Annals of Medicine and Surgery 77 (2022) 103672

Contents lists available at ScienceDirect

Annals of Medicine and Surgery

journal homepage: www.elsevier.com/locate/amsu

Cohort Study

Validity and reliability of the movement assessment battery second edition test in children with and without motor impairment: A prospective cohort study

Mahboubeh Ghayour Najafabadi [a,*], Behnaz Saghaei [a], Ardalan Shariat [b], Lee Ingle [c], Seyedeh Saeideh Babazadeh-Zavieh [d], Masoumeh Shojaei [e], Afkham Daneshfar [e]

[a] Department of Motor Behavior, Faculty of Physical Education and Sport Sciences, University of Tehran, Tehran, Iran
[b] Research Center for War-affected People, Tehran University of Medical Sciences, Tehran, Iran
[c] Department of Sport, Health Exercise Science, University of Hull, Kingston-upon-Hull, UK
[d] School of Rehabilitation Sciences, Department of Physiotherapy, Tehran University of Medical Sciences (TUMS), Tehran, Iran
[e] Department of Motor Behavior, Faculty of Sport Sciences, Alzahra University, Tehran, Iran

ARTICLE INFO

Keywords:
Cognition disorders
Concurrent validity
Reliability
Sensitivity
Specificity

ABSTRACT

Background: Examining the reliability and validity of the second edition movement assessment battery test (MABC-2) in children with and without motor impairment.

Materials and methods: In this prospective cohort study, the MABC-2 test and developmental coordination disorder questionnaire 2007 (DCDQ′07) were completed by children and their parents. By using 95% confidence intervals, minimal detectable change (MDC95) was calculated, and concurrent validity was investigated. By applying the MABC-2 test as a reference standard (cut-off fifth centile), sensitivity and specificity were examined.

Results: 273 children (mean age: 6.3 ± 2.3 years; 70% male) with and without motor impairment completed the investigation. For test-retest reliability, intra-class correlation coefficients (ICCs) was >0.89 for the MABC-2 test. The MDC95 value for the motor skill test was 5.76. There was a significant correlation between the MABC-2 test and DCDQ′07 ($r = 0.60$, $P < 0.001$) and the Go/No-Go test ($r = 0.50$, $P < 0.001$). Overall, the sensitivity was very high (90%), the specificity was low (46%), and positive and negative predictive values were high (69% and 81%, respectively).

Conclusion: The MABC-2 test can be considered a valid and reliable motor skill assessment tool for children with and without motor impairment.

1. Introduction

A developmental coordination disorder (DCD) is a distinct motor disorder determined by marked impairment in age-associated motor coordination and learning [1]. Children with DCD have poor physical and cognition function [2], daily living tasks [3], affecting out-of-school activities [4], and social interactions [5]. Motor control difficulties, attention deficit, speech/articulation difficulties, and non-verbal learning disabilities are all commonplace in children with DCD [6]. They are at higher risk of developing secondary deficits including reduced strength, lack of fitness, and low self-esteem have been reported previously [6–8]. Without any treatment or intervention, these disabilities may continue and worsen in adulthood [6].

To identify effective treatment options, the development of valid and reliable tools is required. Movement deficiency in children with and without DCD has been previously detected through the movement assessment battery for children (MABC). This battery has been validated in several countries [9–13]. The MABC-2 test is an updated version of MABC [14] which includes a lower age inclusion and the scoring system has been updated [6]. Several studies have demonstrated the reliability

Abbreviations: DCD, Developmental coordination disorder; ICCs, Intra-class correlation coefficients; MDC, Minimal detectable change; MABC, Movement assessment battery for children; SEM, Standard error mean; TTS, Total test score.

* Corresponding author. Department of Motor Behavior, Faculty of Sport Sciences, Alzahra University, Tehran, Iran. North Kargar Avenue, Amirabad Street. Tel.: 982161118938; Fax: +982161118820.

E-mail addresses: m.ghayournaj@ut.ac.ir (M. Ghayour Najafabadi), Behnazsaghaie2@gmail.com (B. Saghaei), ardalansh2002@gmail.com (A. Shariat), L.Ingle@hull.ac.uk (L. Ingle), babazadehpt89@gmail.com (S.S. Babazadeh-Zavieh), m.shojaei@alzahra.ac.ir (M. Shojaei), a.daneshfar@alzahra.ac.ir (A. Daneshfar).

https://doi.org/10.1016/j.amsu.2022.103672
Received 21 February 2022; Received in revised form 21 April 2022; Accepted 25 April 2022
Available online 28 April 2022

and validity of MABC-2 in children with DCD [6,9,15]. Nevertheless, to recognize serious clinical changes in motor performance of children with and without DCD, minimal detectable changes (MDC) have yet to be identified for the MABC-2. Therefore, the study aimed to examine the internal consistency, test-retest reliability, concurrent validity, and identify MDC thresholds for the MABC-2 in young children with and without DCD.

2. Materials & methods

2.1. Participants and procedures

This prospective cohort study recruited children from clinics and schools in the Beheshti region of Tehran and the Autism Institute in Qom between February 2018 and February 2019. The study has been reported in line with the STROCSS criteria [16] and is registered (https://www.researchregistry.com/register-now#home/?view_2_search=researchregistry7669&view_2_page=1) under registration UIN: researchregistry7669. Institutional review board approval was received for this study in all centers. Full written informed parental consent was provided [17,18] and the study followed the Declaration of Helsinki's ethical standards. The study included 4- to 9-year-old children who met movement disorder criteria, diagnosed by a psychologist or physician. Children received a minimum of twice per month of physical or occupational therapy. Patients with a history of neurological disorders and those who were unable to participate in the physical therapy plan were excluded from the study. Children were assessed with the MABC-2 and Go/No-Go tests in two phases: baseline and after six months. A Developmental Coordination Disorder Questionnaire 2007 (DCDQ′07) was initially completed by the children's parents.

2.2. Movement assessment battery for children test (MABC-2)

This test includes two parts: a performance test and a checklist. We applied the performance test only [6]. In the test, three different fields have been defined, including manual dexterity, aiming and catching, and balance. Children were required to do three tasks: posting coins, threading a lace, and drawing a tail for the manual dexterity assessment. They were also asked to carry out two tasks, containing catching a beanbag with two hands and throwing a beanbag onto a mat to evaluate aiming and catching. Furthermore, they performed three tasks in the balance domain: one-leg balance, walking heel-to-toe, and jumping on mats [19]. Based on the MABC-2 test guide, we converted item scores into standard scores (mean = 6; standard deviation = 3). The sum of the eight-item standard scores (range 0–101) was the total test score (TTS). The TTS is a valid and reliable score [14,15,20,21].

2.3. Developmental coordination disorder questionnaire 2007 (DCDQ′07)

Parents of the children completed the 15-item questionnaire that evaluated motor coordination [14,22]. They compared the level of the child's coordination with other age-matched children on a 5-point scale [23]. The total DCDQ′07 score was calculated by summing each item's scores [23]. Higher scores indicated better motor performance [23]. The DCDQ′07 is a reliable questionnaire (Cronbach's alpha = 0.89) [22,23].

2.4. Go/No-Go test

During the Go/No-Go test, children were required to press a button on a keyboard ("Go" stimuli) when they viewed the blue color on a computer monitor. When they did not see any blue color ("No-Go" stimuli), participants would not answer. Focusing on speed and accuracy were equally important. In both test conditions, stimuli were randomly dispersed and were presented for 250 ms at a rate of one every 2000 ms [23,24]. This measure assesses cognitive ability in children based on their performance across six core domains evaluating cognition inhibitory [23,25].

2.5. Reliability

Cronbach's alpha was calculated to determine the internal consistency between two modules of the MABC-2 test.

2.6. Minimal detectable change (MDC)

To evaluate the variability, regarding the standard error mean (SEM), which is the least change detected above the measurement error with a given level of confidence at two points in time (95% confidence). Minimal detectable change (MDC) has been considered previously [26,27].

2.7. Concurrent validity

Concurrent validity was defined as the correlation between total scores MABC-2 and DCDQ′07 and MABC-2, and the Go/No-Go test. This criterion was examined by calculating the agreement percentage between the MABC-2 and the DCDQ′07, MABC-2, and Go/No-Go test in two children with and without motor impairment [27].

2.8. Data analysis

A consistency analysis was performed using Cronbach's alpha coefficient to determine the internal consistency of the scale. Analysis was completed using version 21.0 of SPSS (IBM, NY, USA) with a significance level of $P < 0.05$ [26]. MDC95 was a change rate considered before it exceeded the measurement error and variability at the 95% confidence level. Employing the formula ($SD \times \sqrt{1 - r}$), where r is the test-retest reliability coefficient (ICC in MABC-2 test), SD is the standard deviation of the measures, and the standard error of the measurement (SEM), MDC95 was estimated. Finally, MDC95 could be calculated using MDC = standard error of measurement $\times 1.96 \times \sqrt{2}$ [28]. Criterion validity was investigated using accuracy and concurrent validity. Pearson's correlation coefficient and dependent t-tests were used to examine concurrent validity [29]. Strong, moderate, and low correlation coefficients were designated as >0.6, between 0.3 and 0.6, and <0.3 [29]. Cross-tabulations were included to assess the specificity, sensitivity, positive predictive value, and negative accuracy value of the MABC-2 [29].

3. Results

We recruited 300 children (mean age: 6.3 ± 2.3 years; 70% male; 150 healthy and 150 with movement disorder). Basic measurements were completed by all 300 children (T1). Through 6 months of supervision, 27 were lost to follow-up (T2) (Fig. 1). During the first visits, descriptive statistics for the MABC-2 test were completed. Table 1 provides an overview of the mean and standard deviation of scores MABC-2 Test.

3.1. Internal consistency

The internal consistency of the MABC-2 test was high (Cronbach's α = 0.83). The results included manual dexterity (0.59), aiming for and catching (0.79), and the balance domain (0.91). The outcomes represent a sufficient similarity of all the individual domains and the total test score. For test-retest values (Table 2), the ICC for the total score was 0.83, representing a high level of reliability. The tasks and the domains had different ICCs between 0.59 and 0.91. Based on the SEM values, a convenient level of measurement accuracy of the MABC-2 test is evident in Table 2.

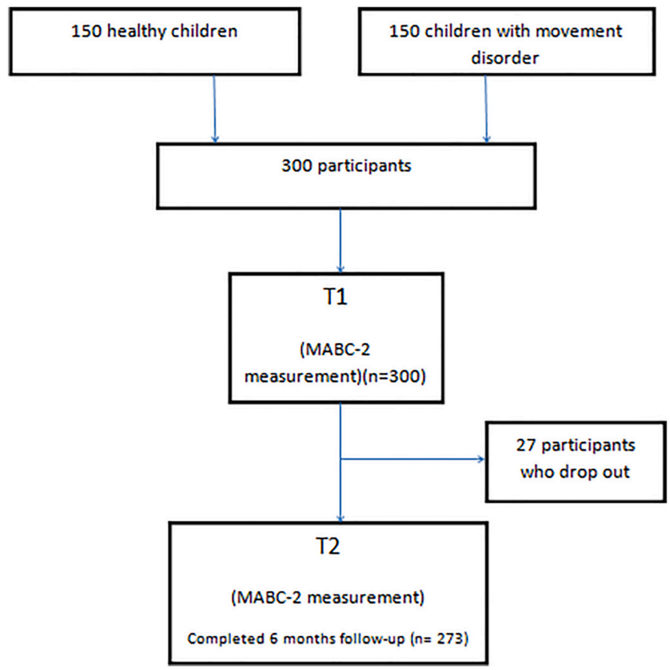

Fig. 1. Study flow chart of participants and measurements.

Table 1
Demographic characteristics of and description the Movement Assessment Battery for Children–Second Edition Test (MABC-2) standard scores at the initial visit (n = 273).

Characteristics	Mean (SD)
Age, y, mean (SD)	6.3 ± (2.3)
Healthy, n	153
Disorder, n	120
Sex, %	
Male	69.6
Female	30.4
MABC-2 parameters	
Items	
Manual Dexterity 1	4.91 ± 3.57
Manual Dexterity 2	5.45 ± 4.2
Manual Dexterity 3	5.25 ± 4.05
Aiming and Catching	
Aiming and Catching 1	6.68 ± 3.17
Aiming and Catching 2	7.00 ± 3.66
Balance 1	6.30 ± 3.87
Balance 2	5.44 ± 4.57
Balance 3	5.23 ± 4.5
Subscales	
Manual Dexterity	15.61±(10.16)
Aiming and Catching	13.58±(5.90)
Balance	17.31±(11.40)
Total	46.64±(24.21)

SD, standard deviation; MABC-2, Movement Assessment Battery for Children.

3.2. Concurrent validity

A significant and moderate correlation was evident between the MABC-2 and the DCDQ′07 (r = 0.60; $P < 0.001$; n = 273), the total scores of the MABC-2 and the Go/No-Go (cognitive inhibitory scale) (r_s = 0.50; $P < 0.001$; n = 273). Using different cut-off scores for the DCDQ′07 test and MABC-2 test scores in children with and without impairment, the sensitivity, specificity, PPV, and NPV criteria are shown in Table 3. If the 15th centile was used as a cut-off point in all categories, the sensitivity and NPV of the MABC-2 for predicting motor impairment in six months **were** high.

Table 2
Test-retest reliability and minimal detectable change (MDC) of the Movement Assessment Battery for Children–Second Edition (MABC-2) Test (n = 273).

MABC-2	ICC	SEM	MDC
Items			
Manual Dexterity 1	0.80(0.74–0.84)	0.612	1.19
Manual Dexterity 2	0.68(0.59–0.75)	1.51	4.18
Manual Dexterity 3	0.80(0.74–0.84)	0.67	1.58
Aiming and Catching 1	0.78(0.71–0.83)	0.58	1.60
Aiming and Catching 2	0.70(0.61–0.76)	1.08	2.99
Balance 1	0.89(0.86–0.92)	0.25	0.69
Balance 2	0.83(0.78–0.86)	0.39	1.08
Balance 3	0.74(0.67–0.80)	0.88	2.43
Subscales			
Manual Dexterity	0.59(0.48–0.68)	1.85	3.56
Aiming and Catching	0.79(0.73–0.84)	1.03	2.85
Balance	0.91(0.88–0.93)	0.60	1.66
Total	0.83(0.78–0.86)	1.08	1.41

ICC, intraclass correlation coefficient; SEM, standard error of measurement; MDC, Minimal detectable change.

Table 3
Movement Assessment Battery for Children - Second Edition (MABC-2). Study participant results and diagnostic values for classifications at two stages.

Instrument	DCDQ positive	DCDQ negative
MABC-2 positive, n	137	61
MABC-2 negative, n	12	54

Instrument	Sensitivity (%)	Specificity (%)	PPV(%)	NPV(%)
MABC-2	90	46	69	81

DCDQ, Developmental coordination disorder questinare; NPV, negative predictive values; PPV, positive predictive values.

4. Discussion

This study determined the validity and reliability of the MABC-2 test in 273, 4- to 9-year-old children. A range of good to excellent internal consistency (Cronbach's α range 0.59–0.91) was observed. Except for manual dexterity, which was classified as moderate (0.59), test-retest reliability values in other domains were high. In line with our findings, previous studies have reported excellent Cronbach's alpha coefficients for the MABC-2 [9,15], although another study reported moderate agreement [30]. To determine the effectiveness of a motor intervention program in children with and without motor impairment, previous studies have recommended the MABC-2 test [27]. The MDC tool is helpful for clinicians and can differentiate between real changes and measurement errors [27,31].

A positive correlation was found between the MABC-2 and the DCDQ′07 (r = 0.60), and between the MABC-2 and the Go/No-Go (r = 0.50), however, Renata et al. [29] found a poor correlation between the MABC-2 and DCDQ′07 in a group of 103 children. Our findings are consistent with findings reported by Pannekoek, Rigoli, Piek, Barret, and Schoemaker [19] showing that the MABC-2 can be used to screen and identify children with and without motor disorders at home, school, or during a play environment. Our study showed that PPP, NPP, and sensitivity were high, and specificity was moderate (sensitivity = 90% and specificity = 46%, PPV = 61, NPV = 81). The MABC-2 is a useful instrument for determining impairment in motor skills. In a similar study, Cleric et al. [26] reported similar results to our findings; excellent sensitivity (90%), moderate specificity (69%), small to moderate PPV (38%), and high NPV (97%).

4.1. Limitations

Our study is limited by a moderate sample size, and we cannot generalize our findings to all young people. A larger trial is required to confirm our findings in a similar population. In future studies, children with all four DCD criteria should be included. It would be helpful for future studies to administer an intervention with more regular re-testing points to determine changes over time. Factors that may influence an increase in performance variability include behavioral and motivational factors and motor performance changes. We found it challenging to recruit participants from remote communities who met the study inclusion criteria.

5. Conclusions

For motor skill assessment in children with and without motor impairments, the MABC-2 is a valid and reliable test. Minimal detectable change values identified should help rehabilitation therapists design effective intervention programs for this population. The MABC-2 is a sensitive tool that may be an acceptable instrument for detecting motor skill performance impairments in children.

Ethical approval

-Institutional review board approval was received for this study in all centers.

-Full written informed parental consent was provided and the study followed the Declaration of Helsinki's ethical standards.

Sources of funding

The authors would like to acknowledge the financial support of University of Tehran for this research under grant number 30701.1.2.

Author contributions

Study concept or design: MGH, ASH.
Data collection: BS, MSH, SSBZ, AD.
Data analysis or interpretation: MGH, ASH.
Writing the paper: MGH, ASH.
Final approval: MGH, ASH, BS, MSH, LA, SSBZ, AD.

Registration of research studies

Name of the registry: **researchregistry.com**.
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Hyperlink to your specific registration (must be publicly accessible and will be checked): https://www.researchregistry.com/register-now#home/?view_2_search=researchregistry7669&view_2_page=1.

Guarantor

Mahboubeh Ghayour Najafabad.

Data availability

The data that support the findings of this study are available from the corresponding author, MGN, upon reasonable request.

Provenance and peer review

Not commissioned, externally peer reviewed.

Declaration of competing interest

The authors declare no conflicts of interest.

6. Acknowledgments

NA.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amsu.2022.103672.

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