

# Reliability and validity of the Chinese version of Questionnaire – Children with Difficulties for Chinese children or adolescents with attention-deficit/hyperactivity disorder: a cross-sectional survey

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**Purpose:** The Questionnaire – Children with Difficulties (QCD) has been developed and used to evaluate daily-life problems in children during specified periods of the day. The objective of this study was to evaluate the reliability and validity of the QCD for Chinese children or adolescents with attention-deficit/hyperactivity disorder (ADHD).

**Patients and methods:** Outpatients with ADHD aged 6–18 years who visited psychiatry clinics were enrolled at four study centers in China. Patients with severe psychiatric disorders were excluded. Parents of all enrolled patients were given the QCD, the Swanson, Nolan and Pelham IV (SNAP-IV), and the Weiss Functional Impairment Scale-Parent (WFIRS-P) questionnaires and were asked to complete all three questionnaires. The reliability of the QCD was examined by Cronbach's alpha, which assessed the internal consistency of the questionnaire. Concurrent criterion validity of QCD scores was examined by Spearman's correlation of QCD with SNAP-IV and WFIRS-P scores.

**Results:** A total of 200 Chinese patients were analyzed (average age, 10.4±2.66 years). The majority of patients were male (77.5%), and 49.0% had the combined ADHD subtype. Cronbach's alpha for QCD was 0.88. Correlation coefficients of the QCD total score with SNAP-IV total score and WFIRS-P average score were –0.47 and –0.57, respectively. Correlations for the QCD with SNAP-IV and WFIRS-P were statistically significant ( $P<0.01$ ). The area under the curve for sensitivity and specificity of the QCD compared with the SNAP-IV and WFIRS-P was 0.70 and 0.71, respectively. The ADHD severity discrimination threshold range of the QCD total score was 30–35.

**Conclusion:** Our study results found the QCD to be a reliable and valid instrument and recommend its use in clinical practice to identify and evaluate daily-life problems of ADHD patients during specified periods of the day in China.

**Keywords:** attention-deficit/hyperactivity disorder, Questionnaire – Children with Difficulties (QCD), reliability, validity

## Introduction

Attention-deficit/hyperactivity disorder (ADHD) is a common chronic neurobehavioral disorder characterized by excessive hyperactivity, impulsivity, inattention, or a combination of these, which affects ~6.26% of school-aged children in China.<sup>1,2</sup> ADHD is associated with a series of negative effects among children and

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adolescents, and puts a serious financial burden on families.<sup>2</sup> Children with ADHD usually face difficulties in various aspects of life – for example, family relationships, school life, friendships, and their daily behaviors during specific periods of the day, such as morning, during school, after school, evening, and night.<sup>3–9</sup> As the symptoms of ADHD are continuously recognized throughout the day and night time,<sup>8,10</sup> the assessment of a child's functioning across various periods of the day is important from the perspective of the long-term prognosis of ADHD.<sup>10</sup>

There are several scales used in clinical practice to measure the symptoms and functional impairment of patients with ADHD in China and abroad. The Swanson, Nolan and Pelham IV (SNAP-IV) rating scale is a commonly used tool to assess ADHD symptoms.<sup>11</sup> The Weiss Functional Impairment Rating Scale-Parent (WFIRS-P) is another tool which is used to assess ADHD-related functional impairment in children and adolescents.<sup>12</sup> However, neither SNAP-IV nor WFIRS-P captures ADHD-related daily-life problems during specified periods of the day. No scale was available for this purpose in China.

In Japan, the Questionnaire – Children with Difficulties (QCD) is commonly used to evaluate parents' perceptions of their child's daily behaviors during specific periods of the day such as morning, school, after school, evening, and night time.<sup>8</sup> The QCD has three key features: the ability to assess life function, the ability to enable the evaluation of life function at each period of the day, and convenience of use in daily clinical practice.<sup>8</sup> The QCD is composed of practical and easy-to-understand questions inquiring about basic daily activities.<sup>13</sup> One of the major advantages of the QCD is that it is more convenient to use than either SNAP-IV or WFIRS-P as it includes only 20 simple questions,<sup>8</sup> which take less time to complete than SNAP-IV (consisting of 26 questions) and WFIRS-P (consisting of 50 questions).<sup>11,12</sup> Moreover, the QCD is more user-friendly in measuring problems in daily life during different time periods of the day, and offers necessary information for selecting appropriate drug therapy.<sup>8</sup>

The reliability and validity of the QCD in assessing daily-life problems of ADHD patients at various times of the day have not been evaluated in China. In order to use the QCD in future Chinese clinical studies, it is critical to evaluate the internal consistency and convergent validity of the QCD in Chinese children or adolescents with ADHD. Therefore, this study was designed to evaluate the reliability and validity of the QCD in Chinese children with ADHD. The major hypothesis of this study was that a satisfactory internal consistency of QCD and good correlations of QCD

scores with SNAP-IV and WFIRS-P scores would be found. Moreover, this study answers the question whether the QCD can be recommended for use in daily clinical practice to identify the daily-life problems of ADHD patients during specified periods of the day in China.

## Patients and methods

### Study design and ethical considerations

This cross-sectional survey study was conducted at four study centers in China (Beijing, Shanghai, Nanjing, and Changsha) using paper questionnaires (study duration: November 2016 to March 2017). The investigators were apprised of all study procedures, and instructed to have face-to-face interviews with the children's parents or guardians to collect data. Institutional ethics committee approval was obtained from each study center: Beijing Anding Hospital of Capital Medical University, Shanghai Mental Health Center, The Second Xiangya Hospital of Central South University, and Nanjing Brain Hospital Affiliated to Nanjing Medical University. Participants in the study were children and adolescents aged 6–18 years with ADHD and their parents/guardians. Written informed consent was taken from each parent on behalf of their children. The QCD as well as the SNAP-IV and WFIRS-P questionnaires were distributed to the parents or guardians of all enrolled patients, and they were asked to complete all questionnaires.

### Participants and demographic characteristics of the patients

Outpatients aged 6–18 years who had been diagnosed with ADHD based on the *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edition (DSM-5) criteria and who had visited psychiatry clinics were enrolled in this study. Patients with neurodegenerative disease, cerebral palsy, bipolar disorder, schizophrenia, psychotic disorder, and other severe psychiatric disorders were excluded.

The following demographic characteristics were recorded for each enrolled participant: age, gender, education level, comorbidity condition, ADHD diagnosis duration, ADHD current therapy, family history of ADHD, and ADHD subtype (Table 1).

### Questionnaire – Children with Difficulties

The QCD comprises 20 questions with regard to ADHD-related difficulties occurring in the morning, during school, after school, in the evening, and overall difficulties over the entire day and night (Table 2). Each question is scored in four grades: 0 = completely disagree, 1 = somewhat (partially)

**Table 1** Patient demographic and baseline characteristics

Variables	Total (N=200)
Age, mean (SD)	10.4 (2.66)
Gender, n (%)	
Male	155 (77.5%)
Female	45 (22.5%)
Education level, n (%)	
Kindergarten	3 (1.5%)
Primary school	153 (76.5%)
Junior high school	35 (17.5%)
High school and above	9 (4.5%)
Comorbidity condition, n (%)	
Yes	65 (32.5%)
No	135 (67.5%)
Details of comorbidity, n (%)	
Learning disability	49 (75.4%)
ODD	20 (30.8%)
Substance abuse	6 (9.2%)
Conduct disorder	11 (16.9%)
Tic disorder	21 (32.3%)
Anxiety	10 (15.4%)
Depression	1 (1.5%)
DMDD	4 (6.2%)
Bidirectional emotion	2 (3.1%)
ADHD diagnosis duration in weeks, mean (SD)	62.6 (96.59)
ADHD current treatment, n (%)	
No intervention	69 (34.5%)
Medical intervention	127 (63.5%)
Atomoxetine	84 (42%)
Methylphenidate	36 (18%)
Other (eg, Chinese traditional medicine)	10 (5%)
Behavior intervention	27 (13.5%)
Behavioral therapy	16 (8.0%)
Parent training	10 (5.0%)
School intervention	1 (0.5%)
Family history of ADHD, n (%)	
Yes	18 (9.0%)
No	182 (91.0%)
ADHD subtype, n (%)	
Combined	98 (49.0%)
Predominantly Inattentive	91 (45.5%)
Predominantly Hyperactive–Impulsive	11 (5.5%)

**Notes:** Because some patients received both behavioral and medication intervention, the cumulative percentage of behavior intervention, medication intervention, and no intervention does not equal 100%. Similarly, in medical intervention, the cumulative percentage does not equal 100% because a few patients received both atomoxetine and Chinese traditional medicine.

**Abbreviations:** ADHD, attention-deficit/hyperactivity disorder; DMDD, destructive mood dysregulation disorders; N, total number of patients; n, number of patients in each category; ODD, oppositional defiant disorder.

agree, 2 = mostly agree, and 3 = completely agree. The average score for the QCD is defined as the average item-level score for all of the items on each assessment. The total score is the sum of all item-level scores. The subdomain score is the sum of all item-level scores within each domain, which is indicated by “items x-x.” Higher scores indicate higher life functioning and less difficulty in children’s daily activities that occur during specific periods of the day.<sup>8</sup>

## SNAP-IV

The SNAP-IV (parents) is a commonly used tool to assess ADHD symptoms in China.<sup>11</sup> It consists of 26 items, and each item is scored on a four-point scale: 0 = not at all, 1 = just a little, 2 = quite a bit, and 3 = very much. The subdomains included in the scale are: inattention (items 1–9), hyperactivity/impulsivity (items 10–18), and oppositional criteria (items 19–26). The average score for the SNAP-IV is defined as the average item-level score for all of the items on each assessment. The total score is the sum of all item-level scores. The subdomain score is the sum of all item-level scores within each domain, which is indicated by “items x-x”. Higher SNAP-IV scores indicate worse ADHD symptoms, and vice versa.

## WFIRS-P

The WFIRS-P assesses ADHD-related functional impairment in children and adolescents in China.<sup>12</sup> It consists of 50 items to be filled out by parents. The subdomains included in the scale are family, school, life skills, child’s self-concept, social activities, and risky activities. It is a four-choice Likert-type scale scored from 0 to 3 (no problem to high problem). The average score for the WFIRS-P is the average item-level score for the items with the response 0, 1, 2, or 3. Responses of “NA” were not included; thus, only items with the response 0, 1, 2, or 3 were included for total/average/subdomain score calculations. Higher WFIRS-P scores indicate less life functioning and more difficulty in children’s daily activities, and vice versa.<sup>12</sup>

## Statistical analyses

A total of 200 ADHD outpatients, with an absolute minimum of 100 subjects, were planned to be enrolled in this study to ensure the item–subject ratio was  $\geq 10$ . Descriptive statistics (frequency and percentage for categorical variables, and mean and SD for continuous variables) were presented. The internal reliability of the QCD scores (total and subscores) was examined by Cronbach’s alpha, which assessed the internal consistency of the questionnaire. Acceptable Cronbach’s alpha values range from 0.70 to 0.95,<sup>14</sup> and a high Cronbach’s alpha value indicates good internal consistency of the items in the scale ( $\geq 0.9$  = Excellent,  $\geq 0.8$  = Good,  $\geq 0.7$  = Acceptable,  $\geq 0.6$  = Questionable,  $\geq 0.5$  = Poor, and  $< 0.5$  = Unacceptable).<sup>15</sup> Concurrent criteria validity of the QCD was examined by Spearman’s correlation of QCD scores (total scores and subscores) with those of the SNAP-IV and WFIRS-P, respectively. The threshold value

**Table 2** QCD scores for children and adolescents by their parents/guardians (N=200)

Questionnaire	0 = completely disagree n (%)	1 = somewhat agree n (%)	2 = mostly agree n (%)	3 = completely agree n (%)	Mean (SD)
<b>Early morning/before going to school (items 1–4)</b>					6.0 (2.88)
1. Can your child promptly get out of his/her bed?	47 (23.5%)	81 (40.5%)	49 (24.5%)	23 (11.5%)	1.24 (0.94)
2. Can your child promptly groom himself/herself (eg, washing face, brushing teeth, and getting dressed)?	41 (20.5%)	84 (42.0%)	50 (25.0%)	25 (12.5%)	1.30 (0.93)
3. Can your child behave in an age-appropriate manner at breakfast?	18 (9.0%)	66 (33.0%)	59 (29.5%)	57 (28.5%)	1.78 (0.96)
4. Can your child spend his/her time before going to school in the morning without getting into trouble or having quarrels with his/her parents or siblings?	28 (14.0%)	53 (26.5%)	67 (33.5%)	52 (26.0%)	1.72 (1.00)
<b>School (items 5–7)</b>					5.4 (2.03)
5. Does your child like going to school?	16 (8.0%)	53 (26.5%)	61 (30.5%)	70 (35.0%)	1.93 (0.97)
6. Can your child behave in class as other children do?	18 (9.0%)	93 (46.5%)	58 (29.0%)	31 (15.5%)	1.51 (0.86)
7. Does your child have friends who accept him/her at school?	7 (3.5%)	66 (33.0%)	64 (32.0%)	63 (31.5%)	1.92 (0.88)
<b>After school (items 8–10)</b>					6.0 (2.14)
8. Can your child discuss events that happened at school with his/her parents/guardian?	12 (6.0%)	62 (31.0%)	71 (35.5%)	55 (27.5%)	1.85 (0.90)
9. Does your child have friends of his/her own age?	6 (3.0%)	49 (24.5%)	65 (32.5%)	80 (40.0%)	2.10 (0.87)
10. Can your child confidently participate in extracurricular activities, such as sports, with children of his/her own age?	8 (4.0%)	57 (28.5%)	55 (27.5%)	80 (40.0%)	2.04 (0.92)
<b>Evening (items 11–14)</b>					6.6 (2.44)
11. Can your child do his/her homework at home without difficulties?	79 (39.5%)	79 (39.5%)	35 (17.5%)	7 (3.5%)	0.85 (0.83)
12. After everyone returns home (including parents/guardians), can your child enjoy family time without constantly quarreling with others?	11 (5.5%)	66 (33.0%)	78 (39.0%)	45 (22.5%)	1.79 (0.86)
13. Can your child converse in a calm manner during dinnertime conversations?	9 (4.5%)	54 (27.0%)	84 (42.0%)	53 (26.5%)	1.91 (0.84)
14. Do the parents feel comfortable being together with the child when engaging in activities (eg, going out or shopping)?	8 (4.0%)	43 (21.5%)	86 (43.0%)	63 (31.5%)	2.02 (0.83)
<b>Night (items 15–18)</b>					5.2 (2.42)
15. Adolescent child (12 years or older): can your child engage in activities at night with friends of his/her own age? These activities may include playing, studying, going to cram school, taking private lessons (eg, playing a musical instrument and/or calligraphy), and playing sports.	12 (22.2%)	14 (25.9%)	15 (27.8%)	13 (24.1%)	1.54 (1.09)
16. Younger children (younger than 12 years): Can your child follow instructions at night (eg, brushing teeth, changing clothes)?	12 (8.2%)	41 (28.1%)	61 (41.8%)	32 (21.9%)	1.77 (0.88)
17. Can your child go to sleep without any difficulties?	36 (18.0%)	50 (25.0%)	55 (27.5%)	59 (29.5%)	1.69 (1.08)
18. Is your child sleeping without waking up during the night?	34 (17.0%)	46 (23.0%)	49 (24.5%)	71 (35.5%)	1.79 (1.11)
<b>Overall behavior (items 19–20)</b>					2.9 (1.43)
19. Does your child have self-confidence? Is your child socially accepted by others (such as belonging to a group of his/her friends), and emotionally stable?	21 (10.5%)	84 (42.0%)	71 (35.5%)	24 (12.0%)	1.49 (0.84)
20. Does your child have more days in the week where he/she is able to spend the day without facing confusion, getting into quarrels, or displaying rebellious behavior?	30 (15.0%)	84 (42.0%)	56 (28.0%)	30 (15.0%)	1.43 (0.92)

**Abbreviations:** ADHD, attention-deficit/hyperactivity disorder; N, total number of patients; n, number of patients in each category; QCD, Questionnaire – Children with Difficulties.

of 0.3–0.7 for the absolute value of correlation coefficient is considered a satisfactory/good correlation.<sup>16</sup> In order to explore the discrimination threshold of the QCD for determining ADHD severity, the receiver operating characteristic

(ROC) analysis method was employed by using a binary classifier system (for SNAP-IV: a mean score of items 1–18 of <1.67 indicates insignificant ADHD symptom whereas  $\geq 1.67$  indicates significant ADHD symptom;<sup>17</sup> for

WFIRS-P: the impaired functions were  $<3$  vs  $\geq 3$ ).<sup>18</sup> The QCD cut-off points from the minimum to maximum values by every five points were tested. Sensitivity, specificity, and accuracy, as well as area under curve (AUC) were presented to measure the accuracy of a diagnostic tool. The two-tailed significance level  $P < 0.05$  was used. All data were analyzed with SAS 9.4 (SAS Inc., Cary, NC, USA).

## Results

### Patient disposition and characteristics

A total of 270 patients were screened for the study; of these, 70 patients were excluded due to not meeting eligibility criteria (Figure S1). A total of 200 eligible Chinese patients were analyzed in this study. The average ( $\pm$ SD) age of the enrolled patient was 10.4 ( $\pm 2.66$ ) years. The majority of patients were male (77.5%), and 49.0% had the combined ADHD subtype. The demographic and baseline characteristics of enrolled patients are summarized in Table 1.

### Distribution of the QCD, SNAP-IV, and WFIRS-P scores

The questionnaires that were filled out completely were collected from the parents and guardians of 200 children. The mean (SD) of the total score of the QCD was 32.0 (9.77). The percentage of respondents who answered each question and the mean (SD) for each question or domain of QCD are shown in Table 2. The mean (SD) for total scores and subscores of SNAP-IV and WFIRS-P are shown in Table 3.

**Table 3** SNAP-IV and WFIRS-P scores for children and adolescents by their parents/guardians

Characteristics	Total (N=200)
<b>SNAP-IV scores, mean (SD)</b>	
Inattention (items 1–9)	15.6 (4.82)
Hyperactivity/impulsivity (items 10–18)	10.9 (6.09)
Oppositional criteria (items 19–26)	9.1 (5.56)
Combination (items 1–18)	26.5 (9.14)
Total score (items 1–26)	35.6 (12.98)
Average total score	1.4 (0.50)
<b>WFIRS-P scores, mean (SD)</b>	
Family (items 1–10)	8.2 (4.92)
School (items 11–20)	9.7 (5.21)
Life skills (items 21–30)	11.1 (4.29)
Child's self-concept (items 31–33)	2.8 (2.11)
Social activities (items 34–40)	5.2 (4.20)
Risk activities (items 41–50)	3.4 (2.67)
Number of items scored 2 or 3	10.4 (7.32)
Total score (items 1–50)	40.4 (17.42)
Average score	0.8 (0.37)

**Abbreviations:** ADHD, attention-deficit/hyperactivity disorder; SNAP-IV, Swanson, Nolan and Pelham IV; N, total number of patients; WFIRS-P, Weiss Functional Impairment Rating Scale-Parent.

### Internal reliability of the QCD

With regard to the internal consistency of the QCD, Cronbach's alpha for the subscores ranged from 0.49 to 0.74, and the Cronbach's alpha for the total score was 0.88 (Table 4). The highest internal consistency was noted for the early morning/before going to school subcategory of the QCD. Likewise, the lowest Cronbach's alpha was noted for the overall behavior subcategory of the QCD. The Cronbach's alpha value for the total QCD score indicates that the QCD is a reliable instrument to assess daily-life problems of ADHD patients during specified periods of the day in China.

### Validity of the QCD

The correlation coefficients of the QCD total score with the SNAP-IV total score and WFIRS-P average score were  $-0.47$  and  $-0.57$ , respectively (Table 5). Correlations for QCD with SNAP-IV and WFIRS-P were statistically significant ( $P < 0.05$ ). With regard to the convergent validity of the QCD, the correlation coefficients between the SNAP-IV score and the QCD subscores ranged from  $-0.15$  to  $-0.47$ . The correlation coefficients between the WFIRS-P score and the QCD subscores ranged from  $-0.16$  to  $-0.57$ . All correlations were significant at  $P < 0.05$ . The lowest correlation was observed between "Night" on the QCD and "Hyperactivity/impulsivity" and "Oppositional criteria" on the SNAP-IV (Table 5). Furthermore, low correlations were observed between "inattention," "hyperactivity/impulsivity score," "oppositional criteria," and "combination" of SNAP-IV and "after school" of QCD scores (Table 5).

### Sensitivity and specificity of the QCD

The AUC calculated from ROC analysis between the QCD and SNAP-IV was 0.70, indicating the accuracy of the QCD (Figure S2). A similar trend of accuracy was observed when the QCD was compared with the WFIRS-P, and the calculated AUC was 0.71. The sensitivity, specificity, and

**Table 4** Internal consistency of the QCD (N=200)

QCD score	Cronbach's alpha score
<b>Subscore</b>	
Early morning/before going to school (items 1–4)	0.74
School (items 5–7)	0.606
After school (items 8–10)	0.713
Evening (items 11–14)	0.701
Night (items 15–18)	0.653
Overall behavior (items 19–20)	0.488
<b>Total score</b>	<b>0.876</b>

**Abbreviations:** N, total number of patients; QCD, Questionnaire – Children with difficulties.

**Table 5** Correlation of the QCD with SNAP-IV and WFIRS-P scores (N=200)

Category	QCD score						
	Early morning/before going to school	School	After school	Evening	Night	Overall behavior	Total score
<b>Correlation with SNAP-IV</b>							
Total score	-0.355	-0.344	-0.238	-0.462	-0.268	-0.362	-0.466
Inattention	-0.238	-0.237	-0.188	-0.382	-0.329	-0.310	-0.379
Hyperactivity/impulsivity	-0.289	-0.209	-0.154	-0.276	-0.139	-0.231	-0.314
Oppositional criteria	-0.301	-0.390	-0.252	-0.435	-0.191	-0.349	-0.424
Combination	-0.325	-0.264	-0.205	-0.391	-0.278	-0.306	-0.415
<b>Correlation with WFIRS-P</b>							
Average score	-0.329	-0.492	-0.439	-0.510	-0.385	-0.352	-0.570
Number of items scored 2 or 3	-0.302	-0.412	-0.319	-0.442	-0.355	-0.283	-0.482
Family	-0.284	-0.387	-0.322	-0.489	-0.318	-0.297	-0.479
School	-0.204	-0.413	-0.258	-0.394	-0.270	-0.215	-0.391
Life skills	-0.288	-0.209	-0.269	-0.368	-0.381	-0.159	-0.390
Child's self-concept	-0.191	-0.344	-0.328	-0.270	-0.260	-0.318	-0.369
Social activities	-0.249	-0.445	-0.483	-0.346	-0.200	-0.352	-0.463
Risk activities	-0.235	-0.318	-0.276	-0.328	-0.281	-0.238	-0.375

**Note:** All correlations were statistically significant at  $P < 0.05$ .

**Abbreviations:** N, total number of patients; QCD, Questionnaire – Children with difficulties; SNAP-IV, Swanson, Nolan and Pelham IV; WFIRS-P, Weiss Functional Impairment Rating Scale-Parent.

accuracy of the QCD against the SNAP-IV and WFIRS-P questionnaires are shown in Table S1.

## Discussion

This is the first site-based study designed to test the reliability and validity of QCD in evaluating daily-life problems at various times of the day in Chinese children or adolescents with ADHD. In China, the SNAP-IV and WFIRS-P questionnaires have been most widely used to evaluate ADHD-related symptoms and function. However, these questionnaires do not inquire about behaviors during specific periods of the day.<sup>11,12</sup> Therefore, there was a need for a convenient, easy-to-use, reliable, and valid questionnaire which assesses daily-life problems at various times of the day among Chinese children or adolescents with ADHD.

The results of the present study indicated that the QCD had sufficient reliability and validity. The internal consistencies of both the total score and the subscores of the QCD were found to be satisfactory. Moreover, the convergent validity was found to be satisfactory for both the total score and the subscores of the QCD, with good correlation with the SNAP-IV and the WFIRS-P. Our study results are consistent with the Japanese study,<sup>8</sup> which concluded that the QCD is a reliable and valid instrument for evaluating daily-life problems in Japanese children during different time periods of the day. The Cronbach's alpha for the total score and subscores of QCD in our study was found to be similar to what was observed in the Japanese study; Cronbach's alpha values for the total score was 0.88 in both studies.<sup>8</sup> Cronbach's alpha

for subscores ranged from 0.49 to 0.74 in the Chinese study, and ranged from 0.57 to 0.78 in the Japanese study.<sup>8</sup> The total score of the QCD significantly correlated with scores on the SNAP-IV and WFIRS-P, but subscores of the QCD exhibited a broad range of correlations in both Chinese and Japanese studies. In our study, the "night" subscore in the QCD displayed a low correlation with the SNAP-IV total score and the WFIRS-P average score. The SNAP-IV and WFIRS-P questionnaires do not include any questions related to sleeping problems or disorders, which could partly explain these low correlations in our study. The sensitivity and specificity of the QCD questionnaire were evaluated using ROC analysis. The AUC values from ROC analysis suggested a fair accuracy of QCD scores when compared with SNAP-IV and WFIRS-P.

In addition to its reliability and validity, the QCD can be completed by parents in ~10–15 minutes and is convenient to use in daily clinical practice in order to identify daily-life difficulties of ADHD patients during specific time periods of the day. The suggested ADHD severity discrimination threshold of the QCD total score was 30–35. Patients who had a QCD total score of  $\leq 30$  may have more impaired functions and, therefore, require immediate attention from their caregivers and further diagnostic tests. Treatment of ADHD requires the designing of a comprehensive and individualized plan for each patient and family. In the case of low subscores in the evening and at night, the clinician should pay more attention to the choice of medication for ADHD – for example, the presence of sleeping disorders

or other comorbidities indicate the patient's need for action during the day or at specific times of the day.

This study has some limitations that need to be considered. Due to the cross-sectional nature of the study design, the responsiveness of the QCD could not be examined by the current study. We have included only ADHD patients in our study, and the QCD scores of normal children or adolescents have not been studied. Future studies should compare these results with a normal community sample. Moreover, the subjects were recruited from only four study centers from tier 1 and 2 cities in China. Therefore, the present findings cannot be generalized for the overall Chinese population. However, the sample size in the present study was large enough to allow us to draw valuable conclusions. Furthermore, in the present cross-sectional survey study, there was only one interview planned for each patient. Because scores were collected on a single occasion, we could not examine test–retest reliability in this study. A follow-up study has been planned, which examines whether the QCD has the ability to distinguish subgroups of ADHD patients with regard to their demographic characteristics and severity of ADHD symptoms or ADHD-related functioning impairment. This will strengthen the evidence for the discriminant validity of the QCD.

## Conclusion

Our study results found the QCD to be a reliable and valid instrument for evaluating daily-life problems of ADHD patients during specified periods of the day in China and recommend its use in daily clinical practice.

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## Author contributions

Yi Zheng, Yasong Du, Lin Yan Su, and Xiao Yan Ke contributed to the study design, data collection and analysis, and critical revision of the manuscript. Yanlei Zhang, Zheng Yuan, and Yun Chen contributed to the study design, data management, analysis, interpretation, and critical revision of the manuscript. Qing Liu contributed to the data management,

analysis, interpretation, and critical revision of the manuscript. All authors contributed toward data analysis, drafting and revising the paper and agree to be accountable for all aspects of the work.

## Disclosure

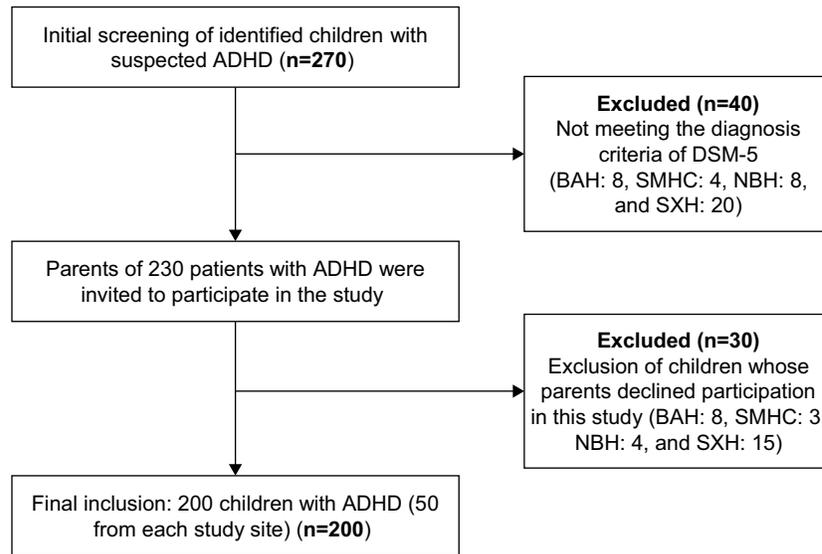
Yanlei Zhang, Zheng Yuan, Yun Chen, and Qing Liu are employees of Eli Lilly and Company. The other authors report no conflicts of interest in this work.

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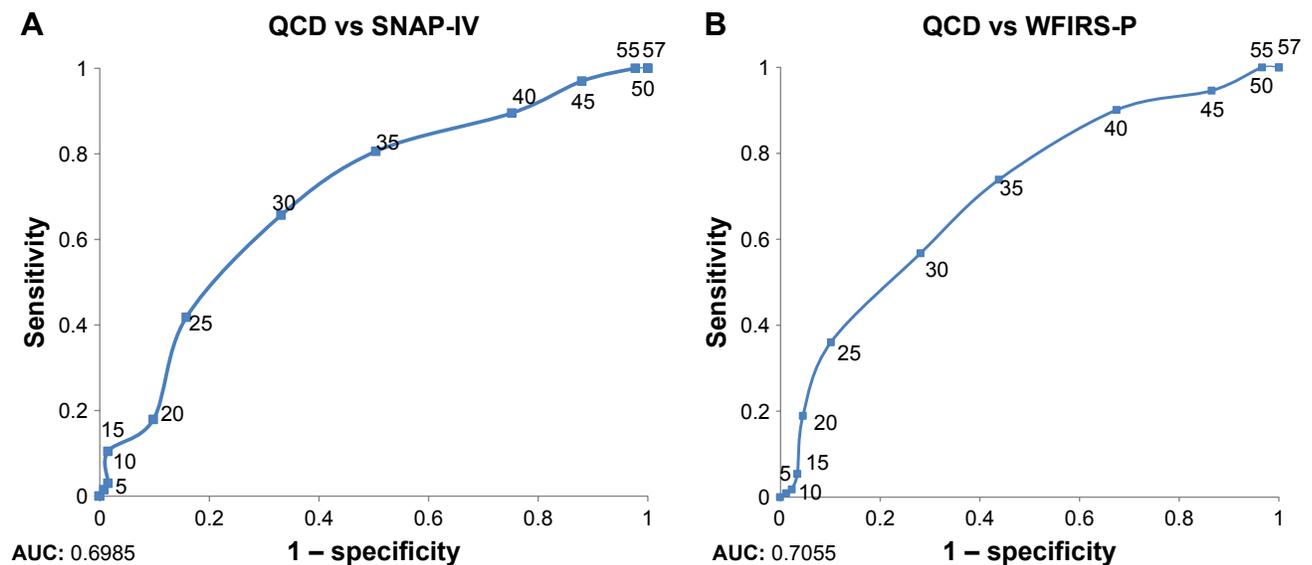
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## Supplementary materials



**Figure S1** Flowchart of patient disposition.

**Abbreviations:** ADHD, attention-deficit/hyperactivity disorder; BAH, Beijing Anding Hospital; DSM-5, *Diagnostic and Statistical Manual of Mental Disorders*, 5th Edition; n, number of patients in each category; NBH, Nanjing Brain Hospital; SMHC, Shanghai Mental Health Center; SXH, The Second Xiangya Hospital of Central South University.



**Figure S2** Sensitivity and specificity of the QCD questionnaire (A, QCD vs SNAP-IV; B, QCD vs WFIRS-P). QCD cut-off points: QCD from minimum to maximum value by every five points. SNAP-IV cut-point: a mean score of items 1–18 of <1.67 indicates insignificant ADHD symptoms, whereas  $\geq 1.67$  indicates significant ADHD symptoms. WFIRS-P cut-off point: the impaired functions <3 vs  $\geq 3$ .

**Abbreviations:** AUC, area under the curve; QCD, Questionnaire – Children with difficulties; SNAP-IV, Swanson, Nolan and Pelham IV; WFIRS-P, Weiss Functional Impairment Rating Scale-Parent.

**Table S1** Sensitivity, specificity, and accuracy of the QCD questionnaire against SNAP-IV and WFIRS-P (N=200)

Cut-off point of QCD total score	SNAP-IV			WFIRS-P		
	Sensitivity	Specificity	Accuracy	Sensitivity	Specificity	Accuracy
30	0.6567	0.6692	0.665	0.5676	0.7191	0.635
35	0.806	0.4962	0.6	0.7387	0.5618	0.66
40	0.8955	0.2481	0.465	0.9009	0.3258	0.645

**Note:** Only the cut-off points with sensitivity  $\geq 0.5$  and accuracy  $\geq 0.6$  are presented.

**Abbreviations:** N, total number of patients; QCD, Questionnaire – Children with difficulties; SNAP-IV, Swanson, Nolan and Pelham IV; WFIRS-P, Weiss Functional Impairment Rating Scale-Parent.

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