Construct and Concurrent Validity of the Democritos Movement Screening Tool for Preschoolers

Antonis Kambas, PhD; Fotini Venetsanou, PhD

School of Physical Education and Sport Science (Dr Kambas), Democritus University of Thrace, Komotini, Greece; School of Physical Education and Sport Science (Dr Venetsanou), National Kapodistrian University of Athens, Athens, Greece.

Purpose: To examine the construct and concurrent validity of the Democritos Movement Screening Tool for Preschool Children (DEMOST-PRE). **Methods:** The DEMOST-PRE was administered to 435 Greek children, aged 48 to 71 months. Construct validity was investigated through correlations between total scores and individual item scores, and scores according to age and sex, whereas concurrent validity was checked by using the Bruininks-Oseretsky Test of Motor Proficiency-Long Form as the test-criterion on a subsample of 50 children. **Results:** Moderate to strong, significant correlations ($r = 0.390$-0.831; $P < .001$) supported the internal consistency of the test. Age displayed a significant effect on children's scores, whereas sex did not. Furthermore, the intra-rater class coefficient calculated for concurrent validity was found to be 0.80. **Conclusions:** On the basis of the aforementioned findings, the DEMOST-PRE has adequate psychometric properties for the Greek sample analyzed. **(Pediatr Phys Ther 2016;28:94–99)** *Key words: age factors, child/preschool, female, growth and development, human, male, motor skills, psychometrics, sex factors, validity of results*

INTRODUCTION

Motor difficulties have negative consequences not only on the motor domain of children's behavior, but also on the social,[1] cognitive,[2] and affective domains.[1] In addition, several researchers have reported that children with motor difficulties are less physically active,[3] have poorer physical fitness,[2] and are at higher risk of having excess weight[4] compared with their peers with typical motor development. Moreover, those difficulties are not temporary; instead, they continue as they grow up.[2]

Therefore, the importance of timely identification of children's motor difficulties becomes apparent. To achieve that, pediatricians, therapists, and preschool educators should select a screening tool that is appropriate for preschoolers and provides valid and reliable information about children's motor development. Thus, children at risk of motor difficulties will be identified and referred for further evaluation. If those children are identified before entering school, enough time is available for intervention to be implemented and the negative consequences of those difficulties in children's lives to be minimized and/or reduced.[5]

The Bruininks-Oseretsky Test of Motor Proficiency (BOTMP)[6] and the Movement Assessment Battery for Children[7] are the 2 most common motor screening tools for preschoolers. However, even though both tools have been used by numerous researchers all over the world, some of their features should be reconsidered. To begin with, the cost of purchasing these tests should be mentioned as it may be prohibitively high for many preschool settings. Second, both time needed for their administration and the inflexible measurement climate of these tests can act as negative factors in preschool motor evaluations.[8] Screening tools should be not only technically adequate but also relatively short and inexpensive,[9] thus the feasibility of using the aforementioned tools for screening is questionable.

The Democritos Movement Screening Tool for Preschool Children (DEMOST-PRE)[10] is a new motor screening instrument, specifically designed for 4- to

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Correspondence: Antonis Kambas, PhD, School of Physical Education and Sport Science, Democritus University of Thrace, University Campus, 69100 Komotini, Greece (akampas@phyed.duth.gr).

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6-year-old children, which has several characteristics that make it promising: (a) the tool is time-effective, requiring less than 15 minutes to administer; (b) it is cost-effective as most equipment needed is already present in preschool settings and only a few specialized materials are needed; (c) the test can be effortlessly administered and scored; (d) the tool motivates the child's participation as the items are presented through short fairytales. However, evidence for the DEMOST-PRE psychometric properties is quite limited, as only 1 study providing support for its content, face and factorial validity has been published.[11] Thus, the aim of the present study was to present additional evidence on the validity of the DEMOST-PRE. For that purpose, 3 criteria were examined: (a) the internal consistency of the tool, (b) the effect of age and sex on both the total score and item scores, and (c) the concurrent validity of the DEMOST-PRE, using the BOTMP-Long Form (LF)[6] as the test criterion.

METHODS

Participants

The sample used to examine internal consistency and age and sex differences included 435 healthy preschool children (238 boys and 197 girls), between the ages of 48 and 71 months (mean age = 60.48 months; standard deviation = 6.98 months), who were classified in 4 age groups (48-54 months [n = 92], 54-59 months [n = 92], 60-65 months [n = 125], and 66-71 months [n = 126]). Stratified sampling was used to ensure representation of the Greek general population in the sample in terms of sex, age, geographical area, and ethnicity. Children having been referred for any developmental delay were not eligible for the study.

To examine concurrent validity of the DEMOST-PRE with the BOTMP-LF,[6] 24 boys and 26 girls (mean age = 61.42 months; standard deviation = 7.00) were selected from the larger initial sample, stratified on age and sex.

Participants' teachers, parents, and legal guardians were informed about the aim of the study, and consent for each child was obtained. Moreover, children were asked and verbally assented to participate in the study. The study was approved by the Democritus University ethics committee.

Instruments

DEMOST-PRE. The DEMOST-PRE consists of 9 items: tapping; jumping repeatedly sideways; running, carrying, and placing a ball in a box; toe-to-heel walking in a backward direction; overhead toss to a specific target; picking up coins and placing them in a box; stepping though 3 vertical hoops; catching a bean bag; and standing jump over a stick. Before the administration of the above items, a hand preference test is performed. Short fairytales, which are part of a story, are used for the presentation of the above items to the child so he/she will be motivated to participate. Depending on the child, approximately 15 minutes is needed for administration of the test.

To obtain a score of a child's performance on the DEMOST-PRE, a process common to motor tests is followed. The child's raw score on each task (time needed to complete the task, number of coins transferred, etc) is recorded, and after completion of the measurement, the raw score is converted to a point score, following the guidelines provided on the DEMOST-PRE record form. The total battery score results from the addition of the 9 point scores.

Kambas and Venetsanou[11] stated that the item scores, providing useful information about children's motor proficiency, can be used for educational or therapeutic purposes; however, only the total DEMOST-PRE score should be used for research purposes. Regarding the DEMOST-PRE technical adequacy, its content, face, and factorial validity have been examined and are sufficiently supported.[11]

BOTMP-LF. The BOTMP-LF consists of 46 items grouped into 8 subsets (running speed and agility, balance, bilateral coordination, strength, upper-limb coordination, response speed, visual-motor control, and upper-limb speed and dexterity) and, according to its author, the test provides a comprehensive index of motor proficiency.[6] The item scoring system varies, ranging from a 2-point (pass/fail) to a 16-point scale. After the raw scores have been recorded, they are converted into a numerical point score. These scores yield the gross motor, fine motor, and total battery composites.

The BOTMP-LF is 1 of the most used assessment tools for children[12] and has been used as a test criterion in several studies.[13,14] Although a second version of this instrument (BOTMP-2)[15] has been published, the old version of the tool was chosen for use in the current study, as enough research supporting BOTMP-2 validity is not available. Consequently, using the BOTMP-2 as a test-criterion would be of limited value.

Procedure

Each child was individually assessed with the DEMOST-PRE in an indoor area. Two trained examiners collected data. Before the data collection, intrarater and interrater reliability had been investigated and found to be excellent with intrarater class coefficient (ICC) = 0.94 and 0.95 for the 2 examiners and interrater ICC = 0.90.[11]

For the examination of concurrent validity, children were individually assessed on the DEMOST-PRE and the BOTMP-LF in a counterbalanced administration order. The interval between the 2 measurements was 6 to 8 days.

Statistical Analyses

A Shapiro-Wilk's test with alpha more than 0.05 and a visual inspection of histograms (normal Q-Q plots and box plots) were used in order for the normality of data to be examined. According to the results, the item scores were not normally distributed for both males and females, with a skewness and kurtosis out of the range of ±1.96.

The internal consistency of the battery was examined through correlations between the total battery score and individual item scores.[16] For that purpose, Spearman correlation coefficients were computed. Correlations between 0.10 and 0.29 were considered "small," those between 0.30 and 0.49 were considered "moderate," and those that were higher than 0.50 were considered "strong." Confidence intervals are also presented as they can help judge the strength of correlations. Confidence intervals indicate the range in which the true score most probably lies. In that way, a moderate correlation may be strong validity evidence in case the score lies within a narrow confidence interval.[17]

For the effect of both age and sex on preschool-aged children's performance to be examined, first a 2-way analysis of variance was applied to the total DEMOST-PRE scores. The model of analysis was 4 (age groups: 48-53 vs 54-59 vs 60-65 vs 66-71 months) × 2 (boys vs girls). Post-hoc comparisons using the Sidak test followed with the alpha level set at 0.05. However, a statistically significant outcome describes only the probability of event will occur, but does not mean that the event is important. For that reason, the practical significance of the results was also examined. Practical significance provides quantified information about the possible importance of the study results, through the quantification of the degree to which those results diverge from the null hypothesis.[18] The metric of effect size, as measured by η^2 values, was used to examine the practical significance of the results. In line with Cohen's[19] criteria, η^2 values should be greater than 0.14 to be considered as having practical significance.

As the item scores were not normally distributed, nonparametric statistics were applied. The effect of age (4 categories) and sex on the 9 items of DEMOST-PRE was checked using the nonparametric Kruskal-Wallis test. Comparisons between categories were performed using the Mann-Whitney test, with the alpha level set at 0.05. Moreover, the r effect size coefficient was also calculated. According to Cohen's[20] suggestions, only values greater than 0.50 can be considered as practically significant.

As norms for the DEMOST-PRE have not been established yet, the z-scores for the DEMOST-PRE and the BOTMP-LF were first calculated and then the ICC, type 3.1, was computed to examine concurrent validity. This type of ICC is used when the information provided by a new instrument is to be compared with a test criterion.[21]

RESULTS

The correlational analysis results, presented in Table 1, revealed strong, significant correlations between the total battery score and each of the 9 item scores, ranging from 0.390 to 0.831 ($P < .001$). In addition, confidence intervals of those correlations are narrow, providing evidence of DEMOST-PRE validity.

The analysis of variance results revealed that the DEMOST-PRE total scores could significantly differentiate among the 4 age groups, $F(3,427) = 50.99$, $P < .001$, $\eta^2 = 0.26$. Post-hoc comparisons showed that the 4 groups differed significantly, with older children displaying better scores than their younger counterparts. Conversely, both sex main effect and sex by age interaction were not found to have a significant effect on children's performance with $F(1,427) = 6.84$, $P > .010$, $\eta^2 = 0.016$, and $F(3,427) = 2.97$, $P > .05$, $\eta^2 = 0.026$, respectively.

TABLE 1
Item-Total Correlation Coefficient

DEMOST's Items	r^a (95% CI)
Tapping	0.479 (0.406-0.545)
Jumping repeatedly sideways	0.741 (0.689-0.786)
Running and carrying and placing a ball in a box	0.666 (0.602-0.719)
Toe-to-heel walking in a backward direction	0.831 (0.795-0.858)
Overhead toss to a specific target	0.498 (0.416-0.567)
Picking up coins and placing them in a box	0.495 (0.414-0.572)
Stepping through 3 vertical hoops	0.390 (0.304-0.470)
Catching a bean bag	0.598 (0.534-0.658)
Standing jump over a stick	0.618 (0.559-0.672)

Abbreviation: CI, confidence interval.
[a]$P < .001$.

The results of the Kruskal-Wallis test indicated a statistically significant effect of age on 8 tests (Kruskal-Wallis x^2 ranged from 15.38 to 63.14, with $P < .001$). A nonsignificant effect of age was found for the item "stepping through 3 vertical hoops" (Kruskal-Wallis $x^2 = 6.11$; $P = .107$). The comparisons made between 4 age categories denoted significant differences between older and younger children in most of the items, with the older ones achieving higher scores (Table 2). However, only in 2 comparisons (children aged 48 to 53 months versus 66 to 71 months on the items toe-to-heel walking in a backward direction and catching a bean bag) the r coefficient of effect size exceeded the 0.50 indicating differences of practical significance.

The Mann-Whitney test indicated statistically significant differences between boys and girls in 5 tests. Those items were tapping, overhead toss to a specific target, stepping through 3 vertical hoops, catching a bean bag, and standing jump over a stick with boys scoring better performance results (Table 2). However, the r coefficient did not exceed the limit of 0.50 in any comparison, so the differences between boys' and girls' performances cannot be considered of practical significance.

The concurrent validity of the DEMOST-PRE with the BOTMP-LF, the ICC (single measure) was found to be 0.80 (95% confidence interval = 0.67 and 0.88).

DISCUSSION

The aim of the present study was to gather evidence about the psychometric features of a new motor screening tool named DEMOST-PRE, by investigating the criteria of (a) internal consistency, (b) effect of age and sex on both

TABLE 2

Post-Hoc Comparisons Between Age Groups' and Sexes' Performances on Both Individual Items and Total DEMOST-PRE Scores

	48-53 vs 54-59	48-53 vs 60-65	48-53 vs 66-71	54-59 vs 60-65	54-59 vs 66-71	60-65 vs 66-71	Boys vs Girls
Tapping			$U = 4271^{a}$, $r = 0.22$	$U = 4277^{a}$, $r = 0.22$		$U = 6459.50^{b}$, $r = 0.16$	$U = 19235.5^{b}$, $r = 0.04$
Jumping repeatedly sideways	$U = 3357.5^{b}$, $r = 0.18$	$U = 3221^{c}$, $r = 0.38$	$U = 25310.5^{c}$, $r = 0.48$	$U = 3597^{c}$, $r = 0.33$	$U = 4463^{a}$, $r = 0.19$	$U = 6409.5^{b}$, $r = 0.16$,	
Running and carrying and placing a ball in a box		$U = 3615^{c}$, $r = 0.32$,	$U = 2811.5^{c}$, $r = 0.44$	$U = 3629^{c}$, $r = 0.33$	$U = 4480.5^{a}$, $r = 0.19$	$U = 6528^{b}$, $r = 0.15$	
Toe-to-heel walking in a backward direction	$U = 3405^{b}$, $r = 0.17$	$U = 2861^{c}$, $r = 0.43$	$U = 2192.5^{c}$, $r = 0.53$	$U = 3136^{c}$, $r = 0.39$	$U = 3917^{c}$, $r = 0.27$	$U = 6285.5^{a}$, $r = 0.17$	
Overhead toss to a specific target	$U = 3289^{a}$, $r = 0.20$	$U = 3598.5^{c}$, $r = 0.33$	$U = 2610^{c}$, $r = 0.47$	$U = 3777^{c}$, $r = 0.30$	$U = 4831.5^{b}$, $r = 0.14$	$U = 6295.5^{a}$, $r = 0.17$	$U = 14671.5^{c}$, $r = 0.32$
Picking up coins and placing them in a box			$U = 3417^{c}$, $r = 0.38$	$U = 4080^{c}$, $r = 0.27$		$U = 6274.5^{a}$, $r = 0.19$	
Stepping through 3 vertical hoops				$U = 4723^{b}$, $r = 0.16$			$U = 21162^{b}$, $r = 0.09$
Catching a bean bag		$U = 3584^{c}$, $r = 0.35$	$U = 2267.5^{c}$, $r = 0.54$	$U = 3412^{c}$, $r = 0.36$	$U = 4723^{b}$, $r = 0.16$	$U = 6193^{a}$, $r = 0.19$	$U = 18296^{c}$, $r = 0.19$
Standing jump over a stick	$U = 3275^{a}$, $r = 0.20$	$U = 3748^{c}$, $r = 0.31$	$U = 3193^{c}$, $r = 0.40$	$U = 4592^{a}$, $r = 0.20$			$U = 19590.5^{a}$, $r = 0.15$
Total DEMOST-PRE score	MD = -5.17^{b}	MD = -11.736^{c}	MD = -17.779^{c}	MD = -6.570^{c}	MD = -12.614^{c}	MD = -6.044^{c}	—

Abbreviations: MD, mean difference; *U*, Mann-Whitney *U* test.

$^{a}P < .01$; $^{b}P < .05$; $^{c}P < .001$.

total and item scores, and (c) concurrent validity of the test with the BOTMP-LF.[6]

Item-total scores correlations were deemed sufficient (they ranged between 0.390 and 0.831), supporting the internal consistency of the battery. It is worthwhile to mention that item-total score correlations are higher than those found for the BOTMP[6,22] and BOTMP-2.[23] Taking these findings into consideration, we conclude that the internal consistency of the DEMOST-PRE, supported by the Spearman correlation coefficient's values, seems to be particularly satisfactory and shows that the items of the battery assess the same underlying construct.

Age was found to be a significant factor affecting the DEMOST-PRE total score, unlike sex, and is consistent with previous studies that revealed both the significance of age for children's motor performance and the absence of significant differences between boys and girls of preschool age, when motor proficiency is assessed by a battery that measures multifaceted motor behavior.[24] This finding confirms the fact that the DEMOST-PRE score differentiates among preschool age groups, and indicates the need for providing separate norms for each 6-month age group.

The analyses of individual item scores did not reveal a clear differentiation either among age groups or between sexes, in accord with previous studies using the BOTMP-Short Form.[22] This finding confirms the suggestion of the DEMOST-PRE authors' to use the total score for research purposes.[11]

The absence of practically significant differences between boys and girls in the present study, both in the total and the individual item scores, is in contrast to the report of superiority of boys or girls in motor performance even at preschool age.[22] However, in this particular period, boys' and girls' biological characteristics are similar rather than different. Except for throwing, very little justification for differences can be attributed to biology.[25] With this in mind, the motor performance differences reported in relevant studies should be examined as a result of factors outside children's sex and discussed as gender differences.

To start with, in a review of motor performance differences in pre-school-aged boys and girls,[26] it was revealed that most of the studies reporting significant differences between boys and girls do not report the effect size of sex as an independent variable. However, as the *P* value alone cannot describe the strength of the relationship between the independent and dependent variables, concerns arise about how "real" the reported motor performance differences are. Moreover, the sociocultural context in which a study is conducted should be taken into account. In populations where cultural and sociological expectations differentiate between genders, larger sex differences in motor performance are often found[27] but those findings cannot be generalized to all preschool populations.

The fact that no significant differences were found between boys' and girls' DEMOST-PRE performances provides valuable information about this instrument. First of all, the DEMOST-PRE seems to be free of gender bias, a very important issue that has to be considered when

selecting an assessment instrument, as the finding of poorer performance by 1 sex may be a result of the items comprising the instrument.[28] Second, the need for separate norms for boys and girls is not apparent. Agreeing with Thomas,[25] we strongly believe that providing different norms for boys and girls of preschool age, during which their differences are of no practical significance, will result in the encouragement of different expectations from boys and girls and in that way to the reinforcement of motor performance differences.

The last criterion used in the current study to determine the validity of the DEMOST-PRE was concurrent validity with the BOTMP-LF. The results revealed a high ICC (0.80). According to Cicchetti,[29] useful rules about the minimum or maximum level of the ICC for concurrent validity are not possible. The only thing that is certain is that a value of 1.00 or .000 is not desirable, because in the first case the new test will be a clone of the old test, and in the second case the validity of the new test will be disputed. Taking the above into consideration, we believe the DEMOST-PRE displays a satisfactory concurrent validity.

However, limitations in this study have to be taken into account. To begin with, all the aforementioned checks were undertaken only in Greece and consequently the Greek reference values cannot be suggested for use in other countries. Future work is needed to examine the suitability of the DEMOST-PRE in other countries. Moreover, among children in the current study, none were diagnosed with motor difficulties, and consequently the ability of the DEMOST-PRE to differentiate those children's scores from the scores of their peers with typical motor development remains to be examined. Finally, the small sample ($n = 50$) used for the concurrent validity study is acknowledged as another limitation. Additional work with a larger sample is required.

A last but not least issue that should be discussed when a screening tool for preschoolers is checked is both its ecological validity and the simplicity of its administration. This is due to the fact that preschoolers display unique behavior during the measurements (they show an inconsistent performance, have short spans of concentration, and show caution with strangers).[30] In a previous article,[11] the features of the DEMOST-PRE that make the measurement of a child a positive experience for both the child and the examiner (easy recording and scoring system; short administration time; the use of fairytales for item presentation; test equipment familiar to children; measurement conducted in preschool settings) are discussed in detail. Those features maximize the comfort level and ensure the accuracy of information about the motor proficiency of children examined.

CONCLUSIONS

The results of the current study provide sufficient evidence for both the construct and concurrent validity of the DEMOST-PRE. Taking into consideration both the current findings and previous ones[29] as well as the fact that the DEMOST-PRE is quick, child-friendly, and easy-to-administer, we conclude that the DEMOST-PRE can serve as a valuable tool for children aged 4 to 6 years. However, further research is needed in order for the technical adequacy of the test to be determined and age norms to be formed.

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CLINICAL BOTTOM LINE

Commentary on "Construct and Concurrent Validity of the Democritos Movement Screening Tool for Preschoolers"

"**How could I apply this information?**"

Educators and clinicians have an important role in screening preschool-aged children for gross motor delay to identify problems or deficits that may lead to a decrease in physical activity or participation. Screening tools and assessments must be valid and reliable to ensure children with limitations are correctly identified. The Democritos Movement Screening Tool for Preschoolers (DEMOST-PRE) is a new motor screening instrument designed to be a quick and easy-to-administer tool to assess motor proficiency. In a previous study,[1] intra- and interrater reliability as well as face and content validity was established. In the current study, further evidence of reliability and validity was documented to increase its potential clinical utility.

"**What should I be mindful about when applying this information?**"

Although psychometric properties of the DEMOST-PRE are now well established, clinicians should consider several factors related to its use. In the United States, the Individuals with Disabilities Education Act (IDEA)[2] specifically differentiates between the terms "screening" and "assessment" when describing tools used in the school setting. In the current study, the DEMOST-PRE was described as a screening tool; however, the authors discussed an intent to gather normative data for discriminative purposes. As a result, this tool may be more correctly described as an assessment rather than a screen. The authors used the BOTMP (first edition),[3] an assessment tool that assesses both gross and fine motor proficiency, to establish concurrent validity of the DEMOST-PRE, therefore, highlighting that the DEMOST-PRE is likely best suited to assess gross and fine motor proficiency as opposed to functional skills such as stair negotiation and classroom mobility. Clinicians should be mindful of this information to select the appropriate type of test for evaluation needs.

The DEMOST-PRE is designed for screening preschool children and is validated for children aged 4 to 6 years; therefore, it may not be universally applicable in the United States where many children start preschool at the age of 3 years. Lastly, as the authors of the current study discussed, no reference age data are available for the DEMOST-PRE so this test is not yet ready for clinical use. When established in Greece, however, the reference values will not be generalizable to populations in other countries unless further research is conducted to validate the test in other populations.

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Krystal Hay, PT, DPT
Helen Carey, PT, DHSc, PCS
The Nisonger Center, UCEDD at The Ohio State University
Columbus, Ohio

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