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# Relationship between fundamental movement skills and body mass index in rural elementary age children

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# The Relationship Between Fundamental Movement Skills and Body Mass Index in Rural Elementary Age Children

(TITLE)

BY

Mariah L. Bolin

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## Abstract

A factor of how much physical activity a child gets could be determined by the level of mastery of fundamental movement skills that are needed for the establishment of skills used in many forms of adult physical activity. Children who master a number of fundamental movement skills are more likely to be physically active and they also may be more likely to take part in physical activity when being compared to peers with a lesser level of motor skill proficiency. Children who are considered overweight tend to engage less often in physical activities, which in turn may prevents them from acquiring fundamental movements skills. Therefore, the purpose of this study was to investigate the relationship between Body Mass Index (BMI) and fundamental movement skills in children ages 5 to 7 in a rural school system. The following two research questions were formulated: Does the performance of locomotor and manipulative fundamental movement skills differ by gender among kindergartner and first grade students? Does the performance of locomotor and manipulative fundamental movement skills differ by BMI levels among kindergartner and first grade students? The results indicated that there was a significant difference for gender in the performance of manipulative skills. Males (M=12.38, SE=.701) outperformed females (M=9.14, SE= .627) in manipulative skills. On the other hand, the second hypothesis was not supported. There was no siginificant difference between chidren of "normal weight" and those who are "overweight" or "obese" when it comes to performance of fundamental movement skills. Overall, of the 39 students included in this study that were grouped according to gender, there was no significant difference when comparing BMI and fundamental movement skills among boys and girls alike. On the other hand, there was a statistical significance when

comparing gender and fundamental movement skills. This research is important for physical educators, parents, teachers, and coaches in order to have a better understanding of a potential relationship between fundamental movment skill development and BMI levels as well as gender differences in the performance of locomotor and manipulative motor skills among early elementary age children.

## Dedication

To my friends and family, thank you for all of the encouragement, love, and support through out this process. Thank you for being understanding when it came to having to dedicate time to writing instead of spending time together and also for supporting my decision to continue my education in order to pursue my career goals.

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## Introduction

In today's world of physical activity, a factor of how much physical activity a child gets could be determined by the level of mastery of fundamental movement skills that are needed for the establishment of skills used in many forms of adult physical activity (Wrotniak, Epstein, Dorn, Jones, & Kondilis, 2006). Fundamental movement skills are comprised of locomotor and manipulative skills. Locomotor skills occur when children move their bodies through a given area of space while utilizing abilities such as skipping, running, and galloping. On the other hand, manipulative skills transpire when a child uses objects such as balls, bats, etc. in a space, instead of using just their bodies, to throw, catch, strike, or bounce, among other skills (Stodden, et al., 2008) Mastery of fundamental movement skills delivers the basis for the development of more sport specific skills (Barnett, Van Beurden, Morgan, Brooks, Beard, 2008).

Children who master a number of fundamental movement skills are more likely to be physically active and they also may be more likely to take part in physical activity when being compared to peers with a lesser level of motor skill proficiency (Wrotinak et al., 2006). Since fundamental movement skills develop in childhood, it is probable that children with lesser fundamental movement skills may become less active youths with poorer fitness abilities (Barnett et al., 2008). The association between motor skill proficiency and regular participation in physical activity starts in early childhood, does not fully mature until the teenage years, and continues into adulthood (Stodden et al., 2008). If children have low fundamental movement skill levels, they will likely have decreased involvement when it comes to movement skills such as running, jumping,

skipping, and/or involvement sports during middle to late childhood, which could lead to an adverse effect on participating in an active lifestyle as they get older, or a more narrow opportunity for engagement in physical activities (Lopes, Stodden, Bianchi, Maia, & Rodrigues, 2012).

There are many factors that are related to lower levels of fundamental movement skills. For instance, overweight children may be less competent in fundamental movement skills than other students who are in shape or lean. This relationship may be an extension from infant weight and motor activity relationships (Wrotinak et al., 2006). Children who are considered overweight tend to engage less often in physical activities, which in turn prevents them from acquiring fundamental movements skills. As a result of carrying excess weight, children's movements could possibly be inhibited and they could also be at risk for not properly developing motor skill proficiency in fundamental movement skills (Logan, Scrabis-Fletcher, Modelsky, and Getchell, 2011). This could lead to unwanted weight gain. Due to obesity being on the rise, this issue could be an ongoing and ever going problem if there is no focus on fundamental movement skills. Therefore, it is very important to study the relationship between BMI and motor skill ability in young children to figure out how early the relationship between obesity and deficient fundamental movement skills occur (Logan et al., 2011).

According to the National Center for Chronic Disease Prevention and Health Promotion (2010), since 1980 child obesity has almost tripled. The occurrence of obesity in 1$^{st}$ grade to 5$^{th}$ grade students has increased from 6.5% in 1980 to 19.6% in 2008. In grades 6$^{th}$ through 12$^{th}$, the percentage has increased from 5.0% to 18.1% (NCCDPHP,

2010). Obesiety is caused by a many factor process that correlates with a low-energy supply and inactivity with possible genetic pre-disposition. Some up to date research has shown that from 1999 to 2008, that obesiety in children, as well as adolescents, has for the most part remained stable but there is still an issue and concern for how ubiquitous obesity still is (Ogden, Carroll, Curtain, Lamb, & Flegal, 2010; Logan et al. 2011). Children who are overweight and/or obese have a greater chance of remaining overweight and/or obese throughout adolescence and in to adulthood (Nader et al., 2006). Children who are over weight may not currently possess any symptoms in the present but the future delevlopment of conditions such as diabetes, hypertension, and cardiovascular disease start to progress in early stages of development (Daniels, 2006).

This study focused on the relationship between fundamental movement skill competency and BMI levels among children ages 5 through 7. Unlike other studies, this study focused on a small rural population in the Midwest rather that urban or suburban populations. A comparable study would be that of Logan, Scrabis-Fletcher, Modelsky, and Getchell, 2011. They studied prechool students using BMI and an assessment tool called the Movement Assessment Battery for Children -2 (MABC-2), which is often used in research and clinical settings to determine motor skill ability in a large spectrum of children, including preschoolers, school-age children, as well as, at risk children (Logan et al., 2011). The significance of this study is to see if the results found are comparable to that of Logan and his counterparts when comparing BMI and fundamental movement skills in early elementary age children. For the purposes of this research the Furtado-Gallagher Computerized Observational Movement Pattern Assessment System -

FG-COMPASS (Furtado & Gallagher, 2012) was used to evaluate the children ages 5-7. The BMI was calculated using a formula provided by the Center for Diesase Control (Center for Disease Control, 2008).

In summary, fundamental movment skills are a crucial component when comes to physical activity participation, not only as a child but also considering the individuals lifespan. The way that children perceive their ability to perform fundamental movement skills may also play a role in their physical activity levels. Obesiety has also been linked to low levels of fundamental movement skill proficiency. Fundamental movement skills need to be developed and assessed efficiently in school settings. The studies aforementioned have focused on urban populations. This study is different in that it will assess children in a rural school system using the Furtado-Gallagher Computerized Observational Movement Pattern Assessment System (FG-COMPASS).

## Literature Review

The following is a literature review that covers the topics of fundamental movement skills, misconceptions, results of under developed fundamental movement skills, body mass index (BMI), why BMI is used, BMI percentiles, and potential shortcomings of using BMI.

### Fundamental Movement Skills

Fundamental movement skills are an extension of the basic movement segment of infancy (Gallahue & Ozmun, 1998). During this phase of motor growth and development, children are trying to discover what movements their bodies are capable of doing through trial and error. Children are gaining heightened control in the performance of separate, sequential, and constant movements as shown by their capability to accept variations in the elements needed to complete a task (Gallahue & Ozmun, 1998). Fundamental movement skills are rudimentary visible patterns of performance and these skills consist of locomotion and manipulative skills (Gallahue & Ozmun, 1998).

Locomotor skills represent an essential feature of learning to move successfully and effectively. These skills include projection of the body into outward space by changing its position in relation to stationary spots on the floor surface. Examples of locomotion include skipping, hopping, and horizontal jumping. Performance of locomotor movements must be demonstrated in a suitably flexible manner due to the fact of children needing to be able to react and adjust to the demands of the environment (Gallahue & Ozmun, 1998).

Gross motor manipulation, or manipulative skills, encompasses a person's association to objects and is categorized by administering force to objects and getting force back from them (Gallahue & Ozmun, 1998). Propulsive movements comprise of actions in which an object, such as a ball, is moved away from the body (ie., throwing, kicking, dribbling, and batting). Absorptive movements include actions in which the child's frame or a body part is located in the route of a moving entity for the reason of putting an end to the entity's movement or to repel that entity (ie., catching) (Gallahue & Ozmun, 1998).

**Misconceptions.** A misconception exists that fundamental movement skills simply emerge with maturation and are minimally influenced by the assignment and environmental factors (Clark, 2007). While maturation does influence the development of fundamental movement skills, it should not be seen as the only factor involved. The situation of the environment and surroundings, for instance, chances for practice, reassurance, teaching, and the setting of the environment all contribute to the development of fundamental movement skills (Gallahue & Ozmun, 1998).

Regrettably, in today's society, several qualified physical education instructors have the idea that children, by some means, will regularly learn how to accomplish fundamental movement skills on their own without proper instruction. Many instructors simply reason that children at this stage of growth will, through the course of maturation, develop established fundamental movement skills on their own. Unfortunately, this is purely not the case for an overwhelming majority of children. Most children do not develop fundamental movement skills on their own. Instead, many children develop

fundamental movement skills by being surrounded by chances to practice, reassurance from peers, parents, and instructors, and teaching in a developmentally appropriate environment. (Gallahue & Ozmun, 1998).

**Results of Under Developed Fundamental Movement Skills.** Stodden et al. (2008) suggested that the development and progess of a child's fundamental motor skill ability could be attributed to how physically active they are. When it comes to physical activity during the early childhood stages, it can be a driving force to how competent they will be in their fundamental movement skills later in life. Amplified physical activity delivers more chances to encourage neuromotor growth, which conversely encourages fundamental movement skill development. Stodden et al. (2008) believe the association among motor skill ability and steady involvement in physical activity originates in early childhood, does not completely mature until adolescence, and endures into adulthood. Children need to acquire the essential fundamental movement skills needed to be active because if children cannot use proper locomotor or manipulative skills proficiently, they will have less chance for engagement in physical activities during adolescence and adulthood. Furthermore, according to Stodden et al. (2008), children who have not acquired satisfactory stages of motor skill ability in early childhood will choose not to continue to be physically active into adolescence and, consequently, will more likely avoid taking part in health-related physical activity later in life (Stodden et al., 2008).

In general, children who are overweight tend to have increased challenges when executing motor skills, particularly locomotor skills, due to their amplified overall mass (Goodway & Rudisill, 1997). Therefore, children who are overweight are more likely to

be physically inactive throughout childhood (Bandini, Schoeller, Dietz, 1990). McKenzie et al. (2012) and Okley, Booth, and Chey (2004) established that body composition is significantly related to motor skill ability stages (Stodden et al., 2008). Hence, it is important to study the relationship among body mass index (BMI) and motor skill ability in young children in order to define how soon these relations occur (Logan et al., 2011).

**Body Mass Index (BMI)**

Body mass index (BMI) is used to calculate the amount of body fat based on a person's height and weight and found by using the equation BMI=body weight[kg]/height$^2$[m]. BMI is used as a tool to detect likely weight issues in children. The Centers for Disease Control (CDC) and the American Academy of Pediatrics (AAP) suggest using BMI to assess for overweight and obesity classifications in children starting at 2 years old (CDC, 2011). During the first year of life, body fat rises from about 16% at birth to amongst 24% and 30% at 1 year on average. By the age of 6, body fat declines to roughly 14% of total body weight. A number of children will go through an increase during the mid-growth spurt of 5 ½ to 7 years. This growth spurt usually stops after age 7 in males but continues in females all the way through adolescence (Gabbard, 2000).

**Why is BMI Used?** Using BMI to estimate obesity levels has become a popular practice in the last few years. This can be attributed to its practicality over the more traditional methods (i.e., skinfolds and hydrostatic weighing) (Gabbard, 2000). The CDC uses BMI to classify children into one of the following categories: obese, overweight, healthy weight, or underweight. However, BMI is not always 100 percent accurate. In order to see if a child truly falls into the category listed by the CDC or if there are other

factors, such as muscle mass or a fat surplus, that play a role in why BMI results would be high, additional testing from a physician would need to be administered. These tests could consist of skinfold thickness dimensions, reviews of diet and eating habits, amount of physical activity engaged in, if there is a family history of being overweight or obese, or any other suitable health tests (CDC 2011).

**BMI Percentiles.** The BMI value can be used in conjuction with well-known BMI-for-age growth charts (for either gender) in order to attain a percentile classification. BMI percentiles are the most frequently used gauge to measure the size and growth patterns of different children throughout the United States. The BMI percentile specifies the comparative location of the child's BMI number between children of the same gender and age. The growth graphs display the weight status categories used with children (underweight, healthy weight, overweight, and obese) (CDC, 2011). These categories are used to identify children in a category in relation to the national average. Ideally, children need to fall in the healthy weight category. But as stated previously, some healthy children may fall into the overweight category but in reality, with a more accurate test, they may actually be considered in the healthy weight category because BMI does not take into account muscle mass.

Table 1

*BMI weight status categories and the equivalent percentiles*

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

**Potential Shortcomings of BMI.** Although height and weight affect body fat, they unfortunately are not direct measurements of overall body fat percentage. BMI may be a simpler way to calculate body fat percentage, but it does not take in to account the difference in mass of bones, muscles or fat. In 2000 the Children's Nutrition Research Center at Baylor College (CNRC) performed a research study that associated subjects' BMI results to the results of a body fat percentage test. The results indicate that for every one out of six subjects who had a normal BMI actually scored a high percentage of body fat on the body fat percentage test. In addition, they found that one out of four children who were considered obese on the BMI scale scored a normal percentage of body fat on the body fat percentage test. Improper BMI classification may avert some individuals from getting essential weight loss assistance and may mislabel others as overweight when they actually have a healthy percentage of body fat (LiveStrong, 2011). Professionals should avoid using BMI to make decisions on an individual basis. Instead, group decisions are recommended. The following are studies that have been conducted in order to determine if there is a significant difference between fundamental movement skills and BMI.

There have been a few studies comparing the relationship between fundamental movement skill performance and BMI levels. The following studies show results of the comparison between BMI and fundamental movement skills. Graf et al. (2004), studied the relationship among body mass index (BMI) and diverse motor tests relating to gross motor development and stamina performance along with free time behavior. Data was collected on 18 comparable elementary schools which were chosen at random from the

schools located in the region of Cologne (Germany). Overall, 668 students (51.0% males; 49.0% females) took part of the study. Results indicated a weak inverse correlation among BMI and motor skill proficiency. In other words, children classified as normal-weight and underweight overperformed their counterparts classified as obese and overweight on the motor skill test (Graf et al., 2004). Along with this study, another large scale study analyzed the relationship between motor skill and BMI.

Lopes et al. (2102) studied the relationship among motor coordination (MC) and weight status (BMI) across the infantile and early youth stages. Data was gathered from 7,175 children aging from ages 6 and 14. Correlations between BMI and MC were negative and ranged between 0.05 and 0.49, indicating that higher scores on the MC test were related with lower BMI values. For both genders, there were significant differences in MC amid the three group's weight position. Normal weight children had significantly higher MC scores than that of overweight children, and obese children had significantly lower scores than overweight children (Lopes et al, 2012).

Studies have been conducted to study the relationships between motor skill ability, physical activity, and BMI in older children (Okely, Booth, & Chey 2004; Wrotniak et al., 2006). Okely et al. (2004) studied the association between motor skill ability and BMI in 4,363 children in the $4^{th}$, $6^{th}$, $8^{th}$, and $10^{th}$ grades. From this study, it was found that as motor skill proficiency increased, body composition decreased, in other words, it was inversely related. Logan et al. (2011) studied the relationship between motor proficiency and BMI in 38 preschool aged children. Results from their study indicate that there was no significant relationship between BMI and motor proficiency.

On the other hand, after combining children according to their BMI percentile ranks, Logan found significant differences among the group with the largest BMI percentile scores and all other groups (Logan et al. 2011). All in all, very small amount of research has directly studied the association between motor skill ability and obesity.

Further, studies have found significant differences between gender in manipulative skills and locomotor skills. Barnett et al. (2008) found that males were more skilled at executing manipulative skills when compared to females. Males had more advanced abilities in the catch, overhand throw, and kick. On the other hand, females scored slightly higher on locomotor skills, but the difference was not statistically significant. In another study, Wrotniak et al. (2006) found that males had significantly quicker running speed and agility, were more successful at the overhand throw, and had a better response speed. Dissimilarities in males and females motor proficiency can be attributed to environmental impacts or their interaction with their peers (Wrotniak et al., 2006). According to Wrotniak (2006), this could be due to the fact that "the type of sports and games that males and females are drawn to participate in give them more opportunity to practice and refine their motor skills and may contribute to gender differences" (p. 1762). Males are drawn to more sports that involve manipulative skills than that of locomotor skills. Regardless of which gender is drawn to either manipulative or locomotor skills, the overall development of fundamental movement skills are a much needed skill during a child's life time.

Fundamental movment skills are a crucial component when comes to physical activity participation, not only as a child but also considering the individuals lifespan.

Obesiety has also been linked to low levels of fundamental movement skill proficiency. Fundamental movement skills need to be developed and assessed efficiently in school settings. The findings of this study involve the use of the FG-COMPASS assessment tool while observing children in a rural Midwest school system. The purpose of this study is to investigate the relationship between Body Mass Index (BMI) and fundamental movement skills in children ages 5 to 7 in a rural school system.

The purpose of the study poses the following research questions: Does the performance of locomotor and manipulative fundamental movement skills differ by gender among kindergartner and first grade students? Does the performance of locomotor and manipulative fundamental movement skills differ from BMI levels among kindergartner and first grade students?

For the first research question, we hypothesize that the performance of manipulative skills, but not locomotor skills, will differ by gender. We predict that males will overperform females on the performance of manipulative skills. For the second research question we hypothesize that performance of manipulative and locomotor skills will differ by BMI levels. We predict that children categorized as "normal weight" will overperform their counterparts categorized as "overweight" and "obese".

# Methods

## Participants

Twenty boys (Mean Age= 78.8, SD=8.17) and 19 girls (Mean age= 79.0, SD=9.76) participated in this study. The sample came from a K-6 public school located in the Shelby County, Illinois. The elementary school contained children from Kindergarten through sixth grade, 180 students total. In regards to demographics, the elementary school contained 99% Caucasian race with over 50% being of low income or poverty level which can be found using the Illinois School Report Card. Because prospective participants were required to perform various fundamental movement skills (skipping, running, throwing, etc.) as part of the research protocol, children with special needs (mentally and physically incapacitated) were excluded from this study. A letter, which briefly explained the purpose of the study, along with the informed consent was sent to parents. Two weeks after the initial contact, an email was sent only to those parents who did not return the signed informed consent. Only those children whose parents signed and returned the informed consent will be selected to be part of the study. Child assesnt was also acquired before the research began. Procedures were approved through the Eastern Illinois University Institutional Review Board. As an incentive to participate in the study, students were rewarded with a colored pedometer if they brought back their informed consent form by the due date assigned.

## Procedures

**Anthropometry**. Before the study began, a parental/guardian permission letter was sent home in order to obtain parent/guardian permission for the study (See Appendix

A). Each eligible student had their height and weight measured, which was used for the calculation of their Body Mass Index (BMI).

Mass was measured on a calibrated electronic scale (an EatSmart Products Precision Digital Bathroom Scale with extra-large backlit 3.5 inch display) to the nearest 0.1 pound before being later converted to kilograms. Students were asked to remove any extra clothing that they had on, such as jackets, sweat shirts, etc. in order to obtain a more accurate weight. Measures were taken with shoes and heavy clothing removed. The scale was calibrated using a 10lb weight after every 15 students in order to ensure scale accuracy. Height was measured to the nearest millimeter using a measuring tape that was taped to the wall with mailing tape. Students were barefoot and stood with their backs to the wall while their height was being taken. The data collection of height and weight was taken out of the view of other students to ensure that students weren't embarrassed or self-conscious. Participants' height and weight measurements were used to calculate the BMI of each student.

**Fundamental Movement Skill Development**. Like the anthropometric data, fundamental movement skill proficiency was assessed during the daily physical education classes. The gym was split in half so that the assessment could be done on one half of the gym, out of sight from other students, and physical education class could take place on the remaining side of the gym. Students were taken five at a time from their regular physical education classes and were videotaped while performing eight fundamental movement skills. The Furtado-Gallagher Computerized Observational Movement Pattern

Assessment System (FG-COMPASS) was administered by a trainedand responsible person.

The FG-COMPASS is a practical assessment tool developed for school settings (See Appendix B). The instrument is comprised of 8 skills divided into two subscales (locomotor, manipulative). The locomotor skills include hopping, horizontal jumping, and skipping. The manipulative skills include throwing, striking with a bat, kicking, hand dribbling, and catching.

Logical validity evidence (Furtado, 2004) and reliability of classification decisions (Furtado & Gallagher, 2012; Furtado & Gallagher, 2013) have been reported for the FG-COMPASS. In the original study (Furtado, 2004), the instrument was developed and logical (content) validity of the FG-COMPASS was assessed using 8 professors and 12 P.E. teachers. Appropriateness and representativeness was assessed by using a four point likert- type scale. On this scale, the ranking of 1 meant "not important at all" and the ranking of 4 meant "very important." The content analysis revealed that 80% of the items under both categories received a rank of "very good" or excellent by the 20 professors and teachers used in the study. One example of an item asked under representativeness was, "Judge the extent to which there is a match between the main purpose of this test and the set of items proposed for the domain of fundamental movement skills." An example of an item asked under appropriateness was, "Rate the degree of importance in testing overhand throwing among 3-6 year-old children."

Relibility of classification decisions was tested subsequently (Furtado, 2012) and the results indicated that six skills of the eleven skills that comprised the assessment tool

required additional examination. Those six skills consisted of the side slide, horizontal jump, leap, kick, hand dribble, and over hand throw. As a result, the decision trees for the six skills were modified.

Therefore, a follow-up study (Furtado & Gallagher, 2013) was conducted to check whether the changes applied to the six skills would improve decision accuracy. Four of of the six skills (horizontal jump, kick, hand dribble, and overhand throw) had acceptable results and were kept as part of the test battery. The two other skills (sliding and leaping) were removed from the test.

In summary, the FG-COMPASS is an up and coming assessment tool that was very suitable for this study and that could be used in future studies devoted to test fundamental movement skill performance.

**How BMI and FMS were scored.** BMI was scored after the height and weight of each participant was taken. Height was taken in meters and weight was taken in pounds and later converted to kilograms. Once these measurements were obtained, a metric BMI caluculator, courtesy of the CDC, was used to calculate each child's BMI and to rank them in the categories of underweight, healthy weight, over weight, and obese based on the percentiles they fell in to. These rankings were used to group students together for this study into two over all groups 1) underweight and healthy weight and 2) over weight and obese.

After the two BMI groups for this study were determined, FMS were then scored for each child using the FG-COMPASS. Prior data collection, training was provided to the rater responsible for coding the videos. Videos from previous studies of children

performing locomotor and manipulative skills were used for training purposes. Once the training was completed, a set of 8 videos per each skill from previous studies was coded by two raters. This served to assess pre data-coding inter-rater reliability for the current study. Weighted kappa statistic was used to assess the level of disagreement bettwen the two raters. The data coding for this study only took place once the kappa values for each skill was inspected and disagreements were discussed between the two raters.

Each chid was coded either as 1, 2, 3, or 4 based on their performance of each fundamental movement skill. Each child was given three opportunities to perform each task. The scores for each of the 8 skills were added up and a composite score was assigned to each student.

**Statistical Analyses**

**Reliabilty.** Intra and inter-rater agreement was examined with weighted kappa. Weighted kappa analyses were performed using MedCalc for Windows, version 12.5 (MedCalc Software, Ostend, Belgium).

**Associations**.The Pearson product-moment correlation was used to investigate the relationship between BMI percentile and the FG-COMPASS total scores. Two separate analyses were conducted, one for each scale of the FG-COMPASS. A 2-tailed test was used with alpha set to .05.

**Group Mean Differences**. Additionally, a two-way factorial multivariate analysis of variance (MANOVA) was conducted to determine gender and BMI level differences in fundamental movement skill performance. Gender and BMI served as the two

independent variables and the locomotor and manipulative subscales of the FG-COMPASS served as the two dependent variables in the model.

The weight status categories and percentile ranges suggested[1] by CDC (CDC, 2008) were used to separate the participants into groups according to BMI levels. Because only one participant fell under the underweight category, we decided to combine the underweight and healthy weight categories and name this new category "normal weight". This produced the following groups: Normal Weight (less than the 85$^{th}$ percentile); Overweight (85$^{th}$ to less than the 95$^{th}$ percentile); and Obese (equal to or greater than the 95$^{th}$ percentile). All analyses were done using IBM SPSS 20.0 (IBM Corp., 2011).

[1] Underweight, healthy weight, overweight, and obese

# Results

## Reliability

**Pre Data Analysis Reliability Agreement**. Three reliability studies were done to increase the internal validity of this study. First, a preliminary independent inter-rater analysis was conducted involving 64 video clips (8 videos for each skill). This was done prior to collection to ensure familiarity with the FG-COMPASS testing protocol. The weighted kappa statistics are presented in Table 2. These values can be interpreted (Altman, 1991) as good (hopping, skipping, kicking, batting) and very good (horizontal jump, overhand throw, stationary dribbling, and catching). In addition, both raters reviewed and discussed all videos in which a consensus could not be reached.

Table 2

*Weight kappa statistics for the preliminary inter-rater reliability analysis*

| Skill | $K_w$ *value* | *SE* | *95% CI* |
|---|---|---|---|
| **Locomotor Subscale** | | | |
| Hopping | .610 | .185 | .248 to .971 |
| Horizontal Jump | 1.00 | na | na |
| Skipping | .724 | .120 | .489 to .960 |
| **Manipulative Subscale** | | | |
| Overhand Throw | 1.00 | na | na |
| Kicking | .714 | .188 | .346 to 1.00 |
| Stationary Dribbling | .909 | .087 | .739 to 1.00 |
| Catching | .915 | .080 | .758 to 1.00 |
| Batting | .739 | .124 | .496 to .982 |

**Post Data Analysis Reliability Agreement (Inter-rater Reliability).**

Independent ratings from two observers were used to examine inter-rater reliability of the

current study. Inter-rater reliability values are presented in Table 3. These values can be interpreted (Altman, 1991) as fair (skipping), moderate (hopping, kicking, stationary dribbling, batting), and good (horizontal jump, overhand throw, catching).

Table 3

*Weight kappa statistics for the post inter-rater reliability analysis*

| Skill | $K_w$ *value* | *SE* | *95% CI* |
|---|---|---|---|
| **Locomotor Subscale** | | | |
| Hopping | .602 | .085 | .435 to .769 |
| Horizontal Jump | .703 | .081 | .544 to .862 |
| Skipping | .369 | .093 | .186 to .552 |
| **Manipulative Subscale** | | | |
| Overhand Throw | .676 | .077 | .525 to .828 |
| Kicking | .508 | .096 | .321 to .695 |
| Stationary Dribbling | .500 | .106 | .293 to .707 |
| Catching | .786 | .063 | .662 to .911 |
| Batting | .517 | .069 | .381 to .652 |

**Correlations**

Two separate Pearson correlation analyses were conducted examining the relationship between BMI percentile and locomotor and manipulative skills. A weak negative correlation that was not significant was found for the locomotor subscale ($r(2) = -.261, p \geq .05$) and the manipulative subscale ($r(2) = -.067, p \geq .05$

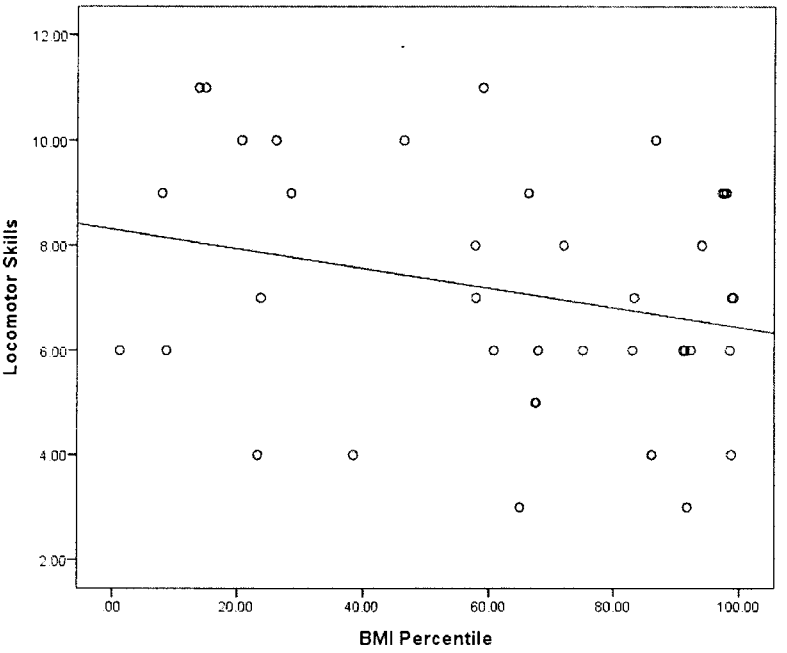


*Figure 1:* Negative nonsignificant relationship between BMI Percentile and Locomotor Skills

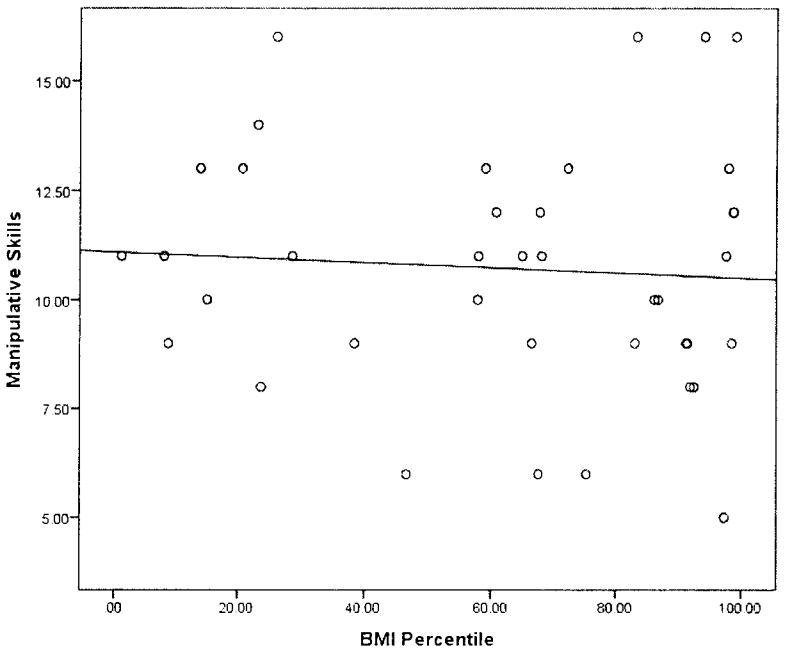


*Figure 1*: Negative nonsignificant relationship between BMI Percentile and Manipulative Skills.

**Two-way Factorial MANOVA**

A two-way Factorial MANOVA was conducted to determine the effect of BMI levels and gender on the performance of locomotor and manipulative fundamental movement skills. MANOVA results indicate that gender [Wilks' Lamda = .637, $F(2,32) = 9.125$, p = .001, $n^2 = .363$] significantly affect the combined dependent variables (see Table 5). No significant main effect was detected for BMI levels or factor interaction. Univariate ANOVA post hoc tests were conducted as follow-up tests (see Table 6). ANOVA results indicate that performance of manipulative fundamental movement skills significantly differs for gender [$F(1,33) = 12.067$, p = .001, $n^2 = .268$] with males ($M = 12.38$, $SE = .701$) overperforming females ($M = 9.14$, $SE = .627$). Performance of locomotor fundamental movement skills does not significantly differ for gender.

Table 4

*Descriptive Statistics*

| | Gender | BMI | *M* | *SD* | *N* |
|---|---|---|---|---|---|
| **Locomotor** | **Male** | Normal Weight | 7.07 | 2.61 | 14 |
| | | Overweight | 6.00 | 2.00 | 3 |
| | | Obese | 6.00 | 1.73 | 3 |
| | | Total | 6.75 | 2.38 | 20 |
| | **Female** | Normal Weight | 7.72 | 2.05 | 11 |
| | | Overweight | 6.25 | 2.87 | 4 |
| | | Obese | 8.25 | 1.50 | 4 |
| | | Total | 7.52 | 2.14 | 19 |
| **Manipulative** | **Male** | Normal Weight | 12.14 | 2.31 | 14 |
| | | Overweight | 11.66 | 3.78 | 3 |
| | | Obese | 13.33 | 2.30 | 3 |
| | | Total | 12.25 | 2.44 | 20 |
| | **Female** | Normal Weight | 9.09 | 2.25 | 11 |
| | | Overweight | 8.75 | .95 | 4 |
| | | Obese | 9.50 | 3.41 | 4 |
| | | Total | 9.10 | 2.23 | 19 |

Table 5

*Multivariate test*

| Effect | Wilks' Lambda | *F* | Hypothesis df | Error df | *p*-value | $n^2$ |
|---|---|---|---|---|---|---|
| **Gender** | .637 | .125 | 2 | 32 | .001* | .363 |
| **BMI** | .929 | 601 | 4 | 64 | .663 | .036 |
| **Sex*BMI** | .960 | 329 | 4 | 64 | .857 | .020 |

*Note.* Significant at $p$=.01

Table 6

*Tests of Between-Subjects Effects*

| **Source** | **Type III SS** | **df** | **Mean Sqr.** | ***F*** | ***p*-value** | $n^2$ |
|---|---|---|---|---|---|---|
| **Gender** | | | | | | |
| Locomotor | 7.494 | 1 | 7.494 | 1.400 | .245 | .041 |
| Manipulative | 72.293 | 1 | 72.293 | 12.067 | .001* | .268 |

*Note.* Significant at $p$=.01

## Discussion

The purpose of this study was to investigate the relationship between Body Mass Index (BMI) and fundamental movement skills in children ages 5 to 7 in a rural school system. Unlike previous studies (Graff et al., 2004: Lopes et al., 2012), we found no significant difference between BMI and FMS. Even though Graff and colleagues found a weak inverse correlation among BMI and motor skill tests, the results showed that the motor quotient (MQ) of the obese and overweight students was poorer than the MQ of the normal-weight and underweight students. There were no significant differences between BMI and FMS in this study unlike in Lopes study where for overweight children, differences only occurred for locomotor skills. Lopes and this study were in agreement that there was no significant difference in the manipulative skills scores among the overweight and nonoverweight subjects. From this research, it can be speculated that the older population of children and adolescents are not in as much of a developmental stage for FMS but their BMI plays a more prominent role in how they perform FMS movements.

The research performed in this study was modeled after Logan's (2011) study on the relationship between motor skill proficiency and BMI in preschool children. The age group tested in this study was from ages 5 to 7 years in children from a rural area. This age range is most similar to that of Logan's study with the exception of their subject being from an urban population. Like Logan's study, this study indicates that there was no significant relationship between BMI and motor proficiency. It can be said that from

comparing these two studies that regardless of location there is no significant relationship between BMI and fundamental movement skills in early elementary age children.

The current study found a significant difference for gender in the performance of manipulative skills. Males ($M$ = 12.38, $SE$ = .701) outperformed females ($M$ = 9.14, $SE$ = .627) in manipulative skills. The gender differences were expected. In relation to gender and fundamental movement skills, the results from this study agree those found in previous studies of Wrotinak et al. (2006) and Barnett et al. (2008). In both studies males were more proficient in performing manipulative skills when compared to females. This could be due to the fact that males are drawn to activities that allow them to practice and improve their manipulative skills which could contribute to gender differences (Wrotinak, 2006). With that said, Barnett (2008) found that females scored slightly higher in locomotor skills than males did but it was not high enough to reach statistical significance.

It can be speculated that early elementary age males and females are drawn to different activities that require different sets of fundamental movement skills. For instance, being as though girls are underperforming in manipulative skills, it could be said that girls are drawn to activities such as hop scotch, jump rope, etc. that involve more locomotor based skills. On the other hand, males take more to the activities that use manipulative skills such as youth football, little league baseball, youth soccer, kickball, etc.

**Limitations of this study**

As for limitations of this study, the sample size was small. A large sample size would have been a better representation of the overall early elementary population, which in turn could limit the influence of outliers or extreme observations. To go along with this, a large sample size is needed to provide outcomes amongst variables that are significantly different.

In addition, the investigators involved in future studies using the FG-COMPASS could use more hours of quality training in order to improve upon the reliability and validity of future results. A firm understanding on the assessment tool and how it is used and interpreted could have possibly improved the reliability and validity of this current study. For example, understanding the language used in the assessment tool and what is exactly expected from each level of the assessment tool would have help to increase the reliability and validity.

**Conclusion and Future Directions**

In conclusion, of the 39 students included in this study that were grouped according to gender, there was no significant difference when comparing BMI and fundamental movement skills among males and females alike. On the other hand, there was a statistical significance when comparing gender and fundamental movement skills. It was found that males had a higher proficiency level when it came to manipulative skills than that of females Recommendations from the findings of this study would suggest that manipulative and locomotor skills need to be emphasized through Physical Education classes and during early learning activities in order create better and more proficient

motor skills in children.

This research is important for physical educators, parents, teachers, and coaches in order to have a better understanding of fundamental movement skill development and ability in early elementary age children. Even though more exact procedures are available, BMI is most commonly performed on children of all age groups due to its simplicity of being able to measure overweight and obesity status. The rural sample collected was somewhat small due to school size, but in terms of this study it was big enough to achieve significant differences in the sample populations. Future studies could include a larger population size in order to obtain more data.

Overall, studies like this one help to show a relationship between BMI, gender, and fundamental movement skills, but this study could be a stepping stone that leads to more extensive experimental studies that would search to find out "why" this relationship exists and what factors can contribute to the relationship. Finding the relationship has to be done before a reason as to "why" that relationship exists.

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## APPENDIX A

## CONSENT TO PARTICIPATE IN RESEARCH

The Relationship Between Fundamental Movement Skills and Body Bass Index in Rural Elementary Age Children

You are invited to participate in a research study conducted by Mariah Bolin and Ovande Furtado, from the Kinesiology and Sport Studies department at Eastern Illinois University. Your participation in this study is entirely voluntary. Please ask questions about anything you do not understand, before deciding whether or not to participate.

- **PURPOSE OF THE STUDY**

The purpose of this study is twofold. Firstly, we seek to investigate the relationship between body mass index (BMI) and fundamental movement skills in children ages 5 to 11 in a rural school system. Secondly, we intend to investigate differences in perceived motor competency among nonoverweight, overweight and obese children ranging in age from 9 to 11.

- **PROCEDURES**

If your child volunteers to participate in this study, he/she will undergo the following procedures:

- He/she will complete a written questionnaire which asks about his/her perceived physical competence. Upon completing the questionnaire, he/she will be directed to a separate classroom where the co-investigator (Mariah Bolin) will measure their height and weight. This will be done out of the view of other participating students.
- On a different day, students will be taken five at a time from their regular PE classes and tested with the FG-COMPASS. This is an instrument that measures your child's actual physical competence on locomotor and manipulative skills (i.e., hopping, throwing, jumping).Your child will be videotaped while performing the skills. This is done because the evaluation is done analyzing the videos at a later time. Only Ms. Bolin and Dr. Furtado will have access to the videotapes.
- For each skill, a brief demonstration will be given. Then, each student will be asked to perform the skill 3 times. Once all students are tested on all 9 skills, they will be returned to their PE teacher. The same procedures above will be used with 5-8 year-old students, except that students in this age group will not be required to complete the perceived physical competence questionnaire.

- **POTENTIAL RISKS AND DISCOMFORTS**

There are no foreseeable risks associated with the participation in this study, other than those risks associated with participation in any physical education class (i.e., physical injury).

- **POTENTIAL BENEFITS TO SUBJECTS AND/OR TO SOCIETY**

Your child will not receive any direct benefit from participating in this study. The potential indirect benefits to students and the research community associated with this study outweigh the unlikely event of a physical injury. Results from this study will allow us to better understand the underline correlates associated with fundamental movement skills and the impact that FMS low proficiency level may have on unwanted weight gain. In addition, the Physical Education teacher (Mariah Bolin) from the school where data will be collected may use the results obtained in this study for teaching planning purposes.

- **INCENTIVES FOR PARTICIPATION**

Your child will not receive any incentives for his/her participation.

- **CONFIDENTIALITY**

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Confidentiality will be maintained by means of your child getting assigned an ID number for data collection purposes upon entrance to the study. This ID number (and not your child's name) will be used on all of the information collected in the study. The information linking these numerical codes with your child's identity will be kept separate from the research records in a locked file, and only the primary investigator (Ovande Furtado) working on this study will have access to these records.

Students will be videotaped while performing the fundamental movement skills. The video sequences will be used at a later time for data coding purposes. Only the PI of this study will have access to the tapes. The video material will be stored at the PI's office at Eastern Illinois University. The tapes will be locked inside a file cabinet to prevent unauthorized persons from accessing them. After one year from the date this study is completed, the tapes will be destroyed.

After the completion of this study, research records (i.e., data and signed inform consents) will be locked at a file cabinet at all times. The records will be kept for a period of 5 years from the completion of this study. After 5 years, all records pertaining to this study will be destroyed using conventional methods.

- **PARTICIPATION AND WITHDRAWAL**

Participation in this research study is voluntary and not a requirement or a condition for being the recipient of benefits or services from Eastern Illinois University or any other organization sponsoring the research project. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind or loss of benefits or services to which you are otherwise entitled.

There is no penalty if you withdraw from the study and you will not lose any benefits to which you are otherwise entitled.

- **IDENTIFICATION OF INVESTIGATORS**

If you have any questions or concerns about this research, please contact:

*Ovande Furtado*
2220 Lantz Building
Charleston, IL 61920
Phone: 581-3999
E-mail: ofurtado@eiu.edu

*Mariah Bolin*
808 Wisconsin
Windsor, IL
Phone: 459-2447
E-mail:bolinml@windsor.k12.il.us

- **RIGHTS OF RESEARCH SUBJECTS**

If you have any questions or concerns about the treatment of human participants in this study, you may call or write:

Institutional Review Board
Eastern Illinois University
600 Lincoln Ave.
Charleston, IL 61920
Telephone: (217) 581-8576
E-mail: eiuirb@www.eiu.edu

You will be given the opportunity to discuss any questions about your rights as a research subject with a member of the IRB. The IRB is an independent committee composed of members of the University community, as well as lay members of the community not connected with EIU. The IRB has reviewed and approved this study.

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I hereby consent to the participation of

_____, a minor/subject in the investigation herein described. I understand that I am free to withdraw my consent and discontinue my child's participation at any time.

Signature of Minor/Handicapped Subject's Parent or Guardian Date

I, the undersigned, have defined and fully explained the investigation to the above subject.

Signature of Investigator Date

# Appendix B

FURTADO-GALLAGHER COMPUTERIZED OBSERVATIONAL MOVEMENT PATTERN ASSESSMENT SYSTEM – FG-COMPASS

= = Rating Scales = =

LOCOMOTOR SKILLS SUBTEST

| | | | | | |
|---|---|---|---|---|---|
| HOPPING | Does the thigh of nonsupport leg lift with vertical thrust of support foot? | Y | Does the nonsupport leg pass behind the support leg? | Y | 4 |
| | | | | N | 3 |
| | | N | Is the nonsupport leg held in front of the body? | N | 2 |
| | | | | Y | 1 |
| HORIZAONTAL JUMP | Are the arms thrust forward and upward forcefully on takeoff? | Y | Do the arms extend reaching above the head at liftoff? | Y | 4 |
| | | | | N | 3 |
| | | N | Does the child take off OR land on one foot? | N | 2 |
| | | | | Y | 1 |
| SKIPPING | Do the arms move rhythmically in opposition to the legs? | Y | Are both hands in front of body at least once? | N | 4 |
| | | | | Y | 3 |
| | | N | Is there a double hop or step? | N | 2 |
| | | | | Y | 1 |

**Key: Y= Yes; N= No**

**Test material needed for administration**

1. Junior-size basketball
2. Tennis ball
3. 4-inch lightweight ball
4. 8- to 10-inch playground ball
5. Lightweight soccer ball
6. Junior-size tennis racquet
7. Plastic bat
8. 4- to 5-inch square beanbag
9. Four traffic cones
10. Gym tape

MANIPULATIVE SKILLS SUBTEST

| | | | | | |
|---|---|---|---|---|---|
| OVERHAND THROW | Does the trunk rotate to throwing side during preparation action? | Y | Is there a contralateral long step forward? | Y | 4 |
| | | | | N | 3 |
| | | N | Is there a step forward? | Y | 2 |
| | | | | N | 1 |
| KICKING | Is there an elongated stride or leap prior to ball contact? | Y | Is the follow-through high w/ support foot rising to toes or leaving a surface entirely? | Y | 4 |
| | | | | N | 3 |
| | | N | Does the child take at least one step toward the ball? | Y | 2 |
| | | | | N | 1 |
| STATIONARY HAND DRIBBLE | Does the ball contact surface in front of OR to the outside of foot on preferred side? | Y | Does the child rely on vision to keep control of the ball? | N | 4 |
| | | | | Y | 3 |
| | | N | Did the child lose control of the ball at least once? | N | 2 |
| | | | | Y | 1 |
| CATCH | Is the ball caught with hands, without making contact with any other body parts? | Y | Is there a well-timed and simultaneous motion in hands grasp? | Y | 4 |
| | | | | N | 3 |
| | | N | Is the ball secured against the chest? | N | 2 |
| | | | | Y | 1 |
| BATTING | Does the strike occur in a long (full arc) horizontal plane? | Y | Is there a differentiated trunk-hip rotation | Y | 4 |
| | | | | N | 3 |
| | | N | Is the motion from back to front in a downward plane? | N | 2 |
| | | | | Y | 1 |