

BMJ Open Quality of life in Chinese children with developmental dyslexia: a cross-sectional study

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To cite: Zou L, Zhu K, Jiang Q, *et al*. Quality of life in Chinese children with developmental dyslexia: a cross-sectional study. *BMJ Open* 2022;**12**:e052278. doi:10.1136/bmjopen-2021-052278

► Prepublication history for this paper is available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-052278>).

Received 14 April 2021

Accepted 24 December 2021



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ABSTRACT

Objectives Our study aimed to compare the quality of life (QoL) between Chinese developmental dyslexia (DD) and healthy children.

Design A cross-sectional study.

Setting The participants were recruited from grades 3–6 in six primary schools in Tianmen, a city of Hubei Province, China.

Participants A total of 5679 students were recruited. After excluding children with visual and auditory dysfunction or psychiatric diseases or with a response rate on the scales or questionnaires of less than 90%, 5352 children were finally included in the analysis. DD children were diagnosed according to their clinical symptoms, which were mainly assessed by the Dyslexia Checklist for Chinese Children and the Pupil Rating Scale Revised Screening for Learning Disabilities.

Outcome measures The QoL for DD and healthy children was appraised by the Quality of Life Scale for Children and Adolescents (QLSCA). Outcome measures included its four domain scores (psychosocial function, physiological and mental health, living environment and satisfaction with QoL) and total score.

Results A total of 186 children were diagnosed with DD. The distribution of DD children in five levels of QoL was statistically different from that of healthy children ($\chi^2=57.63$, $p<0.001$). Compared with healthy children, the proportion of poor or worse QoL in DD was higher, and the proportion of moderate, better or good QoL was lower. The total QLSCA score in DD children was 3.475 lower than that in healthy children ($B=-3.475$, $p=0.006$). Psychosocial function, physiological and mental health, living environment and satisfaction with QoL of DD children were also inferior to those of healthy children.

Conclusion The QoL of DD was significantly lower than that of healthy children, prompting more public efforts to improve DD QoL.

INTRODUCTION

Developmental dyslexia (DD) is the most common type of learning disability (LD), occurring in 3.45%–12.6% of school-aged children in China.^{1 2} It is characterised by difficulties in word recognition, spelling and decoding in the context of adequate intelligence and educational opportunity. DD is a long-term constant defect that adversely

Strengths and limitations of this study

- To the best of our knowledge, the sample size of current study was larger than that of previous studies.
- The comparisons of quality of life (QoL) between dyslexic and non-dyslexic children were based on the stratification of district, gender and age in order to eliminate the impact of these factors on comparisons.
- The current study applied cross-sectional design cannot infer causality of developmental dyslexia and QoL.

affects the educational achievement and social adjustment throughout the life.³ Many studies have suggested that children suffering from DD have more emotional problems than their peers whose reading ability is normal.^{4 5} High rates of anxiety and depression persist in dyslexic children, even after controlling for comorbidity with attention deficit-hyperactivity disorder (ADHD).^{6–8} Anxiety and depression have been inferred to be the consequences of academic performance failure.⁹ These negative consequences are profound and continue into adulthood. Adults with dyslexia exhibited high levels of anxiety, which might prevent them from attending higher education.^{9 10} A study conducted by Moojen *et al* found that though majority of adults with dyslexia had received emotional support for their problems, they still exhibited more depressive symptoms and had a less favourable view of themselves than control subjects.¹¹ In addition, DD frequently co-occurs with ADHD,¹² language impairment¹³ and speech sound disorder.¹⁴ ADHD is recognised as one of the most common comorbidities and is simultaneously diagnosed in 15%–40% of the children with DD. Hence, it is extrapolated that the quality of life (QoL) in children with DD, which is a multidimensional measure including physiological, psychological and social functions,

may be affected to some degree. Children with LD experienced poorer QoL than typically developing children, mainly regarding physical and psychological well-being, relationships with family and friends, social support and school environment.^{15–17} To the best of our knowledge, there are only a few studies with small sample sizes on the QoL of children with DD so far. Lower QoL for DD group (127 Hungarian children) was reported in the school, family, time spent alone, mental health domains and general QoL than that of control group (81 Hungarian children).¹⁸ However, the alphabetic language results could not be directly extended to logographic language due to cross-cultural differences. A case-control study with 60 dyslexic children and 180 normal children was conducted in Shantou City, China, indicating that dyslexia significantly impacted the children's QoL.¹⁹ The current study aimed to expand the sample size to investigate whether the QoL of Chinese children with DD is lower than that of healthy children in a large representative population of school-aged children.

METHODS

Participants

A cross-sectional study was conducted in December 2012. Six primary schools were randomly selected from urban and rural areas in Tianmen, a city in the Hubei Province, China. All students of grades 3–6 from selected schools were recruited. Written informed consent was obtained from the parents or other guardians of all participants.

All participants are not suffered from visual and auditory dysfunction or psychiatric diseases and have normal intelligence according to their annual health examination. The diagnosis of dyslexic children was based on the following criteria: (1) the score of the *Dyslexia Checklist for Chinese Children* (DCCC) was 2 SD higher than the mean value, (2) the score of *Pupil Rating Scale Revised Screening for Learning Disabilities* (PRS) was lower than 65 points and (3) the Chinese language test score was below the 10th percentile of all children in the same grade.

Patient and public involvement

Patients or the public were not involved in the design, or conduct, or reporting, or dissemination plans of our research.

Data collection

Before formal investigation, the uniformly trained investigators explained the procedure and precautions in detail to the principals and head teachers of selected schools. The *Quality of Life Scale for Children and Adolescents* (QLSCA) and the DCCC scale were completed by children and their parents or other guardians respectively depending on written instructions. In addition, parents or other guardians were required to complete a questionnaire related to home literacy environment and use of electronic devices. Moreover, the head teacher of each class evaluated those students whose Chinese language

test was below the 10th percentile by applying the PRS scale based on their performance at school.

All the data were double entered and validated. With regard to cases or items, scales and questionnaires with response rates of less than 90% were excluded; otherwise, missing data were filled by the median value of specific items.

Measuring tools

The QLSCA is a self-evaluation tool for children of 7–18 years old to measure their QoL in China, with a reliability coefficient of 0.885 (Cronbach's α).²⁰ It has 49 items loading on four factors: psychosocial function, physiological and mental health, living environment and satisfaction with QoL. The psychosocial function involves the parent–child relationship, peer relationships, teacher–student relationships, learning ability and attitude and self-concept; physiological and mental health includes physical feelings, negative emotion and work attitudes; the living environment is composed of activity opportunity, life convenience and athletic ability; and satisfaction with QoL mainly reflects self-satisfaction. The score of each item ranges from 1 to 4, and a higher score indicates a better QoL. This scale's nationwide norms have been established according to the district (urban and rural areas), gender and age. The standard T-score converted from the original score based on specific norms was assessed into five ranks: $T < 30$, poor quality; $30 \leq T < 40$, worse quality; $40 \leq T < 60$, moderate quality; $60 \leq T < 70$, better quality; and $T \geq 70$, good quality.

The DCCC has been established in 2006 based on the definition of dyslexia in International Classification of Diseases 10th edition, Diagnostic and Statistical Manual of Mental Disorders 4th edition and clinical symptoms described in relative references.²¹ In 2018, it has proved to have sufficient validity and reliability (Cronbach's $\alpha = 0.974$) to screen for dyslexia among Chinese students from grades 2 through 6 in mainland China.²² The DCCC contains 57 items, 55 of which are loaded on eight factors including the deficit of vocabulary comprehension, the visual deficit of word recognition, the auditory deficit of word recognition, the deficit of spelling, the deficit of written expression and attention, the deficit of oral language and bad reading habits. The remaining two items are used to evaluate the family risk of dyslexia and mathematics ability. The items use 5-point Likert-type scales to assess the frequency of reading disability (never, seldom, sometimes, often and always), and a higher score corresponds to worse reading ability.

The PRS scale is widely adopted to screen learning ability in children and consists of 24 items belonging to 5 factors such as listening comprehension and memory, social behaviour, time and spatial judgments, motion ability and language ability. The reliability coefficients (Cronbach's α) were higher than 0.90 for four factors and 0.84 for one factor.²³ The score of each item ranges from 1 to 5, and a higher score indicates a better learning ability.

A self-designed questionnaire was used, which primarily contained four parts: demographic information, home literacy environment, use of electronic devices and learning habits. Briefly, the demographic information is related to children's age, gender, the district where the school is located, parental education and occupation, and family income. The following variables reflect the home literacy environment: frequency of parent-child reading, whether parents encourage the child to read, whether parents buy books in which the child is interested, frequency of buying new books, whether the child has scheduled time for reading, annual amount spent on books for the child and frequency of extracurricular reading. The total score of the home literacy environment summed by the above 7 variables ranges from 7 to 21. Electronic devices use is appraised by whether the child surf the internet, whether parents set scheduled time for internet surfing and watching TV, the hours spent on computers and TVs per week and the frequency of parents watching TV with the child. The total score of electronic device usage summed by the above 4 variables ranges from 4 to 11. There are three variables regarding learning habits: whether the child learns actively, whether the child has trouble finishing homework and hours spent finishing homework per day. The total score of learning habits summed by the above 3 variables ranges from 3 to 9.

Statistical analysis

Categorical variables were described as proportions (%) and tested with the χ^2 test or Fisher's exact probability. Continuous variables were described as the mean (M) \pm SD and tested with a t-test. Multiple linear regression was applied to explore influential factors of QoL for children by taking 4 factors and the total QLSCA score as dependent variables and the other 11 variables as independent variables. The description of these 11 variables is shown in table 1. The method by which independent variable enters the equation is a stepwise manner. All p values were two-tailed with a significance level of 0.05. Statistical analyses were carried out by PASW Statistics V.18 software.

RESULTS

Participant characteristics

There were 5929 children from grades 3–6 in the selected schools, of which 5679 children returned their scales and questionnaires. After excluding children with visual and auditory dysfunction or psychiatric diseases or with a response rate on the scales or questionnaires of less than 90%, 5352 children were finally included in the analysis. A total of 186 children were recognised as having dyslexia, and the others were recognised as non-dyslexia.

There was a significantly higher proportion of male dyslexic children than non-dyslexic children (79.0% vs 55.5%, $p<0.001$). Concerning district, 128 (68.8%) children lived in urban areas for the dyslexic group compared with 3073 (59.5%) for the non-dyslexic group

($p=0.011$). Given the impact of the district, gender and age on QoL according to the norm in China, the distribution of dyslexic and non-dyslexic children in different age groups was stratified by district and gender. A statistical difference in the distribution was found for urban men/women, but not for rural men/women. The total score of DCCC for dyslexic children was significantly higher than that for non-dyslexic children ($p<0.001$). Regarding family income, there was no statistical difference between the two groups ($p=0.161$). The distribution of dyslexic children was statistically different from that of non-dyslexic children in terms of father's education, mother's education and parents' attitude toward extracurricular activity. The scores of the home literacy environment, electronic device use and learning habits for non-dyslexic children were statistically higher than those for dyslexic children. See details in table 2.

The comparison of QoL between dyslexic and non-dyslexic children

The distribution of dyslexic children in five levels of QoL was significantly different from that of non-dyslexic children (poor quality: 8.6% vs 2.1%; worse quality: 19.9% vs 10.7%; moderate quality: 66.1% vs 74.0%; better quality: 5.4% vs 11.5%; good quality: 0.0% vs 1.7%; $\chi^2=57.63$, $p<0.001$).

Concerning rural men/women, because there was no statistical difference in the distribution of age between dyslexic and non-dyslexic children, the mean scores of the QLSCA and its four factors were compared irrespective of age. The mean scores of physiological and mental health, the satisfaction with QoL and total score for men and living environment for women in the non-dyslexic group were statistically higher than those in the dyslexic group. See details in table 3.

Regarding urban men, non-dyslexic children had statistically higher mean scores of psychosocial function, physiological and mental health, satisfaction with QoL and total score than dyslexic children in different age groups, especially in the 9-year-old and 10-year-old age groups. Regarding urban women, higher mean scores of 4 factors and total score were obtained in the 10-year-old age group. Sporadic positive results were also found in other age groups. See details in table 4.

The influential factors of QoL for children

The multiple linear regression model indicated a significant association between gender, age, district, group (dyslexic group and non-dyslexic group), family income of 2000–3000 CNY monthly, parents' attitude toward extracurricular activity, home literacy environment, use of electronic devices, learning habits and total score of the QLSCA. The total score of the QLSCA for children with dyslexia was 3.475 lower than that for non-dyslexic children ($B=-3.475$, $p=0.006$). See details in table 5. Similar results were obtained for four factors of the QLSCA (data not shown).

Table 1 Description of independent variables for multiple linear regression

Variables	Items	Decoding of each response
Gender	–	1=male, 2=female
Age	–	Measurement data
District	–	1=rural areas, 2=urban areas
Group	–	0=non-dyslexic children, 1=dyslexic children
Family income	–	1=less than 1000 CNY, 2=1000–2000 CNY, 3=2000–3000 CNY, 4=more than 3000 CNY
Father's education	–	1=junior high school or below, 2=senior high school or equivalency, 3=junior college, 4=college diploma or above
Mother's education	–	1=junior high school or below, 2=senior high school or equivalency, 3=junior college, 4=college diploma or above
Parents' attitude to extracurricular activity	–	1=unconcern, 2=sometimes encourage, 3=often encourage
Home literacy environment	The frequency of parent–child reading	1=occasionally, 2=sometimes, 3=often
	The frequency of parents encourage child to read	1=occasionally, 2=sometimes, 3=often
	The frequency of buy books in which child is interested	1=occasionally, 2=sometimes, 3=often
	The frequency of buying new books for child	1=per year or buy when need, 2=per term or per month, 3=per week
	The annual amount spent on books for child	1=less than 150 CNY, 2=150–500 CNY, 3=more than 500 CNY
	Whether child has scheduled time for reading	1=no, 2=yes
Electronic devices use	Whether child surfs the internet	1=yes, 2=no
	Whether parents set scheduled time on surfing internet and watching TV	1=no rule or failure to follow, 2=follow rule, 3=no watching TV
	The hours spent on computer and TV per week	1=less than 15 hours, 2=5–15 hours, 3=less than 5 hours
	The frequency of parents watching TV with child	1=seldom, 2=sometimes, 3=always
Learning habits	The frequency of child learns actively	1=never, 2=sometimes, 3=often
	The frequency of child has trouble in homework	1=always, 2=sometimes, 3=never
	The hours on finishing homework per day	1=more than 2 hours, 2=1–2 hours, 3=less than 1 hour

DISCUSSION

In the present study, we compared the QoL between dyslexic and non-dyslexic groups, enriching existing research. Our results indicated that the proportion of children who had a poor or worse QoL in the dyslexic group was higher than that in the non-dyslexic group. Conversely, a lower proportion of moderate, better or good QoL was observed in the dyslexic group than in the non-dyslexic group. The total QLSCA score in the dyslexic group was 3.475 lower than that in the non-dyslexic group. Moreover, psychosocial function, physiological and mental health, living environment and satisfaction with the QoL of the dyslexic group were inferior to those of the non-dyslexic group. In addition, some demographic indicators (eg, gender, age, district and family income), parents' attitude toward extracurricular

activity, home literacy environment, the use of electronic devices and learning habits affected children's QoL.

DD accounts for approximately 80% of children with LD.^{24 25} Regardless of what scales are applied, the results on LD are more consistent in different countries, indicating that children with LD experience poorer QoL than typically developing children.^{15 17 26 27} For instance, two studies conducted in Wuhan, China have shown that the subjective QoL scores and their dimensions among LD children were lower than those among their peers.^{28 29} Limited to DD, Balazs *et al* have found a lower QoL for DD as compared with the controls in parent reports but not in self-reports.¹⁸ They speculated that the low level of stigma around LDs and sponsored special education from the government for LDs in Hungary mitigated the negative consequences of DD on their QoL. However, there

Table 2 Descriptive statistics of the participants

Variable	Dyslexic group (N, % or M±SD)	Non-dyslexic group (N, % or M±SD)	χ^2 or t test	P value
Gender				
Male	147 (79.0)	2869 (55.5)	40.3	<0.001
Female	39 (21.0)	2297 (44.5)		
District				
Urban	128 (68.8)	3073 (59.5)	6.51	0.011
Rural	58 (31.2)	2093 (40.5)		
Rural males				
<9	7 (13.2)	204 (17.2)	6.045	0.196
9-	14 (26.4)	259 (21.8)		
10-	11 (20.8)	355 (29.9)		
11-	13 (24.5)	280 (23.6)		
12-	8 (15.1)	90 (7.6)		
Rural females				
<9	2 (40.0)	207 (22.9)	4.971	0.199
9-	1 (20.0)	244 (27.0)		
10-	1 (20.0)	238 (26.3)		
11-	0 (0.0)	185 (20.4)		
12-	1 (20.0)	31 (3.4)		
Urban males				
<9	15 (16.0)	425 (25.3)	12.181	0.016
9-	16 (17.0)	424 (25.2)		
10-	32 (34.0)	450 (26.8)		
11-	27 (28.7)	349 (20.8)		
12-	4 (4.3)	33 (2.0)		
Urban females				
<9	2 (5.9)	439 (31.5)	17.189	0.002
9-	12 (35.3)	354 (25.4)		
10-	13 (38.2)	365 (26.2)		
11-	5 (14.7)	220 (15.8)		
12-	2 (5.9)	14 (1.0)		
Total score of DCCC	176.52±23.53	117.00±32.68	-33.358	<0.001
Family income				
<1000 CNY	18 (10.3)	387 (7.9)	5.159	0.161
1000–1999 CNY	57 (32.6)	1455 (29.6)		
2000–2999 CNY	64 (36.6)	1710 (34.7)		
≥3000 CNY	36 (20.6)	1370 (27.8)		
Father's education				
Junior high school or below	77 (43.8)	1519 (30.9)	25.347	<0.001
Senior high school or equivalency	76 (43.2)	2003 (40.8)		
Junior college	19 (10.8)	849 (17.3)		
College diploma or above	4 (2.3)	538 (11.0)		
Mother's education				
Junior high school or below	93 (52.8)	1942 (39.7)	14.05	0.003
Senior high school or equivalency	59 (33.5)	1882 (38.5)		

Continued

Table 2 Continued

Variable	Dyslexic group (N, % or M±SD)	Non-dyslexic group (N, % or M±SD)	χ^2 or t test	P value
Junior college	18 (10.2)	711 (14.5)		
College diploma or above	6 (3.4)	353 (7.2)		
Parents' attitude to extracurricular activity				
Unconcern	24 (12.9)	400 (7.8)	7.505	0.023
Sometimes encourage	66 (35.5)	1737 (33.8)		
Often encourage	96 (51.6)	3004 (58.4)		
Home literacy environment	10.97±2.51	12.34±2.71	6.701	<0.001
Electronic devices use	6.71±1.55	7.04±1.38	2.898	0.001
Learning habits	5.55±1.29	6.74±1.30	12.113	<0.001

DCCC, Dyslexia Checklist for Chinese Children.

is a lack of public awareness of DD in China. Together with parents' excessive focus on academic achievement, Chinese children with DD may be under more stress, resulting in a poorer QoL. DD was rated lower in psychosocial function, physiological and mental health, living environment, satisfaction with QoL and general QoL in the current study, which is broadly consistent with the Hungarian study mentioned above. Several domains (ie, school, family, mental health and general QoL) of DD children measured by another scale were reported to be worse than those of healthy children.¹⁸ Notably, a study conducted among Chinese children found that dyslexia group had lower scores in two factors of QLSCA (psychosocial function, physiological and mental health) than control group, but there was no statistical difference in the other factors.¹⁹ This is a case-control study with no difference of age, sex or residence between children with dyslexia and normal children. Correspondingly, the QoL of the two groups was not compared by the stratification

of these factors, which may be the reason of inconsistent results between this study and our study.

Age and gender have generally been revealed to influence children's QoL in past studies. Our study indicated that QoL declined with age through grades 3–6; this is partly supported by the previous finding that negative stress increases with age in elementary school pupils.³⁰ During this period, academic burdens gradually increase and parent–child relationships, peer relationships and teacher–student relationships become more complex, probably leading to a lower QoL. Overall, the QoL of girls was better than that of boys in domestic studies,^{31–33} including ours. This is inconsistent with most foreign studies,^{34,35} in which the QoL of boys was superior to that of girls. We speculate that different cultural backgrounds and social expectations regarding sexes may be the reason for this inconsistency. Regarding district, urban children showed a higher QoL than rural children in the current study, most likely due to life convenience (eg, Can you

Table 3 The comparison of quality of life between dyslexic and non-dyslexic children for rural men/women

Variable	Dyslexic group (M±SD)	Non-dyslexic group (M±SD)	t test	P value
Males				
Psychosocial function	58.34±10.32	60±9.15	1.287	0.198
Physiological and mental health	33.79±5.34	36.55±5.54	3.547	<0.001
Living environment	20.15±3.84	19.55±4.24	−1.012	0.312
Satisfaction with QoL	23.85±3.47	25.07±3.66	2.371	0.018
Total score	136.13±16.90	141.17±17.33	2.073	0.038
Females				
Psychosocial function	56.60±9.07	62.27±8.76	1.443	0.149
Physiological and mental health	35.00±5.48	37.11±4.92	0.958	0.338
Living environment	15.60±1.52	19.62±4.26	2.11	0.035
Satisfaction with QoL	23.00±3.00	25.48±3.47	1.593	0.111
Total score	130.20±9.45	144.48±16.71	1.909	0.057

QoL, quality of life.

Table 4 The comparison of quality of life between dyslexic and non-dyslexic children for urban men/women

Gender and age	Group	Psychosocial function (M±SD)	Physiological and mental health (M±SD)	Living environment (M±SD)	Satisfaction with QoL (M±SD)	Total score (M±SD)
Males						
<9	Dyslexic group	57.33±7.38	37.07±4.70	22.27±4.32	24.33±3.52	141.90±14.88
	Non-dyslexic group	62.00±8.51	36.73±5.55	21.03±4.15	25.14±3.62	144.90±16.44
	t	2.095	-0.233	-1.133	0.846	0.905
	P	0.037	0.816	0.258	0.398	0.366
9-	Dyslexic group	54.88±6.88	34.44±6.16	20.13±3.79	23.13±3.85	132.56±12.87
	Non-dyslexic group	63.17±8.37	37.27±5.28	21.16±4.10	25.68±3.33	147.29±15.85
	t	3.914	2.093	0.997	3.004	3.668
	P	<0.001	0.037	0.319	0.003	<0.001
10-	Dyslexic group	57.53±8.86	33.19±5.79	20.03±4.91	23.47±3.01	134.22±13.64
	Non-dyslexic group	62.23±8.60	36.84±5.43	21.42±4.29	24.96±3.50	145.46±16.76
	t	2.98	3.666	1.754	2.352	3.702
	P	0.003	<0.001	0.08	0.019	<0.001
11-	Dyslexic group	54.93±8.84	33.52±4.66	20.11±4.59	23.56±3.91	132.11±16.48
	Non-dyslexic group	61.17±9.25	36.64±5.49	21.43±4.14	24.54±3.65	143.78±17.44
	t	3.393	2.876	1.58	1.344	3.363
	P	0.001	0.004	0.115	0.18	0.001
12-	Dyslexic group	57.25±4.19	30.25±6.90	22.00±5.48	24.00±4.76	133.50±19.43
	Non-dyslexic group	58.36±7.66	36.52±5.39	21.45±4.21	25.03±3.10	141.36±13.98
	t	0.283	2.137	-0.238	0.595	1.023
	P	0.779	0.04	0.813	0.556	0.314
Females						
<9	Dyslexic group	58.00±1.41	40.50±4.95	20.00±1.41	26.00±1.41	144.50±3.54
	Non-dyslexic group	64.24±8.31	37.97±5.19	21.05±4.24	26.16±3.43	149.42±16.31
	t	1.06	-0.689	0.35	0.067	0.426
	P	0.29	0.491	0.727	0.947	0.67
9-	Dyslexic group	58.25±9.73	36.75±5.69	19.58±6.14	24.92±4.08	139.50±21.44
	Non-dyslexic group	64.77±8.53	38.01±5.06	21.71±4.22	25.90±3.34	150.39±15.60
	t	2.595	0.845	1.689	0.991	2.348
	P	0.01	0.398	0.092	0.322	0.019
10-	Dyslexic group	56.85±8.69	33.00±3.05	18.38±2.63	22.38±3.75	130.62±13.35
	Non-dyslexic group	63.02±8.36	36.65±5.20	21.69±4.17	25.05±3.66	146.40±16.97
	t	2.612	2.512	2.837	2.575	3.316
	P	0.009	0.012	0.005	0.01	0.001
11-	Dyslexic group	55.20±7.05	31.20±3.83	19.60±3.85	25.20±2.78	131.20±11.39
	Non-dyslexic group	62.34±8.24	36.63±4.99	21.32±3.77	24.52±3.72	144.81±16.51
	t	1.919	2.412	1.011	-0.405	0.272
	P	0.056	0.017	0.313	0.686	0.068
12-	Dyslexic group	48.00±18.39	23.00±0.00	22.00±8.49	20.00±5.66	113.00±32.53
	Non-dyslexic group	59.79±10.48	35.71±4.50	21.93±5.37	24.00±3.55	141.43±17.17
	t	1.388	3.882	-0.017	1.414	2.012
	P	0.187	0.002	0.987	0.179	0.064

Table 5 Multiple linear regression of factors influencing quality of life for children (total score)

Model	Unstandardized coefficients		Standardised coefficients	t	P value
	B	SE	β		
Gender	1.705	0.459	0.050	3.711	<0.001
Age	-1.166	0.193	-0.082	-6.054	<0.001
District	1.757	0.506	0.051	3.473	0.001
Groups (dyslexic group and non-dyslexic group)	-3.475	1.252	-0.037	-2.777	0.006
Family income					
Less than 1000 CNY	Reference				
1000–2000 CNY	1.001	0.914	0.027	1.096	0.273
2000–3000 CNY	2.977	0.911	0.084	3.269	0.001
More than 3000 CNY	1.026	0.939	0.027	1.092	0.275
Father's education					
Junior high school or below	Reference				
Senior high school or equivalency	1.012	0.624	0.029	1.623	0.105
Junior college	1.390	0.867	0.031	1.602	0.109
College diploma or above	2.021	1.071	0.037	1.887	0.059
Mother's education					
Junior high school or below	Reference				
Senior high school or equivalency	0.934	0.610	0.027	1.532	0.126
Junior college	1.031	0.881	0.021	1.170	0.242
College diploma or above	0.986	1.182	0.015	0.834	0.404
Parents' attitude to extracurricular activity					
Unconcern	Reference				
Sometimes encourage	3.527	0.909	0.098	3.878	<0.001
Often encourage	4.371	0.910	0.127	4.804	<0.001
Home literacy environment	0.844	0.097	0.136	8.683	<0.001
Electronic devices use	0.854	0.174	0.070	4.908	<0.001
Learning habits	2.892	0.182	0.225	15.904	<0.001

easily buy your living and school supplies?) and activity opportunism (eg, Do you often have opportunities to travel or watch exhibitions?). In addition, the children from middle-income households seemed to have a better QoL. When basic living needs are satisfied, the impact of adverse health outcomes caused by poverty may no longer be prominent.

The home literacy environment, electronic devices use and learning habits may influence QoL both directly and indirectly. Affluent reading resources and frequent parent–child reading can enhance the relationship between parents and children, which is beneficial for QoL. Long-term use of electronic devices has adverse effects on children's physiology and psychology, such as increasing the risk of obesity³⁶ and attention problems.³⁷ On the other hand, these three factors have been significantly associated with DD risk^{38 39} and probably further influence children's QoL. In addition, parents' attitudes toward extracurricular activities such as physical exercise undoubtedly affect the frequency of their children's

participation in them. Rich extracurricular activities increase children's communication with others and reduce negative emotions to promote QoL.

Some limitations should be considered when interpreting the current findings. First, it is a cross-sectional study; hence, the inference of a causal relationship between DD and QoL is very weak. Second, QoL is affected by various factors, many of which have not been included in our study. Third, this study was conducted in Tianmen, a small-sized city in China with a population of 1.606 million. Our results could not generalise to other cities with different characteristics. Fourth, given big sample size, Intelligence Quotient was evaluated according to annual health examination instead of the Combined Raven Test or the Wechsler Intelligence Scale for Children. The possibility that individual child with mental retardation had been included in current study could not be excluded.

In conclusion, our study indicated that the QoL of DD is worse than that of healthy children, suggesting more

attention and help for DD children. Additional well-designed studies are warranted to confirm our results.

Contributors Guarantor responsible for the overall content: RS. Study conception and design: RS, BZ, LZ. Data collection: LZ, KZ. Statistical analysis: KZ, QJ, XW. Drafting of manuscript: LZ, PX. Review and editing: RS, BZ.

Funding This work was supported by the National Natural Science Foundation of China (No. 81803253 and No. 81673194).

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Ethical Committee of Medical Association of Tongji Medical College, Huazhong University of Science and Technology (approval number: IEC (S082). Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request. Data are available on reasonable request from the corresponding author: songranran@hust.edu.cn, 0000-0002-8354-7698 (ORCID identifier)

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REFERENCES

- Liu L, Wang J, Shao S, *et al*. Descriptive epidemiology of prenatal and perinatal risk factors in a Chinese population with reading disorder. *Sci Rep* 2016;6:36697.
- Chan DW, Ho Connie Suk-han, Tsang Suk-man, *et al*. Prevalence, gender ratio and gender differences in reading-related cognitive abilities among Chinese children with dyslexia in Hong Kong. *Educ Stud* 2007;33:249–65.
- Francis DJ, Shaywitz SE, Stuebing KK, *et al*. Developmental lag versus deficit models of reading disability: a longitudinal, individual growth curves analysis. *J Educ Psychol* 1996;88:3–17.
- Hendren RL, Haft SL, Black JM, *et al*. Recognizing psychiatric comorbidity with reading disorders. *Front Psychiatry* 2018;9:101.
- Willcutt EG, Pennington BF. Psychiatric comorbidity in children and adolescents with reading disability. *J Child Psychol Psychiatry* 2000;41:1039–48.
- Mammarella IC, Ghisi M, Bomba M, *et al*. Anxiety and depression in children with nonverbal learning disabilities, reading disabilities, or typical development. *J Learn Disabil* 2016;49:130–9.
- Goldston DB, Walsh A, Mayfield Arnold E, *et al*. Reading problems, psychiatric disorders, and functional impairment from mid- to late adolescence. *J Am Acad Child Adolesc Psychiatry* 2007;46:25–32.
- Carroll JM, Maughan B, Goodman R, *et al*. Literacy difficulties and psychiatric disorders: evidence for comorbidity. *J Child Psychol Psychiatry* 2005;46:524–32.
- Carroll JM, Iles JE. An assessment of anxiety levels in dyslexic students in higher education. *Br J Educ Psychol* 2006;76:651–62.
- Jordan J-A, McGladdery G, Dyer K. Dyslexia in higher education: implications for maths anxiety, statistics anxiety and psychological well-being. *Dyslexia* 2014;20:225–40.
- Moojen SMP, Gonçalves HA, Bassôa A, *et al*. Adults with dyslexia: how can they achieve academic success despite impairments in basic reading and writing abilities? The role of text structure sensitivity as a compensatory skill. *Ann Dyslexia* 2020;70:115–40.
- Levy F, Young DJ, Bennett KS, *et al*. Comorbid ADHD and mental health disorders: are these children more likely to develop reading disorders? *Atten Defic Hyperact Disord* 2013;5:21–8.
- Pennington BF, Bishop DVM. Relations among speech, language, and reading disorders. *Annu Rev Psychol* 2009;60:283–306.
- Stein CM, Millard C, Kluge A, *et al*. Speech sound disorder influenced by a locus in 15q14 region. *Behav Genet* 2006;36:858–68.
- Ginieri-Coccosis M, Rotsika V, Skevington S, *et al*. Quality of life in newly diagnosed children with specific learning disabilities (SpLD) and differences from typically developing children: a study of child and parent reports. *Child Care Health Dev* 2013;39:581–91.
- Hubert-Dibon G, Bru M, Gras Le Guen C, *et al*. Health-related quality of life for children and adolescents with specific language impairment: a cohort study by a learning disabilities reference center. *PLoS One* 2016;11:e0166541.
- Rotsika V, Coccosis M, Vlassopoulos M, *et al*. Does the subjective quality of life of children with specific learning disabilities (SpLD) agree with their parents' proxy reports? *Qual Life Res* 2011;20:1271–8.
- Balazs J, Miklosi M, Toro KT, *et al*. Reading disability and quality of life based on both self- and parent-reports: importance of gender differences. *Front Psychol* 2016;7:7.
- Huang Y, He M, Li A, *et al*. Personality, behavior characteristics, and life quality impact of children with dyslexia. *Int J Environ Res Public Health* 2020;17:1415.
- Wu H, Liu P, Norm MH. Reliability and validity of children and adolescents' QOL scale. *Chin J School Health* 2006;27:18–21.
- Wu H, Song R, Yao B. The establishment of dyslexia checklist for Chinese children. *Chin J School Health* 2006;27:189–90.
- Hou F, Qi L, Liu L, *et al*. Validity and reliability of the dyslexia checklist for Chinese children. *Front Psychol* 2018;9:9.
- Jing J, Morinaga R, Hai Y. The revision and appraisal of the pupil rating scale revised-screening for learning disabilities. *Chin J Child Health Care* 1998;6:197–200.
- American Academy of Pediatrics, Section on Ophthalmology, Council on Children with Disabilities, American Academy of Ophthalmology, American Association for Pediatric Ophthalmology and Strabismus, *et al*. Joint statement-learning disabilities, dyslexia, and vision. *Pediatrics* 2009;124:837–44.
- Shaywitz SE. Dyslexia. *N Engl J Med* 1998;338:307–12.
- Chan Y, Chan YY, Cheng SL, *et al*. Investigating quality of life and self-stigma in Hong Kong children with specific learning disabilities. *Res Dev Disabil* 2017;68:131–9.
- Karande S, Venkataraman R. Self-perceived health-related quality of life of Indian children with specific learning disability. *J Postgrad Med* 2012;58:246–54.
- Li J, Yu Y, Huang Y. A case-control study of the intelligence structure and quality of life of children with learning disability. *Chin J Sch Health* 2006;27:662–3.
- Wu H, Meng H. The quality of life of children with learning disabilities. *Chin J School Doctor* 2000;14:241–3.
- Yu G, Chen S. The relationship of event stress and academic achievement to behavioral adjustment of elementary school students. *Acta Psychologica Sinica* 2001;33:344–8.
- Xu Z, Zhao M. Research on the quality of school life of primary school students: a case study of 2248 primary school students in Beijing. *J Educat Stud* 2012;8:84–96.
- Peng N, Wang L, Wang L. A study on quality of life among primary and secondary school students in Shanghai. *Chin J School Health* 2005;26:265–8.
- Mo S. Analysis on quality of life among children in a primary school in Qianjiang city of Hubei Province. *Chin J Health Educ* 2013;29:217–39.
- Michel G, Bisegger C, Fuhr DC, *et al*. Age and gender differences in health-related quality of life of children and adolescents in Europe: a multilevel analysis. *Qual Life Res* 2009;18:1147–57.
- Meade T, Dowswell E. Health-related quality of life in a sample of Australian adolescents: gender and age comparison. *Qual Life Res* 2015;24:2933–8.
- Zhang G, Wu L, Zhou L, *et al*. Television watching and risk of childhood obesity: a meta-analysis. *Eur J Public Health* 2016;26:13–18.
- Ferguson CJ. The influence of television and video game use on attention and school problems: a multivariate analysis with other risk factors controlled. *J Psychiatr Res* 2011;45:808–13.
- Sun Z, Zou L, Zhang J, *et al*. Prevalence and associated risk factors of dyslexic children in a middle-sized city of China: a cross-sectional study. *PLoS One* 2013;8:e56688.
- He Z, Shao S, Zhou J, *et al*. Does long time spending on the electronic devices affect the reading abilities? A cross-sectional study among Chinese school-aged children. *Res Dev Disabil* 2014;35:3645–54.