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Associations Among Perceived Motor Competence, Motor Competence, Physical Activity, and Health-Related Physical Fitness of Children Ages 10-15 Years Old.

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I am submitting herewith a thesis written by Emily Marie Post entitled "Associations Among Perceived Motor Competence, Motor Competence, Physical Activity, and Health-Related Physical Fitness of Children Ages 10-15 Years Old.." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Kinesiology.

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Associations Among Perceived Motor Competence, Motor Competence, Physical Activity, and Health-Related Physical Fitness of Children Ages 10-15 Years Old.

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DEDICATION

To my fiancé, Tyler, and my parents, Mike and Jo. Thank you for all of your love, support, and encouragement. God has blessed me tremendously. All I have accomplished is in God's glory.

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ABSTRACT

Purpose: To examine the associations among perceived motor competence (PMC), motor competence (MC), physical activity, and health-related physical fitness during middle childhood and early adolescence. **Method:** Participants were 47, 10-15 year old youth. Each participant completed two visits in East Tennessee or northwest Ohio. During these visits, the participants completed the Bruininks-Oseretsky Test (BOT-2) Analysis Test for Motor Proficiency, Harter's PMC questionnaire, and the FITNESSGRAM battery for health-related physical fitness. The Actigraph GT3X+ accelerometer was used to measure physical activity. **Results:** There were significant associations among health-related physical fitness and both motor percentile ($r_s = 0.44$, $p < 0.01$) and PMC ($r_s = 0.32$, $p < 0.05$). An association was found among PMC and MC ($r_s = 0.47$, $p < 0.05$). There were no significant associations among average daily MVPA and any of the other variables. **Conclusions:** High MC and PMC appear to be associated with higher levels of health-related physical fitness. It is important for children to learn fundamental motor skills to possibly participate in more complex motor skills related to physical fitness and for children to be encouraged in a positive manner while participating in physical activity to possibly increase their PMC.

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CHAPTER 1

INTRODUCTION

Fundamental motor skills are foundational movements that provide the critical basis for children's motor development and engagement in physical activity (Holfelder & Schott, 2014). Motor development and eventual motor competence—the mastery of motor skills—appear to drive physical activity levels in middle to late childhood (Stodden et al., 2008). Unfortunately, recent research suggests that there is a decline from childhood into adolescence in meeting the physical activity recommended guidelines for children and adolescents accumulating moderate-to-vigorous physical activity (MVPA) per day (Troiano et al., 2008). Although most children develop fundamental motor skills before the age of nine, some do not achieve competence and face increasingly limited opportunities for physical activity (Strong et al., 2005). This creates a problematic cycle in which decreasing physical activity undermines motor competence, which in turn contributes to less physical activity.

Lack of regular physical activity combined with the under-development of fundamental motor skills create a skill proficiency barrier that also compromises the development of basic and specialized motor skills and sports-specific skills (Seefeldt, 1980; Metcalfe & Clark, 2002). Basic motor skills include skills such as catching, kicking, throwing, running, leaping, etc. Specialized motor skills and sport specific motor skills are basic motor skills that have been refined for sports that are task specific and include skills such as shooting a basketball into a hoop, hitting a golf ball, agility running through cones, etc. Transitional and sport-specific skills are necessary as children move

toward participation in more complex skill-related activities associated with beneficial lifetime physical activities, such as sport, dance, and other recreational activities (Strong et al., 2005). Children developing this skill barrier will presumably be disadvantaged as they grow into adulthood, facing an increasingly challenging problem of establishing and maintaining healthy physical activity levels. Moreover, the relationship between physical activity and motor competence appears to become stronger from early to later childhood (Stodden & Goodway, 2007; Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006; Salmon, Ball, Hume, Booth, & Crawford, 2008). There are many factors that could possibly influence the relationship between motor competence and physical activity. It is critical to understand the relationship among motor competence, physical activity, perceived motor competence (PMC), and how these factors influence health-related physical fitness (Stodden et al., 2009).

Perceived motor competence is an individual's belief in his or her abilities in different domains of motor skills (Spessato, Gabbard, Robinson, & Valentini, 2012). Children with low perceived motor competence may be reluctant to participate in physical activity, especially as they grow older and face a widening gap between their motor skill level and that of their peers (Stodden et al., 2008). It is important to encourage children to participate in physical activities that promote both actual and perceived motor competence. One approach to facilitating physical activity in children with low motor competence is to use progressions from simple to more complex activities (Barnett et al., 2009). A progression from a simple to a more complex activity would be catching a tennis ball with two hands to catching a tennis ball with one hand or balancing on both

feet, on in front of another, to balancing on one foot. Children who learn the foundational skills are thought to be able to progress to the more complex skills. This, in turn, will lead to a higher level of physical activity because these children are better able to participate in a larger variety of physical activities, which could then lead to higher physical fitness levels.

Health-related physical fitness is another potential factor for the relationship between motor competence and physical activity (Stodden et al., 2008). Health-related fitness is comprised of aerobic capacity, muscular strength, muscular endurance, and flexibility. Children who are more physically active, develop higher levels of health-related physical fitness, and also had a higher level of motor competence (Haga, 2009; Wrotniak et al., 2006). Moreover, children with lower motor competence display lower levels of physical fitness in comparison to children with higher levels of health-related physical fitness as they mature and develop (Haga, 2009; Wrotniak et al., 2006). Therefore, it is thought that increasing the motor competence of adolescents may lead to increased physical activity during adulthood (Stodden & Roberton, 2009). With the widespread prevalence of obesity, it is important to help youth develop motor competency during childhood and adolescence to better foster healthy physical activity and fitness levels during adulthoods. As children progress into adolescence, their perception of themselves greatly influences their health-related physical fitness because they are largely impacted by how their peers view them, leading to their level of participation in sport-related physical activities that increase complex motor skills and overall health-related physical fitness (Stodden & Roberton, 2009).

Lacking health-related physical fitness, motor competence, and perceived motor competence can lead to obesity. There is an increasingly widening gap between normal-weight children and overweight/obese children's gross motor skills because of the inverse relationship between overweight/obesity and motor skills in children (D'Hondt et al., 2013). Individuals with a higher amount of body fat (overweight/obese), struggle more with performing motor skill tasks and they have a slower progression of gaining their motor skills because of the excess adipose tissue (D'Hondt et al., 2013; Carrel et al., 2012). Therefore, obesity contributes to children not learning foundational motor skills, which causes low motor competency, and in turn, leads to an even more sedentary lifestyle (Gentier et al., 2013). As children age, those individuals who are overweight/obese are thought to participate in less activities because they have a lower motor competency, which contributes to not beginning an active and healthy lifestyle because of their low motor skill level unless they are forced to do so.

The relationships between health-related physical fitness, motor competence, perceived motor competence, and physical activity is not well understood, particularly in the adolescent age group. Although research has identified positive relationships among health-related physical fitness, motor competence, and physical activity in young children (3-5 years old) and during middle childhood (5-10 years old), research including these variables during late childhood and adolescence (10-15 years old) is limited (Stodden & Goodway, 2007; Stodden et al., 2008; Caspersen & Christenson, 1985). Therefore, this study will seek to extend the body of research investigating the associations among

health-related physical fitness, motor competence, perceived motor competence, and physical activity during middle childhood and the adolescent time period.

The purpose of the proposed study is to examine the associations between health-related physical fitness, motor competence, perceived motor competence, and physical activity during middle childhood and early adolescence (10-15 years old). It is hypothesized that there will be significant, positive associations between all of the variables (motor competence, health-related physical fitness, perceived motor competence, and physical activity.

Research Question

What associations exist among motor competency, health-related physical fitness, perceived motor competence, and physical activity during middle childhood and early adolescence (10-15 years old)?

Hypothesis

It is hypothesized that there will be significant, positive associations among all of the variables (motor competence, health-related physical fitness, perceived motor competence, and physical activity) during this age period.

CHAPTER 2

LITERATURE REVIEW

Motor competence is an individual’s movement coordination quality when performing a variety of different motor skills that range on a scale from gross to fine motor skills (Holfelder & Schott, 2014). Improved motor development is associated with higher levels of physical activity and higher fitness levels. More favorable body composition is also related to better motor development. These relationships have been established in children (<9 years old), but limited research has been conducted in later childhood and adolescence (10 – 15 years old). Therefore, this thesis will contribute to the literature by examining the associations among motor development, physical activity, and physical fitness in 10 -15 year old youth.

Regular physical activity has been shown to have health benefits for all individuals, especially children and adolescents. Physical activity is defined as any sort of bodily movement that results in energy expenditure (Caspersen & Christenson, 1985). Evidence-based guidelines for physical activity were developed based on research that has shown that physical activity has a positive influence on children in regards to musculoskeletal health, cardiovascular health, adiposity, and mental health (Strong et al., 2005). The 2008 Physical Activity Guidelines for Americans were developed based on this research and recommend 60 minutes or more of either moderate- or vigorous-intensity daily, aerobic physical activity, and should include vigorous-intensity physical activity at least 3 days a week for children and adolescents (U.S. Department of Health and Human Services). It is a well-known fact that adolescents in the 10 to 15 year old age

group, show a decline in physical activity compared to the younger children (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Troiano et al., 2008). Interestingly, only 42% of children and 8% of adolescents in the United States meet these recommendations for daily physical activity (Troiano et al., 2008). There are many reasons that can potentially contribute to this decline. Factors that may impact activity levels include: health-related physical fitness (set of physical attributes achieved over time), motor competence (ability to execute motor tasks), and perceived motor competence (perception of ability to perform motor tasks) (Caspersen & Christenson, 1985).

Although children typically develop their fundamental motor skills before the age of nine, some children do not and continue onto adolescence without the essential motor skills needed in order to be physically active. Stodden et al (2008) developed a heuristic model that is applicable to children up to age 10 years old. Figure 1 illustrates this model and represents the important concepts identified in the literature, but have not been systematically put into one model to show why so many individuals are sedentary (Stodden et al., 2008). The conceptual model describes the relationship between motor competence, perceived motor competence, physical activity, and health related physical fitness. This model has been researched and validated Stodden et al. (2008) for the sections dedicated to early childhood (EC). This model has not, however, been validated for children ages 10-15 years old. Stodden et al. (2008) theorize that the relationship between physical activity and motor competence will strengthen throughout middle and late childhood and that additional factors such as perceived motor competence, health-related physical fitness, and obesity will influence this relationship. Therefore, further

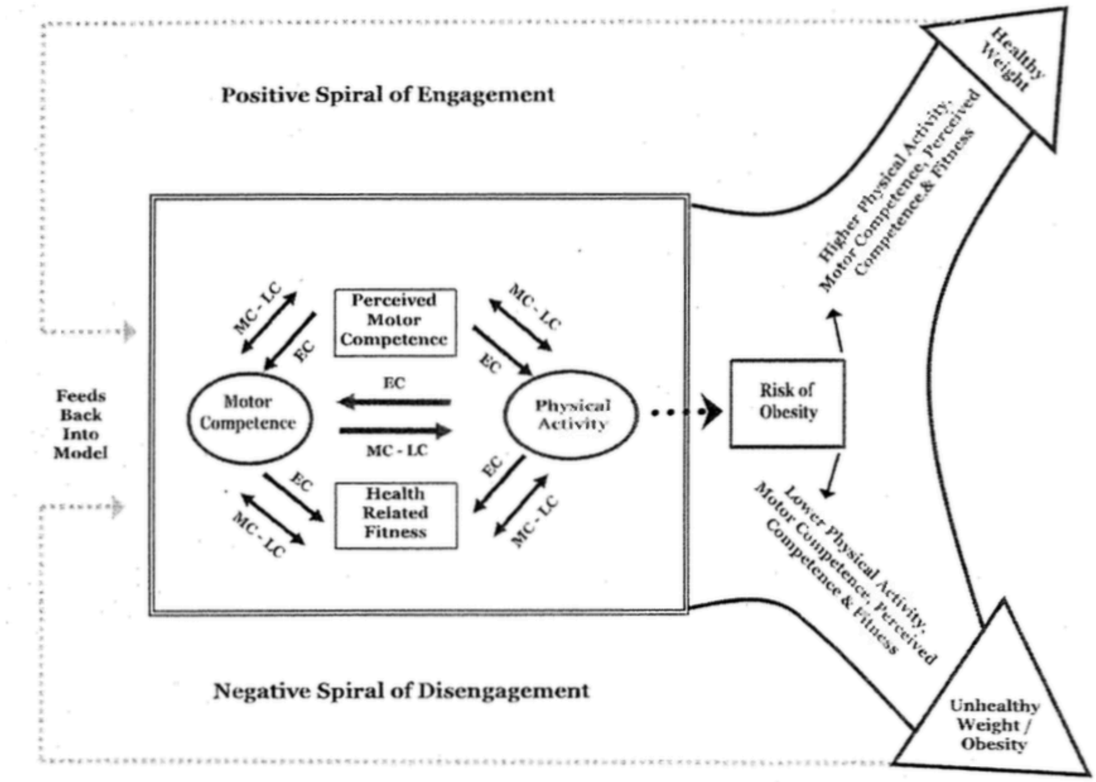

Figure 1: This figure reflects the model proposed by Stodden et al. (2008) explaining the proposed relationship between motor competence, perceived motor competence, health related physical fitness, and physical activity of EC (early childhood) and MC-LC (middle childhood through late childhood) and how these relationships affect the risk of obesity.

research must be done in order to validate this model so that researchers can use this model to describe the associations among physical activity, motor competence, perceived motor competence, physical activity, and health related fitness.

The physical fitness status and physical activity level of each individual child is important because it can affect the child's current health and can pave the way for future health. Children typically learn their fundamental motor skills up to age 9. The largely anaerobic games that are played with children during that age are what help the child learn the basic motor skills and more specialized motor skills (Strong et al., 2005). The children that do not participant in physical activity as often may not completely gain all of the fundamental fine and gross motor skills that are needed for coordination throughout the 10-15 year old age group (pubertal transition age group). There needs to be further research done in the area of motor development and physical activity level of children ages 10-15 to determine if they have gained the essential motor skills needed and if this affects their physical activity level.

2.1 Importance of Motor Development in Children and Adolescents

As children approach the ages of 10-15 (pubertal transition age), more organized activities are available for them to participant in. These physical activity programs are more structured, which require a higher level of motor skills (i.e. sport specific). Most children develop basic movement patterns and skills during their preschool and early school ages (Strong et al., 2005). As these basic skills are acquired, children participate in more complex activities, further increasing their motor skill competency and

coordination. There is less of an emphasis on motor development skills during adolescence, but many of these youth refine these motor skills and build on them to contribute to their physically active lifestyle, which can lead to a higher level of health-related physical fitness (Strong et al., 2005; Barnett, Beurden, Morgan, Brooks, & Beard, 2010). There is a change of emphasis from motor skills in physical activity to emphasis on health, fitness, and behavioral outcomes of physical activity at the age of 10 years old (Figure 2).

If some children do not develop their basic motor skills before adolescence, then they may miss out on building upon those motor skills to create a physically active and healthy lifestyle. If children have not learned their necessary motor skills at a young age, then they may not be able to expand upon those motor skills at an adolescent level. If these adolescents do not have the proper fundamental motor skills, then they will have trouble at the 15-18 year old age group in increasing their overall fitness, especially aerobic fitness because of their lack of being able to participate in complex motor skills (Strong et al., 2005). Fundamental motor skills are the movement patterns of different body parts that are foundational for more complex and specialized movements. Complex motor skills are movements that are carried out when the brain, nervous system, and muscles are working together. Therefore, individuals must have the foundational motor skills before being able to participate in the complex motor skills that many activities made for adolescents require.

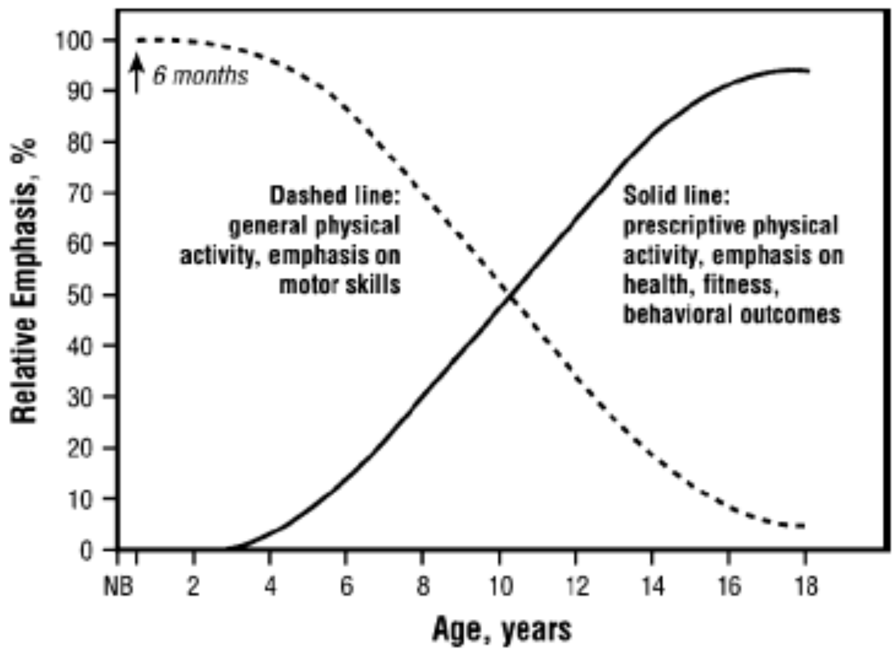

Figure 2: This figure reflects the changing emphasis of physical activity during childhood and adolescence (Kohl, Institute of Medicine, Cook, & Kohl, 2013).

2.2 Relationship Between Motor Development and Physical Activity

Physical activity can have a strong impact motor development in children and adolescents. Preadolescence is the perfect timing to incorporate cognitive and motor skills tasks because this is when children will respond with the most positive reaction, possibly increasing neuromuscular development needed for motor skill (Meyer, Faigenbaum, & Best, 2015). If the baseline of neurocognitive skill has been established, improved motor skill throughout adolescence facilitates the desired skills needed to create a physically active lifestyle as an adult (Meyer, Faigenbaum, & Best, 2015). Wrotniak et al. (2006) studied 8-10 year old children and their motor skills in relation to their physical activity level focusing on motor movement skills because of the likelihood of that being a major causal link to the low physical fitness and physical activity levels of children as they age. There are many elements that factor into why children are less active as they age. Barnett et al. (2009) performed a longitudinal study and found children who participated a physical activity intervention of showed significant differences post-intervention in being able to better perform a kicking motor skill, but not other skills such as catching, throwing, galloping, jumping, and hopping. Furthermore, after the six-year follow up, there were no significant differences in physical activity level between the control and experimental group, but there were positive correlation trends between motor skill and previous physical activity level from the intervention (Barnett et al., 2009). It was believed that there was no significant trend because there was no week to week monitoring of these children to learn the motor skills through

physical activity in order to increase their physical activity levels. Motor proficiency is positively associated with physical activity in children 8-10 years old (Wrotniak et al., 2006). The children that had the highest physical activity levels had the highest motor movement skill level. Running speed, agility, and broad jump are important to motor proficiency and physical activity relationship because these skills were where the higher the children scored in these areas, the better the motor proficiency of the child (Wrotniak et al., 2006). Motor proficiency is also negatively associated with sedentary activity because this study found that the higher the motor skill level, the less likely the child is to become sedentary (Wrotniak et al., 2006). Williams et al. (2008) also found that children with poorer motor skills are less active than children with greater developed motor skills, which foreshadows the lifestyle children will have as they age into adolescence. Therefore there is a high level of importance to be focused on children and their need to develop essential motor skills for their future.

Stroth, Hille, Spitzer, & Reinhardt (2009) examined the visuospatial and motor skill and physical activity relationship on young adults. The correlation between physical activity level of young adults and their relationship with motor skill and visuospatial benefit from physical activity was examined. Spatial processing is higher in that of individuals with a higher physical activity level (Stroth et al., 2009). Spatial processing is imperative in motor skill development and, therefore, increasing the level of physical activity.

Physical activity or motor skill interventions can prove successful if done correctly. Salmon et al. (2008) concluded from their motor skill intervention study that

children, 10-years-old, who were in the fundamental movement skills group had significantly more counts per day in moderate- and vigorous-intensity physical activity min per day, 10 min per day and 8 in per day respectively, post intervention. Therefore, it can be concluded that increasing motor skills for children and adolescents will increase their physical activity significantly as they age (Salmon et al., 2008). It is important to emphasize games and fun to increase enjoyment of learning the motor skills for children in order to increase adherence to the program over time. Females especially had more favorable body mass index (BMI) outcomes post motor skill intervention compared to the control group (Salmon et al., 2008). Females tend to benefit the most from motor skill interventions because they have more space for improvement, seeing as child and adolescent females tend to have lower overall motor competency skills than males (Zask et al., 2012; Salmon et al., 2008). It is important to incorporate motor skills into everyday activities with children as they move into adolescence in order to increase their motor competency, which would in turn increase their physical activity.

2.3 Motor Skills Foreshadowing Physical Activity Patterns as Adults

Increasing motor skill development of children and adolescents will most likely increase their physical activity as they age (Zask et al., 2012; Barnett et al., 2010). It is important that children reach mastery and near mastery performance of several motor skills, such as throwing, jumping, and catching, by the time they are 10 years of age. If children are not proficient in these motor skills by the time they reach 10 years old, they stand the chance of delaying their motor competency because they need these basic skills

for subsequent complex motor skills, thus contributing to a possibly sedentary lifestyle (Barnett et al., 2010; Stodden et al., 2008). The adolescents that develop these basic motor skills enables them to have an active lifestyle, but a barrier may be in place for the children that do not develop these motor skills (Metcalfe & Clark, 2002; Stodden, True, Langendorfer, & Gao, 2012).

Not only does motor skill increase the amount of physical activity a child does, but it physical activity also increases overall movement skill proficiency, especially in obese and overweight children (Cliff et al., 2011). Children becoming more active in physical activities that they like to do, can then foreshadow them being more active into adulthood and decreasing the chance of metabolic diseases. Therefore, motor development plays a crucial role in the physical activity patterns of adulthood individually.

2.4 Relationship Between Motor Development and Physical Fitness

Many studies do not examine the foundations of motor skill because they are focused solely on physical activity in children. Stodden et al. (2008) made researchers aware of the importance of motor development in regards to children's physical fitness level. Exercise is a subcategory of physical activity that is strategic and structured and is used as an objective in the improvement or maintenance of health-related physical fitness (Caspersen & Christenson, 1985). Many individuals disregard that children need to learn the foundational skills before they can participate in many physical activities.

The relationship between motor skill development and physical fitness has been researched time and time again. Chaddock et al. (2012) measured functional magnetic resonance imaging (fMRI) to examine the aerobic fitness level of an individual and his/her brain function. Brain function is directly linked to motor development. In the past, higher fit children have been linked to superior cognitive control in these children and across their lifespan (Chaddock et al., 2012). It can be concluded that a higher fitness level of an individual child will have higher motor control. Chaddock et al. (2012) also concludes that it is assumed that the aerobic fitness level of an individual is associated with neural circuitry that supports motor skill development during childhood. Making this connection between motor skill development and physical fitness level at a young age is tremendously necessary for this study. This study also showed that the higher fit children were able to meet the demands of the more motor control demanding tasks (Chaddock et al., 2012). It can be concluded from this study that children with a higher physical fitness level are better developed in their motor skills because higher fitness levels have a positive relationship with the motor development and cognition.

Haga (2009) stated in her study that focused on ages 9-10 years old that higher motor competence indicated an increased physical fitness level in children. Haga (2009) focused on children ages 9-10, rather than the adolescent age group. Not only does motor competence indicate the physical fitness level of a child, but it also indicates how much physical activity that child is most likely to participate in (Haga, 2009). Determining how physically active a child is may be indicate the approximate physical fitness level of the child. It is assumed in many cases that adolescents who did not develop their motor

coordination as children will eventually grow into coordination as they age. This study proved that assumption wrong in showing that children with low motor control did not regain their motor control as they aged, instead they fell even farther behind than the children with a higher motor control level (Haga, 2009). Many children will not participate in different physical activities because they do not have the motor control to do so. Therefore, they do not learn these normal childhood motor development skills that the other children have learned.

Pontifex et al. (2011) performed a study examining the relationship between cardiorespiratory fitness and cognitive control of preadolescent children. This relationship also included the motor skill level of the children. Lower fit children exhibited a less successful motor skill task performance than the higher fit children (Pontifex et al., 2011). This shows that children with less motor competency are less coordinated and have a lower fitness level. The study also showed that the higher fit children were able to maintain the accurate motor skill response for a longer period of time than the lower fit children (Pontifex et al., 2011). This shows a positively correlation between motor competence, cognition, and physical fitness level.

Many children and adolescent physical activity and overall health fitness programs are focusing their efforts on improving physical activity levels rather than focusing on the motor development and physical fitness level of these children. Hands, Larkin, Parker, Straker, Perry (2009) examined the relationship of physical activity, motor competence, and health-related fitness of adolescents. Many adolescents are not participating in many of the physical activities set aside for them in programs to improve

their health because they do not possess the motor skills to complete the range of activities that are needed to perform correctly and efficiently. In turn, these children with low motor skill tend to be less active, leading to a lower fitness level. The Hands et al. (2009) study found that adolescents who are physically active have a significantly higher physical fitness level than adolescents who are less physically active. This shows the connection between physical activity and physical fitness level of adolescents. The study then states that aerobic fitness level was related to the element of motor competence (Hands et al., 2009).

Stodden et al. (2009) examined the link between motor skill competence and physical fitness in adolescents. This is the same age group that the current study is examining. Increasing adolescents' motor skill competence will increase their physical fitness level as an adolescent and adult (Stodden et al., 2009). It is believed that adolescence is an important time period to ensure that the individual has the proper motor skills needed in order to increase health-related physical fitness. This is crucial because it will allow a smoother transition from adolescence to adulthood in regards to increasing health-related physical fitness (Stodden et al., 2009). If adolescents are proficient in their motor skills at that point in the their life, then they are more likely to be more physically fit as they grow into adulthood because they will be able to perform in physical activities that require high motor skills.

Vlahov, Baghurst, & Mwavita (2014) studied further research of motor development and its effect in predicting high school health-related fitness in a perspective study of gross motor skills. They examined the motor skill level of preschool students

and used the findings to compare to the physical fitness level of the same children eleven years later. Vlahov et al. (2014) concluded that the object control skills are essential in predicting health-related fitness of children when they are adults. This is important for individuals planning children programming in order to increase the motor competence and physical activity levels of children.

According to Zask et al. (2012) many girls do not develop object control skills, but it is assumed that they have developed these skills. Many female children are not exposed to the same experiences as the males are. Therefore, many of the girls do not practice the object control skills; not achieving proficiency in those skills (Zask et al., 2012). Considering that Vlahov et al. (2014) states the importance on object control skills, it is imperative that females practice the object control skills in order to not fall behind in their motor skills compared to the boys. These implications can be further used to develop a program for children to increase physical activity and physical fitness, while increasing motor competence level.

If children do not develop their motor skills at a young age, they can develop Developmental Coordination Disorder (DCD). Faught, Hay, Cairney, & Flouris (2005) looked at the delays that a child with DCD has in regards to physical fitness. This study is relevant because some of the children who do not develop their essential motor skills develop DCD, eventually lead to a low cardiovascular fitness level and overall lower health-related physical fitness. When these children have a low cardiovascular fitness level, they tend to be less active and at a higher health risk (Faught et al., 2005). This study shows a clear linkage between motor skill, and lack there of, and its relationship

with physical fitness in children. Many children avoid being physically active because they lack the skills in the first place that the other children have already gained (Faught et al., 2005). This continues throughout age because the children are already behind and are looked upon with the assumption that they should already have the motor skill development as the other higher fit children.

2.5 Obese Children versus Healthy Children Motor Skill

Overweight children are at a higher risk of chronic health diseases, especially cardiovascular disease. Krombholz (2013) compared overweight and healthy weight preschool children and their motor competence. Other research in the past had concluded that overweight children do not participate in as much physical activity as healthy weight children. This study concluded that overweight children tend to participate in less physical activities when they grow older and have a lower motor competence (Krombholz, 2013; Labbrozzi et al., 2012; Spessto 2012). It is inferred that children participate in less physical activity because they do not have the motor skills to be successful in that activity compared to the other children who are at a healthier weight and have a higher motor competence. Obese children are at a disadvantage in motor skills because these children tend to be less engaged in physical activity, disabling themselves from improving their physical fitness. Morano et al. (2012) suggests enjoyment of the physical activity and increased perception of motor abilities is what will increase physical activity among obese/overweight and inactive children.

2.6 Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2)

The BOT-2 is a test widely and commonly used to determine motor competency in children ages 4 through 21 years old. This test uses a structure that highlights motor performance in broad functional areas; including both fine and gross motor skills that provides a reliable measurement of overall motor proficiency (Bruininks & Bruininks, 2013). The fine motor skills examined tests to control and coordination of the distal musculature of the hands and fingers (Bruininks & Bruininks, 2013). The gross motor skills examined the control and coordination of the arms and hands, large musculature areas of the body (Bruininks & Bruininks, 2013). These fine and gross motor skills are used together to determine the motor competence of the participant. The BOT-2 test consists of fine motor precision (e.g. cutting out a circle, connecting dots), fine motor integration (e.g. copying a star, copying a square), manual dexterity (e.g. transferring pennies, sorting cards, stringing blocks), bilateral coordination (e.g. tapping foot and finger, jumping jacks), balance (e.g. walking forward on a line, standing on one leg on a balance beam), running speed and agility (e.g. shuttle run, one-legged side hop), upper-limb coordination (e.g. throwing a ball at a target, catching a tossed ball), and strength (e.g. standing long jump, sit ups) (Bruininks & Bruininks, 2013). A score and percentile are determined from these tests to determine motor proficiency. The BOT-2 has been deemed reliable and valid in concurrence with several other known motor proficiency tests, such as the Movement ABC motor proficiency test (Miyahara & Clarkson, 2005; Croce, Horvat, & McCarthy, 2001; Horvat & McCarthy, 2001).

2.7 Perceived Motor Competence (PMC)

Perceived motor competence is an individual's awareness and confidence of their capability to perform fine and gross motor tasks (Khodaverdi, 2013). Perceived motor competence can play a crucial role in how physical active or physically fit an individual is, especially adolescents because adolescents have shifted to a more cognitive development and more refined way of gaging their motor capabilities (Stodden et al., 2008). Perceived motor competence is developed socially by previous experiences and feedback received by peers and other social influences (Harter, 1978). Having these influences, social media, family, friends, peers, etc., can pressure children into having a misconstrued perception of their motor competence. Most children do not accurately assess their motor skills, and in many cases overweight children perceive their motor competence lower than what it truly is (Spessato et al., 2012; Harter, 1978). This finding is important because many children need confidence in their abilities to perform a physical task before they perform it.

The encouragement or discouragement of physical activity levels is important in the development of motor skill competence (Pontifex et al., 2011). Many children are encouraged to try activities that are well beyond their realm of motor skill. Many sport activities involve higher motor skill demand, and the coaching/teaching techniques can negatively influence a child if not done properly (Strong et al., 2005). Encouraging children towards activities that will further their motor development and away from activities that will discourage them is essential. This proposed theory is that motor skill competence will increase and physical activity will increase over developmental time

(Pontifex et al., 2011). Pontifex et al. (2011) also mentions a motor competence critical threshold where children could either be hindered away from physical activity or encouraged into physical activity if they are not in the age appropriate motor competence level. This is why it is extremely imperative that children develop their motor skills at their own rate, participating in activities that coincide with their skill level.

If a child is confident in his/her capability to perform a physical task, the child is most likely to not be afraid to perform that task in front of peers or other individuals. This scenario is most applicable to children and adolescents because most of physical activities are performed in-group settings, such as physical education classes, athletics, clubs, etc. It is important to promote opportunities to increase motor competency, but also opportunities to reinforce positive perceptions of the child's motor capabilities (Spessato et al., 2012). Children who have a higher perceived motor competence are more likely to participate in more physical activities, likewise, children with a lower perceived motor competence are less likely to participate in physical activities (Biddle, Whitehead, & Nevill, 2005; Davison, Schmalz, & Downs, 2010; Stodden et al., 2008). There is a significant correlation between children who have greater perception of motor competency and their level of physical activity (Labbrozzi et al., 2012; Stodden et al., 2008). Not only do children with a lower motor competence have a lower physical activity level, but they also have a lower cardiorespiratory fitness (Hardy, Reinten-Reynolds, Espinel, Zask, & Okely, 2012). This can set children and adolescents up for an unhealthy lifestyle as they progress into adulthood. Therefore, influencing a child's

perception of themselves of their motor skills can greatly impact their physical activity level, later in life impacting their weight and health status.

2.8 Physical Activity Accelerometry

An objective source of monitoring physical activity is an accelerometer. An objective way of measuring is more accurate than subjective. The GT3X Actigraph Accelerometer has been validated in children ages 10-15 years old and has been determined to be accurate in monitoring physical activity (Hänggi, Phillips, & Rowlands, 2013; Trost, Loprinzi, Moore, & Pfeiffer, 2011). The validated cut points used for children are the Evenson cut points (Evenson, Catellier, Gill, Ondrak, & McMurray, 2008). Using objective monitoring helps get accurate measures of moderate-to-vigorous physical activity (MVPA) counts to use in data interpretation.

2.9 FITNESSGRAM

The FITNESSGRAM was developed by the Cooper Institute for children as a health-related youth fitness assessment using criterion-referenced standards (Cooper Institute, 2013). This assessment consists of a Progressive Aerobic Cardiovascular Endurance Run (PACER), curl-ups, push-ups, sit-and-reach flexibility, and body mass index (BMI) measurements. The PACER was adapted from a 20-meter shuttle run that simulates a treadmill graded exercise test (Liu, Plowman, & Looney, 1992). The PACER is a 20-meter shuttle run to a cadence. The cadence increases each minute and participants run until volitional fatigue or until failure to cover the 20-meter distance

within the apportioned time on two consecutive shuttles. It was designed to provide a comprehensive physical fitness assessment for children and youth, regardless of gender or age, including cardiovascular fitness, muscle strength, muscular endurance, flexibility, and body composition (Cooper Institute, 2013). Each participant receives a score within each category of the FITNESSGRAM and one overall health fitness score. These scores are compared among criterion-referenced standards associated with good health have been established and validated among many populations of children (Cooper Institute, 2013; Laurson, Saint-Maurice, Karsai, & Csányi, 2015; Freedson, Cureton, & Health, 2000; Welk, De Saint-Maurice Maduro, Laurson, & Brown, 2011a; Welk, Going, Morrow, & Meredith, 2011b). These standards have been found to be accurate and representative of the health levels of children and adolescents throughout the world (Laurson et al., 2015; Welk et al., 2011a; Welk et al., 2011b). The FITNESSGRAM is used in physical education classes throughout the country for individuals up to 18 years old. This testing allows individualized testing for each participant with accurate results and indicators of health fitness zones. Body mass index (BMI) can be used as a proxy for body composition because it has been validated using BMI for children and adolescents by using optimal, universal cut points that do not decrease accuracy of determining health status (Cooper Institute, 2013).

2.9.1 Progressive Aerobic Cardiovascular Endurance Run (PACER)

The PACER is a reliable and valid indication of cardiovascular fitness. Leger, Mercier, Gadoury, & Lambert (1988) found the 20-meter shuttle test (20-MST) to be

reliable in children with a correlation coefficient of 0.89. A regression equation developed by Leger et al. (1988) is used to estimate the aerobic capacity, creating criterion standards for the PACER portion of the FITNESSGRAM. The PACER been compared to the treadmill graded exercise test in regards to VO_{2peak}. Van Mechelen, Hlobil, & Kemper (1986) concluded that that 20-MST, or PACER, is a valid tool to use when assessing maximal aerobic power in children. Not only was maximal aerobic power evaluated, but researchers also assessed maximal heart rate in children in regards to the PACER. Voss & Sandercock (2009) determined that the 20 MST, or PACER, provokes a maximal effort of children ages 11- to 16-years old by causing children to reach their maximum heart rate, regardless of weight class or health status. Scott, Thompson, & Coe (2013) also found that PACER and treadmill both elicited a peak response in kids 10-15 years old.

2.10 Summary and Further Research

In summary, the motor development of a child and adolescent is vital in the individual developing a healthy life. The model developed by Stodden et al. (2008) is validated for children up to age 10 years old and adults 18-25 years old, but not for the ages 10 – 15 years old (adolescence). The conceptual model describes the relationship between motor competence, perceived motor competence, physical activity, and health related fitness. Therefore, further research must be done in order to completely validate this model so that researchers can use it in further research as a strong tool.

CHAPTER 3

MANUSCRIPT

Abstract

Purpose: To examine the associations among perceived motor competence (PMC), motor competence (MC), physical activity, and health-related physical fitness during middle childhood and early adolescence. **Method:** Participants were 47, 10-15 year old youth. Each participant completed two visits in East Tennessee or northwest Ohio. During these visits, the participants completed the Bruininks-Oseretsky Test (BOT-2) Analysis Test for Motor Proficiency, Harter's PMC questionnaire, and the FITNESSGRAM battery for health-related physical fitness. The Actigraph GT3X+ accelerometer was used to measure physical activity. **Results:** There were significant associations among health-related physical fitness and both motor percentile (r_s = 0.44, p < 0.01) and PMC (r_s = 0.32, p < 0.05). An association was found among PMC and MC (r_s = 0.47, p < 0.05). There were no significant associations among average daily MVPA and any of the other variables. **Conclusions:** High MC and PMC appear to be associated with higher levels of health-related physical fitness. It is important for children to learn fundamental motor skills to possibly participate in more complex motor skills related to physical fitness and for children to be encouraged in a positive manner while participating in physical activity to possibly increase their PMC.

Introduction

Fundamental motor skills are foundational movements that provide the critical basis for children's motor development and engagement in physical activity. Motor development and eventual motor competence—the mastery of motor skills—appear to drive physical activity levels in middle to late childhood (Stodden et al., 2008). Unfortunately, recent research suggests that there is a decline from childhood into adolescence in meeting the recommended moderate-to-vigorous physical activity (MVPA) minutes per day guidelines for children and adolescents (Troiano et al., 2008; U.S. Department of Health and Human Services, 2008). Although most children develop fundamental motor skills before the age of nine, some do not achieve motor competence, which may lead to decreasing the type and time spent in physical activity because children may not be willing or able to participate in exercise, sports, and games with their peers (Strong et al., 2005).

Lack of regular physical activity combined with under-development of fundamental motor skills creates a skill proficiency barrier that also compromises the development of basic and specialized motor skills and sports-specific skills (Seefeldt, 1980; Metcalfe & Clark, 2002). Children experiencing this skill barrier will presumably be disadvantaged as they grow into adulthood, facing an increasingly challenging problem of establishing and maintaining healthy physical activity levels, along with increasing their health-related physical fitness. It is critical to understand the relationship among motor competence, physical activity, perceived motor competence (PMC), and how these factors influence health-related physical fitness (Stodden et al., 2009).

PMC is an individual's belief in his or her abilities in different domains of motor skills (Spessato et al., 2012). Children with low PMC may be reluctant to participate in physical activity, especially as they grow older, consequently possibly face a widening gap between their objective motor skill level and health-related physical fitness compared to that of their peers (Stodden et al., 2008). It is important to encourage children to participate in physical activities that promote both actual and PMC. One approach to facilitating physical activity in children with low motor competence is to use progressions from simple to more complex activities (Barnett et al., 2009). PMC is also influential on health-related physical fitness. PMC can either positively or negatively impact a child's health-related physical fitness because the children who have better motor skills typically view themselves more positively; allowing them to participate in more physical activity and become more physically fit (Stodden & Goodway, 2007).

Health-related physical fitness is an important outcome related to motor competence and PMC (Stodden & Roberton, 2009; Haga, 2009). Health-related fitness is comprised of aerobic capacity, muscular strength, muscular endurance, and flexibility. Children who are more physically active, develop higher levels of health-related physical fitness, and also have a higher level of motor competence (Haga, 2009; Wrotniak et al., 2006). Moreover, children with lower motor competence display lower levels of physical fitness in comparison to the children with higher levels of health-related physical fitness as they mature and develop (Haga, 2009; Wrotniak et al., 2006). Therefore, it is thought that increasing the motor competence of adolescents may lead to increased physical activity during adulthood (Stodden & Roberton, 2009). As children progress into

adolescence, their perception of themselves greatly influences their health-related physical fitness because they are largely impacted by how their peers positively or negatively view them, leading to differing levels of participation in sport-related physical activities that increase complex motor skills and overall health-related physical fitness (Stodden & Roberton, 2009).

Lacking PMC, motor competence, and health-related physical fitness can lead to obesity. There is an increasingly widening gap between normal-weight children and overweight/obese children's gross motor skills because of the inverse relationship among overweight/obesity and motor skills in children (D'Hondt et al., 2013). Individuals with a higher amount of body fat (overweight/obese), struggle more with performing motor skill tasks and they have a slower progression of gaining their motor skills because of the excess fat (D'Hondt et al., 2013). Therefore, obesity contributes to children not learning foundational motor skills, which causes low motor competency, and in turn, leads to an even more sedentary lifestyle and a lower health-related physical fitness (Gentier et al., 2013). Children with a lower perceived motor competence will be drawn toward to negative spiral disengagement in activities, creating a lack of opportunities to develop adequate motor skills and keeping an ideal BMI (Stodden et al., 2008; D'Hondt et al., 2013). As children age, those individuals who are overweight/obese are thought to participate in less activities because they have a lower motor competency, which contributes to not beginning an active and healthy lifestyle because of their low motor skill level unless they are forced to do so.

The relationships among PMC, motor competence, physical activity, and health-related physical fitness are not well understood, particularly in the adolescent age group. Although research has identified positive relationships among motor competence, physical activity, and health-related physical fitness in young children (3-5 years old) and during middle childhood (5-10 years old), research including these variables during late childhood and adolescence (10-15 years old) is limited (Stodden & Goodway, 2007; Stodden et al., 2008; Caspersen & Christenson, 1985). Therefore, this study will seek to extend the body of research investigating the associations among PMC, motor competence, physical activity, with health-related physical fitness during middle childhood and the early adolescent time period.

Method

Study Participants

The power analysis ran concluded that 44 participants were needed. Forty-seven participants, ages 10-15, were recruited from an East Tennessee community and a Northwest Ohio community for this cross-sectional study. These participants were recruited via word of mouth, flyers, internet postings, and emails. Adolescents were excluded if the parent(s)/legal guardian indicated any medical condition that would not allow them to participate in physical activity. Each participant signed a participant assent form (Appendices D, F, H) after the investigator read the description of the study from the parental permission sheet to the participant and his/her parental guardian(s) (Appendices C, E, G). Parental permission was then also signed for each participant by

the parental guardian(s) of the participant (Appendices C, E, G). The university Institutional Review Board approved the protocol (Appendix L).

Protocol

Participants reported to the University of Tennessee Health, Physical Education, and Recreation (HPER) building Applied Physiology Laboratory or local gymnasium for two separate visits. Visit 1 was one hour in duration and Visit 2 was 30 minutes in duration. There was a seven-day length in between Visit 1 and Visit 2.

Visit 1

After obtaining parental permission and child participant assent, the participant's standing height, seated height, and weight were measured. These measurements are used to determine the length of the legs and the length of the torso. Using these assessments, maturity offset, a measure of maturity status, was calculated via Mirwald's equations for maturity offset that are reliable and valid (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002). This value indicated whether the participant was pre-peak height velocity, at peak height velocity, or post peak height velocity, creating a categorical variable. Next, the principal investigator (PI) administered the Bruininks-Oseretsky Test (BOT-2, 2013) Analysis Test for Motor Proficiency, Second Edition, which assesses fine and gross motor skills. The BOT-2 test is the most widely used motor proficiency test with motor behavioral research and is appropriate for children and adolescents ages 4-21 years (BOT-2, 2013). Participants did the complete form of the BOT-2 that took one hour per

participant. The BOT-2 test consists of fine motor precision (e.g. cutting out a circle, connecting dots), fine motor integration (e.g. copying a star, copying a square), manual dexterity (e.g. transferring pennies, sorting cards, stringing blocks), bilateral coordination (e.g. tapping foot and finger, jumping jacks), balance (e.g. walking forward on a line, standing on one leg on a balance beam), running speed and agility (e.g. shuttle run, one-legged side hop), upper-limb coordination (e.g. throwing a ball at a target, catching a tossed ball), and strength (e.g. standing long jump, sit ups). Six composite scores were then calculated into a comprehensive score reflecting the overall fine and gross motor skills. This overall score was then calculated into a motor score percentile based upon the BOT-2 reference tables (BOT-2, 2013). The experimenters, who did the scoring, were trained via the Comprehensive Training video provided by BOT-2. This video provides information from the authors of the BOT-2, test administration, scoring, and reporting of information. After each investigator watched the video, s/he ran through practice trials on each other to gain experience with the testing. Reliability testing was randomly conducted on 10% of the participants. Reliability was done by way of both experimenters scoring the same participants to ensure that the results are consistent.

Next, the participant completed a PMC assessment (Harter, 1978). The PMC versions that were used were the “Perceived Competence Scale for Children” (ages 10-13) and “Perceived Competence Scale for Adolescents” (ages 14-15). The children simply answered the “physical” subset of seven questions. The questionnaires consist of one sample question and five assessment questions reflecting how the children feel they do when they are participating in physical activity (score of 1-5). Each of the five

assessment questions received a score out of five points and an average score of the five assessment questions was calculated. Children that feel more confident about their motor skills score higher on this five-point scale and children who feel less confident score lower.

The participant was then fitted with an accelerometer (Actigraph GT3X+, Pensacola, FL) to assess their level of MVPA over the next seven days. The accelerometer was placed above the iliac crest of the right hip using an elastic belt. The participant and parent(s)/legal guardian(s) were given directions for placement and usage for the next seven complete days. Instructions for proper placement were also sent home to the parents/guardians (Appendix K).

Visit 2

During the second visit, approximately seven days after Visit 1, the participants came back for Visit 2 and returned the accelerometer4. The participant then completed the FITNESSGRAM Physical Fitness Battery (Cooper Institute, 2013). This test battery is used to assess health-related fitness, which includes aerobic fitness, muscular strength, muscular endurance, flexibility, and body composition. The first portion of the FITNESSGRAM is the aerobic fitness portion that was assessed using the Progressive Aerobic Cardiovascular Endurance Run (PACER), which is a paced, 20-meter shuttle run. Next, muscular strength and endurance were assessed via curl-ups and pushups to a set cadence. The Back-Saver Sit and Reach test was used to assess flexibility. Age- and gender-specific Body Mass Index (BMI) was used as a proxy for body composition. The

FITNESSGRAM was scored from 0-5 to produce a health-related physical fitness core. The participant scored a point for each category (PACER, push-ups, curl ups, sit-and-reach flexibility, and BMI) that they fell in a healthy fitness zone category determined by Cooper Institute and the Center for Disease Control. The scores ranged from 0 to 5; zero being least physically fit and 5 being most physically fit. Lastly, each participant completed another administration of the PMC questionnaire used during Visit 1.

Statistical Analyses

Motor competence was calculated via BOT-2 data raw scores. The BOT-2 manual provides tables to produce four categories (fine manual, manual coordination, body coordination, and strength and agility) of standard scores and motor percentile categories (BOT-2, 2013). Next, these scores were used to produce an overall standard score and overall motor skill percentile score following BOT-2 protocol (BOT-2, 2013). The overall age- and gender-specific motor skill percentile score determined via BOT-2 manual scoring was used in the statistical analysis. An overall motor skill level from one to five was determined via BOT-2 manual to examine the distribution of the participant pool (1: well-below average, 2: below average, 3: average, 4: above average, 5: well-above average). The PMC questionnaire score was developed from Harter (1978); five perceived motor competence questions assessed (one being least confident and four being most confident). A score of 1-4 was created by each of the questions answers. An average of the five questions was calculated to create an overall PMC score of 1-4 for that session (Harter, 1978). The PMC score from Visit 1 was used for statistical analyses because

there were no statistical differences among Visit 1 and Visit 2 PMC scores for each individual. Raw accelerometer counts were collected. Participants were excluded if they did not have at least three days of 10 hours each day of accelerometer wear time. Three participants were excluded because they did not meet these criteria. The raw accelerometer data were converted to minutes of moderate to vigorous physical activity (MVPA) using cutpoints determined by Evenson, Catellier, Gill, Ondrak, McMurray et al. (2008) for children. These cutpoints were; 0-100 counts per minute (CPM) was sedentary, 101-2295 CPM was light, 2296-4011 CPM was moderate, and 4012- ∞ CPM was vigorous (Evenson et al., 2008). Total minutes of MVPA were divided by the number of days collected from for each individual participant. Physical activity was then expressed as average daily minutes of MVPA. The FITNESSGRAM data collected created an overall healthy fitness zone (HFZ) score of zero through five (zero being least healthy and five being most healthy). Participants received one point for every category that they were within the FITNESSGRAM healthy fitness zone (aerobic fitness (PACER), curl ups, push-ups, flexibility (sit-and-reach), and BMI). The HFZ categories of aerobic fitness, curl ups, push-ups, and flexibility were created by the Cooper Institute FITNESSGRAM. The BMI percentiles were created by the Centers for Disease Control (CDC).

Descriptive univariate statistics were non-normally distributed and were reported as median (M) and interquartile range (IQR). Because some of the variables were not normally distributed (health-related physical fitness and motor competence), nonparametric correlational analyses (Spearman's rank-order correlations) were used to

examine relationships among motor competence and health-related physical fitness, motor competence and physical activity, motor competence and PMC, physical activity and health-related physical fitness, physical activity and PMC, and health-related physical fitness and PMC. An alpha was set to 0.05 was used to determine statistical significance. SPSS 23.0 (IBM, Armonk, NY) was used for all statistical analyses.

Results

Participant Characteristics

Table 1 shows the descriptive statistics of the participants.

Table 1: Descriptive statistics of the participants.

Variable	Total (n = 47)
Caucasian (%)	100.0
Male (%)	54.3
Age (y) (M, IQR)	11.9, 3.4
BMI ($kg \cdot m^{-2}$) (M, IQR)	19.0, 5.0
BMI percentile (M, IQR)	61.0, 49.0
Pre Peak Height Velocity (%)	87.0
Obesity	
Underweight (%)	2.2
Healthy Weight (%)	71.7
Overweight (%)	19.6
Obese (%)	6.5

BOT-2 Assessment (Motor Competence)

Table 2 shows the distribution of the data for the participants for the motor skill BOT-2 assessment. The motor skill scores were categorized into below average, average,

above average, and highly above average via BOT-2 manual given ranges. The majority of the participants (67.4%) were at average level of motor skills. When examined by he motor percentile a median of 50.0 (IQR 52.0-95.0) was found.

Table 2: Classification of motor skill (BOT-2).

Variable	Total (n = 47)
Below Average	17.4%
Average	67.4%
Above Average	13.0%
Highly Above Average	2.2%

Perceived Motor Competence (PMC) Assessment

There was no statistically significant difference among Visit 1, Visit 2, and average PMC scores variables [t(46)= -0.503, $p > 0.05$]. Therefore, Visit 1 score was used for further statistical analyses.

Table 3: PMC average score for Visit 1 and Visit 2 (M, IQR).

PMC Test Day	Total (n = 47)
Visit 1	3.0, 0.8
Visit 2	3.0, 0.8
Average of Visit 1 & 2	3.0, 0.8

Physical Activity Assessment

The average minutes of MVPA per day was 48.7 ± 23.6 minutes. The proportion of the total participants that met the recommended physical activity guidelines was 28.3%.

Health-Related Physical Fitness Assessment

Health-Related Physical fitness was assessed via FITNESSGRAM, including five components of health-related physical fitness (aerobic capacity, curl up, push-up, flexibility, and BMI). The participants overall had higher levels of health-related physical fitness than typically seen nationally. The overall health-related physical fitness category classification distribution is in Table 4.

Table 4: Distribution of the participants for the Health-Related Physical Fitness (1 being least fit and 5 being most fit).

Number of Variables Achieved in the HFZ	Total (n = 47)
1	13.0%
2	10.9%
3	6.5%
4	37.0%
5	32.6%

Table 5 shows the results of the Spearman's rank-order correlation analyses for the total group. There was a significant positive correlation among motor competence percentile and health-related physical fitness [$r_s(47) = 0.44$, $r_s^2 = 0.19$, $p < 0.01$], PMC

and health-related physical fitness [$r_s(47) = 0.32$, $r_s^2 = 0.11$, $p < 0.05$], and PMC and motor competence percentile [$r_s(47) = 0.44$, $r_s^2 = 0.22$, $p < 0.05$]. There were no significant associations among average daily MVPA and motor competence [$r_s(44)= -0.09$, $p > 0.05$], PMC [$r_s(44)= 0.13$, $p > 0.05$], or health-related physical fitness [$r_s(44)= 0.07$, $p > 0.05$].

Table 5: Spearman Rank-Order Correlation Coefficients among motor, physical activity, and fitness variables (r_s).

	Motor Competence Percentile	PMC	Avg. Daily MPVA
Healthy-Related Physical Fitness	0.44**	0.32*	0.07
Motor Competence Percentile	-	0.44*	-0.09
PMC	-	-	0.13

** Denotes significant correlation ($p < 0.01$, 2-tailed).
* Denotes significant correlation ($p < 0.05$, 2-tailed).

Discussion

The purpose of this study was to determine the associations among PMC, motor competence, physical activity, and health-related physical fitness in middle childhood and early adolescence (10-15 years old). It was hypothesized that there would be significant, positive associations among all of the variables (PMC, motor competence, physical activity, and health-related physical fitness). The sample of participants was slightly above average in regards to health-related physical fitness, but was in average ranges comparing to previous research in regards to PMC and motor competence (D’Hondt et

al., 2013). While this study does not apply causality, there are a few explanations for why relationships exist between some of these variables.

There was a significant, positive association between PMC and motor competence. The PMC scores for this study were in an average range for children ages 10-15 years old, comparing to past research. The higher the PMC, the greater the motor competency of a child was and vice versa. This is a significant, moderate correlation indicating that the PMC could possibly have an impact on motor competency. This could possibly be because children who have a higher PMC are more likely to participate in a greater variety of physical activities, likewise, children with a lower PMC are less likely to participate in a variety of physical activities, decreasing the chance of increasing overall motor skills (Biddle et al., 2005; Davison, Schmalz, & Downs, 2010; Stodden et al., 2008). This could also be because motor competence possible drives PMC, which creates the argument of self-efficacy in how a child approaches goals and challenges (Bandura, 1993). In other words, as a child's motor competence increases, s/he has more positive experiences that should promote an increased in perceived motor competence. Lastly, there could possibly be some unknown variable that is driving this association between motor competence and PMC. These results imply the importance to psychologically support a child with positive words of encouragement to help increase their PMC, which in turn could help improve their motor competence. These results are consistent with previous research stating that PMC could possibly positively affect an adolescent's motor competence (Biddle et al., 2005; Davison, Schmalz, & Downs, 2010; Stodden et al., 2008; Pontifex et al., 2011; Whitehead & Biddle, 2008). Many children

who do not participate in physical and motor activities may lack motivation to participate because they may believe that they are not capable of performing these activities successfully (Whitehead & Biddle, 2008).

Biddle et al. states that children and adolescents should be positively encouraged when participating in physical and motor activities in order to increase their PMC and psychological factors associated with these physical activities (Biddle et al., 2005). Enjoyment of an activity is one of the main factors contributing to which individuals participate in an activity; children who typically are participating in many different activities and motor skill programs state that they do so because they enjoy the activity (Whitehead & Biddle, 2008). A higher level of PMC may increase enjoyment of an activity for children, which can increase the likelihood of learning the fundamental motor skills because of the participation in more motor skill programs (Pontifex et al., 2011). One way to increase PMC and promote positive psychological benefits to children is through social interactions with friends during the motor and physical activities because friends may increase the comfort and enjoyment level for the child and also decrease the insecurities (Whitehead & Biddle, 2008). Children also tend to thrive and have an increased sense of self more in activities that are fun, informal, and unstructured (Whitehead & Biddle, 2008). Therefore, finding ways to increase a child's PMC could lead to a greater willingness to participate in motor skill activities, which could then increase their motor competence overall.

There was also a moderate, positive correlation between motor competence and overall health-related physical fitness. Gross motor skills can be reflective of the future

health-related physical fitness status of a child (Baghurst & Mwavita 2014). Fundamental motor skills are theoretically the building blocks for the more complex motor skill movements. Children need to be able to complete complex motor movements in order to improve muscular strength and endurance. Complex movements, such as push-ups or curl-ups, require movements beyond the basic fundamental motor skills. These are more sport-specific motor skills that highly contribute to the overall health-related physical fitness of a child (Baghurst & Mwavita, 2014; Stodden & Roberton, 2009; Hands et al., 2008). This may explain the significant association between motor competence and health-related physical fitness. This association applies specifically to the push-ups and curl ups performed in the FITNESSGRAM. If a child/adolescent has the motor skills to complete these complex movements, then s/he is more likely to be in the healthy fitness zone for muscular strength and endurance (push-ups and curl ups). Additionally, ballistic fundamental motor skill movements, such as jumping, require a higher demand on the neuromuscular system, enhancing control and coordination (Stodden & Roberton, 2009). This may lead to an increased health-related physical fitness for children. These higher health-related physical fitness levels also promote the continued development of motor skills throughout adolescence (Rodrigues, Stodden, & Vítor, 2015).

The mechanics behind running are based upon the fundamental motor skill of learning to run and balance (Hands et al., 2008). As children develop these skills, they can improve their cardiovascular health, which then improves their aerobic fitness and overall health-related physical fitness. Although aerobic fitness is only one component of health-related physical fitness, it is still an important construct that incorporates the

execution of fundamental motor skills (Hands et al., 2008). As children/adolescents participate in a variety of activities, learning the fundamental motor skills, their flexibility may increase because they learn the gross motor skill of balancing and being able to stretch properly. Even though many physical activities can reduce flexibility by reducing range of movement, children tend to participate in balance activities to increase their flexibility (Hands et al., 2008). Lastly, youth who are proficient in their motor skills are more likely to have a favorable BMI. Theoretically, this may be due to the greater opportunity to participate and be successful in physical activities (Rodrigues et al., 2015). If an adolescent is not participating in more complex activities that are related to greater bone and muscle strengthening activities, then the adolescent will not have high motor competency or a high physical fitness level. The higher the health-related physical fitness of a child, the more positive of an effect on weight status it has, promoting a more favorable BMI (Rodrigues et al., 2015).

Older children are more likely to participate in physical activity if they feel competent to do so (Pontifex et al., 2011). Increasing a children's motor skills at a young age may increase their physical activity and health-related physical fitness level because they may feel more competent and better capable to participate in these activities (Spessato et al., 2012; Harter, 1978). These children may then maintain a consistent level of physical activity throughout adolescence, increasing their motor skills as they age, which may allow them to participate in more complex aerobic and strengthening activities (Hands et al., 2008; Stodden & Roberton, 2009). Increasing an adolescent's capability to perform complex motor skills will increase their overall health-related

physical fitness, after fundamental motor skills are learned, and may then contribute to an increase the adolescent's overall health-related physical fitness status (Cliff et al., 2011; Zask et al., 2012; Barnett et al., 2010; Stodden & Roberton, 2009). There are other possibilities as to why there is a significant, positive association between motor competence and health-related physical fitness. Health-related could also possibly drive motor competence. Therefore, the more physical fit a child is, the higher his/her motor competence will be. There could also be other underlying mechanisms responsible for this association between motor competence and health-related physical fitness.

Interestingly, there were no significant associations among average daily MVPA and motor competence, PMC, or health-related physical fitness. The results provided no support for the notion that older children's motor skills are associated with their physical activity level and, therefore, were not consistent with the model hypothesized by Stodden et al. (2008) regarding a positive relationship between motor competence and physical activity in this age group. Previous research has found significant positive associations among motor competence and physical activity in children younger than 10 years of age, but not necessarily children older than 10 years of age (Stodden et al., 2008, Stodden 2006). If children are not physically active at a young age, then their motor skill level may not develop or progress appropriately (Seefeldt, 1980; Metcalfe & Clark, 2002). Adolescents may lack of motor skill development from childhood if they keep a consistent pattern of physical activity, or show a decline in activity levels. Lack of motor skill development may also result from insufficient opportunities to learn or practice motor skills (i.e., in physical education, sports teams, activity classes). Therefore, even if

an adolescent (10-15 years old) is physically active, s/he may not have achieved motor skill proficiency of the motor skills at the younger age, which could provide one explanation as to why there is a lack of association between physical activity and motor competency.

Another possible explanation for the lack of association between motor competence and physical activity is the difference in sport-specific skill that each physical activity requires, especially in the adolescent age group. For example, children who were not active when they were young and did not learn proper motor skills, but participate in cross country running as adolescents, may still not have age-appropriate motor skills because cross country running does not require many motor skills to participate. Cross-country running does not require object control skills, and only slightly requires locomotor skills. Youth need to participate in object control and locomotor skill activities in order to adequately promote overall motor competence. Object control motor skills include skills such as throwing, catching, striking, bouncing, or kicking an object. Locomotor motor skills include skills such as walking, galloping, jumping, hoping, side-sliding, leaping, and skipping. For example, basketball requires high levels of locomotor skills and object control skills. Therefore, this child playing basketball may have a better opportunity to learn both the types of motor skills, creating an enhanced overall motor skill competence.

According to the results of this study, PMC is significantly associated with motor competence and health-related physical fitness, but is not associated with physical activity. These associations are moderate among PMC and motor competence and health-

related physical fitness. These results may be due to the fact that youth may evaluate their abilities based off of their physical attributes and successes in sports/activities, rather than simply the amount of physical activity that they complete. This study does not support the previous research stating that there is a positive association between physical activity and health-related physical fitness (Pontifex et al., 2011; Hands et al., 2008). Physical activity was not significantly associated with the health-related physical fitness likely because some of the components of health-related physical fitness require complex motor skills, but the amount of physical activity done on a regular basis may not necessarily significantly affect it. For example, push-ups require a complex motor skill. Children that are highly active through running, may not have the motor competence to correctly and successful do push-ups. Therefore, they are participating in large amounts of physical activity, but not improving motor skills to increase in the areas that require motor skills; namely push-ups.

This study concurs with previous findings in the literature that motor skill development in adolescents, along with PMC, are important when considering overall physical fitness (Spessato et al., 2012; Harter, 1978; Pontifex 2001; Stodden et al., 2008; Seefeldt, 1980; Metcalfe & Clark, 2002). It is very important to stress motor skills at a young age for children to begin to become physically active and to create a healthy lifestyle. Therefore, positive reinforcement may lead to improved PMC and subsequent higher health-related fitness.

Overall, there are many strengths to this study. The power analysis ran concluded that 44 participants were needed and the sample size used (n=47) was larger than the

number of participants needed. The sample was proportional among males (54.3%) and females (45.7%). Validated, objective tools were used for all of the assessments (BOT-2, GT3X Actigraph accelerometer, FITNESSGRAM). The sample of participants completed the average amount of MVPA that children typically do nationally. Lastly, the proportion of children overweight/obese compared to healthy was similar to national averages via BMI making the information generalizable. One limitation to this study is the homogenous sample. The sample was all Caucasian participants and it was a convenient sample, which may cause slight selection bias. This population of participants had slightly higher health-related physical fitness. Future studies should strive for a diverse sample of adolescents, including all races, genders, and classifications of health status represented by BMI.

The main objective was to assess the associations among PMC, motor competence, physical activity, and health-related physical fitness in youth ages 10-15 years old. There were significant associations among health-related physical fitness and motor competence, motor competence and PMC, and PMC and health-related fitness. This study did not find any significant associations among physical activity and any of the other variables tested. Therefore, this study only partially supports the model proposed by Stodden et al. (2008) concerning the relationships that exist among PMC, motor competence, and health-related physical fitness. Future studies should continue to use the BOT-2, FITNESSGRAM, and objective monitoring of physical activity. They should also strive for a diverse sample of adolescents, including all races, genders, and classifications of health status represented by BMI.

CHAPTER 4

CONCLUSIONS AND RECOMMENDATIONS

The main purpose of this study was to assess the associations among perceived motor competence, motor competence, physical activity, and health-related physical fitness during middle childhood and early adolescence (10-15 years old). This study found significant associations among motor competence and health-related physical fitness, motor competence and perceived motor competence (PMC), and PMC and health-related physical fitness. It is important for children to learn fundamental motor skills to be able to participate in more complex motor skills related to physical fitness and for children to be encouraged in a positive manner while participating in physical activity to possibly increase their PMC. Future studies should continue to use the BOT-2, FITNESSGRAM, and objective monitoring of physical activity. They should also strive for a diverse sample of adolescents, including all races, genders, and classifications of health status represented by BMI.

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APPENDICES

APPENDIX A: Recruitment Flyer The University of Tennessee-Knoxville, TN

Would you like your child to be involved in a research study???

The University of Tennessee

Applied Physiology Laboratory

We are seeking 10 - 15 year old children for a research study to determine how children's ability to complete motor skills (jumping, running, etc.) is related to their physical activity and physical fitness levels.

This study involves two, one-hour sessions at the Health, Physical Education, and Recreation Building (HPER) on the University of Tennessee campus. The children will participate in assessments of motor skills and fitness, complete a questionnaire, and wear an activity monitor for seven days. This research will contribute to the field of motor development in adolescents.

For more information, please contact Emily Post at
Phone: (865) 974 - 6040
Email: epost2@vols.utk.edu

Your participation would be greatly appreciated!

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APPENDIX B: Recruitment Flyer for Saint Henry Middle School Saint Henry, OH

Would you like your child to be involved in a research study?

The University of Tennessee

Applied Physiology Laboratory

We are seeking 10 - 15 year old children for a research study to determine how children's ability to complete motor skills (jumping, running, etc.) is related to their physical activity and physical fitness levels.

This study involves two, one-hour sessions at the Saint Henry Middle School in Saint Henry, Ohio. The children will participate in assessments of motor skills and fitness, complete a questionnaire, and wear an activity monitor for seven days. This research will contribute to the field of motor development in adolescents.

For more information, please contact **Emily Post** at
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APPENDIX C: Informed Parental Consent for The University of Tennessee-Knoxville, TN

Parental Permission
Permission to Take Part in a Research Study

Title: The **Relationship between motor competence and physical activity of children ages 10-15 years old.**

Principal Investigators: Emily Post, B.S.
Dawn P. Coe, Ph.D.

Your permission is required for your child to take part in a research study. This consent form explains the purpose and requirements, of the study. Please read this form carefully. You will be given a chance to ask questions. If you decide to permit your child to be in the study, you will be given a copy of this form. If you choose for your child not to take part in the study, it will not affect your child's rights to care or services. You are also free to remove your child from this study at any time without penalty.

Why is this study being done?
The primary objective of this study is to examine the relationship between physical activity and motor competence in adolescents (10-15 years old). A secondary objective is to determine the impact that the mediating factors (perceived motor competence, physical fitness, and obesity) have on the relationship between physical activity and motor competence. Previous research has shown associations among these variables in young children; however, little research has been conducted with adolescents.

How long will the study last?
Your child's participation will include two visits lasting approximately one hour each. The study will take place at the Applied Physiology Lab in the Health, Physical Education, and Recreation building (1914 Andy Holt Avenue, Knoxville, TN 37996) on the University of Tennessee campus. After the first visit, your child will also be asked to wear a physical activity monitor all day for seven consecutive days. Your child will then return the accelerometer during the second visit.

How many people will be in the study?
About 100 children enrolled in the Knoxville community will be participating in this study.

What will my child do during the study?
During the study, your child will attend two visits. Each visit will be approximately an hour in length. During the first visit, your child's height and weight will be measured and your child will be fitted with a physical activity monitor. The physical activity monitor is a small box, the size of a small pager that is worn on a belt around the waist. The monitor will be worn daily for seven consecutive days (Monday through the following Monday). Your child will then participate in a Bruininks-Oseretsky Test (BOT) Analysis Test for Motor Proficiency. This test consists of motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, running speed and agility, upper limb coordination, and strength. Some of these activities include cutting out a circle, copying a square, sorting cards, one-legged side hop, catching a tossed ball, sit ups, etc. You child will then complete a seven question perceived motor competence questionnaire. This is a questionnaire to determine how your child feels when they are performing certain physical activities. On the second visit your child will participate in the FitnessGram Physical Battery. This test includes aerobic fitness (PACER), muscular strength, muscular endurance, flexibility, and body composition. Next, your child will complete the seven question perceived motor competence assessment again.

Parent/Guardian Initials _____

Risks associated with the study are minimal and considered to be equivalent to the risks that the children normally face when they are active during their physical education class. There are potential risks associated with PACER test and some of the BOT tests that may include lightheadedness, chest discomfort, leg cramps, falling, and muscle sprain/strain. These risks are similar to those typically experienced during aerobic fitness testing during physical education class.
All of these investigators are cardio-pulmonary resuscitation (CPR) certified in case of an emergency. There will also be water and fruit present to hydrate your child after the PACER test. The children/subjects will be told to let the investigators know if they feel anything abnormal (i.e. chest pain, nausea, joint paint, etc.).

Additionally, there is the possibility that a child may experience mild skin irritation from the belt that contains the activity monitor rubbing on the skin. If so, the belt will be adjusted or removed.

Are there benefits to my child for taking part in the study?
There are no direct benefits to your child for participating in this study. Information from this study will be gathered to determine the physical fitness level, physical activity level, and motor competence level in youth. School physical educators will potentially benefit from this information for their physical education courses.

Will I receive the results of my child's assessments?
We will share the results of your child's assessment with you. If your child's values fall below the normal range, we will provide you with the results as well as recommendations for future evaluation if necessary.

What happens if my child gets hurt?
In the event that your child becomes injured as a result of participating in this study, immediate treatment will be available (First Aid and/or CPR). However, you must assume responsibility for all medically necessary treatment. It is important that you tell the researcher, Emily Post, B.S., if you feel that your child has been injured in this study. You can tell the researcher in person or call her at 864-974-6040.

Who do I call if I have questions about the study?
Questions about the study not addressed in this form should be directed to Emily Post, B.S.: 865-974-6040 (Phone #), epost2@vols.utk.edu (E-mail) and if needed, a meeting can be set up. Questions about your child's rights as a research participant should be directed to the University of Tennessee, Knoxville, Office of Research Compliance Officer at 865-974-7697.

What will it cost me to permit my child to be in the study?
There will be no cost to you for your child to be in the study.

Will my child be paid for participating?
Your child will not be paid to participate.

Is the Investigator being paid to do this study?
No, the investigator is not being paid to enroll people in this study.

Parent/Guardian Initials _____

Will anyone know my child is in the study and how is my child's identity being protected?
A record of your child's participation in the study will be kept private and all data will be kept in a confidential file in a locked cabinet in a locked University of Tennessee faculty office for 3 years following completion of the study. After that, your child's data will be destroyed. Only the investigators will have access to your child's data. Study results will be prepared for presentation at professional meetings and publication in journals. However, none of your child's personal information will be revealed. There will be ID numbers created and a key to the ID numbers for your child. The key will be kept separately from the ID numbers. The ID number and key with your child's information on it will be destroyed after the study is finished. Therefore, your child will not be identified in any reports.

What if your child does not want to be in the study?
Your child's participation in this study is voluntary. Your decision whether or not to permit your child to participate in this study will not affect your or your child's current or future relations with the researchers or the University of Tennessee. If you decide to allow your child to participate, you are free to withdraw your child from the study at any time without affecting those relationships. If your child does not wish to participate or becomes upset on one of the testing days, we will attempt to console and comfort your child. We will then try to collect their data on an additional day. If you child does not wish to participate or becomes upset again on the additional day, your child will be removed from the study. If your child decides that s/he no longer wants to participate in the study, we will remove your child from the study.

PERMISSION OF PARENT OR GUARDIAN:
I have read or have had read to me the description of the research study. The investigator or her representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks, discomforts and side effects as well as the possible benefits (if any) of the study. I freely permit my child to take part in this study.

__________________________ _________________________ __________
Printed Name of Parent/Guardian Signature of Parent/Guardian Date & Time

__________________________ ________________________ __________
Printed name of Investigator Signature of Investigator Date

APPENDIX D: Participant Assent Form for The University of Tennessee, Knoxville, TN

Assent Form

Relationship between motor competence and physical activity of children ages 10-15 years old.

☐ The assent discussion was initiated on _____________(date) at _________ (time).

The information was presented in age-appropriate terms.

The minor: ____(Subject's Name)

☐ Agreed to take part in the study on ________________(date) at ______________ (time).

● ●

☐ An assent discussion was not initiated with the minor for the following reason(s):

- ☐ Minor is under 10 years of age
- ☐ Minor is physically incapacitated
- ☐ Minor is cognitively or emotionally unable to participate in an assent discussion
- ☐ Minor refused to take part in the discussion
- ☐ Other____

RESEARCHER/DESIGNEE STATEMENT: I hereby certify that I have discussed the research project with the research participant and/or his/her parent(s) or legal guardian(s). I have explained all the information contained in the permission document, including any risks that may be reasonably expected to occur. I further certify that the research participant was encouraged to ask questions and that all questions were answered.

____
Researcher/Designee Printed Name

____________________________ ______________ ______________
Researcher/Designee Signature Date Time (AM/PM)

____
Minor Subject Printed Name

____________________________ ______________ ______________
Minor Subject Signature (10-15 years) Date Time (AM/PM)

IRB NUMBER: UTK IRB-15-02291-XP
IRB APPROVAL DATE: 05/14/2015
IRB EXPIRATION DATE: 05/13/2016

APPENDIX E: Informed Parental Consent for Episcopal School of Knoxville, TN

Parental Permission
Permission to Take Part in a Research Study

Title: The Relationship between motor competence and physical activity of children ages 10-15 years old.

Principal Investigators: Emily Post, B.S.
Dawn P. Coe, Ph.D.

Your permission is required for your child to take part in a research study. This consent form explains the purpose and requirements, of the study. Please read this form carefully. You will be given a chance to ask questions. If you decide to permit your child to be in the study, you will be given a copy of this form. If you choose for your child not to take part in the study, it will not affect your child's rights to care or services. You are also free to remove your child from this study at any time without penalty.

Why is this study being done?
The primary objective of this study is to examine the relationship between physical activity and motor competence in adolescents (10-15 years old). A secondary objective is to determine the impact that the mediating factors (perceived motor competence, physical fitness, and obesity) have on the relationship between physical activity and motor competence. Previous research has shown associations among these variables in young children; however, little research has been conducted with adolescents.

How long will the study last?
Your child's participation will include two visits lasting approximately one hour each. The study will take place at Emerald Youth Soccer (Emerald Youth Sports, 1718 North Central Street Knoxville, Tennessee*)*. After the first visit, your child will also be asked to wear a physical activity monitor all day for seven consecutive days. Your child will then return the accelerometer during the second visit.

How many people will be in the study?
About 100 children enrolled in the Knoxville community will be participating in this study.

What will my child do during the study?
During the study, your child will attend two visits. Each visit will be approximately an hour in length. During the first visit, your child's height and weight will be measured and your child will be fitted with a physical activity monitor. The physical activity monitor is a small box, the size of a small pager that is worn on a belt around the waist. The monitor will be worn daily for seven consecutive days (Monday through the following Monday). Your child will then participate in a Bruininks-Oseretsky Test (BOT) Analysis Test for Motor Proficiency. This test consists of motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, running speed and agility, upper limb coordination, and strength. Some of these activities include cutting out a circle, copying a square, sorting cards, one-legged side hop, catching a tossed ball, sit ups, etc. You child will then complete a seven question perceived motor competence questionnaire. This is a questionnaire to determine how your child feels when they are performing certain physical activities. On the second visit your child will participate in the FitnessGram Physical Battery. This test includes aerobic fitness (PACER), muscular strength, muscular endurance, and flexibility. Next, your child will complete the seven question perceived motor competence assessment again.

Parent/Guardian Initials _____

Risks associated with the study are minimal and considered to be equivalent to the risks that the children normally face when they are active during their physical education class. There are potential risks associated with PACER test and some of the BOT tests that may include lightheadedness, chest discomfort, leg cramps, falling, and muscle sprain/strain. These risks are similar to those typically experienced during aerobic fitness testing during physical education class.
All of these investigators are cardio-pulmonary resuscitation (CPR) certified in case of an emergency. There will also be water and fruit present to hydrate your child after the PACER test. The children/subjects will be told to let the investigators know if they feel anything abnormal (i.e. chest pain, nausea, joint paint, etc.).

Additionally, there is the possibility that a child may experience mild skin irritation from the belt that contains the activity monitor rubbing on the skin. If so, the belt will be adjusted or removed.

Are there benefits to my child for taking part in the study?
There are no direct benefits to your child for participating in this study. Information from this study will be gathered to determine the physical fitness level, physical activity level, and motor competence level in youth. School physical educators will potentially benefit from this information for their physical education courses.

Will I receive the results of my child's assessments?
We will share the results of your child's assessment with you. If your child's values fall below the normal range, we will provide you with the results as well as recommendations for future evaluation if necessary.

What happens if my child gets hurt?
In the event that your child becomes injured as a result of participating in this study, immediate treatment will be available (First Aid and/or CPR). However, you must assume responsibility for all medically necessary treatment. It is important that you tell the researcher, Emily Post, B.S., if you feel that your child has been injured in this study. You can tell the researcher in person or call her at 864-974-6040.

Who do I call if I have questions about the study?
Questions about the study not addressed in this form should be directed to Emily Post, B.S.: 865-974-6040 (Phone #), epost2@vols.utk.edu (E-mail) and if needed, a meeting can be set up. Questions about your child's rights as a research participant should be directed to the University of Tennessee, Knoxville, Office of Research Compliance Officer at 865-974-7697.

What will it cost me to permit my child to be in the study?
There will be no cost to you for your child to be in the study.

Will my child be paid for participating?
Your child will not be paid to participate.

Is the Investigator being paid to do this study?
No, the investigator is not being paid to enroll people in this study.

Parent/Guardian Initials _____

Will anyone know my child is in the study and how is my child's identity being protected?

A record of your child's participation in the study will be kept private and all data will be kept in a confidential file in a locked cabinet in a locked University of Tennessee faculty office for 3 years following completion of the study. After that, your child's data will be destroyed. Only the investigators will have access to your child's data. Study results will be prepared for presentation at professional meetings and publication in journals. However, none of your child's personal information will be revealed. There will be ID numbers created and a key to the ID numbers for your child. The key will be kept separately from the ID numbers. The ID number and key with your child's information on it will be destroyed after the study is finished. Therefore, your child will not be identified in any reports.

What if your child does not want to be in the study?

Your child's participation in this study is voluntary. Your decision whether or not to permit your child to participate in this study will not affect your or your child's current or future relations with the researchers or the University of Tennessee. If you decide to allow your child to participate, you are free to withdraw your child from the study at any time without affecting those relationships. If your child does not wish to participate or becomes upset on one of the testing days, we will attempt to console and comfort your child. We will then try to collect their data on an additional day. If you child does not wish to participate or becomes upset again on the additional day, your child will be removed from the study. If your child decides that s/he no longer wants to participate in the study, we will remove your child from the study.

PERMISSION OF PARENT OR GUARDIAN:

I have read or have had read to me the description of the research study. The investigator or her representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks, discomforts and side effects as well as the possible benefits (if any) of the study. I freely permit my child to take part in this study.

________________________	________________________	__________
Printed Name of Parent/Guardian	Signature of Parent/Guardian	Date & Time

________________________	________________________	__________
Printed name of Investigator	Signature of Investigator	Date & Time

IRB NUMBER: UTK IRB-15-02291-XP
IRB APPROVAL DATE: 10/19/2015
IRB EXPIRATION DATE: 05/13/2016

APPENDIX F: Participant Assent Form for Episcopal School of Knoxville, TN

Assent Form
Relationship between motor competence and physical activity of children ages 10-15 years old.

☐ The assent discussion was initiated on _____________(date) at __________ (time).

The information was presented in age-appropriate terms.

The minor: ____(Subject's Name)

☐ Agreed to take part in the study on ________________(date) at _______________ (time).

● ●

☐ An assent discussion was not initiated with the minor for the following reason(s):

- ☐ Minor is under 10 years of age
- ☐ Minor is physically incapacitated
- ☐ Minor is cognitively or emotionally unable to participate in an assent discussion
- ☐ Minor refused to take part in the discussion
- ☐ Other____

RESEARCHER/DESIGNEE STATEMENT: I hereby certify that I have discussed the research project with the research participant and/or his/her parent(s) or legal guardian(s). I have explained all the information contained in the permission document, including any risks that may be reasonably expected to occur. I further certify that the research participant was encouraged to ask questions and that all questions were answered.

____
Researcher/Designee Printed Name

______________________________ ________________ _______________
Researcher/Designee Signature Date Time (AM/PM)

____
Minor Subject Printed Name

______________________________ ________________ _______________
Minor Subject Signature (10-15 years) Date Time (AM/PM)

IRB NUMBER: UTK IRB-15-02291-XP
IRB APPROVAL DATE: 05/14/2015
IRB EXPIRATION DATE: 05/13/2016

APPENDIX G: Informed Parental Consent for Saint Henry Middle School Saint Henry, OH

Parental Permission
Permission to Take Part in a Research Study

Title: The Relationship between motor competence and physical activity of children ages 10-15 years old.

Principal Investigators: Emily Post, B.S.
Dawn P. Coe, Ph.D.

Your permission is required for your child to take part in a research study. This consent form explains the purpose and requirements, of the study. Please read this form carefully. You will be given a chance to ask questions. If you decide to permit your child to be in the study, you will be given a copy of this form. If you choose for your child not to take part in the study, it will not affect your child's rights to care or services. You are also free to remove your child from this study at any time without penalty.

Why is this study being done?
The primary objective of this study is to examine the relationship between physical activity and motor competence in adolescents (10-15 years old). A secondary objective is to determine the impact that the mediating factors (perceived motor competence, physical fitness, and obesity) have on the relationship between physical activity and motor competence. Previous research has shown associations among these variables in young children; however, little research has been conducted with adolescents.

How long will the study last?
Your child's participation will include two visits lasting approximately one hour each. The study will take place at Saint Henry Middle School (381 East Columbus Street Saint Henry, Ohio 45883). After the first visit, your child will also be asked to wear a physical activity monitor all day for seven consecutive days. Your child will then return the accelerometer during the second visit.

How many people will be in the study?
About 100 children enrolled in the Knoxville, Tennessee and Saint Henry, Ohio community will be participating in this study.

What will my child do during the study?
During the study, your child will attend two visits. Each visit will be approximately an hour in length. During the first visit, your child's height and weight will be measured and your child will be fitted with a physical activity monitor. The physical activity monitor is a small box, the size of a small pager that is worn on a belt around the waist. The monitor will be worn daily for seven consecutive days (Monday through the following Monday). Your child will then participate in a Bruininks-Oseretsky Test (BOT) Analysis Test for Motor Proficiency. This test consists of motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, running speed and agility, upper limb coordination, and strength. Some of these activities include cutting out a circle, copying a square, sorting cards, one-legged side hop, catching a tossed ball, sit ups, etc. You child will then complete a seven question perceived motor competence questionnaire. This is a questionnaire to determine how your child feels when they are performing certain physical activities. On the second visit your child will participate in the FitnessGram Physical Battery. This test includes aerobic fitness (PACER), muscular strength, muscular endurance, and flexibility. Next, your child will complete the seven question perceived motor competence assessment again.

Parent/Guardian Initials _____

Risks associated with the study are minimal and considered to be equivalent to the risks that the children normally face when they are active during their physical education class. There are potential risks associated with PACER test and some of the BOT tests that may include lightheadedness, chest discomfort, leg cramps, falling, and muscle sprain/strain. These risks are similar to those typically experienced during aerobic fitness testing during physical education class.
All of these investigators are cardio-pulmonary resuscitation (CPR) certified in case of an emergency. There will also be water and fruit present to hydrate your child after the PACER test. The children/subjects will be told to let the investigators know if they feel anything abnormal (i.e. chest pain, nausea, joint paint, etc.).

Additionally, there is the possibility that a child may experience mild skin irritation from the belt that contains the activity monitor rubbing on the skin. If so, the belt will be adjusted or removed.

Are there benefits to my child for taking part in the study?
There are no direct benefits to your child for participating in this study. Information from this study will be gathered to determine the physical fitness level, physical activity level, and motor competence level in youth. School physical educators will potentially benefit from this information for their physical education courses.

Will I receive the results of my child's assessments?
We will share the results of your child's assessment with you. If your child's values fall below the normal range, we will provide you with the results as well as recommendations for future evaluation if necessary.

What happens if my child gets hurt?
In the event that your child becomes injured as a result of participating in this study, immediate treatment will be available (First Aid and/or CPR). However, you must assume responsibility for all medically necessary treatment. It is important that you tell the researcher, Emily Post, B.S., if you feel that your child has been injured in this study. You can tell the researcher in person or call her at 864-974-6040.

Who do I call if I have questions about the study?
Questions about the study not addressed in this form should be directed to Emily Post, B.S.: 865-974-6040 (Phone #), epost2@vols.utk.edu (E-mail) and if needed, a meeting can be set up. Questions about your child's rights as a research participant should be directed to the University of Tennessee, Knoxville, Office of Research Compliance Officer at 865-974-7697.

What will it cost me to permit my child to be in the study?
There will be no cost to you for your child to be in the study.

Will my child be paid for participating?
Your child will not be paid to participate.

Is the Investigator being paid to do this study?
No, the investigator is not being paid to enroll people in this study.

Parent/Guardian Initials _____

Will anyone know my child is in the study and how is my child's identity being protected?

A record of your child's participation in the study will be kept private and all data will be kept in a confidential file in a locked cabinet in a locked University of Tennessee faculty office for 3 years following completion of the study. After that, your child's data will be destroyed. Only the investigators will have access to your child's data. Study results will be prepared for presentation at professional meetings and publication in journals. However, none of your child's personal information will be revealed. There will be ID numbers created and a key to the ID numbers for your child. The key will be kept separately from the ID numbers. The ID number and key with your child's information on it will be destroyed after the study is finished. Therefore, your child will not be identified in any reports.

What if your child does not want to be in the study?

Your child's participation in this study is voluntary. Your decision whether or not to permit your child to participate in this study will not affect your or your child's current or future relations with the researchers or the University of Tennessee. If you decide to allow your child to participate, you are free to withdraw your child from the study at any time without affecting those relationships. If your child does not wish to participate or becomes upset on one of the testing days, we will attempt to console and comfort your child. We will then try to collect their data on an additional day. If you child does not wish to participate or becomes upset again on the additional day, your child will be removed from the study. If your child decides that s/he no longer wants to participate in the study, we will remove your child from the study.

PERMISSION OF PARENT OR GUARDIAN:

I have read or have had read to me the description of the research study. The investigator or her representative has explained the study to me and has answered all of the questions I have at this time. I have been told of the potential risks, discomforts and side effects as well as the possible benefits (if any) of the study. I freely permit my child to take part in this study.

________________________	________________________	__________
Printed Name of Parent/Guardian	Signature of Parent/Guardian	Date & Time

________________________	________________________	__________
Printed name of Investigator	Signature of Investigator	Date & Time

APPENDIX H: Participant Assent Form for Saint Henry Middle School Saint Henry, OH

Assent Form

Relationship between motor competence and physical activity of children ages 10-15 years old.

☐ The assent discussion was initiated on ______________(date) at __________ (time).

The information was presented in age-appropriate terms.

The minor: ____(Subject's Name)

☐ Agreed to take part in the study on _________________(date) at _______________ (time).

● ●

☐ An assent discussion was not initiated with the minor for the following reason(s):

- ☐ Minor is under 10 years of age
- ☐ Minor is physically incapacitated
- ☐ Minor is cognitively or emotionally unable to participate in an assent discussion
- ☐ Minor refused to take part in the discussion
- ☐ Other____

RESEARCHER/DESIGNEE STATEMENT: I hereby certify that I have discussed the research project with the research participant and/or his/her parent(s) or legal guardian(s). I have explained all the information contained in the permission document, including any risks that may be reasonably expected to occur. I further certify that the research participant was encouraged to ask questions and that all questions were answered.

____
Researcher/Designee Printed Name

______________________________ ________________ _______________
Researcher/Designee Signature Date Time (AM/PM)

____
Minor Subject Printed Name

______________________________ ________________ _______________
Minor Subject Signature (10-15 years) Date Time (AM/PM)

IRB NUMBER: UTK IRB-15-02291-XP
IRB APPROVAL DATE: 05/14/2015
IRB EXPIRATION DATE: 05/13/2016

APPENDIX I: Perceived Motor Competence Questionnaire (10-12 Year Olds)

What I Am Like

Name______________________ Age____ Birthday _______________ ☐ Boy ☐ Girl
Month Day (check one)

	Really True for me	Sort of True for me				Sort of True for me	Really True for me
			Sample Sentence				
a.	☐	☐	Some kids would rather play outdoors in their spare time	**BUT**	Other kids would rather watch T.V.	☐	☐
1.	☐	☐	Some kids do very well at all kinds of sports	**BUT**	Other kids don't feel that they are very good when it comes to sports	☐	☐
2.	☐	☐	Some kids wish they could be a lot better at sports	**BUT**	Other kids feel they are good enough at sports	☐	☐
3.	☐	☐	Some kids think they could do well at just about any new sports activity they haven't tried before	**BUT**	Other kids are afraid they might not do well at sports they haven't ever tried	☐	☐
4.	☐	☐	Some kids feel that they are better than others their age at sports	**BUT**	Other kids don't feel they can play as well	☐	☐
5.	☐	☐	In games and sports some kids usually watch instead of play	**BUT**	Other kids usually play rather than just watch	☐	☐

APPENDIX J: Perceived Motor Competence Questionnaire (13-15 Year Olds)

What I Am Like

Name______________________ Age____ Birthday _______________ ☐ Boy ☐ Girl
Month Day (check one)

	Really True for me	Sort of True for me				Sort of True for me	Really True for me
				Sample Sentence			
a.	☐	☐	Some teenagers like to go to movies in their spare time	**BUT**	Other teenagers would rather go to sports events	☐	☐
1.	☐	☐	Some teenagers do very well at all kinds of sports	**BUT**	Other teenagers *don't* feel that they are very good when it comes to sports	☐	☐
2.	☐	☐	Some teenagers think they could do well at just about any new athletic activity	**BUT**	Other teenagers are afraid they might not do well at a new athletic activity	☐	☐
3.	☐	☐	Some teenagers feel that they are better than others their age at sports	**BUT**	Other teenagers don't feel they can play as well	☐	☐
4.	☐	☐	Some teenagers don't do well at new outdoor games	**BUT**	Other teenagers are good at new games right away	☐	☐
5.	☐	☐	Some teenagers do not feel that they are very athletic	**BUT**	Other teenagers feel that they *are* very athletic	☐	☐

APPENDIX K: Placement of the Accelerometer

Placement of the Accelerometer

The accelerometer should be placed around the waist on the right side of the hip just in front of the hipbone. The belt should be placed around the waist, just below the belly button and not over the largest part of the hips. The arrow on the accelerometer should be pointing up when worn around the waist (see picture below). Please contact Emily Post (epost2@vols.utk.edu or 419-852-9929) or Dawn Coe (dcoe@utk.edu or 865-386-7757) if you have questions or need assistance.

IMPORTANT: The accelerometer should be worn by the child at all times for seven (7) days, except when sleeping, swimming, or bathing. We need you to help your child remember to put it on first thing in the morning.

If the accelerometer is displaced over the course of the day, please replace the accelerometer over the hip as shown in the pictures above.

APPENDIX L: Institutional Review Board Approval Letter

THE UNIVERSITY of TENNESSEE UT
KNOXVILLE
Office of Research & Engagement
INSTITUTIONAL REVIEW BOARD (IRB)

1534 White Ave.
Knoxville, TN 37996-1529
865-974-7697
fax 865-974-7400

May 14, 2015

Emily Marie Post
UTK - Kinesiology Recreation & Sport Studies

Re: UTK IRB-15-02291-XP
Study Title: Relationship between motor competence and physical activity of children ages 10-15 years old.

Dear Ms. Post:

The Administrative Section of the UTK Institutional Review Board (IRB) reviewed your **application** for the above referenced project. It determined that your application is eligible for **expedited** review under 45 CFR 46.110(b)(1), category (7). The IRB has reviewed these materials and determined that they do comply with proper consideration for the rights and welfare of human subjects and the regulatory requirements for the protection of human subjects. Therefore, this letter constitutes full approval by the IRB of your application version 1.0, as submitted. Approval of this study will be valid from May 14, 2015 to May 13, 2016.

In the event that subjects are to be recruited using solicitation materials, such as brochures, posters, web-based advertisements, etc., these materials must receive prior approval of the IRB. Any revisions in the approved application must also be submitted to and approved by the IRB prior to implementation. In addition, you are responsible for reporting any unanticipated serious adverse events or other problems involving risks to subjects or others in the manner required by the local IRB policy.

Finally, **re-approval** of your project is required by the IRB in accord with the conditions specified above. You may not continue the research study beyond the time or other limits specified unless you obtain prior written approval of the IRB.

Sincerely,

Colleen P. Gilrane

Colleen P. Gilrane, PhD
Chair
UTK Institutional Review Board

VITA

Emily Marie Post was born on July 25, 1991 in Coldwater, Ohio and raised in Saint Henry, Ohio. She graduated from Saint Henry High School in Saint Henry, Ohio in May of 2010. Emily began her college career in August of 2010 and received a Bachelor of Science degree in Exercise Science and minor in Biology from Ohio Dominican University in December of 2013. She began graduate school at the University of Tennessee, Knoxville in August of 2014. In May of 2016 she graduated with a Master of Science degree in Exercise Physiology from the Department of Kinesiology, Recreation, and Sport Studies while working under Dr. Dawn Coe. She then began her doctoral studies in August of 2016 in Health and Exercise Science with a focus in Exercise Physiology at The Ohio State University while working under Dr. William Kraemer.