

Reliability and validity of the Thai version of the 2007 revised Developmental Coordination Disorder Questionnaire

Natewimon Nantiwat, Sureelak Sutthitongsa, Amornrat Penphattrarakul, Prakasit Wannapaschaiyong, Nattha Ketudat, Pat Rojmahamongkol*

Division of Developmental and Behavioral Pediatrics, Department of Pediatrics, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand.

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ABSTRACT

Background: Developmental coordination disorder (DCD) manifests with clumsiness and affects children's daily activities, academic achievement, peer acceptance, and self-esteem. Early identification and intervention are crucial for improving quality of life. There is no screening test for DCD in Thailand. The 2007 revised version of the Developmental Coordination Disorder Questionnaire (DCDQ'07) is a caregiver-report screening test for 5 to 15-year-old children globally used with good sensitivity and specificity.

Objectives: To translate and validate the Thai version of the DCDQ'07 (DCDQ-T), assessing its content validity, internal consistency, test-retest reliability, and inter-rater reliability.

Materials and methods: After receiving permission from the original questionnaire developer, forward and backward translation processes were performed. The content validity index (CVI), consisting of item-level CVI (I-CVI) and scale-level CVI, universal agreement method (S-CVI/UA), was evaluated by five experts. Reliability was examined by internal consistency in 88 caregivers of 6 to 12-year-old students without the diagnosis of visual impairment, intellectual disability, and neurologic problems that influence movement, in a primary school in Bangkok, Thailand. Test-retest reliability was investigated three months apart in 85 caregivers. Inter-rater reliability was investigated in 20 pairs of both parents-teachers and parents-parents.

Results: Both the I-CVI and S-CVI/UA of DCDQ-T were 1.0. The internal consistency showed a Cronbach's alpha of 0.888. The intraclass correlation coefficient of test-retest reliability was 0.573. Inter-rater reliability between parents and teachers, and parents and parents were 0.199, and 0.149, respectively.

Conclusion: DCDQ-T demonstrated an excellent CVI, good internal consistency, moderate test-retest reliability, and poor inter-rater reliability. Therefore, DCDQ-T could be a useful DCD screening tool for 6 to 12-year-old Thai children. However, a study on its repeatability and the degree of agreement among raters is further required.

Introduction

Developmental coordination disorder (DCD) is a neurodevelopmental disorder related to movement and coordination presented as clumsiness. The overall prevalence of DCD in school-aged children is 5-6%.^{1,2} However, there are different results in studies from different countries. In the UK, the prevalence of DCD in 7-year-olds was 3%.³ In Sweden, a study found a 4.9% and 8.6% prevalence of severe and moderate DCD in 7-year-old children, respectively.⁴ In Thailand, a study found that 10.83 % of 3- to 6-year-old children were suspected of

* Corresponding contributor.

Author's Address: Division of Developmental and Behavioral Pediatrics, Department of Pediatrics, Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand.

E-mail address: patojung@yahoo.com

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having DCD.⁵ In contrast, a study in India showed only 0.8% prevalence of DCD.⁶ DCD is often found to be a coexisting condition with other neurodevelopmental disorders.⁷ International studies demonstrated that DCD was found in 30-50% of children and adolescents with attention-deficit/hyperactivity disorder (ADHD),⁸ up to 70% of those with language problems,⁹ 17.8% of those with learning disabilities,¹⁰ and 79% of children with autism spectrum disorder.¹¹ A study from Thailand found a 35.3 % comorbidity of DCD in 6- to 17- year- old children and adolescents with ADHD.¹²

Poor coordination and clumsiness in DCD negatively affect the child's academic function, participation in activities of the same age group, and acceptance by friends.¹³ Its impacts can be far beyond the motor domains. Research found that children with DCD demonstrated

poorer self-regulation and working memory than typical children.^{14,15} These disadvantages can aggravate the child's academic underachievement and relationship problems with peers; and contribute to their psychological and behavioral complications including low self competence, social isolation, anxiety, depression, and aggressive behavior.¹³ Early diagnosis and prompt intervention for DCD are crucial to improve the child's quality of life since it has positive effect on motor function and skill performance, which lead to restore self-esteem and mental health status.¹¹

Currently, DCD is diagnosed by the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criteria (Figure 1) using information from developmental history, medical history, physical examination, school report together with standard test assessment.^{1,11}

To be diagnosed with developmental coordination disorder, the child must present all of the following criteria;

A.) The child's coordinated motor skill development and achievement is lower than expectation for his/her chronological age and chance for the skill implementation. This can be presented with clumsiness (e.g. dropping or hitting against things), and retard and imprecision in motor skill performance (e.g. catching a ball, writing, or riding a bicycle);

B.) The motor skill problems in criteria A obviously disturb the child's daily activities, academic productivity and leisure time activities;

C.) The motor skill difficulties began at early age; and

D.) The motor skill difficulties are not due to other conditions which are intellectual disability, visual impairment, and neurologic problems (e.g. degenerative disorder, cerebral palsy, or muscular dystrophy)

Figure 1. DSM-5 diagnostic criteria for developmental coordination disorder.

The standard tests widely used for the diagnosis of DCD are the Movement Assessment Battery for Children, 3rd Edition (MABC-3)¹⁶ which takes 30 minutes to complete, and the Bruininks Oseretsky Test of Motor Proficiency, 3rd Edition (BOT-3),¹⁷ which takes 50-90 minutes to administer. Both tests are limited to certified medical personnel such as psychologists, occupational or speech therapists.

The Developmental Coordination Disorder Questionnaire (DCDQ) is a free online questionnaire developed by Wilson BN, et al. in 2000 and was revised in 2007 (DCDQ'07) for DCD screening in 5 to 15 years old children.¹⁸ This 10- to 15-minute parent questionnaire is time-saving and accessible. So, it is widely used and was translated into many languages such as Turkish,¹⁹ French European,²⁰ French Canadian,²¹ German,²² and Korean.²³

As previously mentioned, DCD is prevalent in Thai children; however, the unique cultural context in Thailand—characterized by lower participation in structured physical activities and team sports²⁴—may mask the early signs of DCD, thereby delaying necessary interventions. This underscores the importance of a culturally adapted screening tool that can early and accurately identify DCD

in Thai children. In addition, the implementation of a valid screening instrument tailored to the Thai population would facilitate better allocation of healthcare resources, promote targeted early interventions, and ultimately contribute to improved long-term developmental outcomes.

The DCDQ'07 contains 15 items in a paper-based format that takes caregivers minimal time to complete. It is a convenient screening tool which is practical for clinical use in Thailand. Therefore, this study aimed to translate the DCDQ'07 into Thai language and to test the validity and reliability of the DCDQ-Thai version (DCDQ-T). We specifically focused on the elementary school children (6 to 12 years old) because the participants were recruited from an elementary school, which comprised students within this age range. Although the original DCDQ'07 is designed for 5- to 15-year-old children, our sample reflects the practical age range in the Thai school system where early identification of the DCD is most feasible. This study could also serve as a foundation for future research to further refine DCD screening and intervention strategies in Thai context.

Materials and methods

Study design and participants

This study was approved by the Ethics Committee of the Human Research Protection Unit at the Faculty of Medicine of Siriraj Hospital, Mahidol University, COI number Si158/2023. Informed consent was signed before collecting research data.

This questionnaire-based, cross-sectional research included caregivers of the students who studied at an elementary school (grades 1-6) in Bangkoknoi District in Bangkok, Thailand. As this elementary school included exclusively grades 1 to 6, the students' age range in this study was 6 to 12 years old. The recruitment period was from May to August 2023. Children who were diagnosed with intellectual disability, visual impairment that cannot be corrected with eyeglasses, neurologic problems such as cerebral palsy, muscular dystrophy, and degenerative disorders; and caregivers who cannot read Thai were excluded. The sample size of 87 was calculated based on the Cronbach's alpha coefficient of the original 2007 revised version of Developmental Coordination Disorder Questionnaire (DCDQ'07), which was 0.94,¹⁸ and the confidence level of 0.95 with an error of 0.05. To minimize bias, students were included by stratified randomization from every grade of the school.

Instrument

The DCDQ'07 is developed for caregivers of 5- to 15-year-old children. It consists of 15 Likert scale

questions (score of 1 = *not at all like your child* to score of 5 = *extremely like your child*) comparing children's motor abilities with their equivalent age peers. The questionnaire is divided into three parts which are motor control during movement such as ball catching (6 question items), fine motor/handwriting such as paper cutting (4 question items), and general condition such as clumsiness (5 question items). The range of the score is 15 to 75. Lower scores suggest the presence of developmental coordination disorder (DCD), while higher scores do not. The cutoff points are different between three age groups, which are 5 years to 7 years and 11 months, 8 years to 9 years and 11 months, and 10 years to 15 years. The cutoff score increases with increasing age as shown in Table 1. The DCDQ'07 shows excellent psychometric properties¹⁸ including strong internal consistency with the Cronbach's alpha of 0.94. Favorable concurrent validity demonstrated by its statistically significant correlation with standard motor ability test (Movement Assessment Battery for Children; MABC, and Test of Visual-Motor Integration) which are $r=-0.55$, and $r=0.42$, respectively. The overall sensitivity is 84.6% and the specificity is 70.8%.¹⁸

In this study, the original cut-off scores (Table 1) were used as a provisional reference to provide basic guidance to caregivers whose children scored within the at-risk range. These scores were not used for diagnostic purposes but rather as an initial indicator for recommending motor and coordination skills support.

Table 1. Interpretation of the cut-off scores of the 2007 revised version of Developmental Coordination Disorder Questionnaire.

Age range (years)	Indicative or suspicious of DCD	DCD is unlikely
5 years to 7 years 11 months	15-46	47-75
8 years 0 months to 9 years 11 months	15-55	56-75
10 years 0 months to 15 years	15-57	58-75

Note: DCD: developmental coordination disorder.

Procedures

Translation process and validity testing

The DCDQ'07 was translated into Thai language after obtaining permission from the original developer. The translation process was adapted from standard guidelines for cross-cultural adaptation.²⁵ Initially, forward translation was independently performed by two bilingual translators who are fluent in both Thai and English, one being a developmental and behavioral pediatrician who expertizes on developmental disorders and experienced in medical and psychological instruments; and the other being a professional translator experienced in working in both Thailand and other countries. Afterward, these translators collaboratively reviewed their translations in a consensus meeting to synthesize into a single preliminary Thai version. An independent bilingual translator, who is fluent in both Thai and English and certified for working as an international schoolteacher, and who had no prior knowledge of the original DCDQ'07, conducted backward

translation into English. Next, an expert committee including pediatricians and occupational therapists reviewed and made the consensus to all translated versions. Finally, the backward-translated version was approved by the original developer to ensure equivalence and adherence to the original questionnaire.

The content validity was measured by three developmental and behavioral pediatricians and two occupational therapists. The content validity index (CVI) was tested for the item-level content validity index (I-CVI) and the scale-level content validity index, universal agreement method (S-CVI/UA). The I-CVI was calculated from the number of the experts who rated the item as "quite relevant" and "highly relevant" for each question item divided by the number of all experts. The range of the value of I-CVI is 0 to 1. The S-CVI/UA was computed from dividing the sum of all question items that I-CVI value is 1 by the number of all items. The S-CVI/UA values also range from 0 to 1.

Reliability testing process

The internal consistency of the questionnaire was evaluated by Cronbach's alpha coefficient. Test-retest reliability was performed in the same parent of the entire sample at the beginning of the study and three months apart. Parents and homeroom teachers of twenty students were stratified randomized from three age groups (6 - <8, 8 - <10, and 10-12 years old) by quota which were 8, 6 and 6 students, respectively. They were evaluated for inter-rater reliability between parent-teacher and parent-parent pairs. The weight and height of the children were collected to calculate BMI and converted to the BMI z score, and then categorized as normal (BMI z score between 1SD and -2SD), overweight (BMI z score more than +1SD), and thin (BMI z score less than -2SD) according to WHO BMI-for-ages cut-offs.²⁶ Information was also collected about physician diagnoses of underlying medical conditions, learning disorder (LD), and attention-deficit/hyperactivity disorder (ADHD), as well as parent/teacher reports regarding the child's Thai and English literacy, and behavioral problems, including aggression and anxiety. At the end of the study, the caregivers of the children identified as potentially having DCD, based on the original questionnaire's cutoff point, received guidance in motor and coordination skills practice.

Data analysis

The data was analyzed using IBM SPSS Statistics 22 (SPSS Inc., Chicago, IL, USA). The participants' characteristics were described by descriptive statistics.

The numbers and percentage were used to describe the categorical variables. Mean and standard deviation were used to present normal distributed data. Cronbach's alpha coefficient was analyzed to indicate the internal consistency of the questionnaire, which 0.9 and above reflects excellent, 0.8 - <0.9 reflects good, 0.7 - <0.8 reflects acceptable, 0.6 - <0.7 reflects questionable, 0.5 - <0.6 reflects poor, and <0.5 reflects unacceptable internal consistency, consecutively.²⁷ The intraclass correlation coefficient was calculated to indicate the intra-rater (test-retest) and inter-rater reliability, which 0.9-1 describes as excellent, 0.75 - <0.9 describes as good, 0.5 - <0.75 describes as moderate, and less than 0.5 describes as poor reliability, consecutively.²⁸ Difference of the mean of the DCDQ-T scores between boys and girls were analyzed by independent T test.

Results

Ninety caregivers completed the Thai version of the Developmental Coordination Disorder Questionnaire (DCDQ-T). Two children with the diagnosis of intellectual disability were excluded. Information from 88 participants was analyzed for internal consistency. Demographic data from these 88 participants are exhibited in Table 2. Of the 88 participants, three were withdrawn because of the refusal to fill out the questionnaire 3 months later. As a result, a total of 85 were examined for 3-month test-retest reliability. Twenty pairs of parents and teachers were investigated for inter-rater reliability between two parents and between parent and teacher.

Table 2. Demographic data of children (N=88).

Characteristics	Number (%)
Child's sex	
- Boys	43 (49)
- Girls	45 (51)
Child's age	
- 6 years 0 months to 7 years 11 months	32 (36.4)
- 8 years 0 months to 9 years 11 months	28 (31.8)
- 10 years 0 months to 12 years 11 months	28 (31.8)
Term birth	
Preterm	3 (3.4)
Birth weight (N=71)	
<2,500 gm	8 (11.3)
2,500-4,000 gm	62 (87.3)
>4,000 gm	1 (1.4)
BMI (N=61)	
- Overweight	20 (32.8)
- Normal	37 (60.7)
- Thin	4 (6.5)
Underlying conditions	
- None	74 (84.1)
- ADHD	1 (1.1)
- LD	5 (5.7)
- Medical illnesses	8 (9.1)
Behavioral problems	
- None	83 (94.3)
- Aggression	4 (4.6)
- Anxiety	1 (1.1)
Learning problems	
- None	84 (95.5)
- Thai literacy	3 (3.4)
- English literacy	1 (1.1)
Caregivers	
- Parents	67 (76.1)
- Grandparents	19 (21.6)
- Others	2 (2.3)

Note: ADHD: attention-deficit/hyperactivity disorder, LD: learning disorder.

The content validity index (CVI) of DCDQ-T was reported in Table 3. At the first round, all experts rated 10 question items as “highly relevant”, and 5 as “quite relevant” and suggested some minor wording adjustments. As a result, the I-CVI at the first round was 1.0. After these 5 quite relevant items were changed according to experts’ suggestion, all of them were rated as “highly relevant”. Some items were adapted for Thai culture. For example, the example of the activity “building a cardboard or

cushion fort” in item No.6 was removed because these activities are uncommon for Thai children. For item No.14, the idiom “a bull in a China shop”, which is not used in Thailand, was replaced with “clumsy movement and trend to break things” which is more straightforward for Thai parents. The final validity indexes of the content were 1.0, which indicated acceptable validity, for both I-CVI and S-CVI/UA (Table 3).

Table 3 Content validity index, Cronbach's alpha and intraclass correlation coefficients of the Developmental Coordination Disorder Questionnaire, Thai version.

DCDQ-T items	I-CVI by 5 experts		Each item score (N=88) Mean±SD	Cronbach's alpha if item deleted (N=88)	Reliability		
	1 st round	2 nd round			Test-retest (ICC Two-way mixed-effects model) (N=85)	Parent-Parent (N=20)	Inter-rater (ICC Two-way random-effects model) Parent-teacher (N=20)
1	1.00	1.00	3.64 ± 0.90	0.880	0.594 (0.435-0.717)	0.290 (-0.103-0.626)	-0.126 (-0.500-0.309)
2	1.00	1.00	3.35 ± 0.89	0.879	0.355 (0.151-0.530)	-0.302 (-0.673-0.165)	-0.094 (-0.469-0.335)
3	1.00	1.00	3.14 ± 0.97	0.879	0.454 (0.264-0.610)	-0.363 (-0.728-0.112)	-0.179 (-0.584-0.284)
4	1.00	1.00	4.03 ± 0.90	0.882	0.395 (0.196-0.563)	-0.096 (-0.524-0.359)	0.078 (-0.395-0.503)
5	1.00	1.00	4.28 ± 0.93	0.883	0.412 (0.218-0.575)	0.115 (-0.289-0.506)	-0.103 (-0.535-0.355)
6	1.00	1.00	3.84 ± 1.03	0.878	0.379 (0.178-0.549)	0.074 (-0.344-0.481)	-0.004 (-0.450-0.435)
7	1.00	1.00	3.91 ± 0.98	0.876	0.371 (0.169-0.543)	0.092 (-0.346-0.502)	0.130 (-0.239-0.503)
8	1.00	1.00	3.98 ± 0.97	0.880	0.547 (0.377-0.681)	0.485 (0.057-0.760)	0.054 (-0.371-0.469)
9	1.00	1.00	3.72 ± 0.90	0.881	0.339 (0.133-0.517)	0.342 (-0.089-0.671)	-0.042 (-0.326-0.323)
10	1.00	1.00	3.72 ± 0.97	0.879	0.496 (0.314-0.642)	0.057 (-0.307-0.446)	0.230 (-0.230-0.604)
11	1.00	1.00	4.31 ± 0.75	0.885	0.241 (0.029-0.432)	-0.024 (-0.486-0.427)	0.309 (-0.137-0.653)
12	1.00	1.00	3.56 ± 1.00	0.883	0.348 (0.143-0.524)	0.347 (-0.120-0.682)	-0.297 (-0.684-0.179)
13	1.00	1.00	3.81 ± 0.96	0.879	0.416 (0.221-0.579)	0.081 (-0.357-0.493)	0.215 (-0.253-0.596)
14	1.00	1.00	3.52 ± 1.13	0.884	0.248 (0.033-0.440)	0.052 (-0.366-0.466)	0.019 (-0.445-0.458)
15	1.00	1.00	3.65 ± 1.40	0.889	0.239 (0.027-0.431)	-0.106 (-0.547-0.357)	0.116 (-0.235-0.486)
Overall	S-CVI/UA = 1.0 S-CVI/UA = 1.0		-	0.888	0.573 (0.409-0.702)	0.149 (-0.330-0.554)	0.199 (-0.001-0.389)

Note: I-CVI: item-level content validity index, S-CVI/UA: scale-level content validity index, universal agreement method. ICC values present with 95% confidence interval in the parentheses.

Cronbach's alpha coefficient; Cronbach's alpha if item deleted; the intraclass correlation coefficient for test-retest reliability; and for inter-rater reliability between two parents, and between parent and teacher were demonstrated in Table 3. The Cronbach's alpha if each item deleted, which was slightly varies from 0.888, indicates that no item was needed to be deleted. The mean and

standard deviation of the DCDQ-T subscale and total scores categorized by age group and gender are demonstrated in Table 4. Although girls gained significantly higher mean fine motor/handwriting subscale scores than boys, there were no significant difference of the mean total DCDQ-T scores between genders (Table 4).

Table 4. Mean subscale and total scores of the Developmental Coordination Disorder Questionnaire, Thai version of each age group, classified by gender.

Age group and DCDQ-T scores	All participants (N=88)	Boys (N=43)	Girls (N=45)	p value
6 years 0 months to 7 years 11 months (N=32)				
Control during movement	21.7±3.6	20.6±3.9	22.6±3.2	0.122
Fine motor/ handwriting	15.1±3.3	13.7±3.4	16.2±2.8	0.029*
General coordination	18.1±3.7	17.9±3.3	18.3±4.1	0.798
Total score	54.8±9.9	52.1±9.9	56.8±9.6	0.193
8 years 0 months to 9 years 11 months (N=28)				
Control during movement	22.3±4.0	22.1±3.4	22.6±4.8	0.704
Fine motor/ handwriting	14.9±2.5	13.9±2.2	16.3±2.7	0.012*
General coordination	18.8±3.3	17.8±3.3	20.1±2.9	0.054
Total score	55.9±8.7	53.6±7.6	59.0±9.5	0.105
10 years 0 months to 12 years 11 months (N=28)				
Control during movement	23.0±4.6	24.5±3.8	21.6±4.9	0.090
Fine motor/ handwriting	15.9±3.1	15.5±2.3	16.3±3.4	0.541
General coordination	19.7±3.6	19.2±3.9	20.1±3.4	0.517
Total score	58.3±9.3	59.1±7.5	57.6±10.8	0.667

Note: Data were presented as mean±SD, *p<0.05.

Discussion

This study is the first to translate and validate the 2007 revised version of Developmental Coordination Disorder Questionnaire (DCDQ'07) into Thai, providing the first standardized screening tool for developmental coordination disorder (DCD) in Thailand. The availability of a validated Thai version can facilitate early detection and intervention for children at risk, which was previously limited due to the lack of culturally adapted tools.

To the best of our knowledge, although there were plenty of information about construct and concurrent validity analyses from the original DCDQ'07,¹⁸ and previous translation studies of the DCDQ'07,²⁰⁻²² there was no data regarding content validity index (CVI) in prior cultural adaptations. The DCDQ-T demonstrated excellent content validity (I-CVI and S-CVI/UA=1.0), suggesting strong agreement among experts. The perfect I-CVI and S-CVI/UA values indicate that all five experts consistently judged each item as highly or quite relevant to the construct of developmental coordination disorder. This suggests that the DCDQ-T comprehensively reflects the targeted domains of motor control, fine motor skills/handwriting, and general coordination, as defined by the DSM-5 criteria for DCD and international guidelines. In particular, the expert panel—comprising developmental and behavioral

pediatricians and occupational therapists—ensured that the items were culturally and clinically relevant within the Thai context. For example, modifications made to item examples (e.g., replacing “a bull in a China shop” with a culturally understandable phrase) enhanced item clarity without altering the underlying construct. This process reinforces the content validity by ensuring both conceptual and cultural alignment between the original and translated versions. Therefore, the DCDQ-T appears to be an appropriate instrument for assessing motor coordination difficulties among Thai children.

The internal consistency was good (Cronbach's alpha=0.888), comparable not only to the original DCDQ'07 ($\alpha=0.94$),¹⁸ but also to previous adaptations such as the Turkish ($\alpha=0.890$),¹⁹ German ($\alpha=0.891$),²² and French Canadian ($\alpha=0.949$)²¹ versions. The test-retest reliability was moderate (ICC=0.573), indicating that caregivers provided relatively stable responses over time. The test-retest reliability ICC of the DCDQ-T is less than those of the French Canadian, French European, and Turkish version (0.8-1.00).¹⁹⁻²¹ However, the interval for test-retest reliability of the DCDQ-T was 3 months apart, while the one of other versions was 5-30 days. The inter-rater reliability of the DCDQ-T was poor between two parents (ICC=0.149) and between parents and teachers (ICC=0.199), which can

reflect the difference of Thai parents' and Thai teachers' perception and interpretation of their children's motor abilities, however, there were no previous studies investigated inter-rater ICC of the original DCDQ'07 and other adaptations. The low inter-rater reliability of the DCDQ-T may be explained by Thai cultural context that the children, especially in urban areas, tend to participate less in team sports and outdoor physical activities than their Western counterparts.²⁴ This may limit exposure to tasks assessed by the DCDQ-T, such as throwing or catching a ball. Moreover, the noticeability of these tasks may vary across settings (e.g., home vs. school) and raters (e.g., parents vs. teachers). This underscores the need for population-specific cutoff scores and further investigation into strategies to improve inter-rater agreement, such as rater training or structured observation guidelines.

Consistent with the original DCDQ'07,¹⁸ the DCDQ-T scores showed an increasing trend with age, reflecting the natural progression of motor development in children. This similar trend suggested that the tool effectively captures age-related improvements in motor coordination. There was no gender effect on total DCDQ-T score which is consistent with the original DCDQ'07,¹⁸ French European,²⁰ and French Canadian²¹ versions. The finding that the girls, whose age group were 6-<8, and 8-<10 years old, gained significantly more mean DCDQ-T scores than boys in fine motor/ handwriting subscales is compatible with one previous study which demonstrated that pre-adolescent girls demonstrated better manual performance than their same-age boy peers.²⁹ However, there were no information regarding gender difference in DCDQ subscale scores in the either original English version of DCDQ'07 or other translated languages.

Limitations

The strengths of this study include an adequate sample size for validity testing, which aligns with prior DCDQ'07 validation studies. The use of stratified randomization reduced selection bias, ensuring balanced age representation throughout all grades in the school. In addition, the low dropout rate minimized potential bias from missing data.

Several limitations were acknowledged. Since the constraints of our study context, this study was adapted from the Beaton's guideline for cross-cultural adaptation.²⁵ This led to two main deviations from the guideline. The backward translation used only one professional translator, and we did not pilot the Thai version with a small group of parents before the whole data collection. However, the approval of the back-translated version from the original developer of the DCDQ'07 questionnaire and excellent content validity could imply the quality of the translation. This study conducted in an elementary school whose students' age range is 6-12 years, which did not fully cover the 5-15 years targeted by the original DCDQ'07, and could lead to limiting generalizability. Additionally, the sample was drawn from an urban school, potentially excluding rural children with different activity patterns. Finally, socioeconomic status, which

may influence parental observations and responses, was not assessed. Future studies should expand the sample to include younger and older children and consider the influence of socioeconomic factors on DCDQ-T responses. Moreover, more psychometric properties including concurrent and construct validity, sensitivity, specificity; as well as culturally appropriate cut-off scores for the DCDQ-T should be established.

Conclusion

The Developmental Coordination Disorder Questionnaire, Thai version could be beneficial to screen for developmental coordination disorder in 6- to 12-year-old Thai children due to its good validity, good internal consistency, moderate test-retest reliability, and poor inter-rater reliability. Further studies are required to investigate its repeatability and inter-rater agreement.

Ethical approval

This study was approved by the Ethics Committee of the Human Research Protection Unit at the Faculty of Medicine of Siriraj Hospital, Mahidol University, COI number Si158/2023.

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Conflict of interest

The authors declare no conflict of interest

CRediT authorship contribution statement

Natewimon Nantiwat: methodology, investigation, formal analysis, data curation, writing: original draft; **Sureelak Sutchritpongsa:** validation, project administration; **Amornrat Penphattrarakul:** visualization, writing: review and editing; **Prakasit Wannapaschaiyong:** resources, writing: review and editing; **Nattha Ketudat:** resources, validation; **Pat Rojmahamongkol:** conceptualization, supervision, formal analysis, writing: review and editing

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