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RELATIONSHIP AMONG MOTOR SKILL DEVELOPMENT, AEROBIC CAPACITY, BODY COMPOSITION, AND PERCEIVED COMPETENCE OF FOURTH GRADE SCHOOL CHILDREN

presented by

Sheila Kathleen Kelly

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Crystal F. Branta
Major Professor's Signature

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# RELATIONSHIP AMONG MOTOR SKILL DEVELOPMENT, AEROBIC CAPACITY, BODY COMPOSITION, AND PERCEIVED COMPETENCE OF FOURTH GRADE SCHOOL CHILDREN

By

Sheila Kathleen Kelly

A DISSERTATION

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ABSTRACT

RELATIONSHIP AMONG MOTOR SKILL DEVELOPMENT, AEROBIC CAPACITY, BODY COMPOSITION, AND PERCEIVED COMPETENCE OF FOURTH GRADE SCHOOL CHILDREN

By

Sheila Kathleen Kelly

A few important potential barriers to participation in physical activity that have been identified are the lack of motor skills, low fitness levels, and low perceived competence of children and adolescents (Hands, Parker, & Larkin, 2002). If these barriers are reduced and children and adolescents have positive physical activity experiences while young, youth may be more likely to not only become physically active, but maintain physical activity levels throughout the lifespan (Dennison, Straus, Mellits, & Charney, 1988; Taylor, Blair, Cummings, Wun, & Malina, 1999). There is limited evidence examining the interrelationships among these three variables. Therefore, the purpose of this study was to examine the relationship among fundamental motor skill development (of both locomotor and object-control skills), health-related fitness level (measured by aerobic capacity and body composition), and perceived competence (measured by subscales/domains) of fourth grade students. Participants in this study were 137 fourth grade children (67 males and 70 females) from three schools. Using two assessments from the *FITNESSGRAM* (Cooper Institute for Aerobic Research, 2007), the participants took part in the PACER to measure their aerobic capacity, and their height and weight measurements were taken to determine their body mass index (BMI) as the measure of body composition. The Test of Gross Motor Development-2 (TGMD-2; Ulrich, 2000) was administered to assess the locomotor and object-control fundamental motor skill performance of the participants on 12 skills. Participants' perceived competence in six domains was calculated from scores on the Self-Perception Profile for Children (SPPC; Harter, 1985). According to *FITNESSGRAM* guidelines, 29.5% of participants fell below the standards for aerobic capacity and 29% were considered at an unhealthy weight. Mean TGMD-2 and SPPC scores of the participants were high. Stepwise regression results indicated the most significant predictor variables in various tests were aerobic capacity, object-control skill performance, and the SPPC academic, athletic, and physical appearance domains. Two revised figures (for boys and girls) of the model proposed by Stodden et al. (2008) are introduced for fourth grade students to include the results from this study and potential relationships to physical activity. Although more research is needed for the relationship among these three variables, these findings indicate that children and adolescents should maintain a healthy BMI, increase their aerobic capacity, and engage in fundamental motor skill development (especially object-control skill development) at a young age. Parents, teachers, and coaches should encourage this behavior as well as focusing on enhancing the children's and adolescents' competence in different areas (particularly academic and athletic).

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# CHAPTER ONE

## Introduction

Inadequate physical activity in children is a health-related concern as it is one of the main contributors to childhood obesity (Fox, 2004; Goran, Reynolds, & Lindquist, 1999; Hills, King, & Armstrong, 2007; Reilly & McDowell, 2003). The most recent estimates indicate that 35.5% of children ages 6 to 11 are overweight and 19.6% are considered obese (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). These rates have nearly tripled in the past few decades (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). Although the increase has been minimal in the last few years, there is still a need to focus on reducing these rates given the relatively high prevalence rates and adverse consequences. Given the importance of physical activity in reducing obesity (and for general health, development, and well-being of the child), examining the determinants to participation in physical activity is an important area of research. A few important potential barriers that have been identified are the lack of motor skills, low health-related fitness levels, and low perceived competence of children and adolescents (Hands, Parker, & Larkin, 2002). If these barriers are reduced and children and adolescents have positive physical activity experiences while young, physically active youth may be more likely to maintain physical activity levels throughout the lifespan (Dennison, Straus, Mellits, & Charney, 1988; Taylor, Blair, Cummings, Wun, & Malina, 1999).

There are numerous benefits of an active lifestyle (Surgeon General Report, 1996; Strong et al., 2005). In children, regular physical activity and appropriate nutrition are necessary for normal growth and development of physical fitness, which includes body composition (Strong et al., 2005; Thomas & Thomas, 2008). Lack of activity is a concern because people who are physically inactive may incur health problems such as becoming overweight or obese which increase one's risk of many diseases and health conditions (CDC, 2009). Childhood obesity is associated with a range of physical, social, and psychological consequences, including poor self-esteem, depression, and social isolation (Daniels, Jacobson, McCrindle, Eckel, & Sanner, 2009; Jackson, Mannix, Faga, & McDonald, 2005).

One major reason for encouraging children to be physically active at a younger age is the implications for future physical activity involvement and health benefits. Youth who are inactive as children and adolescents are more likely to grow up to be sedentary adults than youth who are active (Corbin, Pangrazi, & Le Masurier, 2004). However, the magnitude of these findings is weak (Zimmermann-Sloutskis, Wanner, Zimmerman, & Martin, 2010), and additional evidence has identified a genetic component linking physically active adults to more physically active children (Teran-Garcia, Rankinen, & Bouchard, 2008). Lack of physical activity may contribute to childhood obesity, which is the foremost predictor of obesity in adolescence (Salbe et al., 2000). In turn, obese children have a higher tendency to become overweight adults (Saxena, Borzekowski, & Rickert, 2002).

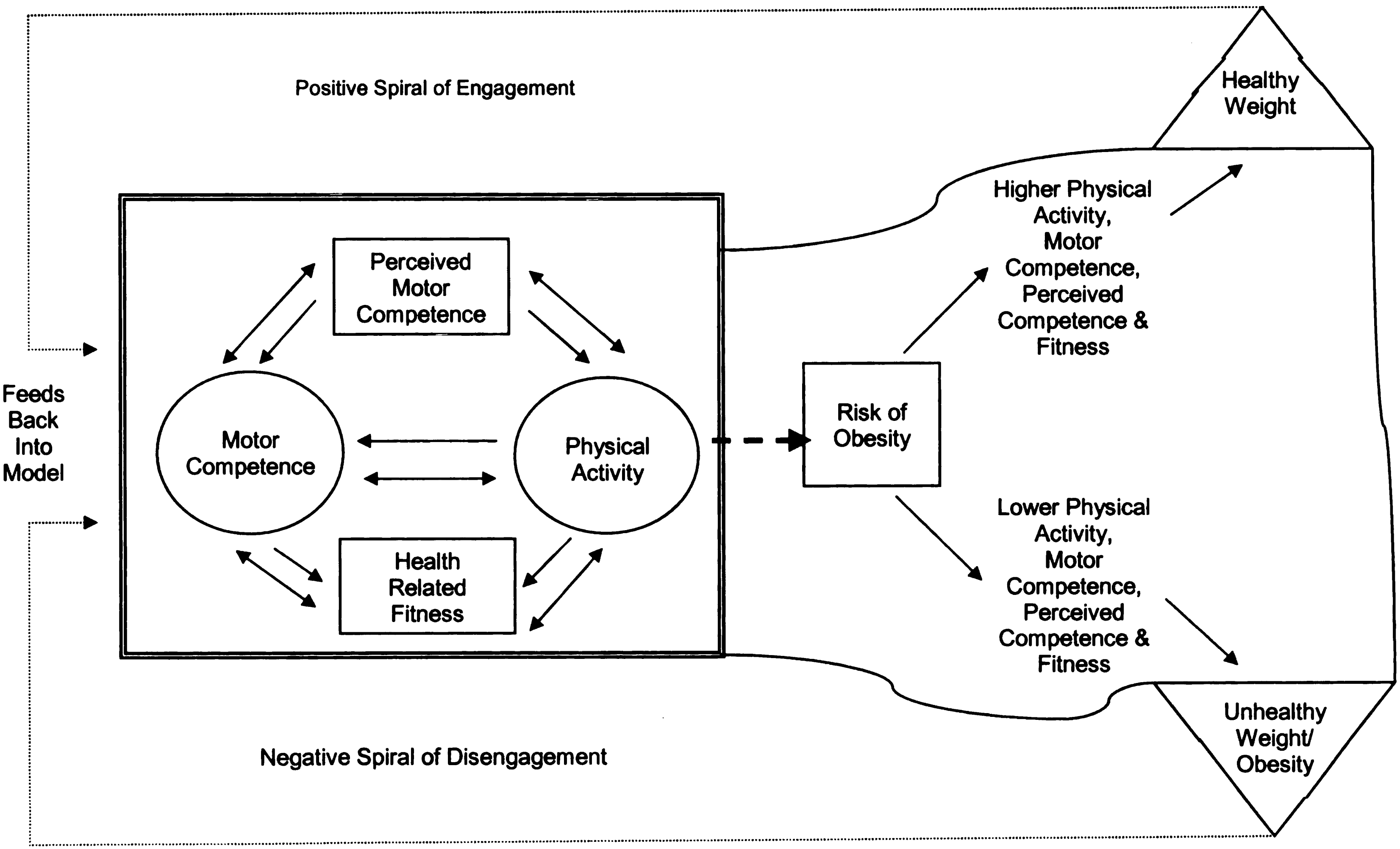
Many factors explain a child's participation in physical activity, which may influence the child's ability to achieve and maintain a healthy weight. One way to approach understanding the determinants of physical activity is by examining the model proposed by Stodden and colleagues (2008; Figure 1). The four main components (motor skill competence, perceived motor competence, health-related fitness, and physical activity) in the inner square of the model are all interrelated and lead to the risk of obesity of children.

*Motor Skill Development of Children*

Motor skill competence in this model refers to proficiency in common fundamental motor skills, which include both locomotor and object control skill development (Stodden et al., 2008). From birth through childhood individuals experience the development of human movement; and as they grow and mature into adolescents, they continue to refine and practice skills learned at younger ages depending on the activities they choose. In general, younger children will demonstrate less advanced movement patterns for fundamental motor skills than older children, but there is variability in the skill level at each age (Thomas, Thomas, & Williams, 2008). Clark and Metcalfe (2002) hypothesized a "mountain of motor development" in which fundamental motor skills must first be learned before individuals can progress into context-specific skills or skillful movements at higher levels of the mountain. Age was often used as a general

Figure 1

*Developmental Mechanisms Influencing Physical Activity Trajectories of Children* (Stodden et al., 2008)



marker of performance and development; however, age does not cause a child to perform motor skills at a certain level and not all children at any given age will demonstrate the same level of motor skill development (Thomas, Thomas, & Williams, 2008). The Test of Gross Motor Development-2 (TGMD-2; Ulrich, 2000) was used in this study to identify the motor skill performance level of the participants on a variety of locomotor and object-control skills. Stodden et al. (2008) suggested that young children's activity might drive their development of motor skill competence, and that the relationship between motor skill competence and physical activity will strengthen over time. However, there are other variables in this relationship to consider as well.

*Health-Related Fitness Levels of Children*

Stodden et al. (2008) identified health-related fitness as a possible mediator in the relationship between motor skill competence and physical activity. Therefore, motor skill competence could influence health-related fitness, which may then influence physical activity, and vice versa. Although children learn fundamental motor skills in early childhood (2 to 5 years of age), it is not until middle childhood that they demonstrate the intermediate to high levels of motor skill competence (Stodden et al., 2008). Therefore, Stodden et al. (2008) suggested that at this point the increased levels of motor skill development should correspond with increased physical activity levels, greater health-related fitness, and higher performance scores. Based on a pilot study (discussed later in this chapter), the two components of health-related fitness which were examined in this study are aerobic capacity and body mass index (as a measure of body fatness).

*Perceived Competence of Children*

Perceived competence was considered an important factor to examine in the fourth grade, when children are typically ages nine or ten. Children's judgments of their competence in the motor domain are not always accurate compared to their actual motor competence (Stodden et al., 2008). However, during mid-childhood, individuals have higher levels of cognitive development and their perceived motor skill competence is more likely to reflect their actual motor skill competence (Harter, 1999). At this point less-skilled children will have lower perceived competence and more-skilled children will have higher perceived competence (Stodden et al., 2008). Stodden et al. (2008) only identified perceived motor competence in their model, but there may be other areas of perceived competence (e.g., academic, physical appearance, athletic, social acceptance) that relate to the other variables previously discussed. Therefore, the Self-Perception Profile for Children (SPPC; Harter, 1985) was used in this study to identify how self-perceptions in different domains of a child's life contribute to the model proposed by Stodden et al. (2008). The SPPC has been broken into six subscales (or domains): (a) academic competence; (b) social/peer acceptance; (c) athletic competence; (d) physical appearance; (e) behavioral conduct; and (f) global self-worth. Although not all of the six subscales are linked to the factors in the model (Stodden et al., 2008), all questions from the SPPC were included in the perceived competence assessment. In fourth grade, children may still find it difficult to differentiate between the subdomains and determine in what areas they feel more competent. In addition, the subscales are highly correlated, and the entire SPPC does not take much longer to complete than if only selected subscales were included in the study. Therefore, all subscales were kept in the SPPC to examine not only the factors predicted to be related to the other variables in the model, but also those factors that are not apparent in the current literature for exploratory reasons.

*Justification for the Study*

Past studies have examined the associations between health-related fitness levels and motor skill development (Hume et al., 2008; Okely, Booth, & Chey, 2004; Okely, Booth, & Patterson, 2001b), health-related fitness levels and psychological factors (Davison & Birch, 2001; Strauss, 2000), and motor skill development and psychological factors (Okely, Booth, & Chey, 2004; Bunker, 1991; Ulrich, 1987). However, to my knowledge no published studies have examined the interrelationships among these three variables. Although the levels of competence of fitness and motor skills have been examined, an individual's perceived competence may be different from his or her actual competence levels. If the perceived competence levels are accurate with actual levels of competence, whether the competence is high or low may ultimately influence physical activity levels. For example, research has shown that children with higher perceived competence and actual competence levels are more likely to have higher physical activity levels than children with lower perceived competence (Barnett, Morgan, van Beurden, & Beard, 2008; Bois, Sarrazin, Brustad, Trouilloud, & Cury, 2005). With the lack of physical activity playing a large role in the current childhood obesity epidemic, the potential factors and psychological repercussions that inadequate physical activity may cause must be identified.

In fourth grade, most children are ages 9 to 11. Most basic movement patterns are established from ages 2 to 10 (Bunker, 1991). Therefore, fundamental motor skills have been learned by children in fourth grade, but the children have not yet reached their peak proficiency for motor skill development of all the fundamental locomotor and object-control skills. The majority of children have also not begun puberty, which causes dynamic growth and development that would influence performance on fitness tests, motor skill assessment, and results on psychological batteries. In addition, due to cognitive development increases, the perceived competence of children is more accurate compared to their actual competence (Stodden et al., 2008). Overall, this is a crucial time to instill a healthy lifestyle in the children's lives, if not before, because overweight and obesity in youth has been shown to start as early as infancy (Ogden et al., 2010).

*Pilot Study*

Recently, a pilot study was conducted to examine the relationship among motor skill development, health-related fitness, and perceived competence. Specifically, the purpose of the pilot study was to address the gaps in the literature (described in the justification for the current study) and investigate the relationship between stage of motor skill development and health-related fitness in children. The role of perceived competence across the six subscales (i.e., academic competence, social acceptance, athletic competence, physical appearance, behavioral conduct, and global self-worth) was also addressed, and the overall relationship between motor skill development, health-related fitness, and perceived competence was to be identified. Specific questions were asked including, what is the relationship between motor skill level and fitness? What is the relationship between motor skill levels and perceived competence? What is the relationship between fitness and perceived competence? Does a gender difference exist among the relationships of motor skill development, health-related fitness, and perceived competence? What is the relationship among motor skill level, fitness, and perceived competence? Participants included 147 students (63 males, 84 females).

Results showed that scores from the TGMD-2 and SPPC were relatively high, and scores from the *FITNESSGRAM/ ACTIVITYGRAM* (hereafter referred to as *FTG*) covered a broad range based on the skill performed. Overall, participants who scored higher on motor skills also had higher levels of physical fitness and higher perceived competence. Participants who scored highest on perceived competence subscales scored highest on the *FTG* tests, compared to those participants in the moderate and low perceived competence groups. Fundamental motor skills scores and fitness levels were also higher for those participants with lower BMIs compared to participants with higher BMIs. Males had higher scores than females on aerobic capacity measured by the PACER (Progressive Aerobic Cardiovascular Endurance Run), object-control skills on the TGMD-2, and in three subscales on the SPPC (i.e., athletic competence, global self-worth competence, and peer acceptance competence). Females scored higher than males on the SPPC behavioral competence subscale, locomotor skills on the TGMD-2, and on three *FTG* tests (i.e., left leg sit-and-reach, trunk lift, and curl up).

This study was beneficial and showed feasibility as a starting point to the current proposed study, as it allowed for testing of the TGMD-2 and Harter's SPPC in a fourth grade sample. Both measurements were feasible in the school setting, and issues that arose in the data collection were addressed in the methodology of the current study. The *FTG* is already a commonly used test battery in fourth grade. In the pilot study, *FTG* scores for each participant were retrieved from the physical education teacher, which was a limitation since the testing had been done that year but not at the time of the TGMD-2 and Harter's SPPC collection. Therefore, all data collection in the current study occurred within six weeks to control for changes that could occur throughout a longer period of time. The pilot study results also revealed a subset of significant variables within the *FTG*, and therefore, only aerobic capacity (PACER) and body composition (BMI) were included as fitness components in the current study, rather than all tests included in the *FTG*.

*Purpose*

The purpose of this study was to examine the relationship among fundamental motor skill development (of both locomotor and object-control skills), health-related fitness level (measured by aerobic capacity and body composition), and perceived competence (measured by subscales/domains) of fourth grade students. In addition, any differences between males and females were addressed. Although the races/ethnicities of the individual participants were not attainable, general race/ethnicity information was collected from the schools to relate to the variable for exploratory purposes.

*Hypotheses*

The following hypotheses were developed for the study:

1. a. BMI, aerobic capacity, locomotor and object-control skill performance of participants will account for a significant percentage of the variance in athletic and physical appearance perceived competence.

   b. BMI, aerobic capacity, locomotor and object-control skill performance of participants will not account for a significant percentage of variance in the academic competence, peer acceptance, behavioral conduct, and global self-worth.

2. a. BMI and locomotor skill performance of participants will account for a significant percentage of the variance in aerobic capacity.

   b. Object-control skill performance of participants will not account for a significant percentage of the variance in aerobic capacity.

3. a. Aerobic capacity, locomotor skill performance, object-control skill performance, and the athletic and physical appearance perceived competence of participants will account for a significant percentage of the variance in body mass index.

   b. Object-control skill performance and the academic competence, peer acceptance, behavioral conduct, and global self-worth of participants will not account for a significant percentage of the variance in body mass index.

4. a. BMI, aerobic capacity, and the athletic and physical appearance perceived competence of participants will account for a significant percentage of locomotor skill performance.

   b. The academic competence, peer acceptance, behavioral conduct, and global self-worth of participants will not account for a significant percentage of locomotor skill performance.

5. a. BMI, aerobic capacity, and the athletic and physical appearance

perceived competence of participants will account for a significant percentage of object-control skill performance.

b. The academic competence, peer acceptance, behavioral conduct, and global self-worth of participants will not account for a significant percentage of object-control skill performance.

*Definition of Terms*

- Children: males and females ages 6 to 11. However, Malina (2004) states the range of adolescence for girls is ages 8 to 19, and for boys is ages 10 to 22 based on the onset of puberty to maturity. Therefore, some children in the proposed study may be transitioning into adolescence.
- *FITNESSGRAM/ACTIVITYGRAM* Healthy Fitness Zone (HFZ): the range of fitness scores associated with good health based on scientific information (Welk & Meredith, 2008).
- *FITNESSGRAM/ACTIVITYGRAM* "Needs Improvement" scores: scores above or below the HFZ. Efforts are needed to bring the score into the HFZ (Welk & Meredith, 2008).
- Overweight: Body mass index (BMI) between the $85^{th}$ and $95^{th}$ age- and sex-specific percentiles according to the CDC (2009). A child or adolescent may also have an unhealthy body weight if his or her body composition score is above the *FTG* HFZ, as determined using the

*FTG* cutoff points although the *FTG* does not distinguish between overweight and obese.

- Obese: BMI greater than or equal to the $95^{th}$ age- and sex-specific percentile according to the CDC (2009). A child or adolescent may also have an unhealthy body weight if his or her body composition score is above the *FTG* HFZ, as determined using the *FTG* cutoff points although the *FTG* does not distinguish between overweight and obese.
- Perceived Competence: individuals' perceptions of their competencies or abilities in specific domains (Harter, 1982). Unless a specific "perceived competence" is explicitly stated (e.g., perceived motor competence), "perceived competence" is a general term including different domains of perceived competence.
- Physical Activity: any body movement produced by the skeletal muscles that results in a substantial increase over the resting energy expenditure (Bouchard & Shephard, 1994).
- Sport: a form of physical activity that involves competition (Bouchard & Shephard, 1994).
- Exercise: a form of leisure-time physical activity that is usually performed on a repeated basis over an extended period of time with a specific external objective such as the improvement of fitness, physical performance, or health (Bouchard & Shephard, 1994).

- Health-Related Fitness: a state characterized by (a) an ability to perform daily activities with vigor and (b) demonstration of traits and capacities that are associated with a low risk of premature development of hypokinetic diseases and conditions (Bouchard & Shephard, 1994). The specific components and examples of subcomponents are discussed in the next chapter.

# CHAPTER TWO

## Review of Literature

This review of literature examines the current research about physical activity, specifically relating to motor skill development, health-related fitness, and perceived competence. An overview of physical activity levels in children and adolescents will first be given. Although data on physical activity levels of youth were not collected in this study, this overview will show the importance and relationship of physical activity to the variables included in the study. In addition, information related to gender and race/ethnicity has also been included as that additional information about the children was collected. After the initial overview of physical activity and pediatric obesity, each variable (i.e., health-related fitness, motor skill development, and psychological factors) has been introduced independently, and then the research describing the relationships between the factors have been discussed. Finally, the purpose of this study was stated.

### *Physical Activity Levels in Children and Adolescents*

*Age-related Trends during Childhood and Adolescence.* Currently, physical activity levels among children have been shown to be moderate to low in relation to the recommended activity levels for children. Strong et al. (2005) recommended that all school-age youth should participate daily in 60 minutes or more of moderate to vigorous physical activity that is developmentally appropriate, enjoyable, and involves a variety of activities. This amount of activity could accrue throughout the day including physical activities during physical education, recess, intramural sports, before and after school programs, and personal exercise or play (Strong et al., 2005).

In general, children's levels of physical activity are higher relative to adults' physical activity levels, but these levels continue to decrease as children enter adolescence. Bradley, McMurray, Harrell, and Deng (2000) found that the activity levels of boys and girls decreased each year between third and tenth grade. The Youth Risk Behavior Survey (YRBS) showed that only 45% of United States youth ages 14 to 18 years (typically the ages adolescents are in high school) participate in moderate-intensity physical activity for 30 minutes on more than two days per week, and only 65% reported participating in vigorous-intensity physical activity for 20 minutes on three or more days per week (Lohman, Going, & Metcalfe, 2004). Due to this concern, one of the ten leading health indicators for the Healthy People 2010 objectives is physical activity (Crespo, 2005). Although many studies have reported physical activity levels of children and adolescents, one major limitation in the comparisons between studies is the measurement tool used. Methods to collect physical activity data range from those used in larger scale studies, such as self-reporting physical activity, that are not always reliable and valid, to more accurate measures, such as the use of accelerometers or pedometers. Troiano et al. (2008) compared the different measures of physical activity and found that in a nationally representative health survey, the accelerometer data were qualitatively consistent with the self-report data. Males were more active than females and the level of physical activity decreased with age, especially during adolescence (Troiano et al., 2008). However, differences arose when comparing adherence to recommended levels of physical activity, in which the self-reported data showed participants claimed higher levels of physical activity than the actual levels measured by accelerometer data (Troiano et al., 2008). Therefore, more objective means of measuring physical activity should be used whenever possible.

*Factors that influence physical activity levels in children and adolescents.* Various factors contribute to the challenge of getting youth to engage in physical activity, sport, and exercise, and to explain the reasons why they participate or choose not to participate in physical activity. Weiss, Corbin, and Pangrazi (2000) suggested three motives about why children and adolescents continue and sustain exercise: (a) they want to develop and demonstrate physical competence, such as athletic skills, physical fitness, and physical appearance; (b) they want to gain peer acceptance and support including friendships, peer group acceptance, and approval, reinforcement, and encouragement by significant adults (parents, teachers, coaches); and (c) their positive experiences related to physical activity are maximized and their negative experiences related to physical activity are minimized because of the fun derived from participation. Whatever a child's reason for participating, it is beneficial for him or her to get involved at a young age, and for those experiences to be as positive as possible.

*Benefits of physical activity.* Encouraging a healthy lifestyle and regular physical activity can influence a person's future behavior. Inactive youth are more likely to be sedentary adults compared to youth who are active (Corbin, Pangrazi, & Le Masurier, 2004); however, tracking of physical activity is difficult to measure and relationships are low to moderate. Studies of adolescents and adults have found that those who had positive and enjoyable experiences with exercise while they were younger were more likely to continue to exercise as they got older (Hands, Parker, & Larkin, 2002). Therefore, children should be introduced to a healthy lifestyle at a young age, and elementary school is a crucial time to begin teaching the importance of physical activity, which can lead to both physical and psychological benefits.

Regular participation in physical activity has many health benefits for children and adolescents. Strong and colleagues (2005) were part of an expert panel which reviewed the current research regarding the influence of physical activity on health and behavioral outcomes in children and adolescents ages 6 to 18 years. They concluded that physical activity decreased adiposity among overweight individuals, may have a positive effect on high-density lipoprotein cholesterol levels (HDL-C), triglyceride levels and skeletal health, may reduce high blood pressure among hypertensive adolescents, leads to greater upper body muscular endurance, and shows better levels of aerobic fitness and improved mental health and academic performance in youth (Strong et al., 2005). Nelson and Gordon-Larsen (2006) found that participation in a range of physical activity-related behaviors, particularly those which included parental sports/exercise involvement, was associated with positive adolescent risk profiles including reduced participation in activities with health risk behaviors and enhanced positive health outcomes such as higher self-esteem and academic performance.

The type of physical activity youth participate in is important to their participation and the benefits that result from physical activity. Most preadolescent children find periods of defined exercise boring or punitive (Barlow & Dietz, 1998). Non-structured moderate intensity exercise seems to contribute to most of the disease- prevention goals and health-promoting benefits (Sothern, Loftin, Suskind, Udall, & Blecker, 1999). For young children, unstructured outdoor play with friends is often vigorous, and children can also reach this high level of physical activity by engaging in organized sports, as long as they are active in the game and not sitting on the bench (Barlow & Dietz, 1998). Therefore, children should be encouraged to become involved in both informal "play" activities and formal organized sports, and physical education should be structured in a way that promotes this idea as well. Berkey and colleagues (2003) found that specifically for 10- to 15-year-old girls and overweight boys, increasing total recreational physical activity over one year was associated with a relative BMI decline. Although contributions about individual and group results in the literature are beneficial, Flegal and Troiano (2000) suggested seeking to understand what factors are causing increases in BMI in the population as a whole as opposed to comparing obese and non-obese individuals.

### *Pediatric Obesity*

*Body mass index (BMI) as a body composition measurement to determine overweight/obesity.* The body mass index (BMI) is a common measure expressing the ratio of weight-to-height. It provides an indication of the appropriateness of a child's weight relative to height, but does not estimate the percentage of fat (Cooper Institute for Aerobic Research, 2007). BMI is found by computing the following formula: weight (kg) / height squared ($m^2$), and it changes from infancy through childhood to adolescence.

The Centers for Disease Control and Prevention (CDC, 2009) defines overweight and obesity using age- and sex-specific BMI percentiles. An adult who has a BMI between 25 and 29 $kg/m^2$ is considered overweight, while an adult who has a BMI of 30 $kg/m^2$ or higher is considered obese. For children and adolescents, high BMI scores are also referred to as overweight and obese. Unlike BMI of adults, the distribution of BMI changes with age as weight and height distributions change, and therefore, calculations for children and adolescents take into account age-specific body fat fluctuations and developmental differences between boys and girls, as specific BMI-for-age calculations are used (Barlow & the Expert Committee, 2007; Defining and Diagnosing Obesity, 2005). BMI-for-age is plotted on a growth chart which determines in which percentile a child or adolescent's score falls. According to a report which included over 300 studies related to the assessment of child and adolescent overweight and obesity, the CDC 2000 growth charts provide the best reference data available for the growth of US children (Krebs et al., 2007). The CDC has charts for boys and girls from birth to age 20 for BMI, height, and weight percentiles (CDC, 2009). Data on White, Black, and Mexican American children and adolescents in the United States was used to develop the CDC BMI-for-age growth charts (Guo, Wu, Chumlea, & Roche, 2002). The weight status category as determined by the BMI-for-age percentiles for children and adolescents is shown in Table 1.

Table 1

*CDC weight status category by BMI-for-age percentiles of children and adolescents*

| Weight Status Category | Percentile Range |
|---|---|
| Underweight | Less than the 5th percentile |
| Healthy Weight | 5th percentile to less than the 85th percentile |
| Overweight | 85th percentile to less than the 95th percentile |
| Obese | Equal or greater than the 95th percentile |

The CDC changed this terminology in 2005 from "at-risk for overweight" if the BMI of the child/adolescent fell between the 85th and 95th percentile, and "overweight" if the BMI of the child/adolescent was equal or greater than the 95th percentile. This change resulted from the seriousness, urgency, and medical nature of childhood obesity, and the need to take action on the issue (Krebs et al., 2007).

The American Academy of Pediatrics recommends that physicians calculate and plot BMI-for-age once a year for all children and adolescents and monitor change to assess those that are overweight or obese (Barlow & the Expert Committee, 2007). A committee of pediatric obesity experts recommended that children with a BMI greater than or equal to the 85th percentile (with complications of obesity) or greater than or equal to the 95th percentile (with or without complications of obesity), undergo evaluation and possible treatment and that treatment begins early, involves the family, and includes permanent changes (Barlow & the Expert Committee, 2007).

*Prevalence of overweight and obesity in children and adolescents.* The childhood obesity rates have continued to rise over the years, and although the percentages have not increased drastically over the past couple years, 19.6% of children ages 6 to 11 and 18.1% of adolescents ages 12 to 19 were still considered obese in 2006, and even more are overweight (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). These levels are still a concern for the health and well-being of children and adolescents.

*Consequences of childhood obesity.* A child or adolescent with a high BMI percentile on the CDC BMI-for-age growth charts has a high risk of being overweight or obese at 35 years of age, and the risk increases with age (Guo, Wu, Chumlea, & Roche, 2002). Dwyer and colleagues (1998) found that the strongest predictor of overweight and overfatness among 11-year-olds was being overweight at age 9, and Salbe et al. (2002) found this result for 5- to 10-year-olds as well. Although the risk of being overweight or obese is less in children than adults, research shows children diagnosed with obesity at seven years of age will have an elevated relative risk, of about three, of becoming obese in adulthood (Wickramasinghe et al., 2005). Therefore, the younger children can confront any overweight/obese issues, the better off they will be in the future.

Physical inactivity may cause health problems and a child who is overweight or obese has an increased risk of many diseases and health conditions. These consequences can be classified into short-term or long-term. Short-term consequences that occur in many obese youth include hypertension, dyslipidemia (for example, high total cholesterol of high levels of triglycerides), type 2 diabetes, sleep disturbances such as sleep apnea, respiratory problems, and adverse effects on growth (CDC, 2009). Many overweight or obese children also face immediate psychological effects such as low self-esteem or negative body image. Possible long-term factors, which do not occur until later in life, include increased risk of coronary heart disease, stroke, gallbladder disease, osteoarthritis, high cholesterol, orthopedic problems (e.g., bowed legs, stress fractures, bone deformities), and some cancers such as endometrial, breast, prostate, and colon (Black, 2004; CDC, 2009).

Childhood obesity has also been found to result in glucose abnormalities leading to type 2 diabetes (Saxena, Borzekowski, & Rickert, 2002). Heavier children are at greater risk for type 2 diabetes and for higher levels of fasting glucose and insulin related to body fatness, physical inactivity, and low fitness levels (Lohman, Going, & Metcalfe, 2004). The insulin resistance caused by obesity can cause what was once termed adult-onset diabetes. However, with the dramatic increase in adult-onset diabetes in children, it has been renamed Type 2 diabetes, and is one of the most publicized consequences of the childhood obesity epidemic. The American Diabetes Association estimates that one in three children born after the year 2000 will develop diabetes before reaching age 50 (Glendening, 2005). One of the ways to combat Type 2 diabetes is by increasing physical activity to help lower overweight and obesity levels.

Various studies have also examined the long and short-term psychosocial consequences of childhood obesity. These consequences include negative self-image, decreased self-esteem, eating disorders, and lower health-related quality of life (Strauss, 2000; Davison & Birch, 2001). Obese children may also face rejection and discrimination from other children and adults, including teachers, and tend to experience more failure and have poor interpersonal relationships (Black, 2004). However, not all studies show psychosocial consequences due to obesity. Swallen, Reither, Haas, and Meier (2005) investigated the health-related quality of life of adolescents using the National Longitudinal Study of Adolescent Health (a nationally representative sample of adolescents in grades 7 to 12) and found that although obesity in adolescence was linked to a poor physical quality of life, the obese adolescents did not have poorer emotional, school, or social functioning.

*Gender & Race/Ethnicity differences in obesity and physical activity.* Gender and race/ethnicity may be factors that contribute to whether or not a child is overweight or obese. Certain ethnic groups may face unique sets of factors for becoming overweight or obese (Haas et al., 2003). In addition, the differences in gender and race/ethnicity may also contribute to the physical activity levels or certain barriers to physical activity of individuals.

Gender differences have been commonly studied in the childhood obesity and physical activity literature. Various studies have reported more overweight males than females (Celi et al., 2003; Dwyer, Allison, & Makin,1998, and Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). However, Celi et al. (2003) found that although the overweight rates were different, obesity rates were similar between males and females, and Pena Reyes et al. (2001) found that the prevalence of obesity was greater in boys than girls.

According to the most recent CDC NHANES data (2003-2006) based on the CDC sex-and-age specific body mass index (BMI) greater than or equal to the 95$^{th}$ percentile indicating obesity, there is a difference in the percentages of obese children 6- to 11-years-old based on race/ethnicity and gender. These numbers are based on the children who had a BMI in the 95$^{th}$ percentile or higher on the CDC growth chart. For non-Hispanic White children, 11.9% of boys and 12.0% of girls were obese. The percentage for obese non-Hispanic Black children equaled 17.6% of boys and 22.1% of girls. For Mexican American children, 27.3% of boys and 19.6% of girls were obese. This number continues to grow for most groups among adolescents ages 12 to 19. The following percentages for adolescents also show the most recent CDC NHANES data (2003-2006) according to the same standards to determine obesity. For non-Hispanic White children, 17.3% of boys and 14.5% of girls were obese. The percentage for obese non-Hispanic Black children was 18.5% of boys and 27.7% of girls. For Mexican American children, 22.1% of boys and 19.9% of girls were obese.

In other smaller studies, varied results were found related to race/ethnicity and gender trends for overweight/obesity. The obesity rates among minority children exceed the obesity rates among White children (Saxena, Borzekowski, & Rickert, 2002). Dwyer et al. (1998) found that the prevalence of overweight and triceps skinfold thickness was greater among African American children than among White children. Black adolescent females are almost twice as likely as White adolescent females to be overweight (Saxena, Borzekowski, & Rickert, 2002). Haas et al. (2003) found that for children ages 6 to 11, boys were more overweight than girls, and Latinos and Blacks had a greater likelihood of being overweight. For adolescents ages 12-17, boys were more overweight than girls, and Latinos and Asian/Pacific Islanders had higher prevalence of overweight (Haas et al., 2003). Thorpe et al. (2004) also found a high rate of overweight among Hispanic children, particularly Hispanic boys. Mexican-American children and adolescents have increased rates of obesity, insulin, resistance, and type 2 diabetes than non-Hispanic White youth (Gomez, Johnson, Selva, & Salis, 2004).

Overall, in general boys are more likely to be overweight or obese than girls (especially in childhood), and African American, Mexican-American, Latino, Hispanic, and Asian/Pacific Islander children and adolescents have a higher overweight/obesity prevalence than White youth. Some researchers hypothesize that these differences may be due to lifestyle, acculturation, and cultural beliefs and practices (Haas et al., 2003).

Race/ethnicity and gender differences in youth are also seen in levels of physical activity and inactivity. There are various reasons for physical activity level differences between males and females. One study showed that boys were significantly more active than girls across all age groups for children aged 7- to 14-years, and for both boys and girls, the most active groups were 10-year-olds (Raustorp, Pangrazi, & Stahle, 2004). In a study examining overweight children, Zabinski et al. (2003) found that overweight girls reported higher body-related barriers to physical activity than overweight boys and indicated body consciousness and concern about others seeing their bodies while being active as the most common type of barrier to physical activity.

Gender differences have also been seen in physical activity intensity levels. Participation in physical activities, particularly the more vigorous activities, is generally lower in females than in males (Hands, Parker, & Larkin, 2002). Robinson and Thomas (2004) also found that girls participated in more low-intensity physical activity, but boys participated in more high-intensity physical activity than did girls. Andersen et al. (1998) supported that girls tended to participate less in vigorous activity than boys, and added that as girls get older there is a steady decline in physical activity; however, as boys get older the percent who participate in vigorous activity increases. Kohl and Hobbs (1998) believe these differences are related to the development of motor skills, body composition during growth, maturation levels and socialization toward sport and physical activity.

Girls in the United States are at a high risk for inactivity, which may be the cause of the statistics seen today regarding obese or overweight females. In 1970, only one out of every 21 girls was obese or overweight; today, one out of every six females is obese or overweight (National Center for Health Statistics, 2002). Cardiovascular disease is also the number one cause of death among all American women (44.6% of all deaths), and the death rate is 69% higher for African American women than for White women (American Heart Association, 2003).

Rates of inactivity have been found to be highest among minority youth, especially females (Saxena, Borzekowski, & Rickert, 2002). Anderson et al. (1998) identified that non-Hispanic Black and Mexican American children aged 8-to16-years were less likely to participate in vigorous physical activity than non-Hispanic Whites. Overall, according to the Youth Behavioral Risk Survelliance System (YRBSS; Grunbaum et al., 2004), 33.4% of students in grades 9 through 12 did not participate in sufficient physical activity. Insufficient participation was higher among Black females (50.4%), Hispanic females (42.6%), and White females (37.5%) compared with Black males (31.8%), Hispanic males (30.3%), and White males (24.8%). By comparing these percentages to the percentages of overweight and obese youth, there is clearly a connection in the statistics between overweight and obesity, and physical activity levels.

Cultural differences may also influence participation in physical activity. Yan and McCullagh (2004) investigated the differences in participatory motivation in physical activities among Chinese, American-born Chinese, and American children and adolescents ages 12 to 16. They found that American children and adolescents participate in sports or physical activities for competition and improving skills, Chinese children and adolescents participate because of social affiliation and wellness, and American-born Chinese children and adolescents participate because of travel, equipment use, and having fun (Yan & McCullagh, 2004).

### *Health-related Physical Fitness Levels of Children and Adolescents*

Many definitions for fitness exist. For the purpose of this study, the health-related fitness as defined by Bouchard and Shephard (1994) will be used. It is a state characterized by an ability to perform daily activities with vigor, and a demonstration of traits and capacities that are associated with a low risk of premature development of hypokinetic diseases and conditions (Bouchard & Shephard, 1994).

One aspect of improving the physical activity of children is improving health-related physical fitness levels. Benefits of fitness programs for children include: (a) an increase in their willingness to become more physically active due to a possible increase in physical ability; (b) improvements in the ability to self-regulate their physical activity levels when children participate in supervised fitness programs; and (c) the development of positive attitudes toward physical activity and fitness during childhood affecting their level of fitness during adulthood (Simons-Morton, Parcel, O'Hara, Blair, & Pate, 1988).

Bouchard and Shephard (1994) break down the components of health-related physical fitness into the following: morphological components, muscular components, motor components, cardiorespiratory components, and metabolic fitness components. There are various ways to test these areas. Some common assessments to measure these components include BMI (morphological component), muscular strength and endurance tests (muscular component), agility, speed of movement, and motor coordination (motor component), and submaximal exercise capacity (cardiorespiratory component). With the exception of metabolic component, the *FTG* is one assessment of these components for children and adolescents.

The *FTG* is a widely-used comprehensive health-related fitness and activity assessment and computerized reporting system, comprised of six major fitness areas with multiple performance task options for most areas to measure all components of physical fitness (Corbin & Pangrazi, 2008). The specific health-related physical fitness components assessed by the *FTG* test battery include aerobic capacity, abdominal strength and endurance, upper body strength and endurance, trunk extensor strength and flexibility, flexibility, and body composition. For the purpose of this study, the aerobic capacity and body composition components will be assessed.

*Cardiovascular Fitness Level and Assessment.* The assessment for cardiovascular fitness used by the *FTG* is the Aerobic Capacity Measurement. This measurement is used as opposed to other terms that are often used interchangeably (e.g., cardiovascular fitness, cardiovascular endurance, cardiorespiratory endurance, aerobic fitness, maximal aerobic power, aerobic work capacity, physical work capacity) because it refers to a functional (physiological) capacity. The field tests that are used to measure this functional capacity are validated compared to $VO_2$ max tests measured in a laboratory setting and the functional capacity is of most interest in relation to health (Cureton & Plowman, 2008). The three *FTG* test options for this measurement are the PACER, the one-mile run, and the walk test. For the purpose of this study, the PACER will be used because it is a fun alternative to distance run tests, and it is appropriate for this age group (Cureton & Plowman, 2008). The pilot study showed the feasibility of conducting the PACER in an indoor school setting. The one-mile run or one-mile walk tests will not be used because the participants may get bored and there may not be an appropriate facility for the test (because running or walking outside may not be an option depending on the weather). In addition, the one-mile run makes it very clear which students are slower than others (as they are the last to finish), which may affect a child psychologically. Students who are the last to finish during the PACER test are the students who perform better than those students who drop out of the test earlier due to fatigue. Barkoukis, Thogersen-Ntoumanis, Ntoumanis, & Nikitaras (2007) recommend that physical education teachers provide opportunities for all students to achieve and feel able in order to foster intrinsic interest and enjoyment. Because this testing will take place with children and in a physical education setting, it is important that a positive motivational climate is created or maintained.

*Body Composition.* Methods for estimating body composition in children and adolescents include underwater/hydrostatic weighing, Bod Pod, DEXA, anthropometry (skinfold measurement), bioelectrical impedance, and BMI. BMI is a simple, accurate and valid measure of fatness in childhood and adolescence (Dietz & Bellizzi, 1999). The American Academy of Pediatrics Expert Committee on obesity evaluation and treatment suggests BMI be used as the tool for the screening and classification of childhood obesity (Barlow & the Expert Committee, 2007), and the International Obesity Task Force supports the use of BMI to assess fatness in children and adolescents (Dietz & Bellizzi, 1999). BMI shows a strong correlation to skinfold thickness in children (Rowland, 1990) and to hydrostatic densitometry (Revicki & Israel, 1986).

The two options recommended by the *FTG* to assess body composition are skinfold measurements and BMI, because the laboratory method is not practical for use in the school setting. Laboratory methods require facilities with materials such as hydrostatic weighing equipment or a Bod Pod, which is uncommon in elementary, middle, and high schools. It is advantageous to use BMI because it is convenient, less expensive, not intrusive, and easy to calculate. The BMI and skinfolds HFZ ranges correspond to 25% fat for boys and 32% fat for girls, and are used in schools throughout the country to encourage health-related fitness (Lohman, Going & Metcalfe, 2004). BMI is the test selected for use by most schools, usually because teachers do not have sufficient training and experience in skinfold measurement. BMI is also easier to calculate with acceptable accuracy than skinfold measurements (Raustrop, Pangrazi, & Stahle, 2004). Although the 5.6% prediction error may make BMI less effective in identifying moderately overweight children (Lohman & Going, 1998), Pietrobelli et al. (1998) found BMI as a way to measure fatness in groups of children and adolescents, but cautioned about interpreting results when comparing BMI across age groups or predicting a specific individual's body fat.

While the CDC classifies children and adolescents into percentiles according to their BMI-for-age to determine overweight and obesity trends, the *FTG* identifies three categories related to BMI of youth aged 5 to 17. BMI scores falling within the HFZ are indicative of a healthy level of body composition. A BMI score that falls within the Needs Improvement range is above the HFZ and indicates that a child or adolescent weighs too much for his or her height. A BMI score that falls within the Very Lean range is below the HFZ and indicates that the child or adolescent's weight is too light for his or her height.

The BMI HFZ ranges may provide a better indication of body composition than height and weight charts (such as those provided by the CDC). The charts show percentiles that plot the distribution of BMI at a given age and can be used to identify children who are overweight, but they may not be overfat (Lohman & Falls, 2006). BMI based on the HFZ charts responds to the concern of a more muscular child. A child with more lean muscle mass will have a higher BMI based on growth charts that may classify him or her as falsely overweight when in reality, does not indicate an unhealthy level of fat. Therefore, a high BMI could be made up either by excess adipose tissue or by muscle hypertrophy, and the opposite is also true (Wickramasinghe et al., 2005).

*Muscular Strength/Endurance & Flexibility Fitness Levels.* The three remaining components of physical fitness are also measured in the FTG. These component assessments include testing for abdominal strength and endurance, upper-body strength and endurance, trunk extensor strength and flexibility, and another flexibility test. However, due to the lack of significant results from these tests in the pilot study (discussed below), these components will not be tested as part of this study.

### *Motor Skill Development of Children*

*Importance of Motor Skill Development.* A child's development of fundamental motor skills is important at a young age. Strong et al. (2005) concluded that during the preschool and early school ages general movement activities develop movement patterns and skills, and after that occurs and skills improve, health, fitness, and behavioral components of physical activities increase in importance. Fisher and colleagues (2005) tested preschool children and found that there was a significant but weak relationship between the habitual physical activity and fundamental movement skills of the participants. The mastery of fundamental motor skills may be an important factor in preventing unhealthy weight gain among children and adolescents (Okely, Booth, & Chey, 2004). Motor skill interventions at a young age may help improve fundamental motor skills and thereby increase physical activity levels. One such intervention was conducted with disadvantaged preschool children and results showed significantly greater improvements in fundamental motor skills (both locomotor and object-control) from pre- to post-intervention, as compared to the control group (Goodway & Branta, 2003).

Participation in sport and physical activity in general may have a positive influence on the fundamental motor skill level of children and adolescents as they get older as well. Ulrich (1987) found that children in grades K through four involved in organized sports performed selected movement ability tasks better than nonparticipants. Houwen, Hartman, and Visscher (2008) also found a positive correlation between physical activity and gross motor skill performance of children ages six to twelve. Thomas and French (1985) found that prior to puberty, physical activity and motor performance differences between boys and girls are minimal. A greater variability exists among boys and among girls, rather than between boys and girls, with most skill differences dependent on practice, opportunity, and interest (Thomas, Thomas, & Williams, 2008).

Fundamental motor skills are critical to participation in most physical activities because they are necessary for the behavioral competencies required for participation (Okely, Booth, & Chey, 2004). These skills are the basic building blocks for more advanced movements (Clark & Metcalfe, 2002), and by providing children with opportunities to explore these movements, it may help children learn the principles that underlie all sports (Bunker, 1991). For example, children must learn how to kick before they can participate in soccer, and in order to play basketball they need to learn basic fundamental motor skills such as jumping. Comparisons of children with high and low motor competence show differences in participation in moderate to vigorous activities (Hands, Parker, & Larkin, 2002).

The development of motor skills also has implications for the future physical activity participation of a child or adolescent. Booth and colleagues (1997) identified low motor skill level as a major barrier to participation in sport. Oftentimes children drop out of sport as they get older, and one reason is because they lack the skill level to sufficiently play a game successfully (Hands, Parker, & Larkin, 2002). In a study examining the relationship of physical activity to fundamental movement skills among adolescents in grades eight and ten, Okely, Booth, and Patterson (2001a) found that fundamental movement skills (run, vertical jump, catch, overhand throw, forehand strike, and kick) are significantly associated with adolescents' participation in organized physical activity (but not nonorganized physical activity). The movement skills significantly predicted time in organized physical activity; however, they only accounted for 3% of the total variation.

Duncan (1997) found that failure to develop a range of fundamental motor skills at a young age makes it more difficult to begin physical activities and sport later in life. Adolescents and adults who are not competent in specific movements find it hard to learn new ways to move their bodies, not only because of the physical demands, but also because of the fear of appearing awkward and unskilled, leading to embarrassment. However, improved fundamental motor skill proficiency may enhance a child's motivation to be physically active through improved self-esteem and enjoyment of physical activity, in addition to improved skills (Okely, Booth, & Chey, 2004).

*Assessment of motor skill/motor performance.* Various instruments exist to assess fundamental motor skill performance. These instruments may be process assessments or product assessments. Process assessments, such as the Test of Gross Motor Development-2nd Edition (TGMD-2; Ulrich, 2000) or the Get Skilled: Get Active process-oriented motor skill assessment tool (New South Wales Department of Education and Training, 2000), measure how the skills are performed. Product assessments, such as the Bruininks-Oseretsky Test of Motor Proficiency (Bruininks, 1978) or The Movement Assessment Battery for Children (M-ABC; Henderson & Sugden, 1992) quantify the skill performance by the skill execution outcome, such as time, distance, or successful attempts.

These two types of measurements will determine the physical competencies of youth; however, only the process assessments can identify the specific skill components that need improvement (Ulrich, 2000).

The TGMD-2 (Ulrich, 2000) will be the process-assessment used in the current study because it is a well-validated, standardized test to measure the fundamental motor skill performance of children between the ages of 3 and 10 years. Children are qualitatively assessed on their performance for both locomotor skills and object-control skills. The locomotor skills are running, galloping, hopping, leaping, horizontal jumping, and sliding. The object-control skills include striking a stationary ball, stationary dribbling, catching, kicking, overhand throwing, and underhand rolling. Children receive a score for each skill based on performance criteria (3 to 5 criteria, depending on the skill). A criterion is scored with a 1 or 0 to indicate its presence or absence. Children demonstrate each skill twice, resulting in a raw score for that skill between 0 and 8 points with 48 being the highest total possible raw score for both the locomotor and object-control skills. The raw scores can be converted into standardized scores per age group.

One concern with using process assessments to identify problem skill features is the challenge of creating a clear scoring and assessment system (Barnett et al., 2009). This challenge becomes even more difficult when multiple people are raters for the fundamental motor skills. Therefore, it is critical that each rater be trained and that inter-rater objectivity is tested.

### *Relationship between Fundamental Motor Skill Development/Level and Fitness Level of Children*

Until recently, the relationship between motor skills and physical activity and fitness levels of children has not been closely examined, but recent studies are showing the important connection between these variables. Stodden et al. (2008) argued that the "degree of motor skill competence is a critically important, yet underestimated, causal mechanism partially responsible for the health-risk behavior of physical inactivity" (p. 302), and they emphasize that much of the physical activity research is focused on the measurement, ignoring the learning that must occur in order to move and be physically active.

Various studies have shown a relationship between youth fundamental motor skill development/level and different fitness components. According to a study (Okely, Booth, & Chey, 2004) examining cross-sectional data of 4,363 children and adolescents in grades 4, 6, 8, and 10, body composition (as determined by BMI and waist circumference) was found to be inversely related to only locomotor skill proficiency; it was unrelated to object-control skill proficiency. Therefore, the heavier children and adolescents performed the fundamental locomotor skills more poorly than the less heavy ones; yet body composition had no influence on the children and adolescents' performance on the fundamental object-control skills. Malina et al. (1995) also studied the association between body composition (using skinfold measurements) and five motor performance items of girls ages 7 to 17 years. He found that as adiposity increased, balance speed, power, and strength decreased.

Another group of researchers examined whether weight status influenced the association among children's fundamental movement skills and physical activity (Hume et al., 2008). While a cause-and-effect relationship could not be tested with the design of the study, results revealed correlations between physical activity and motor skill proficiency, but no interaction between those two variables and weight status (Hume et al., 2008).

A relationship has also been shown between cardiorespiratory endurance and fundamental motor skill proficiency. Okely, Booth, and Patterson (2001b) examined this relationship with adolescents in eighth grade and tenth grade testing both locomotor (run and jump) and object-control (catch, throw, kick, and strike) skills related to cardiorespiratory endurance measured using the PACER. They found a significant relationship between the number of laps measuring cardiorespiratory endurance and each fundamental motor skill (Okely, Booth, & Patterson, 2001b). In addition, gender differences were revealed. Boys had higher levels of cardiorespiratory endurance and were more competent than girls on all fundamental motor skills except the vertical jump (Okely, Booth, & Patterson, 2001b).

### *Psychological Factors*

Psychological factors can both influence fitness levels, motor skill development, and participation in sport, exercise, and physical activity and be influenced by these variables. There are many terms related to the self that are sometimes used interchangeably. Therefore, it is important these terms be defined as related to the proposed study.

Self-perception and self-concept are closely related. According to Horn (2004, p. 102), self-perceptions are "individuals' beliefs, perceptions, attitudes, thoughts, and feelings about themselves in general or about their abilities, skills, competencies, characteristics, and behaviors," while self-concept is "a relatively stable assessment or description of the self in terms of personal characteristics, attributes, and abilities." Horn (2004) explained the latter is the descriptive component of the self (i.e., who am I; what am I; what kind of person am I; what are my strengths and weaknesses?) Davison and Birch (2001) noted that overweight children experience low self-concept across a number of domains of self-concept. In their study examining the relationship between weight status and self-concept in a sample of preschool-aged girls, they found that as early as age 5 years, lower self-concept is noted among girls with higher weight status (Davison & Birch, 2001), although Klesges et al. (1992) found that low self-esteem is not characteristic of obese preschool children.

Self-esteem (or self-worth) is "a relatively stable evaluation or judgment of the overall self" (Horn, 2004, p. 102). Compared to self-concept, Horn (2004) explained self-esteem as the evaluative component of the self (i.e., how much do I value the person I am, the abilities I have, the traits and characteristics that are part of me?) One potential long-term benefit for participating in sports activities is self-esteem (NLSCY, 2001). Data from the NLSCY (2001) showed that 16% of youth who had rarely or never participated in sports reported low levels of self-esteem, four times higher than those who had always participated. Strauss (2000) chose to examine this data to identify trends from childhood to adolescence. He found that although no significant differences among 9 to 10-year-old obese and nonobese children in academic and global self-esteem scores were found among either gender or ethnic group, over the four year period after this time, differences emerged in gender and ethnicity related to weight status. Obese Hispanic and White females showed significantly lower levels of global self-esteem compared to their nonobese counterparts, and there were mild decreases in self-esteem in obese boys compared to nonobese boys. Low self-esteem may then lead to other consequences, linking back to obesity and continuing the cycle. Abernathy, Webster, and Vermeulen (2002) found that low self-esteem of adolescents was associated with low self-mastery, not being happy and interested in life, less physical activity, and not reporting health as excellent.

Perceived competence (or perceived ability) is "the individuals' perceptions of their competencies or abilities in specific domains" (Horn, 2004, p. 103). According to Horn (2004), this construct is perceived to be less global (i.e., they are more typically measured in reference to specific achievement domains) and relatively less stable – especially as they fluctuate over time and across achievement domains. One problem in using the measurement of self-esteem is that unidimensional or global self-esteem does not capture the specific sources from which self-worth is derived, in particular, body esteem or perception of physical appearance (Franklin, Denyer, Steinbeck, Caterson, & Hill, 2006).

The perceived competence of the individual may relate to certain domains. For example, children who are more physically or athletically competent (e.g., believing that they are good at sports and learn new physical activities easily) typically have higher physical activity levels (Davison, Downs, & Birch, 2006). Therefore, they are more likely to have higher fitness levels and are less likely to be overweight or obese.

Two additional terms are often used in lieu of some of the terms above; however, they are quite different. Self-confidence is "the degree of certainty individuals possess about their ability to be successful" (Horn, 2004, p. 103). In a more situational setting, self-efficacy is the belief that one can successfully execute a specific activity in order to obtain a certain outcome (Bandura, 1986). It is consistently an important predictor of physical activity in children and adults regardless of race (Crespo, 2005).

*Psychological Assessment: Self-Perception Profile for Children (SPPC).* Due to the connections between perceived competence and other concepts related to the self (e.g., self-esteem, self-confidence, self-efficacy), this measure will be used as the psychological component of this study in order to identify how the competence in the different domains is affected by fitness levels and motor skill development. There are many instruments to measure psychological components discussed in this review. For the purpose of this study, the Self-Perception Profile for Children (SPPC) will be used in order to measure the participants' competence in different domains as opposed to general psychological factors (e.g., overall self-esteem) or situational factors (e.g., self-efficacy).

The SPPC measures children's perceptions of themselves. It consists of 36-items using a Likert scale to assess perceived competence in five domains (academic competence, social acceptance, athletic competence, physical appearance, behavioral conduct) and a sixth domain of global self-worth. The athletic and academic competence scales directly measure children's judgments of their competency, while the remaining scales measure children's self-adequacy, rather than competence at actual skills (Harter, 1985). The subscales have six questions each which are scored 1 to 4, with 1 and 2 indicating low-perceived competence and 3 and 4 indicating high-perceived competence. The SPPC specifically has been chosen because it is intended for children from ages 8 to 14. The SPPC takes approximately 15 minutes to complete, so it will also be practical to use in this study.

Furthermore, psychometric testing has shown that it is significantly less influenced by socially desirable answers compared with other measures of self-esteem, which is most likely due to the way the survey is formatted (Harter, 1985). For each question, the child responds to the two contrasting statements. For example, one question in the physical appearance domain is, "Some kids are *happy* with their height and weight BUT Other kids wish their height or weight were *different*." Once the child chooses one of the statements, he or she then answers whether the statement is "a little like me" or "a lot like me." This process allows researchers to evaluate the prevalence of children who have high versus low perceived competence in the different domains. An example of a question from the academic domain is, "Some kids feel that they are very *good* at their school work BUT Other kids *worry* about whether they can do the school work assigned to them." In the peer acceptance domain, one question is, "Some kids find it *hard* to make friends BUT For other kids it's pretty *easy*." An example of a question from the athletic domain is, "Some kids do very *well* at all kinds of sports BUT Others *don't* feel that they are very good when it comes to sports." In the behavioral conduct domain, one question is, "Some kids often *do not* like the way they *behave* BUT Other kids usually *like* the way they behave." And finally, an example from the global self-worth domain is, "Some kids *like* the kind of *person* they are BUT Other kids often wish they were someone else."

*Psychological Aspects related to Motor Skill Development in Children*

Relationships have been identified in the literature between two of the three variables, but not the relationship among the three. The final relationship between two variables is between motor skill development and psychological aspects. Children gain self-confidence and self-esteem as a result of successful experiences, particularly in the motor domain (Bunker, 1991), and improved proficiency of fundamental motor skills may improve perceived competence and self-esteem (Ulrich, 1987). Furthermore, the improved proficiency of fundamental motor skills may also enhance motivation to be physically active through improved self-esteem and enjoyment of physical activity, in addition to improved skills (Okely, Booth, & Chey, 2004). Hill (2009) agrees with the psychological benefits of improved skills. In addition, he argues that access to sport participation during the elementary school years is critical because children who develop physical skills in those activities tend to have a higher perceived competence (Hill, 2009), which is a major reason why children continue to participate in specific physical activities and are motivated to be physically active (Hutchinson & Mercier, 2004). Thomas, Thomas, and Williams (2008) found this relationship is also evidenced in the other direction; maintaining motivation to continue participation and practice is essential to skill development and future physical activity as well. Overall, the research using Harter's SPPC has shown an association between childhood overweight and obesity and some, but not all, of the six subscales. Franklin, Denyer, Steinbeck, Caterson, and Hill (2006) found obese children had significantly lowered perceived athletic competence, physical appearance, and global self-worth than their normal weight peers, with lower scores in these domains in girls than in boys. In addition, obese girls also had reduced perceived social acceptance, but no changes were seen in this domain for boys or in academic competence or behavioral conduct for both boys and girls (Franklin et al., 2006).

*Summary of Review of Literature*

This review of literature examined the current research about physical activity, specifically relating to motor skill development, health-related fitness, and perceived competence. Physical activity levels of children and adolescents have been a key component in the childhood obesity literature, due to its implications in contributing to developing and maintaining a healthy lifestyle for youth, and the negative health psychosocial consequences that may emerge from physical inactivity and obesity.

Gender and race/ethnicity may be factors that contribute to the body composition and physical activity levels of children or adolescents. Although there are trends in the literature, mixed results that still remain in the literature prove this area in the childhood obesity and physical activity research is one that needs to continue to be examined.

Three factors that may also contribute to the obesity level and physical activity participation of children and adolescents are the health-related physical fitness, motor skill performance, and perceived competence of youth. Research has shown the importance of developing health-related physical fitness, maintaining a healthy body composition, learning fundamental locomotor and object-control skills and performing them at a developmentally appropriate level, and the influence of perceived competence in different areas of one's life. The current literature examines the relationship between fitness and motor skill development, between fitness and perceived competence, and between motor skill development and perceived competence, but little is known about the relationship among the three variables.

### *Purpose of Study*

There is plenty of evidence to show the importance of the three variables in the study and how they relate to the childhood obesity epidemic and the lack of physical activity of children and adolescents. However, this study focuses on the gap in the research examining the relationship among health-related fitness levels, motor skill performance, and perceived competence.

The pilot study discussed in the introduction revealed results that sparked future investigation. Therefore, the purpose of this study was to examine the relationship among fundamental motor skill development (of both locomotor and object-control skills), health-related fitness level (measured by aerobic capacity and body composition), and perceived competence (measured by subscales/domains) of fourth grade students. In addition, any differences between males and females were addressed. Although the races/ethnicities of the individual participants were not attainable, general race/ethnicity information was collected from the schools to relate to the variable for exploratory purposes.

# CHAPTER THREE

## Method

### *Participants*

Participants in this study were fourth grade students at three elementary schools in Michigan. Students in the fourth grade at School A were Caucasian (94%), Asian (3%), and Hispanic (3%), at School B were Caucasian (86%), Asian/Pacific Islander (8%), African American (4%), and Hispanic (2%), and at School C were Caucasian (60%), Asian (28%), and African American and Hispanic (12% combined). Socioeconomic status of the participants was determined by students who received free and reduced lunches at the schools, or by the demographic data from the website of the school. At School B, 10% of students received free and reduced lunches, and at School C, less than 10 students (17%) were considered economically disadvantaged. This information was not available from School A. Because of the homogeneous sample (predominately middle to upper class, Caucasian students), differences in race/ethnicity and socioeconomic status were not addressed in this study.

There were a total of 221 fourth grade children (66 at School A, 92 at School B, and 63 at School C) enrolled at the schools. Total participants included 137 fourth grade children (62% of the total number of fourth graders enrolled at all schools), consisting of 67 males and 70 females. There were 33 participants from School A (13 males and 20 females), 51 participants from School B (25 males and 26 females), and 53 participants from School C (29 males and 24 females). All students in attendance on the days of the measurements and testing with completed parental consent forms and assent forms were included in the study. On the first day of data collection, students without parental consent forms were informed they would still be able to participate during the next data collection day if they brought back their completed form. Additional data collection days were added in order to collect missing data from participants who were absent during data collection days or turned in their parental consent forms late. One student from School B was excluded from the study because he was absent on the days the PACER, height and weight, and SPPC information were collected, and was absent again during the final make-up day. Therefore, he had only motor skill data and the relationship with the other variables was not able to be assessed.

*Measures*

*FTG PACER and BMI*

Two assessments from the *FTG* test battery were used: the Progressive Aerobic Cardiovascular Endurance Run (PACER) to measure aerobic capacity and the body mass index (BMI) as the measure of body composition. The PACER is a multi-stage, 20-Meter test set to music; therefore, the *FTG* 20-Meter PACER CD was used. The music allows a fun alternative to distance run tests (e.g., one-mile run) for an aerobic capacity test. The objective is for the participants to run as long as possible back and forth across a 20-meter distance at a specified pace that gets faster each minute. During the first minute, the 20-

meter version allows 9 seconds to run the distance, and the lap time decreases by approximately one-half second at each successive level, which occurs every minute. By progressively running faster, the children begin with a warm-up and are able to pace themselves effectively as the time to complete the lap decreases, until the participants can no longer complete two successive laps. The PACER is a valid and reliable test for children; reliability of the test ranges from 0.84 to 0.93 (Leger et al., 1988; Liu, Plowman, & Looney, 1992; & Mahar et al., 1997), and validity of the test ranges from 0.69 to 0.87 (Boreham, Paliczka, & Nichols, 1990; Leger et al., 1988; Liu, Plowman, & Looney, 1992; Mahoney, 1992; Van Mechelen, Hlobil, & Kemper, 1986).

The second component tested from the *FTG* was body mass index (BMI) as the measure of adiposity. In order to calculate BMI, standing height and weight are obtained using standard anthropometric procedures (Malina, 2004) as described below. Participants are asked to remove their shoes and any heavy clothing (e.g., jackets, sweatshirts) before being measured. Height is measured with the participants standing in a standard erect posture (Malina, 2004). In this study, height was measured to the nearest 0.1 cm using a portable stadiometer (Seca Road Rod). Body mass was measured to the nearest 0.1 kg using a calibrated strain gauge scale (Lifesource MD).

*Test of Gross Motor Development-2 (TGMD-2)*

The TGMD-2 includes 12 gross motor skills that are subdivided into two skill areas: locomotor (run, gallop, hop, leap, jump, and slide) and object-control (two-hand strike, stationary bounce, catch, kick, overhand throw, and underhand roll). A demonstration was provided prior to the participants performing each of the skills at stations in the school gymnasium while being videotaped. The researcher scored all the participants' motor skill levels by watching the videotapes, with assistance from another researcher for School A. Both researchers scored the motor skill levels separately and then compared their scores for School A. If any discrepancies existed, the researchers reviewed the video as needed to discuss the participant's performance until a decision was reached for the score. The scorers were trained by an expert in TGMD-2 assessment. Inter-rater reliability ($r = 0.69$) between the TGMD-2 expert and the primary researcher was attained for this investigation.

*Self-Perception Profile for Children (SPPC)*

The SPPC was administered to the participants in each fourth grade classroom or during part of the physical education class. This measure is a 36 item, 4 point Likert scale survey which consists of 6 questions from each of the domains/subscales (i.e., academic, peer acceptance, athletic, physical appearance, behavioral conduct, and global self-worth). Children are instructed to circle the phrase that best describes them, and then they are asked to decide if the phrase they chose is "really true" or "sort of true" for them, checking the appropriate box next to the statement. Scores can range from 1 to 4 for each item, and various items are reverse scored. A score of 4 indicates "really true" for the higher perceived competence, 3 indicates "sort of true" for the higher perceived competence, 2 indicates "sort of true" for the lower perceived competence, and 1 indicates "really true" for lower perceived competence. Therefore, scores of 1 and 2 indicated low perceived competence, and scores of 3 and 4 indicated a high perceived competence. Reliability and validity of this measure have been tested in many studies and was used in the pilot study previous to this one. According to Harter (1985), subscale internal reliabilities range from 0.71 to 0.84. Researchers have found high internal reliability ($r$ = .73-.86; Harter 1982; Harter, 1985), although Shevlin, Adamson, & Collins, 2003) found that the reliability estimates over four administration times within one year ranged from 0.53 to 0.77 in subjects ages 8 to 10, with an increase from the first to last administration for all subscales except for behavioral conduct.

*Procedures*

The researcher visited the principals and physical education teachers at School A and School B in early December 2009 to discuss the data collection process, answer any questions, and ask for input. School C was not added until February 2010 when not enough participants had been recruited from Schools A and B. Then the researcher met with the principal at School C and received approval from the superintendant of the school district to proceed with data collection. All procedures were approved by the Michigan State University Institutional Review Board (IRB). Once IRB approval was obtained, approved consent forms were sent home to all the parents of the fourth graders at all three schools in the students' weekly folders asking parents to return the completed form by the first day of data collection if they wanted their child to participate in the study. Overall percentages for race/ethnicity of the fourth graders were also provided by school administrators. Parental consent forms were collected by the physical education teachers or classroom teachers at the schools. Written and verbal participant assent was obtained on the first day of data collection in each class for participants with completed parental consent forms. The researchers read and explained the assent form verbally to the participants and answered any questions.

All data collection took place over a six-week time period (February to March). The time frame was extended from a three-week schedule due to the addition of a third school, fourth grade field trips, and time conflicts in physical education classes. There were 22 to 25 students in each class at both schools. This length of time for data collection in each class was determined by needed time indicated in the manuals of the measures being used in the study, and from experience during the pilot study. The planned time proved to be an adequate amount of time for testing.

On the first day of data collection, all participants completed the locomotor skill testing. All skills were videotaped to allow for careful analyses and scoring at a later time. Three skills were performed at each station. Running, hopping, and jumping were performed at one station, while galloping, sliding, and leaping were performed at the other. On the second day of data collection, all participants completed the object-control testing. Striking, dribbling, and underhand rolling were performed at one station, while kicking, catching, and throwing were performed at the other. The students who did not have a completed parental consent form were still able to participate during the skill testing; however, they were not videotaped. During the third day of data collection, the participants completed the PACER as a group. All students were allowed to participate in this activity, but only the scores of participants with completed parental consent forms were recorded. After the PACER, the researcher took height and weight measurements individually while the physical education teacher had the students involved in another activity, except for at School A where the graduate research assistant took height and weight measurements on another day. Additional days of data collection were added to collect data for all variables for as many participants as possible.

Research assistants included graduate and undergraduate students who helped with set-up, clean-up, recording PACER testing information, and recording the TGMD-2 data using video cameras. The research team consisted of six graduate students and twelve undergraduate students, as well as the physical education teacher and physical education intern at School C. The goal number of participants was reached; therefore, no additional parental consent forms were sent home and no additional days were added for data collection after the final follow-up days.

*FTG PACER*

The PACER was administered using the established *FTG* PACER protocols (Cooper Institute for Aerobic Research, 2007). The testing took place in the gym at the schools, and cones and tape were used to mark off the 20-meter distance. Students were familiar with the task because the physical education teachers allowed the students to practice the test beforehand in a previous class, and at School B the students were familiar with this test before the practice previous to data collection. The researcher explained the test and they were also allowed to listen to the directions on the CD and run a few minutes of the actual test before performing the test. Participants performed the test as a group (all beginning at the same time), and continued until they failed to reach the line before the beep for the second time. The number of laps was recorded by the researcher and research assistants. Scores were also converted to estimated $VO_2$ Max (ml/kg/min), dependent on the participant's age and gender, using the equation: estimated $VO_2$ max = 31.025 + (3.238 * Max speed) - (3.248 * age) + (.1536 * max speed * age) from the SAS Growth Program for the CDC Growth Charts (CDC Growth Chart Training, 2009). The *FITNESSGRAM* standards for the Healthy Fitness Zone (HFZ) for the PACER tests include $VO_2$ max scores between 42 and 52 ml/kg/min (Cooper Institute for Aerobic Research, 2007). Each participant was classified as "Below the Healthy Fitness Zone (HFZ)" or "In or Above the HFZ" according to the *FITNESSGRAM* standards for the PACER HFZ for males and females.

*BMI*

Standing height and weight measurements were obtained using standard anthropometric procedures (Malina, 2004). Measurements were taken by a graduate research assistant at School A, and by the researcher at Schools B and C. Measurements were taken in the equipment rooms which were connected to the physical education gyms at the schools. Participants were measured individually (without other participants present in the equipment room) to ensure privacy and ensure measurements remained confidential. During the height measurements, they were asked to look straight ahead in order to maintain an erect posture while having their height measured, and were asked to step on the scale and look straight ahead so they would not see their weight. They also stepped on the scale backwards (facing away from the display) in order to ensure they would not see their weight. Measurements were recorded without verbalizing.

BMI measurements were calculated for each participant using the formula: BMI = weight (kg) / height squared ($m^2$). Each participant was classified as "Below the Healthy Fitness Zone (HFZ)", "In the HFZ", or "Above the HFZ" according to the *FITNESSGRAM* standards for the BMI HFZ for males and females. In addition, participants were also classified into one of four groups based on the CDC (2009) age-sex specific BMI percentiles: (a) underweight (BMI $\leq 5^{th}$ percentile); (b) normal weight ($5^{th}$ < BMI < $85^{th}$ percentile); (c) overweight (BMI $\geq 85^{th}$ and < $95^{th}$ percentile); or (d) obese (BMI $\geq 95^{th}$ percentile).

Percentiles were determined using a SAS Growth Program for the CDC Growth Charts (CDC Growth Chart Training, 2009).

*TGMD-2*

The TGMD-2 was administered using standard protocols (Ulrich, 2002). The researcher provided a list of equipment needed to administer the TGMD-2 to each physical education teacher, and brought any necessary items the physical education teacher did not have or did not want to provide. Each participant was given a randomly assigned number, then after lining up in numerical order, they were split into two groups. There was one group at each station (2 stations total for the locomotor skills, and 2 stations total for the object-control skills), and each station was comprised of three skills. The researcher and research assistants demonstrated the skills, and the participants had the opportunity to practice the skill one to two times before each skill was performed twice on video to be scored. Video cameras were positioned in the middle of the gymnasium facing the stations situated on opposite sides of the gymnasium, and re-focused or moved slightly as needed to videotape participants for each skill adequately. All participants were videotaped performing each skill (in numerical order) during both trials by the researcher or research assistants, and the researchers scored each participant's performance in the skills after reviewing the recordings. Each participant's skill performance was evaluated on qualitative performance criteria (3 to 5 criteria, depending on the skill). For each trial, the participant received a score of 1 if the criterion was present, or a 0 if it was absent.

The raw scores on the TGMD-2 were added for both trials of all locomotor and object control skills. Therefore, for each skill there is a possible score ranging from 0 to 6, 0 to 8, or 0 to 10 depending on the number of performance criteria. Then, all the scores from the locomotor skills were added together, and all the scores from the object-control skills were added together. For both the locomotor and object control skills (two separate raw scores), the highest possible raw score for each is 48 points.

*SPPC*

The SPPC was administered either in the classroom or during the participants' physical education period using standard protocols (Harter, 1985). The researcher administered the SPPC in all classes. This procedure involved the researcher explaining the questionnaire, reviewing a sample question, and reading aloud the questions, asking the participants to follow along and mark their answers accordingly, and answering any questions from the participants. Participants were given an additional piece of paper to cover their answers and in order to keep them from working ahead.

Participant scores from all 36 items on the SPPC were entered into an Excel spreadsheet and appropriate questions were reverse-scored. The scores were then calculated for each of the six subscales. Participants who chose not to answer specific questions on the survey were only excluded from the particular subscales in which they left blank answers. Participants with all complete answers for each subscale were included in the data analyses.

*Data Analysis*

All data were entered into the Statistical Package for the Social Sciences (SPSS) computer program and checked twice to ensure accurate data entry by the researcher. Exploratory data analysis was conducted to identify any outliers. No outliers were identified in the data. All participants fell within 4 standard deviations with the exception of the object-control motor skill scores, which is to be expected in fourth grade when there is a larger variability in the object-control skill competency of children.

Descriptive statistics for participants' scores on *FITNESSGRAM*, TGMD-2 and SPPC variables were computed. The means, standard deviations, and ranges of all variables were calculated and also separated by gender. Frequencies and percentages of participants meeting the *FTG HFZ* and Needs Improvement category were also calculated, as well as CDC overweight and obese percentiles. Partial correlations (controlling for age) were calculated to determine the relationships between BMI, $VO_2$ Max, Locomotor Raw Score, Object-Control Raw Score, and all six SPPC subscales individually.

Linear regression analyses were used to test the hypotheses for the study. Both backward regression and stepwise regression analyses were conducted to determine if there was a difference between the tests. Each hypothesis was analyzed using both backward and stepwise linear regression. The analyses were also run with both the dataset including all participants, and the dataset including only those participants with complete data. Results reported include all participants in the dataset and the regression analyses are the results from the stepwise linear regression results.

# CHAPTER FOUR

## Results

### *Descriptive Statistics*

Descriptive statistics were conducted including all the subjects who participated in any portion of the testing in the dataset. Then, the descriptive statistics were conducted again to see if any differences existed between all subjects and only those who had complete data for all testing (e.g., all skills in the TGMD-2, BMI, $VO_2$ max, and all questions on the SPPC). The total number of participants decreased from 134 to 112; therefore, 22 participants were deleted from the dataset. However, even with these participants removed from the dataset, no significant differences existed between those with and without complete data for the descriptive results, correlations, and regression analyses. Therefore, all participants who participated in any portion of the testing were included for the remainder of the results presented.

Table 2 shows the physical descriptive characteristics for the total sample (and separated by gender) including the mean, standard deviation, and range for age, height, weight, and BMI. BMI ranged from 12.79 to 31.17 kg/ $m^2$. Independent t-tests revealed no significant difference in the mean BMI between boys and girls ($p = 0.607$). The percentage of participants who were considered underweight, in the BMI HFZ, overweight, and obese according to the CDC classifications (CDC, 2009) are also presented in Table 2.

Table 2

*Physical Descriptive Characteristics of the Sample*

| *Physical characteristics* | Male | Female | Total |
|---|---|---|---|
| Age (yrs) *n*=137 | 10.1 (0.42) | 10.0 (0.31) | 10.0 (0.37) |
| | 9-11 | 9-11 | 9-11 |
| Height (cm) *n*=135 | 143.4 (5.83) | 141.9 (6.56) | 142.6 (6.23) |
| | 128.2-158.5 | 129.2-156.9 | 128.2-158.5 |
| Weight (kg) *n*=135 | 37.1 (7.81) | 36.9 (8.40) | 37.0 (8.08) |
| | 24.5-69.0 | 24.3-65.2 | 24.3-69.0 |
| BMI (kg/m$^2$) *n*=135 | 17.9 (3.05) | 18.2 (3.15) | 18.1 (3.09) |
| | 13-31 | 13-31 | 13-31 |
| % underweight* | 5.9% | 3.0% | 4.4% |
| % in the FTG HFZ | 69.1% | 71.7% | 70.4% |
| % overweight* | 16.2% | 13.4% | 14.8% |
| % obese* | 8.8% | 11.9% | 10.4% |

*Note.* Age, Height, Weight, and BMI values are Mean (Standard Deviation) with the range below.
*According to the CDI BMI Percentiles (CDC, 2009)

The SAS Growth Program for the CDC Growth Charts (CDC Growth Chart Training, 2009) was used to determine the mean (*m*) height percentile (68$^{th}$ percentile), mean (*m*) weight percentile (63$^{rd}$ percentile), and mean (*m*) BMI percentile (58$^{th}$ percentile). When comparing the individual BMI percentile results from the SAS Growth Program for the CDC Growth Charts (CDC Growth Chart Training, 2009) of the participants to the CDC percentiles, results showed that 6 participants (4%) were classified as underweight (4 boys/6%, 2 girls/3%), 95 participants (71%) fell within the HFZ (47 boys/69%, 48 girls/71%), 20 participants (15%) were classified as overweight (11 boys/16%, 9 girls/14%), and 14 participants (10%) were classified as obese (6 boys/9%, 8 girls/12%).

Each of the motor skills for the Test of Gross Motor Development-2 (TGMD-2) and the overall locomotor and object-control descriptive statistics are presented in Table 3. These scores revealed that participants had slightly higher mean scores on the object-control skills ($m = 41.7 \pm 4.81$) versus locomotor skill scores ($m = 41.1 \pm 3.40$). Similar results were shown between boys and girls. Independent t-tests revealed the mean scores for locomotor skills were not significantly different between boys and girls ($p = 0.616$), however, the mean scores for the object-control skills of boys were significantly higher ($p = 0.000$), than the mean scores for girls.

Table 3

*Test of Gross Motor Development-2 Descriptive Characteristics of the Sample*

| *Locomotor Skills n* = 131 | Male | Female | Total |
|---|---|---|---|
| Run | 7.7 (0.79) | 7.7 (0.78) | 7.7 (0.79) |
| | 4-8 | 4-8 | 4-8 |
| Gallop | 6.1 (1.31) | 6.4 (1.12) | 6.3 (1.22) |
| | 3-8 | 4-8 | 3-8 |
| Hop | 8.8 (1.43) | 8.8 (1.24) | 8.8 (1.33) |
| | 5-10 | 5-10 | 5-10 |
| Leap | 5.1 (0.88) | 5.1 (0.87) | 5.1 (0.87) |
| | 4-6 | 3-6 | 3-6 |
| Jump | 6.0 (2.00) | 6.0 (1.39) | 6.0 (1.71) |
| | 0-8 | 2-8 | 0-8 |
| Slide | 7.2 (1.03) | 7.2 (1.05) | 7.2 (1.04) |
| | 4-8 | 4-8 | 4-8 |
| Locomotor raw score | 41.0 (3.70) | 41.3 (3.12) | 41.1 (3.40) |
| | 27-46 | 34-47 | 27-47 |

*Note.* Values are Mean (Standard Deviation) with the range below.

Table 3 (continued)

*Test of Gross Motor Development-2 Descriptive Characteristics of the Sample*

| *Object-Control Skills n* = 134 | Male | Female | Total |
|---|---|---|---|
| Strike | 8.9 (1.21) | 8.3 (1.62) | 8.6 (1.46) |
| | 6-10 | 4-10 | 4-10 |
| Dribble | 6.6 (1.75) | 5.8 (1.94) | 6.2 (1.89) |
| | 0-8 | 1-8 | 0-8 |
| Catch | 5.8 (0.56) | 5.8 (0.51) | 5.8 (0.54) |
| | 3-6 | 4-6 | 3-6 |
| Kick | 7.5 (0.77) | 7.2 (0.87) | 7.3 (0.84) |
| | 5-8 | 5-8 | 5-8 |
| Throw | 7.8 (0.93) | 7.0 (1.53) | 7.2 (1.33) |
| | 2-8 | 2-8 | 2-8 |
| Roll | 6.9 (1.56) | 6.5 (1.46) | 7.0 (1.52) |
| | 2-8 | 2-8 | 2-8 |
| Object-control raw score | 43.5 (4.50) | 40.5 (4.65) | 42.0 (4.81) |
| | 19-48 | 27-48 | 19-48 |

*Note.* Values are Mean (Standard Deviation) with the range below.

Table 4 shows the descriptive statistics for the Self-Perception Profile for Children (only those participants with completed subscales for each of the six domains: i.e., academic, peer acceptance, athletic, physical appearance, behavioral conduct, and global self-worth), and estimated $VO_2$ max. The mean of the SPPC domain scores ranged from 3.1 to 3.3 on a scale of 1 to 4, with 48.4% to 64.6% of participants having a score greater than 3.0 for the six domains (academic 53.1%, peer acceptance 48.4%, athletic 55.6%, physical appearance 58.3%, behavioral conduct 64.6%, and global self-worth 63.4% with scores greater than 3.0). These results show that many of the participants have a fairly high perceived competence in most domains. Independent t-tests revealed that the only significant difference in the mean scores between boys and girls in all six SPPC domains was in the behavioral conduct domain, in which girls had significant higher scores than boys ($p = 0.002$).

Estimated $VO_2$ max values of the participants ranged from 36.9 to 53.5 ml/kg/min. According to the *FITNESSGRAM* standards for the Healthy Fitness Zone (HFZ) for the PACER test, 29.5% of the participants fell below *FITNESSGRAM* standards for this test. The independent t-test revealed that boys had a significantly higher mean $VO_2$ max than girls ($p = 0.004$).

Table 4

*SPPC Domains & $VO_2$ Max Descriptive Characteristics of the Sample*

| *SPPC Domains* | Male | Female | Total |
|---|---|---|---|
| Academic *n*=128 | 3.1 (0.70) | 3.1 (0.59) | 3.1 (0.64) |
| | 1-4 | 2-4 | 1-4 |
| Peer Acceptance *n*=120 | 3.2 (0.62) | 3.0 (0.75) | 3.1 (0.69) |
| | 2-4 | 1-4 | 1-4 |
| Athletic *n*=126 | 3.1 (0.74) | 3.0 (0.66) | 3.1 (0.70) |
| | 1-4 | 1-4 | 1-4 |
| Physical Appearance *n*=126 | 3.1 (0.72) | 3.2 (0.62) | 3.2 (0.67) |
| | 2-4 | 1-4 | 1-4 |
| Behavioral Conduct *n*=127 | 3.1 (0.56) | 3.4 (0.63) | 3.3 (0.62) |
| | 2-4 | 1-4 | 1-4 |
| Global Self-Worth *n*=123 | 3.3 (0.56) | 3.3 (0.65) | 3.3 (0.61) |
| | 2-4 | 1-4 | 1-4 |
| Estimated $VO_2$ Max | | | |
| $VO_2$ Max (kg/ml/min) *n*=132 | 45.4 (3.53) | 43.7 (2.88) | 44.5 (3.31) |
| | 37-53 | 39-53 | 37-53 |

*Note.* Values are Mean (Standard Deviation) with the range below.

*Partial Correlations*

Both bivariate and partial correlation analyses were conducted to determine if age was a factor in the correlation results. Bivariate correlation results for all participants (not controlling for age) showed various significant correlations at both the 0.01 and 0.05 levels, and did not change significantly when recalculated controlling for age, using partial correlations. Therefore, results shown in Table 5 are the partial correlations for BMI, $VO_2$ max, locomotor skill performance, object-control skill performance, and all 6 SPPC domains (i.e., academic, peer acceptance, athletic, physical appearance, behavioral conduct, and global self-worth), in order to control for any influence of age. The only correlations that were significant in the partial correlation results that were not significant in the bivariate correlation results were object-control skills and the SPPC behavioral conduct domain, and the SPPC athletic domain and the SPPC global self-worth domain. All correlation results include participants with data from any of the testing, not those participants with only complete data for all variables. Overall, BMI was negatively correlated with the majority of the variables, but only significantly with $VO_2$ max $r(109) = -0.292$, $p < .01$ and the academic domain $r(109) = -0.283$, $p < .01$. $VO_2$ max was also significantly positively correlated with locomotor skill scores $r(109) = 0.256$, $p < .01$, object-control skills $r(109) = 0.408$, $p < .01$, and the peer acceptance perceived competence $r(109) = 0.229$, $p < .05$, athletic perceived competence $r(109) = 0.245$, $p < .01$, physical appearance perceived competence $r(109) =$

0.227, $p < .05$ and global self-worth $r(109) = 0.207$, $p < .05$. Locomotor skill scores were significantly positively correlated with object-control skills $r(109) = 0.243$, $p < .01$, and object-control skills were also positively correlated with the athletic domain $r(109) = 0.229$, $p < .05$. The academic domain was significantly correlated with all of the other SPPC domains. All of the other SPPC domains were significantly correlated with each other, except for the peer and behavioral conduct domain, the athletic domain and the behavioral conduct domain, the physical appearance domain and the behavioral conduct domain, and the athletic domain and the global self-worth domain. Correlations according to gender showed similar results (Table 6 for boys and Table 7 for girls).

Table 5

*Partial Correlation Results Controlling for Age with All Subjects*

| | BMI | $VO_2$ Max | Locomotor | Object-Control | Academic | Peer | Athletic | Physical | Behavior | Self-Worth |
|---|---|---|---|---|---|---|---|---|---|---|
| BMI | 1 | | | | | | | | | |
| $VO_2$ Max | -0.292** | 1 | | | | | | | | |
| Locomotor | -0.181 | 0.256** | 1 | | | | | | | |
| Object-Control | -0.173 | 0.408** | 0.243** | 1 | | | | | | |
| Academic | -0.283** | 0.148 | -0.033 | 0.050 | 1 | | | | | |
| Peer Acceptance | -0.157 | 0.229* | 0.130 | 0.088 | 0.357** | 1 | | | | |
| Athletic | 0.017 | 0.245** | 0.170 | 0.229* | 0.288** | 0.330** | 1 | | | |
| Physical Appearance | -0.083 | 0.227* | -0.041 | -0.033 | 0.315** | 0.519** | 0.259** | 1 | | |
| Behavioral Conduct | 0.036 | 0.041 | -0.098 | -0.172 | 0.228* | 0.128 | 0.073 | 0.185 | 1 | |
| Global Self-Worth | -0.112 | 0.207* | -0.050 | -0.030 | 0.367** | 0.473** | 0.122 | 0.516** | 0.454** | 1 |

*Note*. *Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 6

*Partial Correlation Results Controlling for Age - Boys*

| | BMI | $VO_2$ Max | Locomotor | Object-Control | Academic | Peer | Athletic | Physical | Behavior | Self-Worth |
|---|---|---|---|---|---|---|---|---|---|---|
| BMI | 1 | | | | | | | | | |
| $VO_2$ Max | -0.274* | 1 | | | | | | | | |
| Locomotor | -0.109 | 0.212 | 1 | | | | | | | |
| Object-Control | -0.283* | 0.241 | 0.419** | 1 | | | | | | |
| Academic | -0.291* | 0.192 | -0.027 | 0.183 | 1 | | | | | |
| Peer Acceptance | -0.084 | 0.289* | 0.215 | 0.156 | 0.525** | 1 | | | | |
| Athletic | -0.013 | 0.253 | 0.175 | 0.288* | 0.401** | 0.413** | 1 | | | |
| Physical Appearance | -0.064 | 0.380** | -0.024 | -0.135 | 0.474** | 0.613** | 0.468** | 1 | | |
| Behavioral Conduct | 0.077 | 0.262 | -0.203 | -0.120 | 0.196 | 0.074 | -0.033 | 0.333* | 1 | |
| Global Self-Worth | -0.013 | 0.328* | -0.110 | -0.039 | 0.386** | 0.518** | 0.086 | 0.589** | 0.381** | 1 |

*Note*. *Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

Table 7

*Partial Correlation Results Controlling for Age - Girls*

| | BMI | $VO_2$ Max | Locomotor | Object-Control | Academic | Peer | Athletic | Physical | Behavior | Self-Worth |
|---|---|---|---|---|---|---|---|---|---|---|
| BMI | 1 | | | | | | | | | |
| $VO_2$ Max | -0.295* | 1 | | | | | | | | |
| Locomotor | -0.283* | 0.393** | 1 | | | | | | | |
| Object-Control | -0.058 | 0.501** | 0.148 | 1 | | | | | | |
| Academic | -0.039* | 0.109 | -0.029 | -0.086 | 1 | | | | | |
| Peer Acceptance | -0.157 | 0.122 | 0.059 | -0.032 | 0.264 | 1 | | | | |
| Athletic | 0.024 | 0.242 | 0.184 | 0.177 | 0.031 | 0.296* | 1 | | | |
| Physical Appearance | -0.082 | 0.024 | -0.081 | 0.086 | 0.114 | 0.452** | -0.024 | 1 | | |
| Behavioral Conduct | -0.170 | 0.001 | -0.020 | -0.020 | 0.259 | 0.252 | 0.203 | 0.073 | 1 | |
| Global Self-Worth | -0.225 | 0.115 | 0.015 | -0.009 | 0.352** | 0.478** | 0.159 | 0.461** | 0.582** | 1 |

*Note*. *Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

*Stepwise Regression*

Stepwise regression analyses were conducted to determine the significant predictor variables for locomotor skills, object-control skills, BMI, $VO_2$ max, and all six of the SPPC domains. Complete stepwise regression results are presented in Table 8. Stepwise regression results for boys and girls are shown in Tables 9 and 10, respectively.

The first hypothesis stated that (a) BMI, aerobic capacity, locomotor and object-control skill performance of participants would account for a significant percentage of the variance in athletic and physical appearance perceived competence, but (b) would not account for a significant percentage of variance in the academic competence, peer acceptance, behavioral conduct, and global self-worth. This hypothesis was partially supported. When each of the SPPC domains was used as the criterion variable and BMI, $VO_2$ max, locomotor skills and object-control skills were the predictor variables in the models, none of the domains that emerged with predictor variables accounted for more than 10% of the variance. Only object-control skill performance was a significant predictor of athletic perceived competence [adjusted $R^2 = 0.061$, $F(1, 121) = 8.844$, $p = .004$], and object-control skill performance and $VO_2$ max were the significant predictors for physical appearance perceived competence [adjusted $R^2 = 0.083$, $F(2, 115) = 6.211$, $p = .003$]. Results supported part (b) of the hypothesis, with these four predictor variables accounting for 4.8% to 8.9% of the variance in the academic, peer acceptance, and global self-worth domains, while no significant predictors emerged for the behavioral conduct domain.

The gender differences revealed that $VO_2$ max, object-control skill performance, and locomotor skill performance were more significant predictors of the SPPC domains for boys than for girls, particularly in the physical appearance and behavioral conduct domains. For boys, object-control skill performance and $VO_2$ max were significant predictors of physical appearance perceived competence [adjusted $R^2 = 0.202$, $F(2, 58) = 8.321$, $p = .001$], and $VO_2$ max and locomotor skill performance were significant predictors in the behavioral conduct domain [adjusted $R^2 = 0.134$, $F(2, 58) = 5.491$, $p = .007$]. For girls, the only predictor variables that emerged were in the academic and athletic domains. BMI was a significant predictor of academic perceived competence [adjusted $R^2 = 0.078$, $F(1, 63) = 6.333$, $p = .014$], and locomotor skill performance was a significant predictor for athletic perceived competence [adjusted $R^2 = 0.073$, $F(1, 62) = 5.869$, $p = .018$]. No predictor variables emerged for the other SPPC domains.

The second hypothesis stated that (a) BMI and locomotor skill performance of participants would account for a significant percentage of the variance in aerobic capacity, but (b) object-control skill performance of participants would not account for a significant percentage of the variance in aerobic capacity. Again, results partially supported the hypothesis, showing the largest predictors of $VO_2$ max scores were object-control skills, BMI, and physical appearance perceived competence [adjusted $R^2$ = 0.245, $F(3, 111)$ = 12.983, $p$ = .000]. When only locomotor and object-control skills were used as the predictor variables, object-control skills were the significant predictor of $VO_2$ max scores [adjusted $R^2$ = 0.148, $F(1, 127)$ = 23.076, $p$ = .000]. Physical appearance perceived competence and object-control skill performance were the significant predictor variables for boys [adjusted $R^2$ = 0.204, $F(2, 55)$ = 8.067, $p$ = .001], and neither object-control nor locomotor skill performance were significant predictor variables when only those two variables were entered into the model. For girls, BMI, object-control and locomotor skill performance were significant predictor variables of $VO_2$ max [adjusted $R^2$ = 0.340, $F(3, 55)$ = 10.449, $p$ = .000], and both object-control and locomotor skill performance were significant predictor variables when only those two were entered into the model [adjusted $R^2$ = 0.274, $F(2, 64)$ = 13.079, $p$ = .000].

The third hypothesis stated that (a) aerobic capacity, locomotor skill performance, and the athletic and physical appearance perceived competence of participants would account for a significant percentage of the variance in BMI, but (b) object-control skill performance, the academic competence, peer acceptance, behavioral conduct, and global self-worth of participants would not influence the variance in BMI. Only $VO_2$ max, academic perceived competence, and athletic perceived competence were the significant predictors of BMI scores [adjusted $R^2$ = 0.158, $F(3, 111)$ = 7.967, $p$ = .000]. For boys, only academic perceived competence was a significant predictor variable of BMI [adjusted $R^2$ = 0.066, $F$(1,

55) = 4.861, $p = .032$]. For girls, $VO_2$ max and academic perceived competence were significant predictor variables of BMI [adjusted $R^2 = 0.146$, $F(2, 55) = 5.717$, $p = .006$].

The fourth hypothesis stated that (a) BMI, aerobic capacity, and the athletic and physical appearance perceived competence of participants would account for a significant percentage of locomotor skill performance, but (b) the academic competence, peer acceptance, behavioral conduct, and global self-worth of participants would not account for a significant percentage of locomotor skill performance. There was not strong support for this hypothesis, as $VO_2$ max was the only significant predictor for locomotor skill performance [adjusted $R^2$ = 0.056, $F(1, 112) = 7.655$, $p = .007$]. Again, $VO_2$ max was a significant predictor for locomotor skill performance even more so for girls [adjusted $R^2 = 0.134$, $F(1, 56) = 9.634$, $p = .003$, but no significant predictors emerged for locomotor skill performance for boys.

The fifth hypothesis stated (a) BMI, aerobic capacity, and the athletic and physical appearance perceived competence of participants would account for a significant percentage of object-control skill performance, but (b) the academic competence, peer acceptance, behavioral conduct, and global self-worth of participants would not account for a significant percentage of object-control skill performance. This hypothesis is more strongly supported than the last hypothesis as $VO_2$ max and the athletic perceived competence and physical appearance perceived competence accounted for a much higher variance for object-control skill performance [adjusted $R^2$ = 0.206, $F(3, 111)$ = 10.616, $p$ = .000] than the locomotor skill performance. The same variables were significant predictors along with peer acceptance perceived competence for object-control skill performance for boys [adjusted $R^2$ = 0.305, $F(4, 55)$ = 7.025, $p$ = .000]. Only $VO_2$ max was a significant predictor variable for object-control skill performance for girls [adjusted $R^2$ = 0.200, $F(1, 55)$ = 14.786, $p$ = .000].

Table 8

*Stepwise Regression Results – All Participants*

| DV | Predictors | Adjusted $R^2$ | Predictor(s) (Last) |
|---|---|---|---|
| Academic | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.089 | BMI (negative β) |
| Peer | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.055 | $VO_2$ Max |
| Athletic | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.061 | Object-Control |
| Physical | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.048 | $VO_2$ Max |
| | | 0.035 | Object-Control (negative β) |
| Behavior | BMI, $VO_2$ Max, Locomotor, Object-Control | | No variables in model |
| Self-Worth | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.048 | $VO_2$ Max |
| $VO_2$ Max | BMI, Locomotor, Object-Control, all SPPC domains | 0.137 | Object-Control |
| | | 0.068 | Physical |
| | | 0.040 | BMI (negative β) |
| $VO_2$ Max | Locomotor, Object-Control | 0.148 | Object-Control |
| BMI | $VO_2$ Max, Locomotor, Object-Control, all SPPC domains | 0.079 | $VO_2$ Max (negative β) |
| | | 0.055 | Academic (negative β) |
| | | 0.024 | Athletic |

Table 8 (continued)

*Stepwise Regression Results – All Participants*

| DV | Predictors | Adjusted $R^2$ | Predictor(s) (Last) |
|---|---|---|---|
| Locomotor | BMI, $VO_2$ Max, all SPPC domains | 0.056 | $VO_2$ Max |
| Object-Control | BMI, $VO_2$ Max, all SPPC domains | 0.137 | $VO_2$ Max |
| | | 0.046 | Physical (negative β) |
| | | 0.023 | Athletic |

Table 9

*Stepwise Regression Results – Boys*

| DV | Predictors | Adjusted $R^2$ | Predictor(s) (Last) |
|---|---|---|---|
| Academic | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.085 | BMI (negative β) |
| Peer | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.069 | $VO_2$ Max |
| Athletic | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.083 | Object-Control |
| Physical | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.126 | $VO_2$ Max |
| | | 0.076 | Object-Control (negative β) |
| Behavior | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.058 | $VO_2$ Max |
| | | 0.076 | Locomotor (negative β) |
| Self-Worth | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.086 | $VO_2$ Max |
| $VO_2$ Max | BMI, Locomotor, Object-Control, all SPPC domains | 0.131 | Physical |
| | | 0.073 | Object-Control |
| $VO_2$ Max | Locomotor, Object-Control | | No variables in model |
| BMI | $VO_2$ Max, Locomotor, Object-Control, all SPPC domains | 0.066 | Academic (negative β) |
| Locomotor | BMI, $VO_2$ Max, all SPPC domains | | No variables in model |
| Object-Control | BMI, $VO_2$ Max, all SPPC domains | 0.077 | Athletic |
| | | 0.110 | Physical (negative β) |
| | | 0.074 | BMI (negative β) |
| | | 0.044 | Peer |

Table 10

*Stepwise Regression Results – Girls*

| DV | Predictors | Adjusted $R^2$ | Predictor(s) (Last) |
|---|---|---|---|
| Academic | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.078 | BMI (negative β) |
| Peer | BMI, $VO_2$ Max, Locomotor, Object-Control | | No variables in model |
| Athletic | BMI, $VO_2$ Max, Locomotor, Object-Control | 0.073 | Locomotor |
| Physical | BMI, $VO_2$ Max, Locomotor, Object-Control | | No variables in model |
| Behavior | BMI, $VO_2$ Max, Locomotor, Object-Control | | No variables in model |
| Self-Worth | BMI, $VO_2$ Max, Locomotor, Object-Control | | No variables in model |
| $VO_2$ Max | BMI, Locomotor, Object-Control, all SPPC domains | 0.200 | Object-Control |
| | | 0.096 | BMI (negative β) |
| | | 0.044 | Locomotor |
| $VO_2$ Max | Locomotor, Object-Control | 0.187 | Object-Control |
| | | 0.087 | Locomotor |
| BMI | $VO_2$ Max, Locomotor, Object-Control, all SPPC domains | 0.089 | $VO_2$ Max (negative β) |
| | | 0.057 | Academic (negative β) |
| Locomotor | BMI, $VO_2$ Max, all SPPC domains | 0.134 | $VO_2$ Max |
| Object-Control | BMI, $VO_2$ Max, all SPPC domains | 0.200 | $VO_2$ Max |

# CHAPTER FIVE

## Discussion

Stodden et al. (2008) have proposed a model that includes four main components (motor skill competence, perceived motor competence, health-related fitness, and physical activity), which are interrelated and may ultimately lead to the risk of obesity of children. This study explored aspects of this model and expanded the perceived motor competence variable to different domains of perceived competence. The overall purpose of this study was to examine the relationship among fundamental motor skill development (of both locomotor and object-control skills), health-related fitness level (measured by aerobic capacity and body composition), and perceived competence (measured by subscales/domains) of fourth grade male and female students.

Due to the complex relationships amongst the variables, stepwise regression analyses were conducted to determine which variables predicted a significant percentage of the variance of other variables. Overall, a small percent of the variance was explained for any variable; thus, additional factors (e.g., genetics, social influence, practice, opportunity, environment) contribute to motor skill development, health-related fitness levels, and perceived competence of youth. These factors will be discussed throughout this chapter.

Object-control skill performance consistently emerged as a significant predictor of the dependent variables. In the total sample, object-control skill performance was a significant predictor for athletic perceived competence (adjusted $R^2$ = 0.023), physical appearance perceived competence (adjusted $R^2$ = 0.046) and $VO_2$ max (adjusted $R^2$ = 0.137). The results were similar for boys. In girls, object-control skill performance predicted even more of the variance for $VO_2$ max than for the total sample. These findings are in contrast to previous research which has linked locomotor skill performance with aerobic capacity and BMI more so than object-control skill performance (Hands, 2008; Okely, Booth, & Chey, 2004). Only locomotor skill performance was a significant predictor for athletic perceived competence in girls. The influence of object-control skill development on athletic perceived competence is not surprising since the ability to control implements such as bats, balls, or gloves is an important aspect of many sports (e.g., baseball, softball, basketball). In early to middle childhood, children usually acquire more competitive behaviors and begin to use social comparison to peers as a way of judging their competence (Weiss & Stuntz, 2004). Such comparisons may influence the importance of the athletic domain (and the peer acceptance domain which was also a significant predictor). Youth sport is becoming more specialized and children are often expected to perform at a high level at young ages. In turn, there are motor skill, sociological, and psychological consequences related to sport specialization (Wiersma, 2000). These consequences could result in a lowered perceived athletic competence. However, children can clearly distinguish between their abilities in each of the six domains of the SPPC by middle to late childhood (ages 8 to 11; Horn, 2004) and have more realistic evaluations of the self (Harter, 1982). Therefore, actual and perceived competences are more similar to each other than they were in early childhood.

Boys also had a significantly higher mean object-control skill performance score than girls, while there was no difference in the mean locomotor skill performance score. These findings are somewhat supported by the current literature. Researchers have reported that the difference between boys' and girls' performance of motor skills is minimal before puberty (Thomas & French, 1985). In contrast, Hume et al. (2008) found that more 9-12 year old boys achieved mastery/near mastery in object-control skills compared to same age girls, which supports the findings from the current study. Boys may have significantly higher scores on object-control skills because many of the organized sports in which they engage involve object-control skills.

Gender differences in motor performance in elementary school children may be largely socialized by parents (Thomas & French, 1985). In addition, the lack of opportunities and the low expectations for a girl's performance as compared to boy's in a skill such as throwing may have negative consequences for females as they enter puberty (Thomas & Thomas, 2008). Sports that require more vigorous movements and a greater use of space are often considered masculine and often require objects to be manipulated; however, girls possess the physical capabilities to perform well in all kinds of movement activities (Duncan, 1993). The choice of organized physical activity (whether the child's choice or not) may also contribute to the gender difference in object-control skill and lack of gender difference in locomotor skills. Children participate in organized physical activity for a number of reasons including social influence, sport availability and opportunity for boys and girls, and motivation, among other factors. Barnett, van Beurden, Morgan, Brooks, and Beard (2008) found that the most reported organized sport activities in summer and winter for boys ages 8 to 12 in Australia were football, soccer, hockey, baseball, basketball, cricket, and squash. For girls ages 8 to 12, the favorites were netball, soccer, hockey, dance, aerobics, swimming, and football. In this particular study, the most popular activities for boys were ones that all required object-control skills and various locomotor skills (Barnett et al., 2008). Girls participate in some sports that do not require object-control (e.g., swimming, dance, aerobics) as well as some sports that require object-control skills (Barnett et al., 2008). Girls might not get as much practice with object-control skills, therefore, and the mean differences in performance may increase over time.

Fundamental motor skill development in childhood has been shown to be an important facet for encouraging physical activity and preventing and treating childhood obesity by increasing actual and perceived physical competence of children (NSW Department of Health, 2003). According to the results from the current study, it may be beneficial to focus more on object-control skill development than locomotor skill development in middle childhood. By doing so, children's feelings of perceived competence in the athletic and physical appearance domains may improve. In addition, object-control skills are significantly correlated with aerobic capacity not only in childhood (Frey & Chow, 2006), but object-control proficiency in childhood is also associated with adolescent cardiorespiratory fitness (Barnett et al., 2008). Fundamental motor skill development in the primary school years is important in promoting adolescent and long-term fitness (Barnett et al., 2008). Seefeldt and Haubenstricker's (1982) research on the age at which sixty percent of boys and girls perform at a specific developmental level for both locomotor and object-control skills supports this idea as well. In middle childhood, children have typically reached the highest developmental level for most locomotor skills (e.g., running) that are needed for playing sports/games that require object-control. The locomotor skills in which they have not reached the highest developmental level (e.g., long jumping, hopping on one leg) are not as important to excel in to participate in most sports/games. Thelen and Ulrich (1991) use dynamical systems theory to explain that new forms in behavior emerge from the cooperative interactions of multiple components within a task context. The component parts interact among themselves and also with the environment in order to cause movement patterns, control, and coordination (Payne & Isaacs, 2008). Therefore, it may be beneficial in Stodden's model (2008) to partial the motor competence influence into locomotor development early in childhood (when the locomotor component is more important than object-control skills) and object-control development during the middle to later childhood ages (when the object-control component is more important than locomotor skills).

Another interesting finding in this study was that although various predictors of BMI emerged, only academic perceived competence was a significant predictor of BMI. Research has shown a negative association between obesity/high BMI and academic performance of children and adolescents (Datar, Sturm, & Magnabosco, 2004; Kristjansson, Sigfusdottir, & Allegrante, 2010; Sabia, 2007; Schwimmer, Burwinkle, & Varni, 2003). If children are performing better on schoolwork, their academic perceived competence will likely increase (Wagner & Phillips, 1992). However, until recently, little evidence existed suggesting a cause and effect relationship between obesity and academic performance. Cho, Lambert, Kim, and Kim (2009) found that poor school performance increases the risks of adolescents becoming overweight, which in turn causes poor school performance. The current study supports this relationship as well; when academic perceived competence was the dependent variable, BMI was a significant predictor. Results from a study examining the effect of a school-based obesity prevention intervention on weight and academic performance among low income children found that the children participating in the 2-year intervention had higher math and reading scores and weight decreases than the control group (Hollar et al., 2010). In addition, increasing academic performance may be especially important for females as they enter adulthood. Alatupa et al. (2010) found that low grade point averages of students in early and middle adolescence may be a risk factor of adulthood obesity, but only among women. In contrast, Franklin et al. (2006) found that obesity typically does not impact academic achievement in grades 5 and 6 (sample age range 9.2-13.7 years, *m* = 11.3 years).

Due to the lack of cause and effect relationships in the literature (as well as many possibilities for why overweight may influence academic performance), more research should be conducted examining the BMI and academic competence/perceived academic competence area to determine how and why this relationship may or may not exist. Among the first of the researchers to investigate the relationship, Ratey (2008) identified that exercise increases brain derived neurotropic factor (BDNF) levels in the brain, a key element in cognitive function. Spirduso, Poon, and Chodzko-Zajko (2007) proposed that potential mediators between physical activity and cognition (i.e., learning, retrieval, attention, executive function, problem solving, and information processing speed) include sleep effectiveness, energy/fatigue, nutrition, mental health and certain disease states. Therefore, if children are more physically active and regularly exercise, they are more likely to sleep better, have more energy, have higher self-efficacy, and are less likely to have diseases such as Type 2 diabetes. This impact will lead to better concentration/attention, lower absentee levels, and overall, an increased ability to learn, improving academic performance.

Although most of the participants fell within the FTG HFZ for BMI or normal weight category, there were still children who were considered overweight or obese. The most recent national estimates indicate that 35.5% of children ages 6 to 11 are overweight and 19.6% are considered obese (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). In the current study, 14.8% of the participants were overweight and 10.4% were obese. For exploratory purposes, descriptive statistics for aerobic capacity, motor skill performance, and perceived competence were compared for the overweight and obese group to the normal weight subjects. Results showed that the overweight and obese participants had a lower mean $VO_2$ max (43.3 v. 44.5 kg/ml/min), locomotor skill performance (40.1 v. 41.1), object-control skill performance (40.5 v. 42.0), and perceived competence in the academic (2.9 v. 3.1), peer acceptance (3.0 v. 3.1), physical appearance (3.1 v. 3.2), and global self-worth (3.2 v. 3.3) domains. The means of the two groups for the athletic and behavioral conduct perceived competence domains were similar. Additional analyses were not conducted due to the small sample size. However, these preliminary results show that the overweight and obese population of children and adolescents is an important group to investigate and more interventions should be administered in schools for both the students and their parents.

Overall, the findings support various components of the model proposed by Stodden et al. (2008). Specifically, actual motor performance, health-related fitness (as measured by aerobic capacity and BMI), and perceived competence (in the academic, athletic, and physical appearance domains) emerged as the significant predictors. Therefore, perceived competence in the model should perhaps consider the academic, athletic, and physical appearance domains and not just generic perceived motor competence. Likewise, the perceived competences and health-related fitness variables may be more than mediators to physical activity participation; they may directly influence skill outcomes. If children have higher perceived competence in different areas, have higher fitness levels, and have lower BMIs, they may be more likely to be physical active. Therefore, obesity is also probably a significant factor of the main part of the model and should be included within those relationships as well. In the model proposed by Stodden et al. (2008), the risk of obesity is the primary outcome of the interrelationships among these variables that feeds back into the model. Due to the gender differences found in the current study, two separate models should also be created for boys and girls in middle to late childhood. Figures 2 and 3 reflect proposed models for boys and girls, respectively, based on findings from the current study.

These two models show that some variables are bi-directional relationships (depicted by an arrow on each end of the line), while others are only a one-way relationship (depicted by a line ending in an arrow). The three dashed lines from each general variable (i.e., motor skill performance, perceived competence, and health-related fitness) to physical activity are showing that there is a possible relationship. Unfortunately, physical activity was not measured in this study. In addition, note that the figures are different for boys and girls and are specific to fourth grade children. In younger children the relationships may be different. For example, locomotor skill performance may

Figure 2

*Revised Stodden et al. (2008) Model for Fourth Grade Boys*

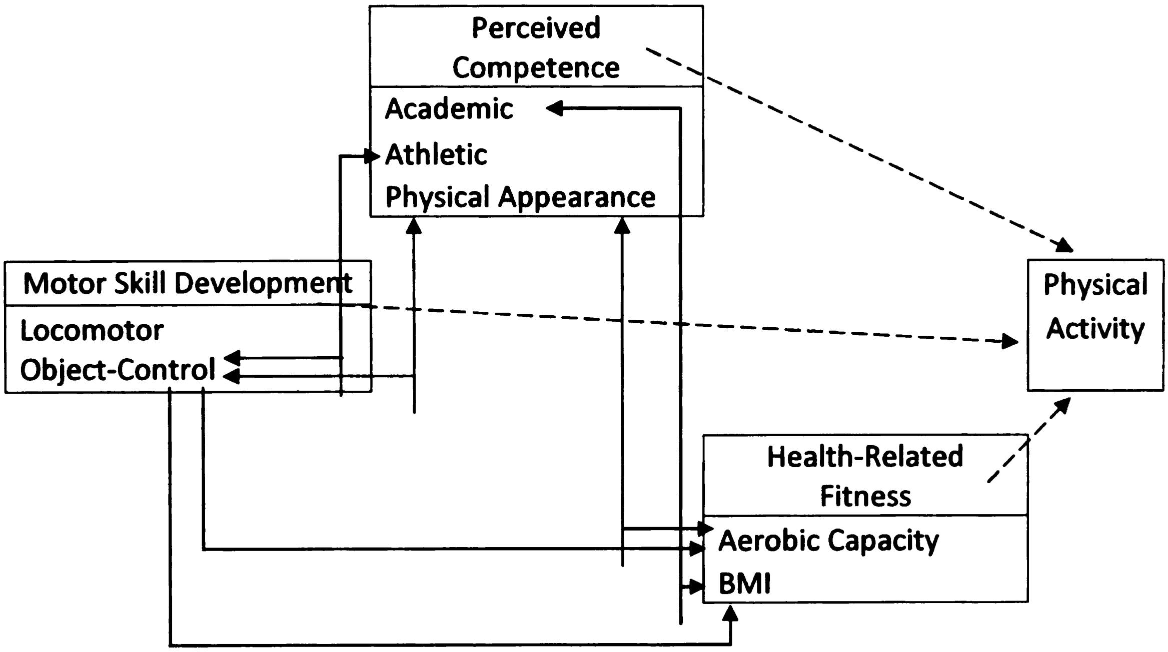
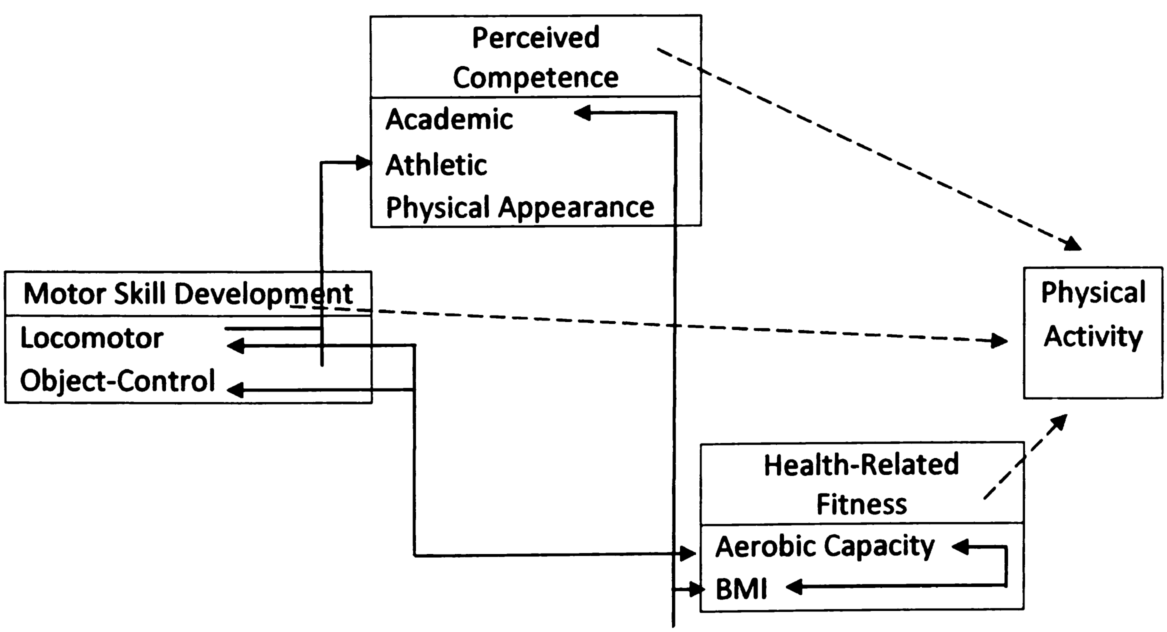



Figure 3

*Revised Stodden et al. (2008) Model for Fourth Grade Girls*



have been a more significant predictor because children typically learn and become more proficient in most of these skills at a younger age. Perceived competence in the different domains may also have been different as younger children do not have as accurate actual competence related to their perceived competence.

These models should also include potential mediators such as race/ ethnicity, socioeconomic status, genetics, social influence, practice, opportunity, and environment. The general importance of these variables was discussed in relation to physical activity throughout the review of literature and in this chapter.

*Strengths of the Study*

There were three main strengths in this study. First, although previous research has examined the relationships between fitness and motor skills, motor skills and perceived competence, and fitness and perceived competence, few studies have simultaneously considered these three sets of variables. Secondly, the same trained and experienced researcher analyzed all the videos of the participants performing the locomotor and object-control skills in the TGMD-2 to ensure consistency of the scoring. Barnett and colleagues (2009) explained that during observation in a field setting, such as the one used in this study, multiple raters may assess fundamental motor skill proficiency of the participants without comparison to an expert rating. The overall reliability of the raters is important, though. Videotaping all the skills eliminated the need for multiple raters and assessment of the performances during the field test. The researcher's scoring was compared to an expert's scoring, therefore increasing the overall reliability of the TGMD-2 in the study.

Third, while BMI may not be the best measure of body composition, direct assessment of height and weight of the participants is a strength as opposed to using self-reported data. Elgar, Roberts, Tudor-Smith, and Moore (2005) stated that self-report bias is not always accurate for predicting overweight and obesity of adolescents and actual and perceived body size contribute to underreporting body weight. Jansen and colleagues (2006) agree that self-reported height and weight of children led to an underestimation of BMI and, therefore, an underestimation of the prevalence of overweight. In field settings, BMI is the most practical method of determining body composition. It is convenient, less expensive than laboratory measures, not intrusive, and easy to calculate. Therefore, BMI should be incorporated where meaningful to study questions.

*Limitations*

Several limitations may influence the results of this study. The sample of fourth grade children was not diverse with regards to race/ethnicity and socioeconomic status. Participants were primarily Caucasian and from middle to upper class families. Race/ethnicity may play a role in body composition, fitness, motor skill performance, and perceived competence. Youth from low socioeconomic status families may be less active than those from middle or high socioeconomic status families, therefore influencing fitness levels and motor skill performance (Sallis, Zakarian, Hovell, & Hofstetter, 1996). For children from low-income families, physical education may be their only opportunity to practice and acquire fundamental motor skills (Thomas, Thomas, & Williams, 2008). For example, children from higher SES environments may have access to private lessons, more choices of movement activities, or financial means to enroll in high cost activities that impact skill development. Therefore, these relationships should be examined in a more diverse sample.

The participants were from three schools chosen by convenience. Randomly selected schools would have made the results stronger. However, the support of the principal, physical education teacher, and, in one case, approval of the superintendent were needed before even distributing parental consent forms. These requirements made choosing schools at random a challenge. Because the participants were from three schools, there were three different physical education teachers and one physical education intern involved with the classes. Experience of the instructors in physical education classes may greatly influence a child's motor skill development, fitness levels, and perceived competence. In addition, physical education classes may vary in time provided for physical education, quality of the curriculum, and the emphasis placed on physical activity and motor skill development. Robinson and Goodway (2009) found that significant motor development gains are obtained from well-designed and developmentally appropriate motor skill interventions regardless of instructional climate. Other researchers have found the teacher's role in providing feedback and reinforcement is important as well (Bunker, 1991), especially when using mastery climate instructional approaches (Robinson, Rudisill, & Goodway, 2009). Thomas and Thomas (2008) add that the curriculum in elementary school should begin with fundamental skills, and then build to transitional skills.

The physical education teachers at these three schools were all certified in physical education, taught a curricula which included a focus on motor skills, and emphasized the importance of physical activity. One physical education teacher even said before the children performed a particular skill, "They should be good at this one; they just practiced it last week!" Physical education time requirements for these three schools were twice a week for 35-40 minutes per class. In schools with less required physical education time, inexperienced physical education teachers, classroom teachers who teach physical education, or a poorly constructed curriculum results, may have been different.

Physical activity outside of school may account for some of the positive results and should be considered in future research. Many students were discussing playing sports outside of school and involvement in physical activity with their families and friends. However, this information was not captured systematically.

The time of data collection during the school year may be a factor, especially fitness tests. Children improve on fitness tests from fall to the spring because of growth and development, but also because of practice from the physical education classes (Thomas & Thomas, 2008). Because the data collection occurred in February to March, scores might have been different than if testing had occurred in early fall, depending on the physical activity levels of participants during the summer vacation. For example, Butterfield, Lehnhard, Mason, McCormick (2008) found that regardless of age, sex, BMI, or sports participation, the PACER scores of the children significantly increased during the school year, decreased over the summer, and returned to the original slope the following year. Participants from some classes were also more familiar with the PACER test measuring aerobic capacity than participants in other classes, and therefore, that experience could have affected the results.

The teacher involvement in parental consent form distribution and collection may have influenced the completion of parental consent forms of the participants. All three physical education teachers involved in this study were experienced and enthusiastic about physical activity and providing the children with the skills needed for a healthy lifestyle. However, the return rate (84%) for parental consent forms was the highest from the physical education teacher who was in full support of the study and encouraged the parents to allow their children to participate. The other two physical education teachers did not put as much emphasis on participation, and the return rates for Schools A and B were 50% and 57%, respectively. The classroom teachers who were more interested in the study and the implications of the results also seemed to promote participation in their classrooms and more parental consent forms were received from the students in their classes.

BMI is not the best measure of body composition because it is only a measure of the relationship between height and weight and does not account for weight from muscle as opposed to fat. It is not as effective in identifying moderately overweight children as other methods of measuring body composition since it does not account for muscle mass (Lohman & Going, 1998). However, BMI is one of the two options of body composition tests used in the *FITNESSGRAM*, and is often used in field settings such as elementary schools. Research comparing BMI with other body composition tests of children has shown that BMI offered a reasonable measure to assess body fat in children and adolescents and that the standards used to identify overweight and obesity in children and adolescents should agree with the standards used to identify grade 1 and grade 2 overweight (BMI of 25 $kg/m^2$ and 30 $kg/m^2$, respectively) in adults (Dietz & Bellizzi, 1999; Pietrobelli et al., 1998). In addition, recent systematic reviews are supportive of current guidelines that recommend percentile-based cut-off points relative to national reference data to define obesity for children and adolescents (Reilly, 2010).

*Implications for Future Research*

This study has shown the importance of the relationships among fitness, motor skill performance, and perceived competence. These relationships should continue to be investigated in order to determine how best to help youth excel in these areas and overall increase physical activity participation and decrease childhood obesity. There are many implications for future research.

A more diverse sample should be used when conducting a study with these variables. Different races/ethnicities should be included in the sample, as well as children from a lower socioeconomic status. This study was conducted in Michigan; therefore, replicating this study in other areas of the United States and also in other countries would be helpful to determine any differences. Goodway, Robinson, and Crowe (2010) found that boys outperformed girls on both locomotor and object-control skill performance in the midwestern and southwestern regions, and children in the midwestern regions had better locomotor skills than those children in other regions. Therefore, geographic region may also have implications for motor skill development.

Future research should also examine the other variables, such as physical activity, in the model proposed by Stodden and colleagues (2008). Mixed results have been found for the relationship between physical activity and motor skill performance. Fisher et al. (2005) found that fundamental motor skills (15 tasks based on the Movement Assessment Battery) of preschool children were significantly associated with their habitual physical activity (time spent in moderate-to-vigorous physical activity and total physical activity), but the association between the two variables was weak ($r = 0.18$ for the time spent in moderate-to-vigorous physical activity measurement and $r = 0.10$ for the total physical activity measurement). Okely, Booth, and Patterson (2001) found a similar relationship when examining the fundamental motor skills and physical activity of adolescents.

Additional factors that may influence these variables, such as social influence, the effects of practice, environment, and opportunities because the activities youth participate in outside of school will influence aerobic capacity, body composition, motor skill performance, and perceived competence, should be examined. Okely, Booth, and Patterson (2001) and Ulrich (1987) found that adolescents in grades 8 and 10 and children in grades K through 4, respectively, who performed better on motor skills spent more time in organized physical activity. The amount of time children spend practicing within organized or recreational activities will make a difference in performance levels as well. Before puberty, poor performance for both boys and girls is largely due to lack of practice rather than growth and development factors (Thomas & Thomas, 2008).

This study included experienced and well-educated physical education teachers; therefore, it would be interesting to include participants who receive physical education instruction from classroom teachers who are not trained in physical education. Physical education classes should be taught by certified physical education teachers or, in elementary school, at least classroom teachers who have received special training in physical fitness education (Simons-Morton, 1988). The motor skills and fitness levels of children who do not receive adequate and developmentally appropriate instruction may suffer otherwise.

*Conclusion*

The present study adds to the knowledge base concerning the importance of motor skill performance, fitness levels, and perceived competence of children and adolescents. More research is needed to determine the relationship of these variables in other populations and the influence of these variables on physical activity levels and childhood obesity. However, results from this study show children and adolescents should strive for a healthy BMI, increase their aerobic capacity, and engage in fundamental motor skill development (especially object-control skill development) at a young age. Parents, teachers, and coaches should encourage this behavior as well as focusing on enhancing the children and adolescents' academic and athletic competence because at this age, the actual and perceived competence is similar. Specifically, relationships in Figures 2 and 3 should be considered for boys and girls in order to encourage recommended levels of physical activity participation.

APPENDICES

## APPENDIX A

### Letter to Parents

Cover Letter for Parents

January 15, 2010

Dear Parents:

We are entering a research endeavor with individuals in the Department of Kinesiology at Michigan State University. This research will benefit the students by providing important information on the children's motor skill development, physical activity behaviors, health-related fitness, and feelings of self-competence. The data will help the researchers analyze the proposed link between motor skill development, physical activity, self-competence, and health-related fitness. These variables are important to consider for the overall health and well-being of children and youth. The data also will provide [redacted] with information that will help her assess the effectiveness of the physical education program.

The study has been approved by the Institutional Review Board at Michigan State University indicating that the procedures are safe and that the rights of human subjects have been protected. All relevant school policies will be followed. The children will spend about 15-30 minutes filling out a questionnaire; they will spend physical education class time performing a running test and basic skills such as jumping, skipping, hopping, running, and catching. All students will participate in the running and motor skill activities as part of the physical education class period, but they will not be videotaped or have their scores recorded unless they have completed parental consent forms. Height and weight measurements will also be taken behind a portable screen in the gym. Participants will be measured individually to ensure confidentiality and will be asked to step on the scale facing away from the digital display so they will not see their weight. Measurements will be recorded without verbalizing. [redacted] will oversee the classes, while the researchers will score the performances of the children. The motor skills will be videotaped and scored later for efficiency. Participants will also be asked to wear a device that measures physical activity for one week; this device is worn on the upper arm under the participant's clothing and is small and unobtrusive. Participation is voluntary and children may withdraw from the study at any time.

We fully support this joint endeavor and ask that you consider providing consent for your child to participate by signing the enclosed form and having your son/daughter return it to the classroom teacher. Please contact Sheila Kelly or Kyle Morrison, the MSU doctoral students conducting this study for their dissertation, if you have questions at kellyshe@msu.edu or [redacted]; morri310@msu.edu or [redacted].

Sincerely,

[redacted]
Principal

[redacted]
Physical Education Teacher

# APPENDIX B

## Parental Consent Form

Parental Consent Form

Project Title: The relationship among motor skill development, physical activity, aerobic capacity, body composition, and perceived competence of fourth grade school children.

Your child's school has agreed to take part in a research study being conducted by Sheila Kelly and Kyle Morrison, both doctoral students, under the supervision of Dr. Crystal Branta from the Department of Kinesiology at Michigan State University. The purpose of this study is to investigate the relationship between fundamental motor skill level, physical activity, health-related fitness, and perceived competence to determine how these factors may interact to influence healthy activity of children. Only children in fourth grade will be included. Students who are not capable of fundamental motor skills due to physical disability will not be able to participate.

Research studies have both benefits and risks of participation. The benefits of this research include: understanding the relationship between motor skill development and fitness of children, determining if a child's self-competence is influenced by skill and fitness, and providing data to improve physical education at your child's elementary school. General results from this study (as a group, not individual results) will be given to the principal, the physical education teacher, and any interested parents. The risks are minimal, but include potentially raising the child's awareness of their competencies related to others. All instruments have been validated and used with hundreds of children without experiencing any of the potential risks.

Participation in this study will involve a survey, which will take 15-30 minutes in the classroom as a group to complete. Questions will focus on your child's perceived competence related to school, sports, social interactions, physical appearance, and behavioral conduct. Participation will also include a fundamental motor test assessing basic locomotor skills and object-control skills, a running test, and height and weight measurements. This testing will take during physical education class periods. One physical education class period (30-40 minutes) will involve testing locomotor skills (run, gallop, hop, leap, horizontal jump), one class period (30-40 minutes) will involve testing object-control skills (striking a stationary ball, stationary dribble, catch, kick, overhand throw, underhand roll), and part of one class period (less than 30 minutes) will involve the running test to measure aerobic capacity and taking height/weight measurements. We plan to videotape the motor tests for efficiency and score the tests later. Your child will also be asked to wear an activity monitor that measures physical activity for one week; this device is worn on the upper arm under the clothing and is unobtrusive and the size of an mp3 player (iPod). This activity monitor is not to be worn during water activities including showers. These fundamental locomotor and object-control skills listed above and the running test will be part of regular physical education classroom activities, but we are requesting permission to record and use this data for research purposes. If you do not sign the consent form, your child's height and weight will not be taken or recorded, he/she will not receive an armband to measure physical activity, and he/she will not complete the survey portion of the study. Students who do not have completed parental consent forms or who do not give assent will be asked to read or do other work during class when the survey is given.

Responses to the survey and results to motor skills test and physical activity assessment will remain confidential. No one except the investigators and the Institutional Review Board will have access to these responses. Results will be based on the answers given by all participants as a group, insuring confidentiality to individual responses. Your child's confidentiality will be protected to the maximum extent allowable by law. Written and electronic records will be kept in the primary investigator's locked file cabinet and in a password-protected computer file for three years following the final completion of the study and then destroyed.

Although the running test and motor skill activities are common in a physical education setting, please be aware of the university policy. If your child is injured as a result of their participation in this research project, Michigan State University will assist you in obtaining emergency care, if necessary, for your child's research related injuries. If you have insurance for medical care, your insurance carrier will be billed in the ordinary manner. As with any medical insurance, any costs that are not covered or in excess of what are paid by your insurance, including deductibles, will be your responsibility. The University's policy is not to provide financial compensation for lost wages, disability, pain or discomfort, unless required by law to do so. This does not mean that you are giving up any legal rights you may have. If you have concerns or questions about this study, such as scientific issues, how to do any part of it, or to report an injury, please contact Sheila Kelly at [redacted] or by e-mail at kellyshe@msu.edu, Kyle Morrison at [redacted] or morri310@msu.edu, or the primary investigator Dr. Crystal Branta at [redacted] or by e-mail at cbranta@msu.edu. You may contact any of us by regular mail at: 134 IM Circle, Dept. of Kinesiology, MSU, East Lansing, MI 48824.

Your child's participation in this study would be greatly appreciated. However, please know that participation is voluntary and he or she may withdraw from participation at any time without penalty. Furthermore, he or she may refuse to answer specific questions on the survey or elect not to participate in a fitness or motor skill test if your child feels uncomfortable, and still be part of the study. If you have any questions or concerns about your role and rights as the parent of a research participant, would like to obtain information or offer input, or would like to register a complaint about this research study, you may contact, anonymously if you wish, the Michigan State University Human Research Protection Program at 517-355-2180, FAX 517-432-4503, or e-mail irb@msu.edu, or regular mail at: 207 Olds Hall, MSU, East Lansing, MI 48824.

Thank you for your time and cooperation,

Your signature below indicates that you DO wish for your child to participate in this study.

______________________________ __________

Parent's Signature Date

I grant permission for the motor skills testing to be videotaped.

______________________________ __________

Parent's Signature Date

______________________________

Child's Name (Please Print)

## APPENDIX C

## Participant Assent Form

Assent Form

Project Title: The relationship among motor skill development, physical activity, aerobic capacity, body composition, and perceived competence of fourth grade school children.

Your principal and teachers have agreed to take part in a research study being conducted by Sheila Kelly and Kyle Morrison, students from Michigan State University. The purpose of this study is to look at your motor skill level, physical activity behaviors, physical fitness, and feelings about your abilities.

If you want to participate in this study you will take a survey about your feelings about school, sports, social interactions, physical appearance, and behavioral conduct. Participation will also include a running test, height and weight measurements, and fundamental motor skill tests. One PE class (30-40 minutes) will involve testing locomotor skills (run, gallop, hop, leap, horizontal jump), one PE class (30-40 minutes) will involve testing object-control skills (striking a stationary ball, stationary dribble, catch, kick, overhand throw, underhand roll), and part of one PE class (less than 30 minutes) will involve the running test and taking height/weight measurements. You will participate in the running and motor skill activities in PE class, but if you do not agree we will not write down or videotape your tests. If you do not want to take the survey, you will read or do other work while your classmates take the survey. You will also be asked to wear a small armband that measures your physical activity for one week. If you do not want to wear the armband or have your height or weight measurements taken, you can say no.

No one except the MSU researchers will see your responses and scores. Your principal, teachers, and classmates will not see any of your responses or scores.

Your participation in this study would be really helpful, but you can choose if you want to participate in the study or not. You may also decide you do not want to participate at any time, or you can decide not to participate in certain tests or answer certain questions at any time without anyone getting mad. If you have questions about this, please talk to one of the Michigan State students. If you wish to participate, please follow the directions of the leader and complete the form.

Sign below if you agree to be videotaped and participate in the study.

____________________________________ ____________

Participant's Signature Date

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## REFERENCES

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