, bone density, skeletal breadths and relative fatness (Malina, 1984). What remains unknown is the influence of physical activity and fitness on these parameters in overweight, growing children.

Growth and Maturation

Childhood represents a period of growth, maturation, and development. Growth is the increase in size, either of the body as a whole or its parts (Malina, 1984). Normal growth includes changes in body composition, height, and weight. Growth occurs in phases that span from infancy to adulthood. Rapid gains are made during early childhood and growth is steady during middle childhood (Malina, 1984). Body weight is broken down into two separate components, lean body mass and fat mass. Lean body mass (LBM) refers to the weight of all lean tissues including bone, muscle, and organs. Fat mass is all fat tissues, including subcutaneous, visceral, and other fats such as cholesterol (Broekoff, 1985). Girls and boys follow similar growth patterns prior to puberty. Although both genders gain lean body mass, however, boys tend to have more fat-free mass than girls. On average, girls exceed boys in both relative and absolute fat during
childhood growth. The differences between girls and boys are not great until adolescence approaches (Malina, 1984).

**Physical Fitness**

Physical activity and physical fitness are related but not the same, each has a unique definition. Physical activity is a broad term that refers to a continuum that ranges from sedentary behavior to being active on a daily basis. A physically active individual may choose to play tennis twice a week or walk on a regular basis; a physically active person accumulates 30 minutes of activity most days of the week (Pate, Pratt, Blair, Haskell, Macera, Bouchard, et al., 1995). An inactive person chooses to participate in no or minimal activity and is considered sedentary. Exercise is physical activity with the intention to improve health and well-being. Physical fitness requires one to adopt a physically active lifestyle to a higher level. Physical fitness is an outcome of a physically active lifestyle. Physical activity that ranges from moderate to vigorous intensities may improve children’s cardiovascular fitness (Ruiz, Rizzo, Hurtig-Wennlof, Ortega, Warnberg, & Sjostrom, 2006).

Although controversial, fitness has been demonstrated to be as important as obesity when evaluating health risks in adults and children (Lee, Blair, & Jackson, 1999; Sallis, McKenzie, & Alcaraz, 1993). Other studies indicate that adiposity better predicts cardiovascular health risks (Christou, Gentile, DeSouza, Seals, & Gates, 2005). Both fatness and aerobic fitness have also deemed important in regards to cardiovascular health risks (Katzmarzyk, Gagnon, Leon, Skinner, Wilmore, Rao, & Bouchard, 2001). However, this is unexplored in children except as fitness tests have predetermined an overweight child to be unfit. Fitness is measured and evaluated by testing several field
and laboratory tests are available to assess the current fitness level of children. FITNESSGRAM, the Presidential Physical Fitness Test, and the AAHPERD Youth Fitness Test have been developed to assess the fitness of children (Morrow, Jackson, Disch, & Mood, 2002). These testing batteries measure fitness in the following areas: aerobic capacity, body composition, muscular strength, muscular endurance, and flexibility.

Laboratory exercise tests have also been designed for young populations. Aerobic exercise testing and the measurement of oxygen consumption are two laboratory tests that have been adjusted for children, usually to a submaximal setting, to evaluate fitness at the physiological level (Rowland, 1993). When considering body composition, physical activity is associated with loss of adipose tissue (Welk & Blair, 2000). Assuming that physical activity leads to fitness, fitness would also be associated with lean body mass, rather than fat mass. When investigating the relationship of physical fitness and the incidence of overweight in school children, researchers found an inverse relationship between the prevalence of overweight and the number of fitness tests passed girls (Kim, Must, Fitzmaurice, Gillman, Chomitz, Kramer, et al., 2005). A moderately high percentage of boys, 62%, did not pass any of the fitness tests were overweight compared to the small percentage, 5%, that passed all the tests. A similar relationship was observed with girls in the study. The association of regular exercise, physical fitness, and body fat was studied specifically in prepubertal boys. Boys that participated at least 3 times per week in physical activity had higher levels of physical fitness had lower body fat in several regions on the body in comparison to the non-active group of participants (Ara, Vicente-Rodriguez, Jimenez-Ramirez, Dorado, Serrano-Sanchez, & Calbet, 2004).
Physical Activity

Physical activity is a predictor of health risk. Regular physical activity is recommended for all that intend on living a long, healthy life. The influence of exercise and/or physical activity on body composition has been studied in adults. Energy balance is the key factor in adult body composition (Dietz, 2004). When the calories consumed match the calories expended body weight and fat are stable. To reduce fat and weight, adults must expend more calories than consumed, generally by a combination of increasing physical activity and decreasing caloric intake. Clearly, most obesity is a result of energy imbalance where more activity could reduce excess fat (Dietz, 2004). In addition to energy intake and expenditure, a third factor—growth—may influence obesity because children are still growing and maturing, while adults have reached maximum stature and sexual maturation.

Children who are overweight and sedentary are at increased health risk, unlikely to change and likely to increase in obesity because they are inactive and therefore have difficulty achieving negative energy balance. Overweight children need to incorporate physical activity into their life, in order to combat the consequences of excess adiposity. The problems associated with overweight often follow the child into adolescence and into adulthood. Overweight children have a 10-fold greater risk of being overweight in early adulthood than children of normal weight (Thompson, et al., 2007). The effect of exercise on growing children is an area of interest to many health professionals. In adults, the weight loss caused by exercise is associated with the maintenance or preservation of lean body mass, in comparison to losses of fat-free mass in hypocaloric dieting (Despres, 1994). Weight loss caused by caloric restriction is typically not
recommended for children because children are growing and need to gain lean body mass (Schwingshandl & Borkenstein, 1995). Loss of lean body mass by hypocaloric dieting is problematic in growing children. Lean body mass is greater in children who are physically active, likely resulting from exercise and physical exertion.

Many studies have investigated the effect of exercise on body composition and fitness in overweight and obese children. An improvement in body composition and cardiovascular fitness resulted from a 5 day-a-week regimen in children that were categorized as overweight or obese. The exercise intervention was associated with a decrease in total fat mass and also promoted the growth of fat-free mass in the children (Owens, Gutin, Allison, Riggs, Ferguson, Litaker, et al., 1999). When an increase of recreational activity is added to the lifestyle of children, a relative decline in BMI occurred in girls and overweight boys. Activities such as aerobics/dance, walking, and strength training elicited different BMI fluctuations in girls and boys. Since BMI was used as a measure, it is impossible to determine what components of body weight were actually altered in the children (Berkey, Rockett, Gillman, & Colditz, 2003).

When a physical training program is implemented in a specific obese population, body composition changes favorably. African American girls participating in a 5-day per week, 10-week intervention were placed in an exercise program or a lifestyle program that involved no physical activity. The exercise intervention did not include an altered diet to prevent the loss of lean body mass. The girls in the exercise program showed significant decreases in body fat, as well as increases in fat-free mass (Gutin, Cucuzzo, Islam, Smith, Moffatt, & Pargman, 1995). An overweight or obese child responds well to exercise, but returning to a sedentary lifestyle may reverse the positive body composition
changes that have taken place. As a group of obese children participated in a four-month period of training, increases in bone density and fat-free mass were observed, as well as a decline in body fat and fat mass. However, when the children were removed from the exercise program, substantial gains in body fat occurred (Gutin, Owens, Okuyama, Riggs, Ferguson, & Litaker, 1999).

Exercise itself can have an impact on the body fatness of children. Increases in lean body mass or maintenance of fat-free mass may contribute to the short-term and long-term state of body composition in children struggling with overweight and obesity. Many studies have indicated that vigorous exercise produces favorable effects on cardiovascular fitness, percent body fat, bone density, visceral adiposity, and some risk factors for cardiovascular disease and diabetes (Gutin, Barbeau, & Yin, 2004). When weight reduction programs cause decreases in lean body mass, the effects on body composition in the future may be negative. Children that lose the most lean body mass have the largest gains in weight, months after the weight-reduction intervention (Schwingshandl & Borkenstein, 1995). Clearly, exercise interventions should not focus on the reduction of body fat alone; preservation of lean body mass must also be taken into consideration.

**Overweight and Obesity**

The Centers for Disease Control and Prevention classify children/adolescents as underweight, healthy weight, overweight and obese (Centers for Disease Control and Prevention, 2008). Anthropometric and body composition measures are used for young populations to determine an individual’s status relative to healthy weight, overweight or obesity. Concern exists about the appropriateness and accuracy of body composition
measures for children. Measures such as body mass index (BMI) and hydrodensitometry may be appropriate for adult populations but validity is threatened when these are applied to young populations (Pietrobelli, Faith, Allison, Gallagher, Chiumello, & Heymsfield, 1998). Body Mass Index has been used as a surrogate for body fat and as a criterion for overweight and obesity. In average infants and children, body mass index increases from birth to the first birthday, decreases slightly until age 6 years then increases steadily through childhood until after puberty (Lobstein, Baur & Uauy, 2004). Body mass index has been used to estimate fatness in children, identifying childhood obesity as a BMI for age and gender equal to or above the 95th percentile.

Body mass index is scrutinized because greater values are assumed to indicate greater body fatness. The measure has been correlated with percent body fat and is predictive of fat in large population studies. However, BMI is not a direct measure of fatness because BMI includes both the lean and fat components of body weight. The variability of fat-free mass in children can influence BMI, causing underestimates of overweight and obesity (Wells, Coward, Cole, & Davies, 2002). Another particular problem is overestimation in individuals with high lean body mass (Sardinha, Going, Teixeira & Lohman, 1999). A rising BMI value may not be indicative of the development of overweight or obesity in children, because it could represent estimation error or increased lean body mass. Increased lean body mass is an outcome of physical activity, heredity, or a combination of both. Although the use of BMI has been encouraged as an approximate classification of obesity, BMI alone cannot accurately predict total body fat or percent body fat in children. Since adipose tissue growth and
distribution vary with age and sex, adult interpretations of BMI cannot be applied to children without age and sex adjustments (Pietrobelli, et al., 1998).

Growth charts were developed by the Centers for Disease Control and Prevention (CDC) to take age and sex into consideration because body fat changes with age and differs between girls and boys. The charts convert BMI into a percentile. When a child falls at or above the 95th percentile, he or she is considered to be obese. Placement at the 85th to less than the 95th percentile is overweight categorization. With the use of BMI, the adjusted growth charts, and additional measures or criteria, health professionals can identify the development of overweight or obesity in children (Mei, Grummer-Strawn, Pietrobelli, Goulding, Goran, & Dietz, 2002). Other experts in the field have called for the identification of BMI cutoff points throughout childhood and adolescence, allowing for adult overweight and obesity to be predicted and mortality risks reduced. However, the use of growth charts and the concept of cutoff points are difficult to apply to all children due to the influence of ethnicity, gender and age (Dietz & Robinson, 1998).

Obesity and overweight is at epidemic proportions in adult population of the United States and other developed countries. As the percentage of body fatness increases in these adult populations, a similar trend is developing in children and adolescents. The influence of exercise and/or physical activity on lowering body fatness has been studied in adults. Fewer studies have examined fat loss in children and most have focused on body weight. No studies have documented the influence of growth on obesity in children. Nor have studies examined physical fitness and obesity during growth. Hypothetically, a growing child could move from obesity to normal weight as a result of growth with no changes in diet or increases in physical activity. For example, an obese
child with a BMI percentile in the overweight category could grow 6 cm in a year while maintaining weight. In this example, normal growth would reduce BMI and the BMI percentile would place the child in the “normal” category. Similarly, during normal growth lean body mass increases more rapidly than fat, suggesting that overly fat children could benefit from decreases in relative fat.
REFERENCES FOR REVIEW OF LITERATURE


APPENDIX A: BODY MASS INDEX (BMI) RELATED TABLES AND FIGURES

Table 1. Baseline demographic information for groups created by body mass index (BMI) classification. Overweight/obese and normal weight determined when participant is classified into the 85th or greater percentile or below the 70th percentile respectively.

<table>
<thead>
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</tr>
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<tbody>
<tr>
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<tr>
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<td>7.4637</td>
<td>1.255</td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td>49.3984</td>
<td>4.2311</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td></td>
<td>55.3819</td>
<td>11.2398</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
<td>15.8187</td>
<td>0.7204</td>
</tr>
<tr>
<td>BMI Percentile</td>
<td></td>
<td>51.1250</td>
<td>16.8479</td>
</tr>
<tr>
<td>BMI zscore</td>
<td></td>
<td>0.0313</td>
<td>0.4644</td>
</tr>
<tr>
<td>Overweight/Obese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>16</td>
<td>7.4469</td>
<td>1.1472</td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td>50.0703</td>
<td>4.6301</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td></td>
<td>75.2488</td>
<td>24.6557</td>
</tr>
<tr>
<td>BMI</td>
<td></td>
<td>20.6813</td>
<td>3.7682</td>
</tr>
<tr>
<td>BMI Percentile</td>
<td></td>
<td>93.3125</td>
<td>4.6003</td>
</tr>
<tr>
<td>BMI zscore</td>
<td></td>
<td>1.7813</td>
<td>0.7064</td>
</tr>
</tbody>
</table>
Table 2. End line demographic information for groups created by body mass index (BMI) classification. Overweight/obese and normal weight determined when participant is classified into the 85<sup>th</sup> or greater percentile or below the 70<sup>th</sup> percentile respectively.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>Normal Weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>19</td>
<td>8.0579</td>
<td>1.2438</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>51.006</td>
<td>4.5024</td>
<td>49.232</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>59.557</td>
<td>13.529</td>
<td>55.356</td>
</tr>
<tr>
<td>BMI</td>
<td>15.878</td>
<td>1.0597</td>
<td>16.092</td>
</tr>
<tr>
<td>BMI Percentile</td>
<td>47.947</td>
<td>20.323</td>
<td>51.214</td>
</tr>
<tr>
<td>BMI zscore</td>
<td>-0.0263</td>
<td>0.6765</td>
<td>0.2143</td>
</tr>
<tr>
<td>Overweight/Obese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>13</td>
<td>8.1000</td>
<td>1.1380</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>51.750</td>
<td>4.5506</td>
<td>51.607</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>85.170</td>
<td>27.206</td>
<td>91.200</td>
</tr>
<tr>
<td>BMI</td>
<td>21.807</td>
<td>3.7071</td>
<td>22.800</td>
</tr>
<tr>
<td>BMI Percentile</td>
<td>95.000</td>
<td>3.8944</td>
<td>93.714</td>
</tr>
<tr>
<td>BMI zscore</td>
<td>2.0000</td>
<td>0.7360</td>
<td>1.5714</td>
</tr>
</tbody>
</table>
Table 3. Baseline demographic information for groups created by body fat percentage calculated by BOD POD measurement. Overweight/obese classification determined when males and females have 20% or greater and 30% or greater body fat percentage respectively.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td>Normal Weight</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>14</td>
<td>7.6586</td>
<td>1.0578</td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td>49.4554</td>
<td>4.0755</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td></td>
<td>56.3700</td>
<td>10.6771</td>
</tr>
<tr>
<td>Lean Body Mass (lbs)</td>
<td></td>
<td>48.2132</td>
<td>8.5803</td>
</tr>
<tr>
<td>Overweight/Obese</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>17</td>
<td>7.4053</td>
<td>1.1830</td>
</tr>
<tr>
<td>Height (cm)</td>
<td></td>
<td>50.5000</td>
<td>4.2112</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td></td>
<td>74.0459</td>
<td>24.6671</td>
</tr>
<tr>
<td>Body Fat %</td>
<td></td>
<td>28.4471</td>
<td>7.4374</td>
</tr>
<tr>
<td>Lean Body Mass (lbs)</td>
<td></td>
<td>51.7845</td>
<td>13.6853</td>
</tr>
</tbody>
</table>
Table 4. End line demographic information for groups created by body fat percentage calculated by BOD POD measurement. Overweight/obese classification determined when males and females have 20% or greater and 30% or greater body fat percentage respectively.

<table>
<thead>
<tr>
<th></th>
<th>Male</th>
<th>Female</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>Mean</td>
<td>S.D.</td>
</tr>
<tr>
<td><strong>Normal Weight</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>19</td>
<td>7.9779</td>
<td>1.2300</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>50.5068</td>
<td>4.8068</td>
<td>48.6875</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>60.1047</td>
<td>13.7449</td>
<td>55.2281</td>
</tr>
<tr>
<td>Body Fat %</td>
<td>12.4158</td>
<td>4.6781</td>
<td>17.8000</td>
</tr>
<tr>
<td>Lean Body Mass (lbs)</td>
<td>52.2976</td>
<td>10.3444</td>
<td>45.2586</td>
</tr>
<tr>
<td><strong>Overweight/Obese</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>13</td>
<td>8.2169</td>
<td>1.1448</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>52.4808</td>
<td>3.7825</td>
<td>54.3000</td>
</tr>
<tr>
<td>Weight (lbs)</td>
<td>84.3715</td>
<td>27.8308</td>
<td>105.9480</td>
</tr>
<tr>
<td>Body Fat %</td>
<td>30.3769</td>
<td>8.3801</td>
<td>36.3800</td>
</tr>
<tr>
<td>Lean Body Mass (lbs)</td>
<td>57.0316</td>
<td>13.7158</td>
<td>65.3313</td>
</tr>
</tbody>
</table>
Table 5. Children that switched groups when classification is based on percent body fat (Bod Pod) and overweight is above 20% and 30% fat for males and females respectively.

<table>
<thead>
<tr>
<th>Code</th>
<th>Sex</th>
<th>age</th>
<th>Pre body fat</th>
<th>Post body fat</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>DH04</td>
<td>M</td>
<td>6.45</td>
<td>22</td>
<td>11.7</td>
<td>10.3</td>
</tr>
<tr>
<td>AM04</td>
<td>M</td>
<td>6.58</td>
<td>22.6</td>
<td>18.9</td>
<td>3.7</td>
</tr>
<tr>
<td>SH09</td>
<td>M</td>
<td>9.78</td>
<td>22.8</td>
<td>19.5</td>
<td>3.3</td>
</tr>
<tr>
<td>CC20</td>
<td>M</td>
<td>8.25</td>
<td>21</td>
<td>19.1</td>
<td>1.9</td>
</tr>
<tr>
<td>NN21</td>
<td>M</td>
<td>7.57</td>
<td>23.9</td>
<td>16.9</td>
<td>7</td>
</tr>
<tr>
<td>TH05</td>
<td>M</td>
<td>8.89</td>
<td>19.1</td>
<td>21.7</td>
<td>(-2.6)</td>
</tr>
<tr>
<td>Mean males</td>
<td></td>
<td></td>
<td>7.92</td>
<td>21.9</td>
<td>17.96667</td>
</tr>
<tr>
<td>AK12</td>
<td>F</td>
<td>6.52</td>
<td>28.7</td>
<td>33.6</td>
<td>(-4.9)</td>
</tr>
<tr>
<td>CA23</td>
<td>F</td>
<td>9.41</td>
<td>19.3</td>
<td>20.4</td>
<td>(-1.1)</td>
</tr>
<tr>
<td>Mean Females</td>
<td></td>
<td></td>
<td>7.965</td>
<td>24</td>
<td>27</td>
</tr>
<tr>
<td>Overall mean</td>
<td></td>
<td></td>
<td>7.93125</td>
<td>22.425</td>
<td>20.225</td>
</tr>
</tbody>
</table>
Table 6. Descriptive statistics for percent body fat calculated by Bod Pod at baseline for participants classified as normal weight (less than 20 & 30% fat for males and females respectively) and overweight (above 20 and 30% fat) at both baseline and endline.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean percent</th>
<th>SD</th>
<th>Lower boundary of CI</th>
<th>Upper boundary of CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal weight (n=34)</td>
<td>18.28</td>
<td>5.81</td>
<td>16.23</td>
<td>20.35</td>
</tr>
<tr>
<td>Overweight (n=19)</td>
<td>30.28</td>
<td>8.37</td>
<td>26.36</td>
<td>34.19</td>
</tr>
<tr>
<td>All participant (n=53)</td>
<td>22.81</td>
<td>8.99</td>
<td>20.33</td>
<td>25.29</td>
</tr>
</tbody>
</table>
Table 7. Descriptive statistics for percent body fat calculated by Bod Pod at end line for participants classified as normal weight (less than 20 & 30% fat for males and females respectively) and overweight (above 20 and 30% fat) at both pre and post test, and participants whose classification changed based on percent body fat between pre and post test.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean percent</th>
<th>SD</th>
<th>Lower boundary of CI</th>
<th>Upper boundary of CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal weight (n=31)</td>
<td>14.71</td>
<td>5.96</td>
<td>12.52</td>
<td>16.896</td>
</tr>
<tr>
<td>Overweight to normal weight (n=5)</td>
<td>17.22</td>
<td>3.25</td>
<td>13.19</td>
<td>21.25</td>
</tr>
<tr>
<td>Normal weight to overweight (n=3)</td>
<td>25.23</td>
<td>7.27</td>
<td>7.16</td>
<td>43.31</td>
</tr>
<tr>
<td>Overweight (n=14)</td>
<td>34.26</td>
<td>8.96</td>
<td>29.09</td>
<td>39.44</td>
</tr>
<tr>
<td>All participant (n=53)</td>
<td>20.71</td>
<td>10.8</td>
<td>17.73</td>
<td>23.69</td>
</tr>
</tbody>
</table>
Table 8. Confidence intervals at baseline and endpoint for BMI percentiles using three weight categories, normal weight, overweight at both points and change (overweight at baseline but not at end point).

<table>
<thead>
<tr>
<th></th>
<th>Normal weight</th>
<th>Change</th>
<th>Overweight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>40.7621-53.8305</td>
<td>86.2329-89.1005</td>
<td>90.6608-94.3021</td>
</tr>
<tr>
<td>End point</td>
<td>36.1091-51.7427</td>
<td>63.4560-83.8773</td>
<td>92.5791-96.5209</td>
</tr>
</tbody>
</table>
Table 9. Descriptive statistics for BMI z score, BMI and BMI percentile by overweight and normal weight groups based on BMI percentile where normal weight is from 40th to 60th percentile and overweight is the 85th and above percentile.

<table>
<thead>
<tr>
<th>time</th>
<th>preclass</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre</td>
<td>normal weight</td>
<td>27</td>
<td>-0.1296</td>
<td>0.5476</td>
<td>-0.3463</td>
<td>0.0870</td>
</tr>
<tr>
<td></td>
<td>percentile</td>
<td>27</td>
<td>47.2963</td>
<td>16.5176</td>
<td>40.7621</td>
<td>53.8305</td>
</tr>
<tr>
<td></td>
<td>bmi</td>
<td>27</td>
<td>15.5963</td>
<td>0.7648</td>
<td>15.2937</td>
<td>15.8989</td>
</tr>
<tr>
<td></td>
<td>Valid N (listwise)</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>over weight</td>
<td>27</td>
<td>1.7037</td>
<td>0.7240</td>
<td>1.4173</td>
<td>1.9901</td>
</tr>
<tr>
<td></td>
<td>percentile</td>
<td>27</td>
<td>92.4815</td>
<td>4.6024</td>
<td>90.6608</td>
<td>94.3021</td>
</tr>
<tr>
<td></td>
<td>bmi</td>
<td>27</td>
<td>20.5556</td>
<td>4.3345</td>
<td>18.8409</td>
<td>22.2702</td>
</tr>
<tr>
<td></td>
<td>Valid N (listwise)</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>post</td>
<td>normal weight</td>
<td>27</td>
<td>-0.0926</td>
<td>0.6799</td>
<td>-0.3615</td>
<td>0.1764</td>
</tr>
<tr>
<td></td>
<td>percentile</td>
<td>27</td>
<td>43.9259</td>
<td>19.7600</td>
<td>36.1091</td>
<td>51.7427</td>
</tr>
<tr>
<td></td>
<td>bmi</td>
<td>27</td>
<td>15.6667</td>
<td>1.0050</td>
<td>15.2691</td>
<td>16.0642</td>
</tr>
<tr>
<td></td>
<td>Valid N (listwise)</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>over weight</td>
<td>20</td>
<td>1.8500</td>
<td>1.0650</td>
<td>1.3516</td>
<td>2.3484</td>
</tr>
<tr>
<td></td>
<td>percentile</td>
<td>20</td>
<td>94.5500</td>
<td>4.2112</td>
<td>92.5791</td>
<td>96.5209</td>
</tr>
<tr>
<td></td>
<td>bmi</td>
<td>20</td>
<td>22.1550</td>
<td>4.6586</td>
<td>19.9747</td>
<td>24.3353</td>
</tr>
<tr>
<td></td>
<td>Valid N (listwise)</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>changed to normal</td>
<td>6</td>
<td>0.8333</td>
<td>0.2582</td>
<td>0.5624</td>
<td>1.1043</td>
</tr>
<tr>
<td></td>
<td>percentile</td>
<td>6</td>
<td>73.6667</td>
<td>9.7297</td>
<td>63.4560</td>
<td>83.8773</td>
</tr>
<tr>
<td></td>
<td>bmi</td>
<td>6</td>
<td>17.3333</td>
<td>0.9893</td>
<td>16.2952</td>
<td>18.3715</td>
</tr>
<tr>
<td></td>
<td>Valid N (listwise)</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 10. Mean and percent of participants in overweight, normal weight and change group at or above numeric indicators (selected based on approximately 50% of a group being above or below that point) for components of somatotype at baseline and the end point.

<table>
<thead>
<tr>
<th></th>
<th>Baseline m</th>
<th>End point m</th>
<th>Numeric indicator</th>
<th>Baseline percent</th>
<th>End point percent</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Endomorph</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (n=27)</td>
<td>2.2</td>
<td>3.5</td>
<td>LT= 4.5</td>
<td>100%</td>
<td>78%</td>
</tr>
<tr>
<td>Change (n=5.5)</td>
<td>2.6</td>
<td>2.8</td>
<td>LT=4.5</td>
<td>100%</td>
<td>86%</td>
</tr>
<tr>
<td>Overweight (n=21)</td>
<td>5.0</td>
<td>3.2</td>
<td>LT=4.5</td>
<td>48%</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Mesomorph</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (n=27)</td>
<td>3.6</td>
<td>4.5</td>
<td>LT=3.6</td>
<td>48%</td>
<td>19%</td>
</tr>
<tr>
<td>Change (n=5.5)</td>
<td>4.5</td>
<td>4.5</td>
<td>LT=3.6</td>
<td>0%</td>
<td>20%</td>
</tr>
<tr>
<td>Overweight (n=21)</td>
<td>5.2</td>
<td>4.6</td>
<td>LT=3.6</td>
<td>5%</td>
<td>20%</td>
</tr>
<tr>
<td><strong>Ectomorph</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal (n=27)</td>
<td>2.9</td>
<td>2.2</td>
<td>GT=2.9</td>
<td>50%</td>
<td>60%</td>
</tr>
<tr>
<td>Change (n=5.5)</td>
<td>1.0</td>
<td>2.1</td>
<td>GT=2.9</td>
<td>0%</td>
<td>60%</td>
</tr>
<tr>
<td>Overweight (n=21)</td>
<td>.88</td>
<td>2.1</td>
<td>GT=2.9</td>
<td>5%</td>
<td>62%</td>
</tr>
</tbody>
</table>

1 N=6 at baseline and 5 at end point
Table 11. Pre-tests (baseline) descriptive statistics for percent body fat based on Bod Pod.

<table>
<thead>
<tr>
<th>Group</th>
<th>Average body fat</th>
<th>SD</th>
<th>Minimum</th>
<th>Maximum</th>
<th>N</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal weight</td>
<td>18.54</td>
<td>5.9</td>
<td>4.7</td>
<td>28.8</td>
<td>34</td>
<td>16.48</td>
<td>20.59</td>
</tr>
<tr>
<td>Males (below 20%)</td>
<td>14.26</td>
<td>4.33</td>
<td>4.7</td>
<td>19.30</td>
<td>14</td>
<td>11.77</td>
<td>16.76</td>
</tr>
<tr>
<td>Females (below 30%)</td>
<td>21.25</td>
<td>4.96</td>
<td>14.10</td>
<td>28.8</td>
<td>19</td>
<td>18.86</td>
<td>23.64</td>
</tr>
<tr>
<td>Overweight</td>
<td>30.46</td>
<td>8.55</td>
<td>21</td>
<td>47</td>
<td>19</td>
<td>26.34</td>
<td>34.58</td>
</tr>
<tr>
<td>Males (above 20%)</td>
<td>28.45</td>
<td>7.44</td>
<td>21</td>
<td>47</td>
<td>17</td>
<td>24.62</td>
<td>32.27</td>
</tr>
<tr>
<td>Females (above 30%)</td>
<td>40.63</td>
<td>5.74</td>
<td>34</td>
<td>44</td>
<td>3</td>
<td>26.36</td>
<td>54.90</td>
</tr>
</tbody>
</table>
APPENDIX B: BODY MASS INDEX (BMI) RELATED TEXT

From the baseline to end point of the study the body mass index (BMI) percentile for age and gender dropped below the 85th percentile for 22% (n=6) of the overweight participants. All six had BMI percentiles of 85-90 at baseline. However, at the end of the study these participants were no longer classified as overweight. Six other participants with BMI percentiles of 85-90 at baseline remained in the same BMI percentile category (overweight/obese) at the end point. None of the normal weight participants changed categories as determined by BMI percentile. At the end point two were above the 70th percentile, the cut-off used for recruiting normal weight participants in this study. The six participants originally in the overweight group but no longer meeting the CDC criteria for overweight based on BMI percentile were placed in a new group (named “change”) for some analyses. The goal of the change group was to identify factors related to the positive change. Two of the change group were below the 70th percentile for BMI and three others at or below the 80th percentile by the end point (see Appendix Table 1 for descriptive data on these participants). Data describing the participants by BMI group and gender at baseline and end point are presented in Table 1.

Hypothesis 1.

To address the question, do overweight and obese children follow the same growth pattern as children of normal weight, a MANOVA repeated measures with group (weight category) and time (growth) as independent measures and mass, stature, circumference of the hips and waist, percent body fat, sum of skinfolds, femur and humerus breadth, and lean body mass as dependent variables was completed. The
dependent variables used in this analysis were deemed normally distributed after examining the skewness, kurtosis and Q-Q plots within each group (e.g., normal weight, overweight and change). Further, interclass correlation was used to assure reliability of these variables resulting in eight R > .94 and one R = .85. The multivariate tests produced three significant results for between subjects [F(16,84)=4.89, p = .0001], within subjects [F(8,42)=31.38, p = .0001] and the interaction for group by time [F(16,84)=2.27, p = .008]. The interaction of growth (baseline and endpoint) and group (overweight, normal weight and change from overweight) was the effect of primary interest to answer the question.

After Bonferroni (.05/8) alpha was set at .006 for remaining tests. The ANOVA follow-up test produced one significant interaction for mass [F(2,49)=17.09, p = .0001] (see Figure 2), the remaining interactions were not significant. The overweight group in absolute weight gained twice what the normal or change groups gained during the seven months of the study. The effect size describing differences between the normal and overweight groups at the base line was 2.1 and at the end point was 2.4. As a percent of their initial mass the overweight group gained 9.4%, the normal weight group gained 5.7% and the change group gained 4.4% (Table 2). The overweight group was heavier at the beginning and gained more weight than either of the other groups. The normal and change groups demonstrated similar patterns of weight gain across time.

Significant within subjects effects were found for increases in mass [F(1,49)=76.69, p = .0001], stature [F(1,49)=55.15, p = .0001], lean body mass [F(1,49)=44.53, p = .0001], femur breadth [F(1,49)=83.53, p = .0001] and humerus breadth [F(1,49)=86.90, p = .0001]. These results were consistent with growth expectations for children in this age range (Table 2). Waist circumference, subcutaneous fat (sum of
skinfolds) and percent fat did not change significantly during this time period. Based on the confidence intervals waist circumference was both not significant and the same because the baseline confidence interval completely encompasses the confidence interval for the end point. Subcutaneous fat (sum of skinfolds) and percent fat were not different nor did these meet the criteria to be declared the same.

The between subjects tests produced seven significant effects indicating differences between the three groups; mass \[F(2,49)=11.19, p=.0001\], waist circumference \[F(2,49)=13.56, p=.0001\], subcutaneous fat \[F(2,49)=21.54, p=.0001\], lean body mass \[F(2,49)=5.58, p=.007\], percent body fat \[F(2,49)=17.63, p=.0001\], femur breadth \[F(2,49)=6.26, p=.0001\], and humerus breadth \[F(2,49)=8.00, p=.0001\] (Table 2). Using Schefee’ follow-up tests, two patterns emerged for the group comparisons. For mass, waist circumference, lean body mass and femur breadth the overweight and normal weight groups were different from each other but neither group was different from the change group. Subcutaneous fat (sum of skinfolds), percent fat and humerus breadth produced differences between the overweight group and both other groups which were not different from each other. Stature did not produce a statistically significant difference among the groups (effect sizes .19-.21), however the groups do not meet the criteria to be declared the same either based on 95% confidence intervals.

To further understand the impact of growth on overweight a regression with mass at the end point of the study as the dependent variable and waist circumference, percent fat, subcutaneous fat, lean body mass, femur breadth and humerus breadth at the beginning of the study as predictors was completed. The analysis produced three significant models, accounting for 92-98% of the variance. The first model used one
predictor, waist circumference. Little was gained by adding percent fat or lean body mass both of which are more difficult and expensive to measure. Sum of skinfolds, humerus and femur were not significant predictors in any of the models.

Waist circumference increased over time for 56% of participants. There was considerable overlap among groups for waist circumference at baseline (NW minimum 48 maximum 62; OW minimum 52 maximum 108; change minimum 52 maximum 70) and end point (NW minimum 54 maximum 65; OW minimum 55 maximum 96; change minimum 52 maximum 70). Twenty-five of the normal weight group had waist circumferences below 60 cm at baseline and 15 of the overweight group were at or above that point. Thus, waist circumference would have classified 74% of the participants into the same category at baseline as BMI percentile. Eight of twelve of those with BMI percentiles at baseline from 85-90 had waist circumferences below 60 cm, however four each were from the change group and overweight group.

Somatotype

Physique has been used to assess muscle, fat and linearity using somatotype rating scales. The Health Carter Somatotype scale was used to assess somatotype for all participants at baseline and end point. Generally overweight has been associated with endomorphy when the excess weight came from excess fat and with mesomorphy when the excess weight came from muscle and bone. A somatotype of 7-1-1 represented classic endomorphy and 1-7-1 classic mesomorphy. There were no classic profiles at either point in time, consistent with most people having balanced somatotypes. Exemplar profiles from these participants indicated tendency, for example 1-5-0, 1-2-4 presenting tendency toward mesomorphy and ectomorphy respectively. At baseline the normal
weight group was balanced with tendency to meso-ecto (average ratings of 2-4-3) while the overweight group was meso-endo (average ratings of 5-5-1). By the end point the normal weight group were balanced with meso-endo (average ratings of 4-5-2) tendency and the overweight group were balanced with meso-endo (average ratings of 3-5-2) tendency (Table 3). From baseline to the endpoint 63% of the normal weight participants registered a decrease in ectomorphy, 85% increased mesomorphy and 63% increased endomorphy. For the overweight participants 78% increased in the ectomorphy component, and over half decreased in endomorphy (63%) and mesomorphy (56%). These data suggest that most participants demonstrated a change in physique, although much of the change was small and groups regressed toward the mean across time.

Percent body fat

A secondary question related to this hypothesis was whether children changed weight classification over time (e.g., those in the change group) or were misclassified by BMI initially. BMI has been criticized because fat and lean mass are not separated, as in other methods of assessing weight status such as percent body fat. To address this issue, percent body fat as measured using air displacement plethysmography in the Bod Pod was used to form groups. Most participants had data on both the Bod Pod and BMI. One child did not complete the Bod Pod portion of the study at baseline and one participant did not participate in the end point data collection. Males at or above 20% and females at or above 30% body fat were classified as overly fat. At baseline fewer participants were classified as overly fat (n=20) when using body fat than when using BMI (Table 4). Percent fat increased for some participants such that they were no longer in the normal range for body fat at the end point (Table Appendix 2 provides descriptive information on
the participants changing classification based on percent fat). This method for grouping participants produced large effect sizes for stature (e.s.=-0.83) and mass (e.s.=-2.81) indicating that the overly fat group was both taller and heavier (Table 5) than the normal group.

Three variables (e.g., waist circumference, waist-to-hip ratio, and sum of skinfolds) that were not used in either method of classifying (BMI or percent fat) and were related to obesity and health risk were compared at baseline and endpoint (Table 6). The goal was to confirm the accuracy of classification using BMI and/or percent fat. The changes across time for subcutaneous fat (sums of skinfolds), waist circumference and waist-to-hip ratio (WHR) were generally small regardless of the grouping method. The between group mean differences (effect sizes) tended to be greater when groups were formed using percent fat than when using BMI, for example waist effect sizes at baseline for BMI was 3.5 and for percent fat was 4.4, and for skinfolds were 4.5 and 6.5 respectively. Differences were moderate and similar for waist-to-hip ratio (es=0.6 to 0.7). The change group means typically fell between the normal weight and the overweight/overfat groups at baseline and with the distance narrowing further by the endpoint. Effect sizes were not considered for the change groups because of the small number in each group. Waist circumference of 60 cm and greater resulted in the same classification for 79% of the participants as body fat. Using two compartments (percent fat) to assess weight status produced fewer overweight participants, greater differences between the overly fat and normal fat groups, and was sensitive to change in both directions (shifts from and to overly fat classifications).

Predicting weight
Two discriminant analyses were conducted to determine what, if any, variables predicted normality versus obesity at the end point. Possible predictor variables were gender, age, and stature, mass, waist, WHR, sum of skinfolds, endomorphy and lean body mass at each time point. For the BMI groups (normal and overweight) two significant predictors were entered using stepwise method, sum of skinfolds and age with $\chi^2(2)=35.5$, $p=.0001$. Age and sum of skinfolds correctly predicted 85% of the normal and overweight participants, including all of those in the normal range. When predicting body fat group membership significant predictors were endomorphy and gender with $\chi^2(2)=46.6$, $p=.0001$ and 91% correct prediction of group membership. Again, all participants in the normal (not fat) group were predicted correctly. Endomorphy uses a subset of skinfolds corrected for stature.

Agreement

The two methods of classification, percent body fat and BMI percentile, agreed on 66% of the participants, while classifying 42% (n=22) as normal fat/weight and 23% as overweight and overly fat (n=12). These participants were in the same group at both the baseline and end point. The two methods of assessing weight status agreed on one additional participant, who began the study overweight and overly fat but ended in the normal classification for percent body fat and BMI. The remaining third of the participants (n=17) were classified differently depending upon the measure used and the time period. Forming two groups, obese and normal, from the participants where BMI and body fat agreed produced groups with no overlap on either characteristic (Table 7) at either point in time. These two groups had the greatest potential for identifying differences because of the separation between the groups. Examining the effect sizes
from baseline to end point provided another way to look at growth patterns and change versus misclassification (Table 8). Thus, the next section will focus on areas of agreement between the BMI and body fat where one group was normal and the other obese.

Large effect sizes between normal and obese participants (Table 8) were noted for additional body composition variables including waist circumference, waist-to-hip ratio, and sum of skinfolds. Large effect sizes were also evident for additional anthropometric variables representing mesomorphy (e.g., femur and humerus breadth, calf and arm mass) and stature. The 95% confidence intervals and large effect sizes for waist and hip circumferences, humerus breadth, arm and calf mass (circumference-skinfold) indicates that there is no overlap between the weight groups at either point in time. Stature and femur did not overlap at baseline but did at the end point. Generally effect sizes (excluding mass or sum of skinfolds) contrasting the groups decrease at the end point (mean es=-3.1) when compared to the baseline (mean es=-3.9). These data confirm and support the accuracy of the groups formed when BMI and body fat agree. Waist circumference of 60 cm splits the participants into the same normal and obese groups with 94% accuracy.

Hypothesis 2.

In order to test the second hypothesis physical activity was assessed. Self-reported recall of physical activity was more susceptible to error than direct measures of physical activity. An outcome of being physically active is physical fitness, and generally fitness and activity are related. Therefore it was important to assess both the reliability of the self-report data and to determine whether or not physical activity recall
was consistent with physical fitness. Further, field measures of physical fitness and laboratory measures should be related. In the case of overweight participants a cycle ergometer test was more likely to reduce performance differences when compared to a running test. Thus, three methods of defining physical activity were used; self-reported physical activity recall, a field measure of physical fitness, and a laboratory measure of physical fitness.

Physical activity and fitness

Intraclass reliability (normal weight R=.73; overweight R=.78) for minutes of physical activity was similar to the fitnessgram data for pacer (R=.67 & .80), curl ups (R=.75 & .83) and pushups (R=.79 & .90). Data in this study for curl-ups and push-ups did not meet the assumption of normality. Fitnessgram provides performance categories including “healthy zone”, most participants were in the healthy zone at baseline (93% normal weight, 81% overweight and 83% of those who would no longer be overweight) and at the end point (100% normal weight, 85% of the overweight and 83% of the change group). Thus, using the categories provided by Fitnessgram was not possible because most participants would be in the same category.

Two measures from sub-maximal exercise were calculated based on the cycle ergometer test. First, total work in joules was calculated (workload in watts * 60) for each minute of exercise and, if necessary, watts for the partial last minute of exercise then summed across the entire test. This was converted to kjoules (joules/1000). Second, the heart rate for participants at workload 14.71 in minute 2 of exercise was identified. This timeframe and workload was selected because at baseline and endpoint this included the greatest number of participants. These data were determined to be normal based on
skewness, kurtosis and stem-and-leaf plots. At baseline some children did not complete the cycle test because of equipment issues or because some younger children could not complete the test. At the end point all but one participant completed the test. Therefore, baseline to end point comparisons had less power for this test than for other measurements. Thus, reliability was estimated using measures at the end point. The number of laps completed for pacer and the kjoules at the end point were modestly correlated at $r(30)=.39$, $p=.04$, kjoules and heart rate for minute 2 at workload 14.71 were correlated $r(31)=-.64$, $p<.0001$ and the reliability of heart rate minute 2 (workload 14.71) comparing the two time periods was $R=63$.

Just over 60% of the participants completed the cycle ergometer test at both baseline and end point, thus providing the most accurate picture of changes due to development across time (Table 9) using a longitudinal approach. The exercise effect sizes (kjoules and heart rate) were uniformly small indicating small changes across time and virtually no difference between BMI groups or percent fat groups. During the same time period considerable change was evident based on the effect sizes for lean body mass, upper arm muscle, and calf muscle regardless of the group or grouping method. This yielded no obvious way to identify more and less active or fit participants.

To provide an additional opportunity for weight group differences to emerge data was examined using a cross-sectional approach to increase the size of the groups. Table 10 presents baseline and end point data for normal weight and obese participants where BMI and percent fat agreed on weight category; these categories included 65% of the participants. Small differences were observed when comparing the two weight groups on six fitness variables (average effect size 0.24). Most effect sizes were small, with push-
ups the largest and moderate effect sizes for pacer. Again no clear method to separate participants based on physical activity and fitness emerged.

Physical activity as a mediating factor in weight gain in obese children

Clearly, the small differences in fitness and activity between the most reliable and extreme weight groups suggest that activity may not be a significant explanatory factor in the obesity of these participants. Several approaches were used to examine this issue. First, the BMI overweight group at the end point (n=21) were divided based on the amount of mass gained into two groups with groups separated into a weight gain of less than 3 kg and a minimum of 3 kg. Each group had nine participants with BMI above the 85th percentile for age and gender. Three t-tests compared the two groups on the end point data for pacer, kJoules and self-reported physical activity (ranked). None of the tests were significant \[t(\text{18})=0.13, p=0.90 \text{ for } \text{kJoules}; L(\text{19})=1.52, p\leq 0.05 \text{ for pacer}; t(\text{18})=-1.91, p=0.07 \text{ self report}\}. Based on the confidence intervals pacer (gain LT 3kg m=13, CI 7-18; gain 3 kg m=9, CI 7-12) and kJoules (gain LT 3 kg m=11.3, CI 7.5-15; gain 3 kg m=10.9, CI 6.4-15) could be declared the same, while physical activity self report was neither the same nor statistically different (gain LT 3 kg m=4830, CI 2416-7245; gain 3 kg m=7385, CI 4694-10,077).

When overly fat participants were grouped by the percent fat gained (n=8) or lost (n=9), t-tests revealed no significant differences for pacer \[t(\text{15})=0.42, p=0.68\], kJoules \[t(\text{14})=-0.87, p=0.40\] and rank of self-reported physical activity \[L(\text{18})=0.17, p\leq 0.05\]. While the groups were not different, none could be declared the same based on confidence intervals for pacer \[% \text{fat loss m}=12, \text{CI}=7-16; %\text{fat gain m}=10, \text{CI} 6-14\], physical
activity self-report [% fat loss m=5412, CI 2479-8344; % fat gain m=6082; CI 3391-8773] and kjoules [% fat loss m=10.4, CI 4.2-16.6; % fat gain m=12.9, CI 9.1-16.8].

Analysis of Pairs

Participants were recruited as pairs, matched on age, gender and ethnicity, with one of the pair in the normal BMI percentile range and the other above the 85th percentile for BMI. The analysis of physical activity as a modifier of weight gain in this study has focused on the participants that remained overweight or normal from baseline to the endpoint. This section will focus on the remaining participants. Eleven pairs had one or both individuals with a BMI percentile (n=6) or body fat percent enough different (n=7) that the category (normal versus overly fat or overweight) was different at the end point than it was at the baseline. In one pair both changed categories and in another pair BMI and percent fat changed for a total of 11 pairs. The effect sizes (Tables 12 and 13) were larger at the baseline (mean es=1.46) than at the end point (mean es=1.01). Most effect sizes for the physical activity and fitness variables were small at both times. At baseline large effect sizes favoring the overweight group were found for BMI, percent fat, mass, waist circumference, hip circumference, arm and calf circumference, sum of skinfolds, endomorphy and mesomorphy. The only large effect size favoring the normal weight group was for ectomorphy. Five effect sizes had large (0.8 or greater) decreases between baseline and the end point. BMI (5.1 to 4.4) and sum of skinfolds (3.9 to 3.1) reflect the fact that more participants moved toward normal weight, fat and BMI rather than increasing those characteristics. The three components of somatotype had large changes from baseline to end point [endo from 4.0 to -0.3; meso from 2.4 to 0.3; ecto from -3.7 to 0.0]. Baseline-endpoint effect sizes showed increases in endomorphy (es=4.5),
mesomorphy (es=2.0) and a decrease ectomorphy (es=-1.6) for the normal weight half of the pairs. The overweight had small changes for endomorphy (es=-0.23) and mesomorphy (es=.09) and a large increase in ectomorphy (es=2.4) from baseline to endpoint. Considering that 4.0 is the midpoint of the somatotype scale for each component, the physique of the normal weights went from balanced meso-ecto (2.1-3.5-3.1) to meso-endo (3.9-4.5-2.1) while the overweight halves of the pairs remained meso-endo (3.7-4.7-.9 to 3.2-4.9-2.1).
APPENDIX C: MATERIALS AND PAPERWORK FROM DATA COLLECTION

INFORMED ASSENT DOCUMENT

Title of Study: The Influence of Growth on Body Composition, Physical Activity, and Fitness in Overweight Children

Investigator: Jennifer D. Smith, B.S

I want to learn about how you grow. I also want to measure how physically active and physically fit you are. I would like you to be in my study because you are 5-9 years old.

What will you do for my research?

If you allow me to measure you for my study, I will need your help during this school year. You will need to visit me at Iowa State University two times in the fall. During your first visit, you and your parent/guardian are going to fill out some papers to tell me about your birthday, if you take any medicine, and about your health. I am also going to measure many things. I want to know how tall you are and how much you weigh. I also want to measure around your hips and around your stomach. I'm also going to learn about your body type by measuring how much fat is on your body and how big your bones are. I will use calipers to squeeze your skin in five spots on your body so I know how much fat is under your skin. You will also sit in a BOD POD to measure your body fat. The BOD POD is like a big pea pod that you sit inside. You don’t have to sit inside the pod very long, only about five minutes. The machine quietly measures the amount of fat in your body. All of those body measurements will take 30-45 minutes. When measuring your physical fitness, I will have you ride a special bike. As you ride this bike, you will wear a mask that allows me to measure the air you breathe in and out. The amount of time you spend riding the bikes depends on your own fitness. You will be done with all of the above measurements in about 2 hours.

During your second visit this fall, I will ask you and your parent/guardian to think about the activities you do. I want you to think about any lessons or sports you played and tell me about them. Your parent/guardian can help you remember. This activity will take 15-20 minutes of your time. I will use a test called FITNESSGRAM to measure your fitness too. You may have done this test at school during physical education. You will do curl-ups and push-ups while listening to a CD that tells you how fast to do each exercise. You will also do the PACER, which has you run back and forth in a gym. The test helps me understand how healthy your heart and lungs are. The amount of time it takes to finish the fitness testing depends on your own fitness. All of the measurements for the second visit will take about 2 hours. You will come two times at the end of the school year and I will repeat all of the measurements I just explained to you.

I need you to come to Iowa State University two times this fall and two times at the end of the school year. I will take all of these measurements two times, once in the fall and once in the spring, to see how much you changed. I always explain or read simple instructions to you about the things you do for my research. I want you to understand everything that is taking place. Your parent/guardian will stay with you during all four of the appointments so you feel safe and comfortable.
What you may expect?

All of the tests will be done so you stay safe. When you exercise for my research, you may feel tired during and after the tests. You will need to work hard when exercising so I know how healthy your lungs, heart, and muscles are. If you aren’t used to exercising a lot, you may feel tired and sore the next day. It may also feel funny to wear a mask when riding the special bike for fitness testing. I’ll let you try it on ahead of time so you know how it feels. As you ride the bike or perform the FITNESSGRAM, my helpers or I will watch you carefully and let you know if you need to stop. I will ask you many times how you feel and ask if you need to stop as you exercise.

It may feel funny or embarrassing when I measure the fat at different spots on your body. You will need to move or remove your clothing when I measure spots on your body, like the skin on your back. The calipers do not hurt; they only squeeze your skin. The calipers for measuring how big your bones are do not hurt either. It may feel weird to sit in the BOD POD but it has a large window so you can see outside at all times. I will keep everything private and you can always have your parent/guardian with you.

Only the people helping me with my research can see your measurements; no one else will see your information. If you don’t feel comfortable, you may stop exercising or being measured at any time. Your parent/guardian can be with you all the time. All of the people that help with my research are trained to help if anyone becomes sick or hurt. Everyone knows CPR and can help if an emergency takes place.

How does this help?

By letting me measure you, you will help me understand how kids grow. I will also learn how to create exercise programs for kids. We want to know how exercise and activity, like sports and lessons, help students gain weight and get taller.

What do you get?

You will receive free money in the fall and the spring when you help me with my research. After we measure you this fall, you will get $25 on a gift card(s) to use at places like restaurants, bowling alleys, etc. You will receive $50 on gift cards when you are measured again in the spring, at the end of the school year. Those gift cards will be for the same kind of places: restaurants, book stores, etc. After you are measured four times, you will have gotten $75 in gift cards!

Iowa State University also has an after-school program that is like the physical education you get at school. The program also has swimming lessons. You will also get to come to the program for free to get exercise and time to play with others.
Do you have to help me?

Even if your parent/guardian says "yes" and lets you help me with my research, you do not have to help. You can say "no" or stop any of the measurements. I want you to help because you want to help. You do not have to help if you don’t want to. I will not be mad if you decide to stop or if you say "no". I don’t want you to be scared or afraid of any of the measurements. You can still come and play in our after school program called Swim and Gym if you don’t say "yes" or if you stop in the middle of my research.

Who will see your information?

When I measure you, I will write down numbers and information on papers. Only the people helping me with my research will see these papers. I will not put your name on the papers with your information. I will use codes that are made of numbers and letters. I will keep the papers locked-up in rooms. I will keep the papers in my office and the lab we use for measurements. When I am done with my research, I will destroy all the paper so no one can see it.

What happens if you have a question?

If you have questions at any time during my research you can ask me. You can ask any question you want. No question is silly. You can ask me in person or your parent/guardian can call or email me. I want you to understand everything we do.

- My phone number is 291-0779 and 294-3100
- My email address is gavsnomm@iastate.edu

*************************************************************************

PARTICIPANT SIGNATURE

When you sign this sheet, it means you will help me with my research because you want to. It also means that we talked about what you will do to help me. Even though you sign this paper, you can change your mind and say "no" when being measured. I will give you a copy of this information so you can look at it with your parent/guardian if you have any questions.

Participant's Name (printed) 

(Participant's Signature) (Date) 

ORA 10/06
INVESTIGATOR STATEMENT

I certify that the participant has been given adequate time to read and learn about the study and all of their questions have been answered. It is my opinion that the participant understands the purpose, risks, benefits and the procedures that will be followed in this study and has voluntarily agreed to participate.

__________________________________________  ______________
(Signature of Person Obtaining Informed Consent)  (Date)
Assent Script for Young Children

Title of Study: The Influence of Growth on Body Composition, Physical Activity, and Fitness in Overweight Children

Investigator: Jennifer D. Smith, B.S

I want to learn about how you grow. I also want to measure how physically active and physically fit you are. I would like you to be in my study because you are 5-9 years old.

What will you do?

- I will measure many things: how tall you are, how much you weight, the distance around parts of your body, how much fat is under your skin, how wide your bones are, how much muscle and fat you have, how much you play and exercise, and how strong your lungs & heart are

- When you do the FITNESSGRAM, you will do push-ups, sit-ups, and run

- You will visit me 2 times in the fall and 2 times at the end of the school year.
- Each time you come to visit me, you will stay for about 2 hours.
What can you expect?

- I will need you to work hard so you will get tired. I will make sure you feel okay and you can stop at any time during my research.

- I will need to see parts of your body when measuring but your parent/guardian can always be with you. You might feel embarrassed or a little scared.
- Everyone helping me with my research knows how to give help if you get hurt or sick.

Why do I need your help?

- You will help me learn about how kids grow. I want to know how to help kids exercise and grow.

What do you get?

- After you come two times in the fall, you get $25 on a gift card. The gift card can be used at a restaurant, store, or fun place like a bowling alley.
- After you come back in the spring, you get $50 on gift cards. They can be used at restaurants, stores, and fun places too!
- You will get a total of $75 on gift cards when you are done.
- You also get to come to an after school program called Swim & Gym at Iowa State University for free. You can play games, sports and swim!

Do you have to help me?
• Even if your parent/guardian says "yes", you can say "no" at any time in my research. I won't get mad if you don't want to help.

![Smiling emoji]

• You can still come to Swim & Gym for free to play and exercise, even if you say "no".

Who will see your information?

• Only my helpers and I will see your information. I will keep everything locked up in my office and the lab I use when measuring you.

![Lock icon]

Do you have questions?

• If you have any questions, you can ask me at any time. No question is silly.
• You can ask me in person. Your parent/guardian can call me or send me an email with a computer.

![Question mark, cell phone, and computer icons]

• My phone number is 294-3100 or 291-0779
• My email address is gavsmom@lastate.edu
INFORMED CONSENT DOCUMENT

Title of Study: The Influence of Growth on Body Composition, Physical Activity, and Fitness in Overweight Children

Investigator: Jennifer D. Smith, B.S

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

INTRODUCTION

The purpose of this study is to learn about the growth pattern in children, as well as the influence of physical activity on growth. You are being invited to participate in this study because you reside in Central Iowa and your child is 5-9 years of age.

DESCRIPTION OF PROCEDURES

If you agree to participate in this study, your child’s participation will last for the 2007-2008 academic school year. Participation will last 8-9 months and will involve four visits to the Department of Kinesiology. Appointments will last approximately 2 hours. The first appointment may last longer than others due to discussion and paperwork. Information about birth date, medications, and medical conditions will be recorded. The laboratory and measurements will be discussed using a script. During the first 2-hour appointment, your child will participate in the following study procedures. Your child’s height and weight will be measured initially for group placement. Waist and hip circumferences will be measured. A somatotype classification will be performed which includes skinfold, height, weight, and bone breadth measurement. Skinfold measurements will be taken at five separate sites on your child’s body. A BOD POD will also be used to measure body composition in approximately five minutes. The physical portion of the appointment will take 30-45 minutes to complete. The remaining time will be devoted to measuring cardiovascular fitness. Aerobic fitness will be measured in the laboratory setting on cycle-ergometer, which is an adapted bike. The length of time your child exercises depends on his or her personal fitness. All measurements will be completed in approximately 2 hours.

During the second 2-hour appointment, physical activity will be recalled by using a retrospective method. With your help, your child will recall physical activity by month and week. The retrospective recall should take no longer than 15-20 minutes to complete. Physical fitness will also be measured using the FITNESSGRAM test battery. Your child will complete the curl-up, push-up, and PACER subtests. The duration of the fitness test battery depends on your child’s personal fitness. All of the measurements for the second appointment should take no longer than 2 hours. Measurements will be taken during two initial appointments at the beginning of the school year. All measurements will be repeated during two appointments at the end of the school year as well. The appointments will be organized in the same 2-hour fashion. All procedures and measurements will be explain or read to your child in simple, age-appropriate language. You will stay with your child during each of the four appointments.

ORA 10/06
RISKS

While participating in this study your child may experience the following risks: fatigue, physical discomfort due to fitness testing, discomfort with body composition measurements, and possible privacy issues. Children will be challenged during fitness testing to work as hard as possible. Fatigue and discomfort associated with vigorous exercise will be expected. Skin calipers will be used to measure body composition and circumferences taken along the waist and hip. Clothing will need to be shifted or partially removed to access areas on the body. Any measurement with privacy issues, including weight, will be performed in the laboratory setting. Children will also need to sit inside a BOD POD, a small chamber, for body composition assessment. While riding the cycle-ergometer, a mask will be worn to collect expelled gases during fitness testing. The chamber or mask may cause discomfort for participants.

All personnel involved with data collection are certified in CPR. In the event of an emergency, the proper care will be provided. As your child exercises vigorously, associated personnel or I will carefully watch your child. We will stop your child if we feel he or she shouldn’t continue with fitness testing. I will periodically ask how your child feels during exercise and ask if he or she wants to stop.

BENEFITS

If your child decides to participate in this study there may be no direct benefit to him or her. It is hoped that the information gained in this study will benefit society by providing research that will design or redesign weight-reduction programs for young populations. Successful weight-reduction programs may combat the obesity/overweight epidemic in the United States.

COSTS AND COMPENSATION

Your child will not have any costs from participating in this study. Your child will be compensated for participating in this study. You will need to provide your social security number (SSN) and address in order for us to pay you.

Your child will receive payment on two separate occasions during the study. After meeting two times during the beginning of the study, the amount of $25 will be given to the child with a gift card(s). The gift card(s) can be redeemed at local businesses for products or services. After meeting two times at the end of the school year, your child will receive $50 in the form of gift cards. The gift cards can also be redeemed at local businesses for products or services. Compensation via gift card(s) will total $75 at the end of the study.

Your child will also be allowed to participate in the ISU Swim & Gym program for a semester at no cost. The program is an exercise program designed for children. Children are exposed to gymnastics, swimming, sports, organized games, and nutrition education.

Mileage will be reimbursed.
PARTICIPANT RIGHTS

Your child’s participation in this study is completely voluntary and he or she may refuse to participate or leave the study at any time. If your child decides to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which he or she is otherwise entitled. Your child will still be encouraged to attend the Swim and Gym program offered at Iowa State University.

RESEARCH INJURY

Emergency treatment of any injuries that may occur as a direct result of participation in this research is available at the Iowa State University Thomas B. Thielen Student Health Center, and/or referred to Mary Greeley Medical Center or another physician or medical facility at the location of the research activity. Compensation for any injuries will be paid if it is determined under the Iowa Tort Claims Act, Chapter 669 Iowa Code. Claims for compensation should be submitted on approved forms to the State Appeals Board and are available from the Iowa State University Office of Risk Management and Insurance.

CONFIDENTIALITY

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies, auditing departments of Iowa State University, and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, the following measures will be taken. The names of participants will not be used; codes will be used for identification. The primary investigator and Dr. Kathi Thomas will have access to the data during the study. Data will be kept in a file box. The file box will be kept in Ms. Smith’s office, Dr. Thomas’ office, or in the Pedagogy Laboratory. All areas are locked and access is restricted. Data will be entered on Ms. Smith’s laptop, which is password protected. Statistical analysis will be performed on a computer in the Pedagogy Laboratory. The computer is password protected and the laboratory is locked with restricted access. Data will be kept until September 1, 2009 and destroyed/erased thereafter. If the results are published, your identity will remain confidential.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study.

- For further information about the study, contact Jennifer Smith at 291-0779. Advising faculty, Dr. Katherine Thomas, may also be contacted at 294-8677.

- If you have any questions about the rights of research subjects or research-related injury, please contact the IRB Administrator, (515) 294-4566, IRB@iastate.edu, or Director,
(515) 294-3115, Office of Research Assurances, Iowa State University, Ames, Iowa 50011.

***************************************************************************

PARTICIPANT SIGNATURE

Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered. You will receive a copy of the written informed consent prior to your participation in the study.

Participant’s Name (printed) ____________________________________________

(Participant’s Signature) ________________________________________________ (Date)

(Signature of Parent/Guardian or Legally Authorized Representative) ____________ (Date)

INVESTIGATOR STATEMENT

I certify that the participant has been given adequate time to read and learn about the study and all of their questions have been answered. It is my opinion that the participant understands the purpose, risks, benefits and the procedures that will be followed in this study and has voluntarily agreed to participate.

(Signature of Person Obtaining Informed Consent) ____________________________ (Date)

ORA 10/06
Participants Needed for Research!

Children, ages 5 to 9 years, are needed for a study at Iowa State University. Children may fall into all weight classifications defined by the Centers for Disease Control and Prevention (CDC). Children may be normal weight, at-risk for overweight, or overweight. Classification is defined by body mass index (BMI).

Natural growth, physical activity, and physical fitness will be measured during the 2007-2008 school year. Each child will be measured in the beginning of the school year and at the end of the school year. Participation in the study is voluntary and research is conducted in a confidential manner.

Compensation is provided for participation in the study. Families will be reimbursed for mileage. Children will also be allowed to participate in ISU Swim & Gym for a semester—at no cost! Swim & Gym is an exercise program designed for children. If you would like additional information or would like your child to participate in this study please contact:

Jenny Smith, Masters Student
Department of Kinesiology, ISU
294-3867
gavsmom@iastate.edu
Participant Information Sheet

All information is confidential. Medical information is collected to ensure the safety and health of your child. Data and information is kept in a file box and locked in an office/laboratory.

First Name_________________ Last Name_________________

Age_________ Birth Date__________

Medical Conditions

Do any of the listed medical conditions affect your child’s ability to exercise and participate in physical activity?

Medications

Do any of the listed medications need to be present as your child exercises? If so, which medications?

Is there any other information you need to share about your child to ensure his or her safety during the study?
Procedures Order and Script

Appointment One

Paperwork
• Consent and assent forms will be explained and signed.
• With the help of your parent/guardian, I am going to learn about your birth date, any medicines you take, and how healthy you are.

Height
• I am going to measure how tall you are. You will not wear shoes. You still stand with your back to the equipment and look forward. When instructed, you will take a deep breath and walk away from the apparatus and I will record your how tall you are.

Weight
• I am going to measure how much you weigh with a scale. You will stand on the scale and hold as still as possible. You will wear shorts and a t-shirt, but no shoes. When instructed, I will tell you to step off the scale.

Circumferences
• I am going to measure the distance around your waist and your hips with a measuring tape. You will need to lift your shirt and may need to shift the waistband of your shorts so I can put the measuring tape directly against your skin.

Skinfold Measurements
• Skinfold measurements will be taken in five spots on your body. A skinfold caliper is going to squeeze your skin to measure how much fat is under the skin. Five skinfold spots will be used. Each site will be measured three times to make sure I’m measuring you correctly.
• I will measure you on the top part of your arm (triceps), on your back (subscapular), on your stomach (abdominal), by the hip (suprailiac), and on the lower leg (medial calf).
• To measure by the hip and on the abdomen, you need to shift your shirt or you’re your shorts so I can grasp the skin correctly. You will need to move or partially remove your t-shirt so I can grasp the skin by your shoulder blades. Of course your parent/guardian can be with you when I do this.
Somatotype

- This tells me what kind of body you have. Everyone has a certain kind of body. I must take a number of measurements. I will use your height and weight that I already measured.
- I am going to use three skinfold measures I have already measured too.
- I will also use an instrument to measure bone breadth. This measures how wide your bones are. I will be measuring how wide your bones are at the end of your elbow and at your knee.

BOD POD

- The BOD POD is used to measure body composition. Body composition means I measure how much of your body is lean body mass and fat mass. Lean body mass is muscle and bone. Fat mass is the fat under your skin and around your organs.
- The BOD POD is a small chamber that uses air to measure how much of your body is muscle and fat. It’s like a pea pod. You will sit in the chamber in shorts and a t-shirt. If you have jewelry, a watch, or any extra accessories on, you will need to remove them. As you sit in the pod, you will need to sit still. It takes about five minutes for the machine to measure you.
- The pod also has a large window so you can look out into the room at all times. Your parent/guardian can remain right next to the window.

Cycle-Ergometer

- The equipment is like a bike. The bike will measure how long you can exercise before you are too tired to continue. It will become more and more difficult to pedal as exercise over time. As you ride the cycle, you will breath into a mask. The mask will always give you air and oxygen to breath as you exercise. When you breathe out, or exhale, the mask will collect your air. It helps the machine measure how fit you are when you exercise.
- It is important that you pedal and exercise as long as you can when riding the cycle. When you feel like you cannot pedal anymore, you may slow down. I don’t want you to stop immediately because that may cause pain in your legs. I want you to pedal slowly. At any time you need to stop, just let me know and you may stop the measurement. I will be next to you at all times and will ask you how you feel throughout the measurement.
Appointment Two

Activity Measurement:
- You and your parent/guardian will sit down and tell me the physical activities you participated in over previous months. I want you to tell me any sports, lessons, physical education, or other organized activity you participated in on a regular basis. You will tell me what physical activities you participated in for each designated month. You will also tell me how many times a week you did that activity.
- For example, you may have played in the Ames Soccer League last August. You had practices 2 times a week and games on Saturdays.

FITNESSGRAM
- FITNESSGRAM is used to test your physical fitness. Many schools use this in physical education to see how fast and strong you are. FITNESSGRAM is neat because it uses a CD. The CD tells you what to do. I will repeat these instructions if you need to hear them again. You will do three tests: curl-ups, push-ups, and the PACER. You will do all of the tests in a gymnasium.

- **Curl-ups:** You will do this test on gymnastic mats. The CD will tell you when to curl-up and when to lie back down. You will keep your arms by your side. As you curl-up, your finger tips will slide by a line that I create on the floor. You cannot use your arms or elbows to help you sit-up. When you cannot keep pace with the CD or if you start using the wrong part of your body to curl-up, the test will be finished. The CD and I will help keep track of the number of curl-ups you complete.

- **Push-ups:** You will do this test on gymnastic mats. The CD will tell you when to push-up and when to go down. You must support your weight above the ground during the test. You cannot rest your body on the mat. The CD will have you start in the “up” position. When you cannot keep pace with the CD or if you rest your body on the ground, the test will be finished. The CD and I will help keep track of the number of push-ups you complete.

- **PACER:** This test is a running test. It tests your aerobic fitness, which is your heart and lungs. It requires that you run back and forth across the gym. The distance is 20m, which will be identified by cones. The CD provides beeps, which tell you when to run. As you hear the beep, you start running across the gym. You want to reach the other side before you hear another beep. As soon as you hear the next beep, you must run across the gym again. You are allowed a “freebie”: The first time you do not make it across the gym before the beep, you can continue with the test. However, the second time you do not make it before the beep, the test will be finished. The CD and I count laps during the test.
The information provided for each measurement will be explained to each participant and the parent/guardian. A copy of this information will be given to each parent/guardian. Questions may be asked at any time in the study. Parents are encouraged to stay with their child during each measurement. To ensure privacy, measurements will be taken in a laboratory setting. Fitness testing is done in a gymnasium. Appointment One and Two will occur in different order for many children because of counter-balancing.
PWC-170 Cycle Ergometer Exercise Test

Eligibility

1. Have you started taking any new medications in the last ___ months, other than vitamins? YES NO
   If yes, for what reason(s): ____________________________ ____________________________

2. Are you currently enrolled in PE class? YES NO
   a. If yes, are you currently allowed to participate? YES NO
   b. If no, would you be allowed to participate if you were enrolled in PE? YES NO

3. Are you sick today? YES NO

Workload and Heart Rate Monitoring

The subject should complete as many stages as needed to reach a heart rate of at least 165 beats per minute (bpm). Each stage is two minutes in length. Record the subject’s heart rate. Weigh the subject to determine the initial workload. Record the subject’s average heart rate during the last 10 seconds of each minute of every stage.

Follow Appendix A in the MOP for how to increase the workload at the end of each 2-minute stage. Record the total workload for each stage. Signs and symptoms of fatigue that indicate test termination are addressed in Appendix B.

4. The initial workload is based on the girl’s weight.
   Indicate her weight with a check (✓) in the appropriate box.
   □ < 50 kg = 0.25 Kp (or < 110 lbs)
   □ 50-100 kg = 0.50 Kp (or 110-220 lbs)
   □ > 100 kg = 0.75 Kp (or > 220 lbs)

5. Tester Initials: ___ ___ ___

6. Pre-exercise heart rate:
   a. Monitor: _____ bpm
   b. Radial pulse (for 6 secs * 10): _____ bpm

7. STAGE I  a. Initial Workload: __ _ __ Kp
   b. Heart Rate Minute 1: _____ bpm
   c. Heart Rate Minute 2: _____ bpm

8. STAGE II a. Total Workload: __ _ __ Kp
   b. Heart Rate Minute 3: _____ bpm
   c. Heart Rate Minute 4: _____ bpm

9. STAGE III a. Total Workload: __ _ __ Kp
   b. Heart Rate Minute 5: _____ bpm
   c. Heart Rate Minute 6: _____ bpm

If necessary, continue on to STAGE IV.

10. STAGE IV  a. Total Workload: __ _ __ Kp
    b. Heart Rate Minute 7: _____ bpm
    c. Heart Rate Minute 8: _____ bpm

11. Was the test terminated due to signs and symptoms of exercise intolerance? YES NO

   If YES, reason: ________________________________________
MANUAL OF PROCEDURES
PWC-170 CYCLE ERGOMETER EXERCISE TEST
INTRODUCTION
The PWC-170 Cycle Ergometer Exercise Test (PWC) is to be completed in a random sample of up to forty eligible and consented girls per school. Data collection activities for each girl will take place during one visit. At the visit, the girl completes three or four stages of the sub-maximal bicycle test while her heart rate is monitored. This manual will address the specific procedures needed for the data collection of this measurement.

GENERAL MEASUREMENT PROCEDURES

Equipment Set-up
The attributes of the space in which the bike test is performed will likely differ by site. Each bike requires a minimum of an 8' by 10' space. Whenever possible, arrange for a space where the bike(s) can be kept safely until all of the girls have been measured. The space should also be as private as possible so as not to attract the attention of other students or disrupt other school activities. There should be a private area (bathroom or behind privacy screens) where the heart rate monitors can be put on the girls. Some sites may set up 4 bikes at a time, providing there is enough space (approximately 300 square feet). All sites should find an appropriate room or gym and reserve the space in advance. All equipment needs to be set-up before the girls arrive.

Monark bikes must be calibrated prior to the first fitness test of the day. Be sure that the bike is in the location in which the test will take place. If you move the bike, you must re-calibrate it. See Appendix B for details on calibration.

Objective
The objective of the PWC 170 test is to provide an estimate of cardiorespiratory fitness. As a secondary outcome, cardiorespiratory fitness will be examined across the intervention period in the intervention and control schools.

Methods
Physical Work Capacity (PWC) at a heart rate of 170 beats per minute (bpm) will be predicted from a multi-stage cycle ergometry test. Each participant will exercise on a Monark (model 818) mechanically-braked cycle ergometer. All ergometers will be calibrated daily prior to any testing each day. The subject will pedal at 60 rpm for three, two-minute stages. The initial workload will be based on the subject’s weight. The resistance during the next two to three stages will be increased depending on the girl’s heart rate response at the end of each stage (see Appendix A). The average heart rate during the final 10 seconds of each workload will be measured by a Polar heart rate monitor. The protocol is designed to obtain heart rates in the range of 160-170 bpm during the final stage. Heart rates measured during each stage will be used to predict a PWC at a heart rate of 170 bpm. The power output (watts) is then reported in absolute units (watts), relative to body mass kg, or relative to fat free mass (FFM) (watts/kg or watts/kg FFB)
After the eligibility questions have been answered, the girl either proceeds to the exercise test, is rescheduled for another PWC-170 screening at a later date, or she is thanked for her time and excused. If she proceeds to the exercise test, follow these steps:

**Pre-Test Preparations**

1. Be sure the cycle ergometer is calibrated before beginning (See Appendix B for the procedure on how to calibrate the bike).
2. Put the metronome in a location that can be easily seen and heard from the ergometer and turn it on.
3. Verify that the girl is wearing appropriate attire for the exercise test. If not, provide her with a clean t-shirt and shorts that she can change into in a private area or reschedule the visit.
4. Weigh the subject, in kilograms (kg) or pounds (lbs), and check the appropriate category on the MFI.
5. The tester records her/his initials on the MFI.

**Heart Rate Monitor Preparations**

6. Moisten the inside of the transmitter with water before the girl puts it on. Have the girl put the heart rate transmitter and belt combination around her lower chest, below the bra line. The word Polar must be upright, such that someone looking at her could read it. If she has trouble adjusting or connecting the belt, a female staff person may assist her.
7. Touch the receiver watch to the heart rate transmitter and check to be sure the heart rate is being transmitted. If you have trouble getting a signal, try these steps:
   a. Check that the transmitter is on correctly (ie touching the skin in proper position).
   b. Tighten the belt (with knots if necessary).
   c. Try using some electrode gel.
   d. Try a different heart rate monitor.
8. Next check the accuracy of the monitor by getting a pulse from the girl and correlating it to what the monitor is recording. The pulse is obtained from the radial artery or carotid artery for 10 seconds. **Count the number of beats, starting with one after the very first beat** and multiply by 6 to obtain beats per minute. Refer to MFI data collection form for the Heart Rate Conversion Chart. The pulse rate in beats per minute (bpm) should be within 5 beats of the heart rate obtained by the heart rate monitor during the same 6 seconds of taking the pulse. If not, use a different heart rate monitor.
9. Record the pre-exercise heart rates, both from the monitor and from the pulse on the data collection form (MFI).
10. Put the watch receiver of the heart rate monitor on the handlebar of the cycle ergometer, facing outward so that you can easily read the heart rate.
PWC-170 Cycle Ergometer Preparations
11. Adjust the seat height so that the leg is almost extended (approximately 165-170° at the knee joint) when the girl is seated on the ergometer with the hands on the handlebars. Set the handlebars at approximately 20° angle toward the rider.
12. With the aid of a metronome or music, have the girl begin pedaling at 60 rpm, zero workload. For simplicity, have the metronome set at 120; each sound being a down stroke by one leg.

Begin Fitness Testing
13. Once the subject is at 60 rpm, initiate the first workload (based on her weight). Record this initial workload on the MFI.
14. Start the stopwatch to initiate the test. The subject pedals at the prescribed workload for 2 minutes.
   a. Monitor the subject to be sure she is attaining the proper pedal cadence.
   b. Monitor the heart rate to be sure that no spurious or strange readings are obtained.
   c. Record the average heart rate obtained during the last 10 seconds of the first minute at the stage.
   d. Continue to monitor the girl, her cadence and her heart rate as she pedals.
   e. Record and assess the average heart rate obtained during the last 10 seconds of the work stage. Follow the appropriate increment in workload as outline in Appendix A.
   f. Continue with steps (a) through (e), recording total workloads and heart rates as required on the MFI.
   g. The heart rate for each successive stage should increase. If it does not, check the heart rate monitor as a spurious reading may have been obtained. Try having the girl re-adjust the belt to be sure it is off the bra. Alternatively, press firmly on the transmitter to obtain better contact. If neither method works, take a 6 second pulse rate (HR6) at the appropriate time using the radial pulse (HR6 x 10 = HR/min). Record this pulse rate on the MFI at the appropriate minute.
15. The goal is to obtain a heart rate of approximately 165 beats per minute during the final stage of exercise.
16. The test should culminate in three stages; however, if the heart rate is less than 165 during the third stage a fourth stage will be necessary. This stage should follow the same procedures as the previous three stages.
17. At the end of the test have the subject continue to pedal at “zero” or very little workload (~0.25 Kp; slow pedal rate) until her heart rate is 120 bpm or below; then end the test and have the girl remove her heart rate monitor.
18. If a subject terminates early, record the reason on the MFI form.
19. Clean the heart rate transmitter with soapy water.

Safety
The PWC 170 test does not pose risks above those encountered in ordinary physical activity. Safety criteria are assessed at the time of the consent based on the parent/guardian's response to two questions:

(1) Has a doctor told your child to avoid exercise for health reasons?
(2) Does your child have any of the following conditions?
- Muscle, bone, or joint problems that limit her ability to ride a bike?
- Heart problem that requires a limit in physical activity?
- Fainting with exercise in the past 6 months?
- Uncontrolled asthma?
- Very high blood pressure that is not controlled on medication?
- Diabetes with frequent very low or very high blood glucose levels (sugars)?
- Thyroid problems not controlled on medication?
- Seizures not controlled on medication?
- Sickle cell disease, cystic fibrosis, anorexia nervosa, severe kidney problems, or severe liver problems?
- A blood condition that increases the risk of bleeding?

A person is ineligible for the fitness test if her parent/guardian answers yes to either of these questions. Because some medications may interfere with the value of the exercise test, drug information is obtained from the parent/guardian at the time of consent. Additionally, the girls are asked a few questions about their ability to participate in PE and their general health on the day of the test.

A test will be terminated if any of the events in the Exercise Test Termination Criteria arises (see Appendix D). TAAG staff are trained to recognize these signs and symptoms.

To ensure a standard of hygiene, wipe down cycle ergometer with Lysol or other disinfectant spray at least once a week. Do not spray the disinfectant directly onto the cycle ergometer; instead spray it onto a paper towel and then wipe down the bike. Do not use chlorinated solutions. This is to avoid corrosion of the moving parts of the bike.
APPENDIX A.
PWC-170 CYCLE ERGOMETER WORKLOAD ADJUSTMENT ALGORITHM

Initial Workload for STAGE I:

<table>
<thead>
<tr>
<th>Body Mass</th>
<th>Workload</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 50 kg</td>
<td>0.25 Kp</td>
</tr>
<tr>
<td>≥ 50 kg</td>
<td>0.50 Kp</td>
</tr>
</tbody>
</table>

If the average heart rate obtained during the last 10 seconds of STAGE I is:

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 90 bt/min</td>
<td>then add 2 Kp for Stage II</td>
</tr>
<tr>
<td>91-120 bt/min</td>
<td>then add 1 Kp for Stage II</td>
</tr>
<tr>
<td>121-149 bt/min</td>
<td>then add 0.5 Kp for Stage II</td>
</tr>
<tr>
<td>150-165 bt/min</td>
<td>then add 0.25 Kp for Stage II</td>
</tr>
<tr>
<td>&gt;165</td>
<td>then DONE</td>
</tr>
</tbody>
</table>

If the average heart rate obtained during the last 10 seconds of STAGE II is:

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 120 bt/min</td>
<td>then add 2 Kp for Stage III</td>
</tr>
<tr>
<td>121-140 bt/min</td>
<td>then add 1 Kp for Stage III</td>
</tr>
<tr>
<td>141-160 bt/min</td>
<td>then add 0.5 Kp for Stage III</td>
</tr>
<tr>
<td>160-165 bt/min</td>
<td>then add 0.25 Kp for Stage III</td>
</tr>
<tr>
<td>&gt;165</td>
<td>then DONE</td>
</tr>
</tbody>
</table>

If the average heart rate obtained during the last 10 seconds of STAGE III is:

<table>
<thead>
<tr>
<th>Heart Rate</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 120 bt/min</td>
<td>then add 2 Kp for Stage IV</td>
</tr>
<tr>
<td>121-140 bt/min</td>
<td>then add 1 Kp for Stage IV</td>
</tr>
<tr>
<td>141-160 bt/min</td>
<td>then add 0.5 Kp for Stage IV</td>
</tr>
<tr>
<td>160-165 bt/min</td>
<td>then add 0.25 Kp for Stage IV</td>
</tr>
<tr>
<td>&gt;165</td>
<td>then DONE</td>
</tr>
</tbody>
</table>

If a fourth stage is necessary, complete STAGE IV and the test, recording the two heart rates on the MFI.
APPENDIX B.
CALIBRATION OF MONARK 828E EXERCISE BIKE

ZERO ADJUSTMENT OF METER BOARD

1. Remove the transport tape for the pendulum. Loosen tension device so the brake belt feels
loose. Check that the pendulum will hang in vertical position. The index on the pendulum
weight shall now be aligned with the index at the 0-position on the meter board.
2. If adjustment is necessary, first loosen the lock nut and then change the position of the meter
board so that it will have its 0-index in line with the index of the weight. Tighten the lock nut
after the adjustment. See Figure 1 (fig 9 on page 15 of the manual).
3. Check at the same time that the scale for kiloponds to the left of the electronic meter will
have its 0-index in line with the index in the window.
4. If needed, the position of the scale can be adjusted after the adjusting screw has been
loosened.
5. Tighten the screw firmly after the adjustment.

CALIBRATION OF PENDULUM SCALE

1. Loosen the tension device so the brake belt feels loose.
2. Check 0-adjustment. See ZERO ADJUSTMENT OF METER BOARD above.
3. Detach the front screw in the frame covers.
4. Fasten a known weight, e.g. 4kg, at the balancing spring.
   NOTE: The weight should not be less than 3kg, due to the possibility of inferior accuracy.
5. Take the left cover a little to the side so the weight cord hangs between the covers. See
   Figure 2. (fig 10 on page 17 of the manual).
6. When correctly set, it should be possible to read this weight from the corresponding place on
   the meter board. See Figure 2. (fig 10 on page 17 of the manual).
7. Should there be a deviation, adjust the pendulum to the correct weight on the scale by means
   of the adjusting weight inside the pendulum. See Figure 1.
8. To change the position of the adjusting weight, loosen the lock screw of the weight.
9. Should the index of the pendulum weight be too LOW, move the adjusting weight upwards
   in weight.
10. Should the index of the pendulum weight be too HIGH, the adjusting weight is moved
    somewhat downwards and locked in the new position.
11. Repeat until the correct reading is achieved.

Check the calibration of the pendulum any time the bike is moved, prior to doing a fitness test.
APPENDIX C.
PWC-170 CYCLE ERGOMETER MAINTENANCE

ROUTINE MAINTENANCE

Daily Check:
   ___ Straps in good condition
   ___ Batteries in working order and in place
   ___ Check for loose pedals and tighten as needed
   ___ Make sure seat is not loose; tighten as needed
   ___ Make sure maintenance kit is in box
   ___ Check belt for excessive wear and replace if needed
   ___ Proper calibration

Weekly Check:
   ___ Wipe down with a disinfectant at least once a week (do not spray directly on ergometer)
APPENDIX D.
EXERCISE TEST TERMINATION CRITERIA

All exercise testing will be conducted under staff supervision. The PWC exercise test should be terminated if any of the following signs or symptoms of exercise intolerance or mechanical failure occurs. If the test is prematurely terminated, the reason should be noted in #13 on the MFI data collection form.

1. Breathlessness or unusual shortness of breath
2. Cold clammy skin
3. Dizziness
4. Extremely high heart rate (>190 beats/min)
5. Facial flushing
6. Leg fatigue, pain, cramp
7. Pallor (touch skin and color slow to return)
8. Participant requests to stop
9. Unable to keep up pedal rate
10. Vertigo
11. Signs of poor perfusion: lightheadedness, confusion, ataxia, pallor, cyanosis, nausea, or cold and clammy skin.
12. Failure of heart rate to increase with increased exercise intensity.
13. Physical or verbal manifestations of severe fatigue.
14. Failure of the testing equipment.