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Influence of parental education on the intelligence quotient profiles and socially adaptive behavior of school-age children with autism spectrum disorder in eastern China

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Abstract: Intelligence quotient (IQ) and adaptive behavior are the influencing factors of autism spectrum disorder (ASD) in children entering mainstream schools. This study explored the association between parental education level, IQ, and adaptive behavior in ASD groups. A total of 257 school-age ASD children were enrolled in our study from January 2017 to June 2021. Their parents completed a standard demographic form, including age at autism diagnosis, gender, school placement, and parents' educational background. The Chinese version of the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV) was completed by a certified assessor for each enrolled child. Parents were interviewed on adaptive behavior using the Chinese version of the Adaptive Behavior Assessment System, Second Edition (ABAS-II). The average IQ of school-age ASD children was 76.88 (standard deviation (SD)=22.62) and boys had higher IQ levels than girls. The IQ was positively correlated with age. The General Adaptive Composite (GAC) score was 82.47 (SD=15.86) and adaptive behavior did not increase with age. ASD children who attended mainstream schools had better adaptive behavior profiles than other children. The mother's education level showed a significant correlation with the IQ and adaptive behavior of autistic children, while the father's education level did not. Consequently, better training and support for parents may help autistic children enter mainstream schools, with adaptive training being the most urgently required skill for parents.

Key words: Autism spectrum disorder (ASD); School-age children; Intelligence quotient (IQ); Adaptive behavior; Parental education

1 Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized by problems in social interactions, communication disorders, and repetitive behaviors (Battle, 2013). Despite the variability of data across different geographical areas, epidemiological studies have suggested that the prevalence of ASD is globally on the rise. At the Autism and Developmental Disabilities Monitoring (ADDM) Network sites, ASD prevalence estimate has increased from 18.5 per 1000 children (one in 54) aged 8 years in the surveillance year 2016 to 23.0 (one in 44) in the surveillance year 2018 (Maenner et al., 2020, 2021). The prevalence of ASD among seven million schoolchildren in England, based on the Spring School Census 2017 from the Pupil Level Annual Schools Census of the National Pupil Database, was 1.76% (Roman-Urrestarazu et al., 2021). The reported prevalence of ASD in China is slightly lower than that in western countries, with the latest study reporting 0.7% (Zhou et al., 2020). However, regardless of country, the prevalence of ASD has shown a gradual upward trend (Sun et al., 2019). China has a huge population, making it a significant economic force. However, high intervention costs and prognostic management place a considerable pressure on families and society.

There is a growing demand for special education resources for children with autism worldwide. Pupils with ASD are increasingly educated in inclusive mainstream classrooms (Dillenburger et al., 2017). The proportion of children with autism attending mainstream

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schools in the United States rose from 12% to 59% between 1991 and 2009 (Snyder and Dillow, 2012). European Union countries unanimously implemented the right to education for children with special education needs, including ASD children (van Kessel et al., 2021). Data from a survey of the United Kingdom in 2012 displayed that 70% of these children are taught in mainstream schools (Andrew, 2012). With the promotion of integrated education, in-class education has become an important form of placement for ASD children (Hu and Fan, 2016). It was found that children who continued to study in general education/inclusive classrooms had higher achievements than those transferred to special education classrooms (Kim et al., 2018). Moreover, autistic children can benefit from inclusive education, as shown by improving social skills and well-being, because they are educated alongside their typical peers (Lai et al., 2020). China's service programs primarily focus on children aged between zero and six years. Meanwhile, the connections between the government, healthcare system, institutes, schools, community, and families remains weak, and the cooperation among these institutions are underdeveloped (Sun et al., 2013). Therefore, implementing inclusive education is difficult, and for children with autism in China, attending mainstream schools remains an obstacle in the education pathway (Sun et al., 2013; Jin and Zhou, 2018).

It is general practice to assess the intelligence quotient (IQ) of children with autism to select appropriate educational placements. Intelligence is a key factor that affects phenotypic variation across the ASD spectrum (Rommelse et al., 2015). Among ASD people, IQ strongly predicts school, work, and social functioning outcomes (Holwerda et al., 2012). According to previous research on the structure of IQ in children with autism, some children with ASD spoke fluent language, and a number of these individuals depicted specific cognitive strengths and talents that are unique to children with ASD (Meilleur et al., 2015), while others showed poor performance on a range of cognitive tasks, such as slow processing speed, dysgraphia, learning disability as well as impaired perception (Li et al., 2017). The analysis of the intelligence structure of high-functioning children with autism in China has revealed that ASD children can also exhibit weak processing speed and working memory (Lin et al., 2016; Deng et al., 2020). These above studies have shed light on interventions for ASD children. Furthermore, data from the US suggested that the proportion of ASD combined with intellectual disability has declined from approximately 50% in 2000 and 2002 to 35.2% in 2018; 23.1% of ASD children were classified in the borderline range (70<IQ⩽85), and 41.7% were classified in the average or higher range (IQ>85) (Maenner et al., 2021). The proportion of children with autism in China with normal IQ has not yet reached this level. A study by Jia and Wang (2010) demonstrated that 61% of Chinese children with autism had an IQ lower than 70, while 39% had borderline or normal IQ. This is lower than that observed in western countries. On the one hand, the sample size of this study was limited; on the other hand, the early identification and early intervention of autism vary among different regions, which requires further exploration in these fields.

In addition to cognitive disability, difficulties in adaptive skills pose real obstacles to the daily functioning of ASD children entering mainstream schools (Szatmari et al., 2015; van Schalkwyk and Volkmar, 2017). Adaptive abilities broadly refer to an individual's functional skills surrounding developmentally appropriate daily activities and play a role in personal independence and social responsibility. Autism can affect an individual's development and ability to support their daily functioning and life adaptation (Lai et al., 2020). There is wide variation in school performance among individuals with ASD (Keen et al., 2016). However, ASD children have a relatively poor ability to cooperate with multimodal resources to achieve communicative purposes (Deng et al., 2020), and the low levels of peer acceptance and social status are generally ignored and rejected by ordinary children in the class (Zhang et al., 2019). Moreover, adaptive behavioral impairments are present at all ages in ASD patients who increasingly fall behind their peers in adaptive behavior with age (Chatham et al., 2018). Decreased capacity for independent functioning may be related to real-world outcomes of ASD, which appears to be an important barrier to engaging in post-secondary education and lower the likelihood of independent living for ASD students (Shattuck et al., 2012; van Schalkwyk and Volkmar, 2017). Adaptive behavior may be a more important skill for ASD children for interventions targeting individual or societal outcomes. In fact, cognitive, verbal, and motor rehabilitation trainings are more readily available, whereas the training of

adaptive behavior often encounters more difficulties in the real environment. Thus, it is important to explore factors that can facilitate training and ensure continued support for adaptive behavior training.

Parental involvement is one of the factors associated with the development of inclusive education in ASD children (van Kessel et al., 2021). Previous studies have revealed that parental perceptions of autism, parental stress, and socioeconomic status (SES) have important implications for understanding behavioral problems and unmet service needs in children with autism (Taylor and Henninger, 2015; Haney et al., 2018). Parents experience great challenges and increased parenting pressure in dealing with the complex demands of caring for their children. However, when parents receive support and become more involved in their children's interventions, they will gain greater parenting self-efficacy and will be more satisfied with the training received as part of these therapies (Kurzrok et al., 2021). Improving parental skills provides children with opportunities for continuous learning in various situations. Parent-mediated intervention can not only improve the parent–child interaction and parental awareness of events and activities, but also has a long-term beneficial effect on improving children's language comprehension ability and reducing the severity of autism (Oono et al., 2013). However, most interventions for ASD are evaluated solely regarding child outcomes while ignoring parental factors that may influence the immediate and long-term effects of treatment (Karst and van Hecke, 2012).

Raising an ASD child can be a huge challenge for parents and families, and the resulting decreased parental effectiveness, increased parental stress, significant financial strain, and time pressures can cause imbalances in family functioning (Karst and van Hecke, 2012). Poor family functioning has been found to predict poor functioning in ASD children (Lei and Kantor, 2021), and children from disadvantaged backgrounds tend to lag behind their peers in academic performance (Demir-Lira et al., 2021). Therefore, it is critical to explore factors that contribute to successful family functioning. Relative to income and occupation, parental education is considered a stronger predictor of academic achievement and is commonly used to measure SES (Duncan and Magnuson, 2012). Besides, because this parameter is more stable than income or occupation, it is also closely related to the home-learning environment and the parent–child interaction, while parental involvement in home-based learning activities is linked to children's IQ and adaptive behavior skills (McCormick et al., 2020). In previous studies, parents' educational levels were usually evaluated as a whole (Milgramm et al., 2022; Morsa et al., 2022). In addition, there is a lack of relevant research data on China. Therefore, this study makes an important contribution by exploring the influence of parents' education levels on the functioning of autistic children in eastern China.

We included school-age ASD children as the study group. We postulated that the cognitive abilities and socio-adaptive skills of school-age children diagnosed with autism may serve as crucial determinants influencing their integration into mainstream educational settings. Given their pivotal role in child rearing, parents possessing higher levels of education are likely to exhibit enhanced aptitude for learning, thereby enabling them to effectively facilitate the intellectual and social development of their autistic offspring. Hence, this study aimed to: identify the IQ profiles of school-age ASD children using the Chinese version of the Wechsler Intelligence Scale for Children, Fourth Edition (WISC-IV); explore the social adaptive behavior of ASD children using Chinese version of the Adaptive Behavior Assessment System, Second Edition (ABAS-II); and explore the association between parental education and IQ and social adaptability in school-age ASD groups. The results of this study can provide information for the medical community and policymakers to develop care strategies for ASD children, assist school-age children in achieving better-integrated education, and support future ASD research in China.

2 Materials and methods

2.1 Participants

All study participants were recruited between January 2017 and June 2021 from the Department of Developmental and Behavioral Pediatrics at the Children's Hospital of Zhejiang University School of Medicine, Hangzhou, China. All children included in the study were school-aged, with Mandarin as their native language, were diagnosed with ASD by medical teams in developmental-behavioral pediatrics, and met the diagnostic criteria for ASD in the Diagnostic and

Statistical Manual of Mental Disorders, Fifth Edition (DSM5). The mean age of all the children in the study group was 7.55 years (standard deviation (SD)=1.59), with the mean age at diagnosis at 6.58 years, ranging from 2.20 to 13.10 years. Based on the age at diagnosis, the enrolled children were divided into two groups: diagnosed at school-age (n=182) and at non-school-age (n=75).

2.2 Materials

2.2.1 Demographic form

The parents completed a standard demographic form designed for the study group. This form requested information regarding the age of autism diagnosis, gender, school placement, and the parents' educational background.

2.2.2 Chinese version of WISC-IV

The WISC-IV scale was published in 2003 (Naglieri and Paolitto, 2005) and is currently used in the clinical setting in English-speaking countries. It measures the intellectual ability and cognitive function of 6–16-year-old children and adolescents. This psychometric measure was developed to provide an overall measure of general cognitive ability and a full scale intelligence quotient (FSIQ). It consists of four factors to measure intellectual functioning: Verbal Comprehension Index (VCI), Perceptual Reasoning Index (PRI), Working Memory Index (WMI), and Processing Speed Index (PSI). The VCI includes the vocabulary (VOC), similarities (SIM), and comprehension (COM) subtests, which encompass the block design (BD), picture concept (PC), and matrix reasoning (MR) subtests. The WMI includes the digit span (DS) and letter-number sequencing (LNS) subtests, and the PSI includes the coding (CD) and symbol search (SS) subtests. The average value for FSIQ and all subtests was 100, with an SD of 15. Full IQ scores at 70<IQ≤85 were defined as borderline level, IQ>85 as normal level, and IQ≤70 as mental retardation. This scale was introduced by Zhang (2009) in China and has been used in several studies, which fits well with Chinese children, including those with autism (Li et al., 2017). In this study, the scale was completed by a certified assessor for each included child. If the child completed more than one test during school age, the last result was used for the analysis.

2.2.3 Chinese version of ABAS-II

ABAS-II was used to assess the adaptive behavior of children aged 6–18 years (Oakland, 2011). It was introduced in China after standardization in 2016, and the revised Chinese version of the ABAS-II was consistent with the original version in structure and function (Li and Qiu, 2016). It includes a General Adaptive Composite (GAC), which is divided into three domains: conceptual skills (communication, functional academics, and self-direction skills), social skills (leisure and social skills), and practical skills (community use, home or school living, health and safety, and self-care). Parents were interviewed using the Chinese version of ABAS-II. Respondents completed ABAS-II by indicating whether and how frequently (never, sometimes, or always) the child could perform an activity independently when needed. The WISC-IV scale results were selected for analysis on the same day.

2.3 Data analysis

All medical records of the enrolled cases were reviewed by the research team, along with information about diagnoses and previous assessments (intellectual and adaptive functioning). Demographic questionnaires were completed by each family. Continuous variables were presented as mean±SD (normal distribution), and categorical variables were expressed as percentages. The t-test was used to compare normally distributed mean differences between the two groups. Among multiple groups, if the data followed normal distribution, one-way analysis of variance (ANOVA) was used for comparison, and the least significant difference-t (LSD-t) method was further conducted for pairwise comparison when the difference between groups was statistically significant. If the data did not follow normal distribution, Kruskal-Wallis H-test was used for comparison between groups. A two-sided P<0.05 was considered statistically significant. All analyses were performed by R 3.6.0 with a random seed set to 123.

3 Results

3.1 Participant characteristics

This study enrolled 257 ASD children, including 219 males (85.21%) and 38 females (14.79%), equivalent

to a ratio of 5.76:1. The details of demographic data are shown in Table 1.

3.2 Intelligence quotient and adaptive behavior profiles

In this study, 31.52% of the ASD children had IQ less than 70, 30.74% had borderline IQ, and 37.74% had normal IQ. The average IQ level of a total of 257 school-age ASD children was 76.88 (SD=22.62), with VCI of 78.26 (SD=22.01), PRI of 85.56 (SD=24.88), WMI of 76.91 (SD=20.91), and PSI of 76.67 (SD=20.33). The analysis of the ABAS-II results demonstrated the following scores: GAC of 82.47 (SD=15.86), conceptual skills of 82.47 (SD=14.82), social skills of 78.32 (SD=18.08), and practical skills of 86.86 (SD=15.20). The IQ level and adaptive behavior profiles of autistic children of different ages at diagnosis, genders, and grades were summarized in Table 2.

The findings revealed that FSIQ score and each index IQ score of children diagnosed at school age were higher than those of non-school-age children. Males with ASD (78.30±23.11) had significantly higher IQs than females (68.71±17.67), with P=0.016. The senior grade group of ASD children exhibited higher IQ scores compared to the other three groups, with the highest score 87.62±25.92 (P<0.001).

The ABAS-II analysis results depicted no statistical difference in scores between the two groups diagnosed at different ages (P>0.05). Males had better adaptive ability than females, but only conceptual skills exhibited statistically significant difference. The senior grade group featured significantly better GAC (P=0.001), conceptual skills (P<0.001), and social skills (P=0.003) compared to the other three groups.

The correlation between children's IQ and adaptive behavior profiles and age is displayed in Table 3. The correlation between FSIQ and age was statistically significant (r=0.241, P<0.001) in the WISC-IV test, while the correlation between age and adaptive behavior was not significant (r=0.051, P=0.414).

3.3 Parental education

The influence of the father's education level was compared to the IQ of ASD children, and it was found that the group in which fathers had the least education had the highest FSIQ score (85.80±20.13), those in the junior college group had the lowest IQ score (70.88±19.96), and the difference between the groups was statistically significant (P=0.007). Among them, PRI and PSI demonstrated the same distribution pattern; the highest VCI score was exhibited in the lowest educational attainment; only the WMI had the highest score in the college or above group (82.59±21.71). The analysis of the influence of the mother's education on children's IQ revealed that children whose mothers

Table 1 Participant characteristics

Index	Classification	n	Percentage (%)
Total		257	100.00
Sex	Female	38	14.79
	Male	219	85.21
Age at diagnosis	Non-school-age group	75	29.18
	School-age group	182	70.82
Grade	Kindergarten	98	38.13
	Lower grade	117	45.53
	Senior grade	34	13.23
	Others (special school or not enrolled)	8	3.11
Father's education	Middle school	96	37.35
	Junior college	48	18.68
	College or above	108	42.02
	Others (primary school or no schooling)	5	1.95
Mother's education	Middle school	76	29.57
	Junior college	65	25.29
	College or above	106	41.25
	Others (primary school or no schooling)	10	3.89

Table 2 Intelligence quotient and adaptive behavior profiles of different ages at diagnosis, genders, and grades

Index	Classification	Age at diagnosis			Gender		
		Non-school-age (*n*=75)	School-age (*n*=182)	*P* value	Female (*n*=38)	Male (*n*=219)	*P* value
WISC-IV	FSIQ	72.05±20.39	78.87±23.24	0.028	68.71±17.67	78.30±23.11	0.016
	VCI	72.89±19.61	80.48±22.60	0.012	69.95±18.89	79.71±22.23	0.011
	PRI	81.08±24.46	87.41±24.87	0.063	77.13±21.19	87.03±25.22	0.023
	WMI	73.53±19.07	78.31±21.51	0.096	70.08±15.74	78.10±21.49	0.008
	PSI	73.11±18.74	78.13±20.83	0.072	73.08±17.41	77.29±20.77	0.240
ABAS-II	GAC	83.44±14.16	82.07±16.54	0.529	79.18±15.22	83.04±15.94	0.167
	Conceptual skills	83.16±13.23	82.19±15.46	0.633	77.89±14.93	83.26±14.70	0.039
	Social skills	77.85±14.71	78.52±19.33	0.766	73.68±19.15	79.13±17.80	0.087
	Practical skills	88.44±14.22	86.20±15.58	0.284	85.18±14.45	87.15±15.34	0.464

Index	Classification	Grade				
		Kindergarten (*n*=98)	Lower grade (*n*=117)	Senior grade (*n*=34)	Others (*n*=8)	*P* value
WISC-IV	FSIQ	69.34±20.49	81.09±20.84	87.62±25.92	62.00±24.96	<0.001
	VCI	72.79±20.04	80.54±20.41	89.91±26.57	62.63±21.79	<0.001
	PRI	79.46±24.79	89.54±23.38	92.74±25.26	71.75±28.29	0.002
	WMI	70.56±18.74	79.79±19.57	86.97±24.01	70.00±28.40	<0.001
	PSI	67.63±17.98	83.28±19.02	84.32±19.70	58.00±16.12	<0.001
ABAS-II	GAC	78.90±16.35	85.28±13.69	86.35±17.52	68.50±18.54	0.001
	Conceptual skills	78.88±14.66	84.95±12.91	87.53±16.54	68.75±19.64	<0.001[a]
	Social skills	74.71±17.47	80.82±16.72	83.50±21.08	64.00±18.56	0.003
	Practical skills	84.05±16.38	89.47±13.12	88.74±15.99	75.00±16.48	0.006

Data are expressed as mean±standard deviation (SD). WISC-IV: the Wechsler Intelligence Scale for Children, Fourth Edition; ABAS-II: the Adaptive Behavior Assessment System, Second Edition; FSIQ: full scale intelligence quotient; VCI: Verbal Comprehension Index; PRI: Perceptual Reasoning Index; WMI: Working Memory Index; PSI: Processing Speed Index; GAC: General Adaptive Composite. [a] Represents the value analyzed by Kruskal-Wallis test, and the rest are analyzed by one-way analysis of variance (ANOVA).

Table 3 Spearman correlation analysis between intelligence quotient and adaptive behavior profiles and children's age

Index	Classification	*r* value	*P* value
WISC-IV	FSIQ	0.241	<0.001
	VCI	0.220	<0.001
	PRI	0.174	0.005
	WMI	0.209	<0.001
	PSI	0.242	0.001
ABAS-II	GAC	0.051	0.414
	Conceptual skills	0.064	0.304
	Social skills	0.072	0.249
	Practical skills	0.024	0.699

WISC-IV: the Wechsler Intelligence Scale for Children, Fourth Edition; ABAS-II: the Adaptive Behavior Assessment System, Second Edition; FSIQ: full scale intelligence quotient; VCI: Verbal Comprehension Index; PRI: Perceptual Reasoning Index; WMI: Working Memory Index; PSI: Processing Speed Index; GAC: General Adaptive Composite.

had the highest education level had the highest FSIQ score and each subtest score. The differences between groups were statistically significant (FSIQ, VCI, PRI, and WMI: $P<0.001$; PSI: $P=0.020$).

Regarding adaptive behavior, the maternal education level was significantly associated with GAC ($P=0.038$) and conceptual skill scores ($P=0.020$), whereas only differences in social skills accounted for statistically significant differences in the fathers' education levels ($P=0.038$). However, the educational level of both father ($P=0.229$) and mother ($P=0.135$) had no statistically significant effect on their children's practical skills (Table 4).

4 Discussion

In this study, we set out to uncover the neurocognitive profile and social behavior of normative and relative strengths and weaknesses of ASD children as a vulnerable group. We hypothesized that their intelligence

Table 4 Intelligence quotient level and adaptive behavior vs. parental education

Index	Classification	Father's education				
		Middle school (*n*=96)	Junior college (*n*=48)	College or above (*n*=108)	Others (*n*=5)	*P* value
WISC-IV	FSIQ	73.54±20.23	70.88±19.96	82.10±24.76	85.80±20.13	0.007[a]
	VCI	74.41±19.94	74.75±19.07	82.42±24.06	96.40±20.61	0.019[a]
	PRI	83.39±23.55	78.88±22.00	90.16±26.73	92.40±18.84	0.040
	WMI	72.51±19.12	72.83±20.30	82.59±21.71	78.00±12.28	0.002
	PSI	75.99±19.91	69.73±18.72	80.08±20.92	82.40±16.62	0.027
ABAS-II	GAC	79.54±15.98	83.42±14.85	84.90±16.04	77.00±12.75	0.086
	Conceptual skills	79.99±15.33	83.29±13.49	84.49±15.00	78.60±6.50	0.159
	Social skills	74.65±17.01	78.48±19.08	81.78±18.13	72.80±16.89	0.038
	Practice skills	84.70±15.26	87.65±14.54	88.69±15.41	81.20±13.05	0.229
Index	Classification	Mother's education				
		Middle school (*n*=76)	Junior college (*n*=65)	College or above (*n*=106)	Others (*n*=10)	*P* value
WISC-IV	FSIQ	68.99±19.54	74.42±18.99	84.80±24.76	68.90±16.46	<0.001[a]
	VCI	71.14±19.79	75.88±18.75	85.48±23.92	71.40±14.25	<0.001[a]
	PRI	76.88±22.62	84.35±21.12	93.26±26.55	77.80±23.03	<0.001
	WMI	69.36±17.68	74.95±20.03	84.07±21.57	71.30±20.00	<0.001
	PSI	73.00±20.67	74.02±18.81	81.35±20.81	72.10±13.55	0.020
ABAS-II	GAC	79.68±16.10	82.46±14.71	85.25±15.75	74.10±18.19	0.038
	Conceptual skills	79.25±15.23	82.29±13.30	85.48±14.87	76.20±15.62	0.020
	Social skills	75.34±17.78	77.74±16.85	81.50±18.68	71.10±17.84	0.071
	Practical skills	85.26±15.33	87.26±14.62	88.58±14.91	78.10±18.90	0.135

Data are expressed as mean±standard deviation (SD). WISC-IV: the Wechsler Intelligence Scale for Children, Fourth Edition; ABAS-II: the Adaptive Behavior Assessment System, Second Edition; FSIQ: full scale intelligence quotient; VCI: Verbal Comprehension Index; PRI: Perceptual Reasoning Index; WMI: Working Memory Index; PSI: Processing Speed Index; GAC: General Adaptive Composite. [a] Represents the value analyzed by Kruskal-Wallis test, and the rest are analyzed by one-way analysis of variance (ANOVA).

level and social adaptability at the school age might be important factors affecting their entry into mainstream schools, and parents, as the children's main caregivers, played an important role in the cultivation of their children's intelligence development and social adaptability. The results indeed showed that the mother's education level, but not the father's education, had a significant correlation with the IQ and adaptive behavior of their autistic children.

The average IQ level of school-age children with autism included in this study reached a borderline level (70<IQ≤85), 31.52% were classified as having an IQ of ≤70, 30.74% were classified in the borderline range, and 37.74% were in the average or higher range (IQ>85). The distribution of children's IQs was close to that reported by a US study in 2018 (Maenner et al., 2021), and as expected, their cognitive levels still lagged behind their peers. The correlation between ASD children's IQ level and age, as well as the grading, indicated that cognition can continue to develop with age, and a good IQ level can better support children's learning in mainstream schools. In terms of gender, the average IQ levels of boys were higher than those of girls. This is consistent with previous study indicating a lower proportion of females than males with high-functioning ASD (Fombonne, 2009). However, a study in China indicated that preschool ASD girls with FSIQ>70 had higher IQ levels than boys (Deng et al., 2020). These were contrasting conclusions, but given that there were only 38 girls A included in the study, they clearly did not represent the overall distribution of intelligence among females with autism. These findings only provide some evidence for gender differences in IQ in school-age children with autism, and more attention should be paid to the intellectual problems and life outcomes of Chinese female autistic patients.

Furthermore, an earlier diagnosis did not indicate a better IQ, the IQ levels of children diagnosed early were lower than those of school-age children. Another study of 3833 ASD children aged eight years also found that Children with ASD and IQ≤70 had a lower median age at diagnosis (44 months) than children with IQ>70 (53 months) (Maenner et al., 2021). However, children who received the intervention before the age of four years achieved superior verbal developmental quotient gains compared to their older counterparts (Vivanti et al., 2016). The reasons underlying this difference are not fully understood and may be related to the severity of symptoms, the intensity and breadth of rehabilitation training, or the support level of the family. The importance of early diagnosis and subsequent early intervention in ASD has been well established (Elder et al., 2017). Additional efforts are needed to better understand the impact and value of early diagnosis and service needs of children with ASD.

The ABAS-II results revealed that the overall adaptability of ASD children was marginal. Although cognitive levels of boys were higher than those of girls, there was no statistical difference between the two genders in any social adjustment areas except conceptual skills. While previous research has depicted that lower IQ is associated with poorer adaptive functioning (McQuaid et al., 2021), this does not mean that children with autism with lower IQs cannot have higher levels of adaptive behavior. Simultaneously, adaptive behavior did not increase with age, consistent with previous study by Pugliese et al. (2015), while children with autism who attended higher grades had higher adaptive behavior scores. This explains why better adaptive behavior can support children's adjustment in ordinary schools, and it further proves that adaptive functioning is an essential skill for daily functioning and is also a condition for social acceptance for ASD children.

Because of the differences in the developmental rules of IQ and adaptive behavior of autistic children, the influence of parents and families on the development of autistic children becomes an important aspect to study. Parents and family functioning can be affected by developmental challenges faced by ASD children (Rao and Beidel, 2009). According to early theories of the etiology of autism, parents, especially mothers, are blamed, leading to stigmatization and isolation. Nowadays, the mothers bear the primary responsibility for her children and have been increasingly involved in interventions for ASD in most families. As primary caregivers for children, highly educated mothers may have better cognitive and learning skills as well as self-regulation skills. As a neurodevelopmental heterogeneity, symptoms of ASD persist and change throughout life and the focus of the intervention also shifts over time. Therefore, it is particularly important whether caregivers can maintain good conditions, accept pressure and challenges, detect changes in training content in time, and seek or provide corresponding assistance for their children.

This study focused on the educational level of parents, which is a stable evaluation index of family economic status and a signal of parents' learning ability. Previous studies have tended to analyze parents' education levels as a whole (Milgramm et al., 2022; Morsa et al., 2022), and mothers' influence on their children emerged when the educational levels of fathers and mothers were analyzed independently. Research has indicated that the educational background of parents is an influencing factor in family functioning, which is related to language development in ASD (de Jesus Alvarenga Carvalho et al., 2016). We found that ASD children's IQ was related to the mother's education, while the presence of highly educated fathers did not yield the higher levels of cognitive performance in their children. For this reason, mothers may be an important support point for families, especially those with low education levels. However, we have also raised the possibility that the absence of a father's role could be detrimental to the recovery of autistic children. Therefore, improving learning of fathers and acquiring their ability to raise children with autism may be an important practical task.

Adaptive behavior differs from IQ levels. We indicated that highly educated mothers had a protective effect on GAC adaptive behavior and conception skills in children with autism. Meanwhile, autistic children with highly educated fathers had the highest scores. Both fathers and mothers with higher education levels exhibited an advantage as parents, but there was no difference in the education levels of the parents in some areas, especially in practical skills with a high degree of relevance to life. Therefore, even highly educated families face difficulties in adaptive behavior training. The study of Dawson et al. (2010) has demonstrated that comprehensive developmental and behavioral interventions implemented subsequent to early diagnosis of ASD can enhance adaptive behavior and mitigate the severity of ASD symptoms. Parents give

more importance to the cognition and language training of their children, and rehabilitation is the focus of most rehabilitation institutions. In contrast, it is easy to ignore the cultivation of adaptive behavior, which is often more dependent on the family environment and needs to be related to family and daily life. Moreover, adaptability is more closely related to an individual's independence and social responsibility than intellectual ability (Wei et al., 2008). Thus, cooperation between rehabilitation institutions and families to improve family function may be an effective countermeasure to promote the development of adaptive behavioral capacity.

5 Limitations

In this work, the influence of parental education level on the IQ and adaptive behavior of children with ASD was explored in an attempt to highlight more appropriate family support and auxiliary strategies. The enrolled autistic children had borderline IQ, possibly due to establishing a three-level maternal and child healthcare system to facilitate early detection and the high local economic and cultural levels to facilitate early intervention. Early detection and intervention improve the cognitive levels of autistic children and reduce the proportion of children with intellectual disabilities, which makes our conclusions biased. Additionally, we assessed children because of the need for educational placement. This means that parents were willing to send their children to mainstream schools; perhaps their parents paid more attention to their children's cognitive and behavioral training. At the same time, some severely autistic children were excluded because their parents had stopped supporting their admission to mainstream schools. Therefore, the sample source was biased. Finally, this was a cross-sectional survey with a small regional sample that did not assess the children's rehabilitation history or autism symptom severity. Therefore, more comprehensive and long-term tracking is needed to evaluate the factors interfering with children's IQ and adaptive behavior.

6 Conclusions

Herein, the influence of parental education level on the IQ and adaptive behavior of autistic children was explored in an attempt to find more appropriate family support and auxiliary strategies. Overall, better training and support for parents may help autistic children enter mainstream schools, with adaptive training being the most urgently required skill for parents.

Data availability statement

All statistical data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Author contributions

Wenhao LI conceived the study and wrote the draft of the manuscript. Chao SONG conducted literature search and completed the data analysis. Lifei HU and Lingling WU engaged in behavioral observation. Wenhao LI, Chao SONG, and Lifei HU conducted the IQ test. Zhiwei ZHU conceived, designed, and supervised the whole research. All authors have read and approved the final manuscript, and therefore, have full access to all the data in the study and take responsibility for the integrity and security of the data.

Compliance with ethics guidelines

Wenhao LI, Chao SONG, Lifei HU, Lingling WU, and Zhiwei ZHU declare that they have no conflict of interest.

This study was approved by the Institutional Review Board of Children's Hospital of Zhejiang University School of Medicine (No. 2022-IRB-014), and written informed consent was obtained from the caregiver of every participant.

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