
VALIDITY AND RELIABILITY OF THE MEDICINE BALL THROW FOR KINDERGARTEN CHILDREN

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ABSTRACT

Davis, KL, Kang, M, Boswell, BB, DuBose, KD, Altman, SR, and Binkley, HM. Validity and reliability of the medicine ball throw for kindergarten children. *J Strength Cond Res* 22(6): 1958–1963, 2008—The purpose of this study was to establish validity and reliability evidence for the medicine ball throw test for kindergarten students, an underrepresented group in the literature. The subjects were 105 students, 5–7 years old, BMI $17.44 \pm 3.17 \text{ kg}\cdot\text{m}^{-2}$, 43% female and 57% male. Intraclass correlation coefficients (ICCs) were used to examine reliability, and Pearson correlation coefficients and a paired *t*-test were used to examine validity. To accomplish this, the kindergarten students completed the medicine ball throw test on two different days and the modified pull-up test, the “criterion” measure, on another day. For the medicine ball throw, each student sat on the floor before throwing the medicine ball forward like a chest pass three times. The medicine ball throw was highly reliable both within 1 day (ICCs = 0.93 and 0.94 for day 1 and day 2, respectively) and across 2 days (ICC = 0.88), with all reliability estimates over the acceptable level of 0.80. The medicine ball throw scores were positively related with height ($r = 0.34$) and weight ($r = 0.34$), and there was a significant difference between the 5-year-old group (mean \pm SD; 111.78 ± 34.93) and the 6-year-old group (135.60 ± 39.77), $t = -3.23$, $p = 0.002$, which supports correlational and known-difference evidence of validity for the medicine ball throw test. Even though no correlation was found between the medicine ball throw test and the modified pull-up test, $r = -0.04$, other forms of validity evidence (i.e., known-

difference and correlational) were apparent. In conclusion, the medicine ball throw test seems to be a valid and reliable measure of upper-body strength for kindergarten children.

KEY WORDS strength, youth, resistance training, physical education

INTRODUCTION

A large body of evidence exists indicating that strength training can be an effective method of conditioning for children (8). In addition to increasing muscular strength, resistance training programs for children and youth have been related to improvements in motor skill performance (7,14,27), improvements in body composition (30), and a reduction in sport-related injuries (25). However, a review of the literature concerning resistance training for children reveals a clear lack of information concerning children under 7 years of age.

One of the glaring omissions in the literature involving very young children is the absence of reliable and valid measures of upper-body strength or power. As explained by motor development experts (10,13), there are a number of reasons that kindergarten children are often not included in research studies, in general. These reasons include a) greater variability observed in their motor skill performances compared with older children, b) increased difficulty in motivating these children to consistently exert maximal effort, and c) shorter attention spans compared with older children (10,13). Despite these challenges, assessment of strength is essential at this age because strength is an important health-related fitness component throughout the life span.

Literature related to medicine ball training, of both a theoretical and applied nature, often focuses on quality of life and performance benefits without much attention to the potential assessment applications. Several advantages of medicine ball training, particularly when compared with traditional weight training activities, are noted. Medicine ball exercises for children provide the opportunity to strengthen the body through dynamic movements that require balance and coordination (6). Medicine ball exercises also train the body to function as a unit instead of isolating individual

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muscles or muscle groups and permit a range of exercises that involve simple to complex movement patterns. These patterns closely mimic the natural body positions and movement speeds that occur in daily life and in the performance of sports skills (6). The ability to mimic functional movement and vary the complexity of movements makes medicine ball exercise an ideal resistance training activity for children. Because medicine ball exercises are adaptable to varying skill levels, many individuals (including children) can receive the quality of life and performance benefits associated with the exercises. Likewise, children may also benefit if the medicine ball throw is found to be an effective assessment tool.

Although limited research exists involving strength measures and very young children, a review of the related literature by Beunen and Thomis (3) indicates that children aged 3–6 years demonstrate minimal gender differences in strength and that, during this period, strength levels gradually increase each year. Increases in strength were associated with changes in growth patterns and improvements in motor skills such as running, jumping, and throwing (3). Although this review provides valuable general information about strength development in children aged 3–6 years, additional research is needed to establish valid and reliable measures of upper-body strength. One of the valid and reliable measures of upper-body strength that has been used with older children is the seated shot put, more commonly known as the medicine ball throw.

Studies have been conducted using the medicine ball throw or the closely related seated shot put as an assessment tool with older African American women, university-age weight training students and football players, high school wrestlers, and healthy women (1,15–17,27). Stockbrugger and Haennel (26) evaluated the use of a medicine ball throw test in 20 male and female athletes aged 16–30. Validity was established between the medicine ball throw and the vertical jump power index ($r = 0.906$), and the test-retest reliability of the medicine ball throw was 0.996. In the second study, elite female gymnasts aged 10–11 years were evaluated for upper-body power using three different medicine ball tests: the overhead forward throw, the overhead backward throw, and the chest press (medicine ball throw). Their results indicate that there were no differences between the mean throw distance and the throw type, meaning that each of the three tests would measure the upper-body power equally well (24).

Mayhew et al. (18), when using the backward overhead medicine ball (BOMB) throw method, determined that particular throw to be unsatisfactory in terms of predicting explosive power in college football players. Duncan et al. (4) have suggested that the BOMB throw is a reliable method to assess total body explosive power in male adolescent rugby players. In all of the recent studies, the sample is fairly small in size, and it typically consists of elite athletes, not young children in physical education classes. There has been virtually no research conducted on the use of the medicine

ball throw as a test of power and strength in young children. Therefore, the purpose of this study was twofold: first, to determine whether the medicine ball throw test was stable across time to establish reliability evidence, and, second, to determine whether there was a relationship between the medicine ball throw test and the modified pull-up test to establish validity evidence.

METHODS

Experimental Approach to the Problem

The purpose of this study was to establish validity and reliability evidence for the medicine ball throw test for kindergarten students. There are no specific independent and dependent variables for the designed study. Rather, the modified pull-up test was considered the “criterion” measure, and the medicine ball throw test is the field measure for validation. By comparing a commonly used test of upper-body strength for children (i.e., the modified pull-up), it was assumed that the shared performance scores for similar movement patterns would support the ability of the medicine ball throw to assess upper-body strength. A priori power calculation for the validity study indicated that a sample size of 88 would be necessary, given the effect size of 0.3 and the power of 0.9. Power calculation is not applicable for a reliability study.

Subjects

The subjects selected for this study consisted of 105 kindergarten children from two elementary schools, one in North Carolina and one in Tennessee. The kindergarten students were 5–6 years of age, their average BMI was $17.44 \pm 3.17 \text{ kg}\cdot\text{m}^{-2}$, and 43% were female students and 57% were male students. The race/ethnicity of the children was more diverse than the increasing diversity of students in American schools: the majority of the subjects were African American (51%), with a smaller number of children from the following ethnic groups: 35% European American, 8% Hispanic American, 5% Asian American, and fewer than 1% multiracial. The subjects were recruited from the regular physical education classes at each school for participation in the study (eight classes total). Written informed consent was obtained from school principals and parents/guardians of the kindergarten students. This study was approved by the institutional review boards at East Carolina University and at Middle Tennessee State University.

Testing Procedures

The kindergarten students were tested on three different occasions. On day 1, the kindergarten students performed the medicine ball throw test. On day 2, they performed the modified pull-up test. On day 3, which was exactly 7 days after day 1, the medicine ball throw test was repeated a second time. The time frame between the medicine ball tests was selected to prevent memory and motor retention of the skill

and to decrease the likelihood of training effects. One test was performed each day on the basis of the time scheduled for the average kindergarten class (usually 30–45 minutes).

When the medicine ball throw test was administered, one researcher demonstrated the skill. Each student sat on the floor with his or her back against the wall. The student held the ball in front of him or her with both hands, resting it against his or her lap. The students were instructed that on the tester's command ("go"), that "you will lift the medicine ball to your chest and throw it forward as hard as you can." Each subject performed two practice throws, and then the distance of the next three throws was recorded, with a 1- to 2-minute rest between each throw. The measurement was taken to the nearest eighth of an inch and converted to a metric unit (24). The lane for throwing the medicine ball forward was marked to be exactly 36 in wide.

For the modified pull-up test, one investigator also demonstrated the skill before the modified pull-up test was administered. Each kindergarten student was positioned on his or her back with the shoulders directly below a bar that was set 1–2 in beyond the child's reach. An elastic band was placed 7–8 in below the bar. The students started in a "down position": hanging from the bar, with the buttocks off of the floor, the arms and legs straight, with only the heels touching the floor. An overhand grip was used. A successful pull-up was completed when the child's chin touched the elastic band. Each subject completed as many pull-ups as possible while keeping his or her hips and knees straight (21).

The data were collected on several days, and multiple subjects were tested concurrently within the physical education classes; therefore, both of the schools had enough equipment to test two to three separate groups of children. This allowed the researchers to complete data collection during a short period of time at two different schools, with minimal disruption to the regular physical education curriculum.

Instrumentation

Medicine Ball. For the medicine ball throw test, the POWER Med-Ball medicine ball by Power Systems was selected because it is a perfectly balanced medicine ball that maintains its round shape and has a textured surface to provide a good gripping surface. Each medicine ball weighed 2 lb (with an 8-in diameter), the lightest weight available. The researchers chose this weight because it was practical and developmentally appropriate for the kindergarten age group. Furthermore, Viitasalo (28) found that lighter medicine balls produced more reliable measurements of throw distance.

Modified Pull-Up Bar. For the modified pull-up test, a standard modified pull-up bar was selected that had a grip width of 34 in, a grip height of 16.5–37.5 in, and a total weight of 35 lb. This modified pull-up bar was selected because it had an adjustable grip height; therefore, adjustments could be made based on the length of the child's arms, which decreased the stress and risk of injury for this population.

Tape Measure. The Stanley Bostitch 34106 tape measure was selected to measure the distance of the medicine ball throws because it is a long, heavy-duty tape that is graduated in one-eighth-inch increments. It was taped to the floor, and it withstood the force of the 2-lb medicine balls landing on it without tearing or moving the tape.

Statistical Analyses

Descriptive statistics of the medicine ball throw and the modified pull-up scores were calculated first. Reliability was assessed for the medicine ball throw within 1 day and across days with an intraclass correlation coefficient (R) via one-way analysis of variance (ANOVA). A dependent t -test was also performed to determine whether there were significant differences between the day 1 and day 2 scores for the medicine ball throw. For establishing validity evidence, the Pearson correlation coefficient, r , was computed between the medicine ball throw individual average distance scores and the modified pull-up total number scores. In addition, the correlational evidence of validity of the medicine ball throw test was evaluated through the relationship between the height and weight of the kindergarten children, and the known-difference evidence supporting validity was evaluated by comparing the medicine ball throw by the age groups.

RESULTS

Descriptive statistics for the sample, including means and standard deviations, are presented in Table 1. The average distance of the medicine ball throw was 124.71 ± 39.31 cm, and the average number of modified pull-ups was 3.18 ± 3.69 . The reliability estimates of the medicine ball throw were 0.93 and 0.94 for within day 1 and day 2, respectively, and the test-retest reliability was 0.88. Paired t -test results showed no difference between the medicine ball throw scores from day 1 and day 2, $t = -1.33$, $p = 0.19$. The results for reliability demonstrate that the medicine ball throw is a highly reliable measure both within 1 day and across 2 days, with all reliability estimates over the acceptable level of 0.80.

Comparisons were made between the medicine ball throw and the modified pull-up scores to establish validity evidence. The modified pull-up test was considered the "criterion" measure. Results of the medicine ball throw on both days were combined to conduct the correlation analysis between the medicine ball throw scores and the modified pull-up scores. No correlation was found between the medicine ball throw test and the modified pull-up test, $r = -0.04$.

Further analysis was completed to explore different types of validity evidence. The medicine ball throw scores were positively correlated with height ($r = 0.34$) and weight ($r = 0.34$), which supported correlational evidence of validity of the medicine ball throw test. At this young age, strength seems to be influenced more by growth patterns (e.g., height and weight) than by gender differences (10). The literature on the use of the medicine ball throw has demonstrated that the body size of subjects correlates positively with the distance

TABLE 1. Descriptive statistics for the sample.

	5 years old*		6 years old†		Total‡	
	Mean	SD	Mean	SD	Mean	SD
MBT-day 1 (cm)	109.50	36.07	135.12	43.29	123.41	41.97
MBT-day 2 (cm)	114.07	36.58	136.07	38.63	126.01	39.11
MBT-ave (cm)	111.78	34.93	135.60	39.77	124.71	39.31
Modified pull-up (number of pull-ups)	3.75	4.18	2.70	3.18	3.18	3.69
Height (m)	1.16	0.07	1.17	0.06	1.17	0.06
Weight (kg)	25.02	6.64	22.97	4.63	23.91	5.70

MBT-day 1 = average of three medicine ball throws on day 1; MBT-day 2 = average of three medicine ball throws on day 2; MBT-ave = average between MBT-day 1 and MBT-day 2 scores. **n* = 48; †*n* = 57; ‡*N* = 105.

that they can throw the medicine ball (16,26). Therefore, the case can be made for establishing the validity evidence of the medicine ball throw test through the evidence of a relationship between the height and weight of the kindergarten children in this study.

Because the strength of very young children increases gradually from year to year, a comparison was made between the scores from the medicine ball throw test between the 5-year-old age group and the 6-year-old age group (3,9). An independent *t*-test was used to support the known-difference evidence of validity. A statistically significant mean difference in the medicine ball throw between the age groups would provide known-difference evidence supporting validity (2,22). The results show a significant difference between the 5-year-old group (mean ± *SD*; 111.78 ± 34.93) and the 6-year-old group (135.60 ± 39.77), *t* = -3.23, *p* = 0.002. The 6-year-old group demonstrated higher mean scores than the 5-year-old group. Therefore, these results provide additional evidence of validity based on known-difference evidence between the age groups.

DISCUSSION

The medicine ball test was designed to assess upper-body strength using a general movement pattern common to many sport skills (26). To evaluate the reliability and validity of this test, kindergarten children were tested using a movement pattern similar to a forward chest pass. The seated position of the medicine ball throw in this study eliminated the power commonly generated from the trunk and lower extremities. It was hypothesized that this test could provide physical education teachers with a reliable field test for assessing upper-body strength or power in young children. Even though only moderate correlations for validity evidence were indicated, it seems that the medicine ball throw is a highly reliable test of upper-body strength or power in kindergarten students aged 5–6 years.

The researchers chose the modified pull-up test as the “criterion” measure because it is the most commonly used measure of upper-body strength or power in children (19). Although the modified pull-up has been determined as a reliable measure of upper-body strength in children 10 years of age and above (5,23), it has not been validated against criterion measures of upper-body strength in children (21). Previous studies involving the seated shot put test, which is similar to the medicine ball throw used in this study, have used the seated shot put as a measure of upper-body power (12). However, most of these studies have included subjects who were older than 10 years of age (24). Several of these authors investigated the use of the medicine ball throw/seated shot put with subjects who were athletes and not physical education students (16,24,26,29). In these studies involving older children and adolescents, the seated shot put was validated against either the bench press or the vertical jump. Neither of those criterion measures would have been appropriate for kindergarten children aged 5–6 years. Therefore, a limitation of this study was the use of the modified pull-up as the “criterion” measure for establishing validity evidence.

One factor that could have influenced the low validity estimate (*r* = -0.04) between the medicine ball throw and the modified pull-up scores was the skewed range of scores from the modified pull-up test, with more than 78.1% of the scores being four or less. This implied that the modified pull-up scores failed to measure all of the ability levels of kindergarten children’s muscular strength (i.e., floor effect). The *Fitnessgram*®/*Activitygram*® *Test Administration Manual* (19) lists the criterion-referenced standards for boys and girls, aged 5–6, as a range of 2–7 modified pull-ups. However, approximately 44% of the subjects in the present study performed either a score of one (27%) or zero (17%) on the modified pull-up. Another possible reason for the lack of

a relationship between the two measures is the different muscle groups recruited to complete the two tests.

A further limitation of the study was that the researchers found it difficult to discern correct and incorrect forms with the modified pull-up protocol (21) for kindergarten children. The validation results of this study indicate that the modified pull-up test lacks sensitivity to the strength and power levels of the kindergarten age group. It seems that the difficulty in establishing a valid relationship between upper-body strength and the modified pull-up centers on establishing a clear protocol that will produce upper-body strength and power in children aged 5–6 years (16). It is not always feasible or desirable to determine the maximum lifting ability of younger subjects. Determining the relative contributions of muscle strength, muscle mass, and muscular coordination at different developmental stages along the age continuum might prove beneficial. Future research is needed to examine different protocols for the use of, and validation of, the medicine ball throw compared with a relevant measure for children below 10 years of age.

Unexpected results were obtained by comparing gender differences related to the medicine ball throw test. An independent *t*-test was used to examine the difference in the medicine ball throw scores for boys and girls. The results show a significant difference between boys (135.17 ± 43.33) and girls (110.77 ± 28.04), $t = 3.49$, $p < 0.001$. Motor development literature indicates that there are minimal gender differences in strength before puberty (3,11,20,24), especially in respect to 5- and 6-year-old children. Gender differences found in the current study may be attributable more to changes in neural adaptation, specifically the ability to coordinate the agonist and antagonist muscles as well as increased ability to activate motor units effectively (3,13).

PRACTICAL APPLICATIONS

With the increased support for resistance training in children, there is a need for adequate age-appropriate measures to test and evaluate improvement and performance of medicine ball training programs in physical education classes for young children. The implication for practitioners in using the medicine ball throw for children aged 5–6 years is that the medicine ball throw seems to be a reliable field test of upper-body strength for that age group, but it could not be validated using the modified pull-up test. However, other forms of validity evidence (i.e., known-difference and correlational) were apparent. Medicine ball throw tests have several advantages: they are inexpensive, they offer flexibility in testing, and they can provide physical education teachers with information on the effectiveness of strength programs for children (26). One benefit of the medicine ball throw test is that it is flexible in simulating different types of movement patterns. Whether such tests are appropriate for evaluating specific sport skill patterns or whether they are better suited to assess general physical fitness is a topic for future investigators.

In conclusion, the medicine ball throw test seems to be a valid and reliable measure of upper-body strength for kindergarten children. The amount of body mass (height and weight) and the degree of muscular development may contribute to the success of the medicine ball throw performance. Many activity patterns that impact physical fitness are begun in early childhood; therefore, it is important that valid, reliable, and feasible measures are developed to identify children who are not developing healthy fitness habits (12). Because a properly designed and supervised resistance training program can increase strength and enhance the motor fitness skills of children, it follows that an assessment tool is needed to evaluate whether resistance training programs for young children are effective in enhancing overall health and in preventing childhood obesity.

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