

The Relationship Between Body Weight and Motor Skill Competence in Hispanic Low-SES Preschool Children

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Abstract The purpose of this study was to investigate the relationship between motor competence and BMI in Hispanic preschool children from low SES backgrounds. One hundred and forty-eight Hispanic low SES preschool children (male = 81, female = 67) participated in this study. All children were measured on gross and fine motor competence using the Peabody Developmental Motor Scales-2 (PDMS-2). Body Mass Index (BMI) was calculated for all participants. A Pearson correlation was used to analyze the relationship between the preschool children's BMI and PDMS-2 performance. A 2 (gender) × 3 (BMI) MANOVA was conducted to assess the gender and BMI differences on each PDMS-2 subtest. Nearly one-third of children in the study demonstrated gross and fine motor delays and slightly over one-third of the children were classified as overweight or obese. A significant negative correlation was found between BMI and visual motor integration scores. The MANOVA analysis showed that low SES Hispanic boys were significantly better in gross motor skill competence and girls were more advanced in fine motor performance. These findings will make a significant contribution to the literature in identifying relationship between motor competence and children's body weight. This study is also beneficial to practitioners and educators in designing intervention and preschool curriculum to improve children identified with motor delays and to reduce BMI through physical activity.

Keywords Low income · Hispanic children · Motor proficiency · BMI

Introduction

Over the past two decades, researchers have documented developmental delays and lack of motor competence among economically disadvantaged preschool children (Goodway and Branta 2003; Goodway et al. 2010; Hamilton et al. 1999; Liu et al. 2015; Pope et al. 2011). The negative implications of developmental delay in motor skills include failure to participate in physical activity, general education classes, and social experiences on the playground (Goodway and Branta 2003; Hamilton et al. 1999; Pope et al. 2011; Seefeldt 1982; Stodden et al. 2014). Consequently, children may become less active because of their motor skill challenges. Therefore, understanding the underlying reasons or contributing factors to motor delays in disadvantaged young children is an important topic for early childhood educators, movement specialists, and physical educators working with young children.

Recently, one emerging line of research inquiry has focused on motor competence in children as a pathway for physically active lifestyle. Several studies have investigated the relationship between physical activity participation and the presence of fundamental motor skills in preschool children. Holfelder and Schott (2014) conducted a systematic review to examine the relationship between fundamental motor skills and physical activity for children of all ages. In an analysis of 23 studies, they noted a positive relationship between participation in physical activity and fundamental motor skills studies regardless of age and gender.

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It is known that high levels of physical activity are not widely achieved for most preschool children (Tucker 2008). The National Association for Sport and Physical Education (NASPE 2002) recommended that children ages 3–5 need to accumulate 60 min of structured physical activity on a daily basis and engage in a minimum of 60 min of unstructured physical activity per day. In a meta-analysis review of 39 studies, Tucker (2008) reported that only 54 % of the studies demonstrated preschool children meeting the minimal NASPE standards for physical activity.

In addition, physical activity level is extremely low among Hispanic preschool-aged children (McKenzie et al. 1992; McKenzie et al. 1997; Mendoza et al. 2014). For example, Mendoza et al. (2014) studied the adiposity in 96 Latino preschool children (ages 3–5 years) from four Head Start centers in a large metropolitan area. Results indicated that moderate to vigorous physical activity was significantly and inversely related to body mass index (BMI). In addition, McKenzie et al. (1992) examined the physical activity patterns of 4-year-old children from a bi-ethnic sample. A total 287 children from low to middle socioeconomic status (SES) participated in the study of which 115 were Caucasian and 172 Hispanic. Children were observed during two 60-min home visits and two unstructured preschool recesses for 30 min each over a 2-year period. Researchers reported that children were much less active at home and Hispanic children were less active than Caucasian children at home and during recess. Children with lower levels of physical activity were more likely to have greater BMI than their more active peers with lower BMI.

Undoubtedly, the prevalence of obesity among preschool children is most alarming in Hispanic children and children who are from low SES families (Lo et al. 2013; Pan et al. 2015; Taveras et al. 2013). The prevalence of obesity for Hispanic children was 22.4 % (CDC 2011). BMI has also been found to correlate with children's SES status. Many longitudinal and cross sectional research studies have examined the relationship of low SES and BMI in children. Researchers found a stable and enduring positive relationship between low income and BMI persisting from early childhood into adolescence and adulthood (Demment et al. 2014; Freitas et al. 2012; Gigante et al. 2012; Graversen et al. 2015; Lane et al. 2012; McMillan and Erdmann 2010; Ventura et al. 2009).

In addition, a body of research has provided strong evidence on fundamental motor skill delays among preschool children who are economically disadvantaged or ethnically diverse (Goodway and Branta 2003; Goodway et al. 2003, 2010; Pope et al. 2011; Robinson and Goodway 2009). For example, Goodway et al. (2010) studied fundamental motor skill development in disadvantaged

preschoolers including Hispanic children. Results indicated that preschoolers were developmentally delayed in locomotor and object-control skills. Pope et al. (2011) assessed object-control skills of 111 Hispanic preschool children and revealed that 83 % of the participants scored poor and 17 % of children scored very poor.

Several researchers have investigated the relationship between BMI and motor competence in young children with a limited focus. The majority of studies have focused on BMI and performance on object-control and locomotor skills among preschool and elementary school-aged children abroad with mixed findings (Morano et al. 2011; Spessato et al. 2013). Morano et al. (2011) examined preschool children and found overweight children performed poorly on object-control and locomotor skills when compared to their non-overweight peers. In contrast, Spessato et al. (2013) studied 178 children aged 4–7 years old in Brazil and found a weak inverse relationship between BMI and gross motor performance for children ages 6- and 7-year olds. Researchers did not find a significant relationship in 4- and 5-year old children.

One study has provided a comprehensive motor profile of low SES Hispanic preschool children on balance, gross and fine motor assessment (Liu et al. 2015). Liu et al. showed that the 37 preschool children enrolled in a Head Start program with predominantly Hispanic children performed significantly poor when compared to their age-matched peers on both fine and gross motor skills. None of the studies reviewed demonstrate a link between fine and gross motor profile and obesity among Hispanic preschool children.

Understanding the relationship of low SES Hispanic preschool children's motor competence and BMI is important (Morano et al. 2011; Spessato et al. 2013; Stodden et al. 2008). The prevalence of obesity for Hispanic children from low SES background is high. Understanding the relationship between motor competence and BMI can provide insight into designing effective interventions to lower obesity and increase physical activity in young children. Therefore, the purpose of the present study was to investigate the relationship between BMI and motor competence of low SES Hispanic preschool children. It was hypothesized that there would a negative correlation between fine and gross motor competence and BMI for low SES Hispanic preschool children.

Methods

Participants

One hundred-forty-eight Hispanic low SES preschool children (male = 81, female = 67) participated in this

study. Low SES is defined as a family that falls below the poverty line and the family's income is less than the average family's threshold and attending day care setting not qualifying for subsidy (U.S. Census Bureau 2014). The age of the participants ranged from 36 to 60 months ($M = 55$ months). Children were recruited from a large state-funded preschool serving economically disadvantaged students located in Central Texas. Parents were informed of their rights and the process of the assessments being conducted. Parent consent forms were obtained prior to each child's participation. Participants' demographic information is presented in Table 1. The local University Institutional Review Board approved this study.

Instrument

Peabody Developmental Motor Scales-2 (PDMS-2)

The PDMS-2 is a norm referenced test that assesses children's motor performance from birth to 5 years of age (Folio and Fewell 2000). PDMS-2 is chosen because it provides a comprehensive evaluation of motor delays in preschool children's gross and fine motor skill development. PDMS-2 assesses five motor skill categories with two subtests assessing fine motor development includes grasping and visual-motor integration, and three subtests on gross motor development contains, stationary, locomotion, and object manipulation. It offers a more extensive and complete assessment of fundamental motor skill development in early childhood, which has been shown to be valid in identifying motor delays. A zero score was given if the child's performance did not meet PDMS-2 score criteria. There is a specific criterion given for each test item. If the child's performance met the score criterion for a 2, the child received a score of 2. If the child's performance met the score criterion for a 1, the child received a score of 1. After the raw scores had been collected and calculated they were then converted to standard scores, percentile, and quotient scores. Gross Motor Quotient (GMQ) is a quotient score that measures the ability to utilize the large muscle groups such as push up, jumping, and kicking. Fine Motor Quotient (FMQ) measures the competence of a child to use his or her hands through object manipulation such as grasping a marker, cutting, and

folding paper. Total Motor Quotient (TMQ) can be calculated through a combination of fine and gross motor performance to derive to a total motor capability of the child. Each child's FMQ, GMQ and TMQ can then be classified into one of the seven categories: very poor, poor, below average, average, above average, superior, or very superior.

Body Mass Index

The center for disease control and prevention (CDC 2015) suggest that BMI can be used to screen children ages two and beyond. BMI utilizes anthropometric measurements such height and weight to calculate a given percentage of fat for children. BMI can help track what category a child falls under, such as overweight or obese, as listed by the CDC. Children with BMI-for-age percentile \geq the 85th percentile are considered overweight and children with BMI for age \geq 95th percentile are considered obese (Krebs et al. 2007). BMI was calculated by using the BMI growth chart for young children that included age, weight, height and gender. Each child was classified as healthy weight, overweight, or obese using the BMI growth chart.

Procedures

Children's performance was assessed at a local school's gymnasium. Their weights and heights were measured when they first walked into the gym. Children were instructed to remove their shoes and hats and asked to stand straight against the wall to get an accurate reading for height. All participants wore light clothes no coats and shoes for recording weight measurement. The Seca 813 high capacity electrical floor scale (Seca gmbh & co. kg., Germany) was used to measure the children's weight.

The child's chronological age was used to determine an appropriate starting task. Once the task was selected for each PDMS-2 skill assessment, a demonstration was provided to the child first. Children were given opportunity to practice the task after the demonstration. If the child did not understand the task or made a mistake during the practice, more verbal explanation, demonstration, and practice were given. The assessment was performed over a short period of time. That is, a break was given between each subtest to keep children focused on the various tasks and reinforcements were used (e.g., playing with tennis ball or other favorite activities after each task) to motivate them to complete the assessments. The examiners followed the examiner competence recommendations and the directions in the PDMS-2 manual for each assessment. An inter-rater reliability test was performed between the principal investigator and research assistant. Both the principal investigator and a research assistant evaluated the

Table 1 Demographic information of participants on age, gender, height and weight

Mean age (mos)	Height (in) mean	Weight (lb) mean	N	Male	Female
55	42.53	42.68	148	81	67

children's motor skill performance in all areas. The assistant was considered trained once 90 % agreement with the principal investigator was achieved (Saigal et al. 2005). After assessing 10 children, the inter-rater agreement between the principal investigator and the assistant was 99 %. Two Spanish speaking graduate assistants were on site to help with translating the PDMS-2 instructions to children who predominantly spoke Spanish.

Data Analysis

PMDS-2 raw scores were converted to standard scores for each subtest and quotient scores for each child. The quotient scores were generated for each fundamental motor skill area (i.e., fine, gross and total). A Pearson correlation was used to analyze the relationship between the preschool children's BMI and PMDS-2 performance. A 2 (gender) \times 3 (BMI) MANOVA was conducted to explore the gender difference on motor competence and assess BMI difference on each subtest of the preschool children. The significance was set at a p value of .05 level.

Results

BMI Percentiles

The BMI data indicated that 33 % of the low SES preschool children were classified as being either overweight or obese. The percentage of children in the overweight category was 16 % and the percentage of children categorized as obese was 17 %. No children were classified in the underweight category. This findings indicate that 1/3 of low SES preschool children in this study were overweight for their age group and the percentage of obese children was at 17 %, which is identical to the CDC statistics.

Fine and Gross Motor Performance

The PMDS-2 scores showed that 20 % of the low SES children's TMQ scores were below average, and 7 % performed in the poor or very poor category. On the GMQ scores, 19 % of the low SES preschool children scored below average and 14 % children had a GMQ score in the poor category. In addition, 12 % of the children's FMQ scores were below average, 4 % children had FMQ scores in poor and very poor category. These results suggest that 27 % of the children have below average or worse performance, which means that these children are delayed for their age group in both gross and fine motor development. Furthermore, gross motor tasks (GMQ) showed the greatest area for improvement with 33 % of the children scoring

below average. Thus, 1/3 of all children in the study had motor delays.

BMI and Motor Performance

A Pearson correlation was performed to examine the relationship between BMI and fine and gross motor performance (GMQ, FMQ, TMQ). A significant negative correlation was found between BMI and visual-motor integration, $r(146) = -.181$, $p < .05$. This finding indicated that motor skill performance was negatively related to BMI for Hispanic low SES children.

A 2 \times 3 MANOVA analysis showed a significant gender differences on stationary subtest, $F(1, 144) = 4.590$, $\eta^2 = .031$, $p = .034$; object manipulation subtest, $F(1, 144) = 12.904$, $\eta^2 = .082$, $p = .000$; grasping subtest, $F(1, 144) = 4.707$, $\eta^2 = .032$, $p = .032$; and visual-motor integration subtest, $F(1, 144) = 7.406$, $\eta^2 = .049$, $p = .007$. No significant difference was found on locomotor subtest ($p = .059$). These findings suggested that low SES Hispanic boys were significantly better in gross motor skill development (i.e., stationary and object manipulation) while girls were more advanced in fine motor skill development (grasping and visual-motor integration). Participants' PMDS-2 and BMI scores are presented in Table 2.

In addition, children in three BMI categories showed no significant score difference on PMDS-2 motor skill performance ($p = .678$). These results suggest that the children in this study who were Hispanic and from low SES backgrounds, performed.

Discussion

The purpose of this study was to investigate the relationship between motor competence and BMI in Hispanic preschool children from low SES families. Specifically, our study investigated the relationship between BMI and gross and fine motor performance in an economically disadvantaged

Table 2 Participants' PDMS-2 and BMI mean, standard deviation (SD) scores

PDMS subtest and BMI %	Mean	SD
Stationary	45.757	27.1435
Locomotion	38.595	25.6989
Object-manipulation	32.250	24.7966
Grasping	48.892	26.1610
Visual-motor integration	44.595	23.7738
BMI %	65.797	24.4002

population that has not been well studied. The results of this study supported our hypothesis that a negative relationship exists between Hispanic low SES children's PMDS-2 performance and their BMI. A negative relationship was found between participants' gross motor performance (i.e., object manipulation) and BMI, and their fine motor performance (i.e., visual-motor integration) and BMI. In addition, nearly one-third of Hispanic low SES children demonstrated delays in their gross motor skill performance. This finding is consistent with studies that have reported delays in gross motor skill performance in ethnically diverse and economically disadvantaged children (Goodway and Branta 2003; Goodway et al. 2003, 2010; Pope et al. 2011; Robinson and Goodway 2009). Our study also showed that Hispanic low SES preschool children delayed on their fine motor performance which was consistent with Liu et al. (2015) that Hispanic preschool children were delayed on fine and gross motor skill performance. Our study replicates findings examining relationship between gross motor performance and BMI in preschool children (Morano et al. 2011; Spesato et al. 2013) and adds the newly found correlation results between fine motor performance and BMI to the literature. The participants' BMI percentage was slightly higher than the 14.5 % average reported by the CDC for children 2–4 years of age from low income families (CDC 2011) indicating that Hispanic preschool children from low SES backgrounds may need to increase opportunities for physical activity and motor skill instructions.

Prior to this study, no known attempt had been made to measure and compare relationship between motor competence and BMI in Hispanic preschool children from low SES backgrounds. Previous studies measure primarily a small subset of gross motor skills involving locomotor and object-control skills (Goodway and Branta 2003; Goodway et al. 2003, 2010; Pope et al. 2011; Robinson and Goodway 2009). This study presents a complete profile of motor competence for young children including object manipulation, locomotion, stationary, visual-motor integration, and grasping skills.

Furthermore, this study builds upon the model proposed by Stodden et al. (2008). That is, preschool children's lack of ability to perform motor skills contributes to higher BMI, which is associated with lower rates of participation in physical activity that leads to a healthy lifestyle. Our study examined the relationship between motor competence and BMI in Hispanic preschool children from low SES backgrounds to demonstrate this existent link and supported Stodden's model.

Similar to the results of Goodway et al. (2010), our study also found that economically disadvantaged preschool boys performed better than girls in object-control skills. In addition, boys were significantly better than girls on stationary tasks (e.g., static balance, push ups, sit ups,

and imitation movements). Stationary skills including balance, strength and imitation movements are critical for development of many complex motor and sport specific skills for children later in life. A child who is proficient in these skills is more likely to maintain a healthy and active lifestyle. In addition to gross motor performance differences, our findings indicated that girls outperformed boys in fine motor skills such as grasping and visual-motor integration. To our knowledge, this is the first study to explore gender differences in fine motor skills among economically disadvantaged preschool children.

Our findings have significant implications for practitioners and educators. There is a need for educators to examine opportunities for children to participate in structured and unstructured activity during the school days. Increasing opportunities to learn and practice skills taught during the day may improve children's motor proficiency. This could have a positive impact on children's participation in physical activity as well as the development of social, cognitive, and psychological skills later in life. It is also recommended that practitioners and early childhood educators include skill-based instruction for gross and fine motor skills in their daily curriculum. As a comprehensive approach to reduce BMI, educators and practitioners are recommended to increase physical activity, improve motor competence, provide opportunities for skilled-based instruction, and provide nutritious food choices to promote a healthy lifestyle.

The results of this study also have implications for policy makers. One implication is that preschools should be encouraged to monitor their students' BMI. Our study showed that 1/3 of the Hispanic preschool children were considered overweight and obese and they were delayed in fine and gross motor skill performance. Currently, guidelines by the CDC do not promote or discourage monitoring BMI for preschool children. It offers guidelines for safeguards if BMI is offered (CDC 2015). We suggest policy makers take into consideration the prevalence of obesity in preschool children and set clear policies to support the monitoring of BMI. Policy makers should also consider requiring physical education classes for state supported pre-K programs serving Hispanic preschool children from low SES backgrounds. Our data clearly demonstrated Hispanic preschool children with low SES background lacked motor competence in both gross and fine motor skills and they had high BMI. NASPE (2002) guidelines call for structured physical activity lessons which is best taught by a physical educator.

One limitation of the study is that children sometimes were not highly motivated to perform the tasks that were requested on the 2nd or the 3rd time because the nature of the Peabody is to assess their skill level through several similar tasks with different difficulties. Researchers let children take multiple short breaks during the test and give

them incentives like stickers and reward cards to motivate children to perform to their best ability.

There are relatively few studies investigating delays in visual motor integration and fine motor skills for this population. More assessment is necessary in future research to better understand motor skill delays in this population. Future research should also explore the mediating factors such as motor skill competence, BMI, physical activity, or type of instruction on motor skill performance.

In conclusion, the present study indicates that our sample of Hispanic children from low SES backgrounds was delayed in their fine and gross motor skill performance as measured by PDMS-2. Moreover, findings suggest that this delay is related to their body weight since 30 % of them are overweight and obese, and a negative correlation is found between BMI and motor performance. These findings will make a significant contribution to the literature in identifying relationship between motor proficiency development and children's body weight. This study may be beneficial to practitioners and educators in designing intervention and preschool curriculum to improve children identified with motor delays and to reduce BMI through physical activity. It is imperative to the success of the child in classroom, playground, physical activity, and life with healthy body weight and high motor competence.

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