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Characteristics of Visual Function in Children With Cerebral Palsy and Intellectual Disabilities in Urban Beijing

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Objective: To investigate ocular development and the characteristics of visual function among children with cerebral palsy (CP) and intellectual disabilities in Beijing's Chaoyang District schools.

Methods: A total of 160 children (320 eyes) with CP and intellectual disabilities, including 86 males and 74 females aged between 6 and 18 years old (median, 13.5 years), were included in this study. A total of 214 healthy children aged 6 to 18 years (median, 10 years) were recruited as a control group for visual function, including 116 males and 98 females. Subjective far vision, objective vision (electrophysiological sweep visual evoked potential), corrected vision, near stereopsis, ametropia, the anterior segment, and the fundus were examined.

Results: A total of 232 eyes (76.32%) were ametropic among 304 eyes that could cooperate; 200 eyes (65.79%) were astigmatic, 16 eyes (5.26%) were hyperopic, and 120 eyes (39.47%) were myopic. A total of 64 children had strabismus (40%), and 24 had nystagmus (15%). The near stereopsis test showed that 72 children (64.29%) demonstrated 100″ and less. A total of 214 healthy children aged 6 to 18 years were recruited as a control group for visual function. There was a significant difference in visual functions between children with intellectual disabilities and those without ($Z = -10.370$; $P < 0.001$).

Conclusions: The prevalence of abnormal visual function in children with CP and intellectual disability was significantly higher than that in healthy children. Among them, myopia is the main refractive error, and the correction rate was low.

Translational Relevance: The electrical signals generated by stimulating the retina with black and white stripes are transmitted to the brain. Scanning electrophysiological devices can capture the activity of the cerebral cortex and convert it into an electroencephalogram. Scanning electrophysiological electrooculography is used to examine the objective vision of children with cerebral palsy.

Introduction

Cerebral palsy (CP) is a permanent postural and/or motor dysfunction caused by nonprogressive interference in the developing brain of a fetus or infant and is one of the leading causes of motor disorders in children.[1] Michael-Asalu et al.[2] reported that the incidence of CP was approximately 0.3% in 2019, which is decreasing owing to significant advances in perinatal technology in medicine. The common causes of CP are intrauterine infection, premature birth or hypoxic asphyxia, craniocerebral disorders, genetics, radiation, and pharmacological side effects.[3] Hollung et al.[4] reported that 50% to 60% of children with CP also had varying degrees of intellectual impairment. Owing to various developmental factors, the intelligence of children with CP is significantly lower, accompanied by obvious obstacles to social adaptability. Globally, approximately 42% of visual impairments are caused by ametropia.[5] However, incidences of visual abnormalities in children with CP are significantly higher, highlighting the need for attention from caregivers and society. The ocular development of children with CP and intellectual disabilities attending schools for special needs children in Beijing's Chaoyang District was assessed via eye screening to provide a better understanding of the characteristics of ocular development and the early prevention and treatment of associated eye diseases.

Methods

Ethical Approval

Data collection procedures were conducted in accordance with all local laws and the principles of the Declaration of Helsinki. The study was approved by local institutional review committees, including the ethics committees of Tianjin Medical University and Tianjin Eye Hospital.

Diagnostic Criteria for CP

The main manifestations of CP include dyskinesia and abnormal posture. Neuroimaging reveals severe periventricular white matter softening, polycystic cortical softening, and encephalomalacia.[6] The key points are as follows: (1) brain injury resulting in CP is nonprogressive; (2) the lesion causing dyskinesia is in the brain; (3) the onset of symptoms occurs in infancy; (4) it is sometimes accompanied by intellectual disabilities, epilepsy, sensory and perceptual impairment, and other abnormalities; and (5), except for central dyskinesia caused by progressive diseases and temporary motor abnormalities in healthy children, the three main types are spasmodic, dyskinesia, and ataxia.

Diagnostic Criteria for Intellectual Disabilities

The World Health Organization's diagnostic screening criteria for intellectual disabilities[7] involves different screening methods for different ages, including the drawing test for children aged 6 to 12 years and the infant junior middle school students' social life ability scale for children aged 13 to 18 years. In this study, children aged 6 to 18 years were assessed using the Wechsler intelligence scale. If their IQ was less than 70 and the development quotient was less than 80, the infant junior high school student's social life ability scale was used to determine the level of intellectual impairment. The IQ indicated mild intellectual disability at 55 to 69, moderate intellectual disability at 40 to 54, severe intellectual disability at 25 to 39, and extremely severe intellectual disability at less than 24.

Diagnosis of Amblyopia

This study was performed in accordance with the consensus of Chinese experts on preventing and treating amblyopia in children.[8] Amblyopia is caused by vision deprivation and/or abnormal binocular interaction during visual immaturity. According to different etiologies, it is divided into strabismic, ametropic, anisometropic and visual deprivation amblyopia. Children between the ages of 3 and 5 years have a lower limit of normal visual acuity of 20/40, whereas children aged 6 years and older have a lower limit of normal visual acuity of 20/30. The following age-related amblyopia risk factors were specified[9]: refractive error in children aged 31 to 48 months was defined as hyperopia of greater than +4.00 (diopter of spherical [DS]), astigmatism of greater than 2.00 (diopter of cylindrical [DC]), myopia of less than −3.00 DS, or refractive error in children aged more than 48 months was defined as anisometropic spherical equivalent (SE) refraction of more than 2.00 DS, hyperopia of more than 3.50 DS, astigmatism of more than 1.50 DC, and myopia of less than −1.50 DS in children.

Anisometropia

Differences in binocular hyperopia SE refraction were 1.50 DS or greater or astigmatism of 1.00 DC or greater, whereas refractive error amblyopia was defined as hyperopia of 5.00 DS or greater and/or astigmatism of 2.00 DC or greater, which are risk factors for amblyopia.

Ametropia

Emmetropia is characterized by a SE between −0.50 DS and +0.75 DS. In mild, moderate, and high myopia, the SE is −0.75 DS or less, −3.00 DS to −6.00 DS, and more than 6.00 DS, respectively. In mild, moderate and high hyperopia, the SE is +1.00 D or greater S, +3.00 DS, to +6.00 DS, and more than +6.00 DS, respectively. The SE in astigmatism is more than 0.50 DS, and more than 2.00 DS indicates high astigmatism.[10]

Exclusion Criteria

The exclusion criteria were as follows: (i) children with CP without intellectual disabilities; (ii) children who could not adhere to the study protocols; (iii) children with ocular diseases caused by trauma and (iv) children with a history of eye medications and eye surgery.

Contents and Methods

Children with CP and healthy children were subjected to the same examination. A handheld slit lamp and fundus camera were used to check the anterior segments and fundus. The screening criteria for visual function included subjective far vision (Lea chart), objective vision (electrophysiological sweep visual evoked potential, S-VEP), refractive error (SPOT vision screening and cycloplegia), strabismus, color vision, and stereopsis (Titmus test). Objective vision was checked by German Roland electrophysiological scanning VEP (S-VEP). Electrode films were pasted on the forehead, occipital bone, and earlobe of the screened children. Black and white bars of different sizes were seen at a distance of one m from the screen, and the computer automatically recorded objective vision. Children with CP and intellectual disabilities exhibited poor cooperation during the examination, and inspectors exercised more patience with them.

Study Design

Data on subjective far vision, objective vision, ametropia, and near stereopsis were collected and analysed. The SE (SE = S+C/2) was recorded as the value of the ametropia. All the data were analysed using SPSS version 22. Data are presented as the median and quartile median (Q1, Q3). Differences in examination outcomes among children of different sexes, degrees of intellectual impairment, pathogeny, and age groups were abnormally distributed. The nonparametric independent samples Mann–Whitney *U* test or the multiple independent samples Kruskal–Wallis H test was used to specify that the standard with a statistically significant difference in different parameters was a *P* value of less than 0.05. Nonparametric groups were compared in pairs by correcting for an alpha, $\alpha' = 2\alpha/k(k-1)$, where k is the number of comparisons and $\alpha = 0.05$. Therefore, the threshold for significant differences in different parameters was set at a *P* value of less than 0.017.

Results

Visual Function and Eye Disease With CP

A total of 160 children (320 eyes) with CP and intellectual disabilities, including 86 males and 74 females aged between 6 and 18 years (median, 13.5 years). Overall, 16 eyes (5%) could not be analyzed for subjective far vision and ametropia; of the remaining 304 eyes (95%), including 232 eyes with ametropia (76.32%), 200 eyes with astigmatism (65.79%), 16 eyes with hyperopia (5.26%), 120 eyes with myopia (39.47%), and 16 eyes with amblyopia risk factors (5.26%). There were 64 cases with strabismus (40%), including 56 cases of exotropia, 8 cases of esotropia (5%), 8 cases of achroma (5%), and 24 cases of nystagmus (15%). There were 112 cases completed near stereopsis examination, of which 72 cases (64.29%) were within 100″ and 40 cases (35.71%) were between 200″ and 900″. There were 8 people with glasses (the correction rate was 6.90%) 216 eyes needed glasses correction but were not corrected (the uncorrected rate was 93.10%). The median and quartile of which were 0.30 (0.10, 0.40) for logarithm of the minimum angle of resolution (logMAR) subjective distant vision, 0.10 (0.00, 0.30) for logMAR objective vision, 0.10 (0.00, 0.10) for logMAR corrected vision, 100″ (100″, 400″) for near stereoacuity, and −0.75 (−2.50, 0.50) for ametropia.

According to the Children's Wechsler Intelligence Scale score, there were 72 cases in the 6- to 12-year-old experimental group, 32 cases with mild intellectual disabilities had a score of 55 to 69, 16 cases with moderate intellectual disabilities had a score of 40 to 54, and 24 cases with severe intellectual disabilities had a score of 25 to 39. There were 88 cases in the 13- to 18-year-old experimental group, 48 cases with mild intellectual disabilities had a score of 55 to 69, 24 cases with moderate intellectual disabilities had a score of 40 to 54, and 16 cases with severe intellectual disabilities had a score of 25 to 39.

Characteristics of Different Sex Groups With CP

There was no significant difference in subjective far vision, objective vision, corrected far vision, ametropia or near stereopsis acuity between different sex groups of the 6- to 12-year-old group and the 13- to 18-year-old group ($P > 0.05$) (Tables 1 and 2; Supplementary Table).

Characteristics of Different Degrees of Intellectual Disability With CP

There were 144 eyes in the 6- to 12-year-old group. The median and quartile were 0.30 (0.22, 0.40) for subjective far vision, 0.10 (0.00, 0.22) for objective vision, 0.10 (0.00, 0.10) for corrected vision, 100″ (100″, 600″) for near stereoacuity, and −1.00 D (−2.5 D, 0.50 D) for ametropia. Severely intellectually disabled children had poor visual function. There were significant differences in subjective far vision, objective vision, corrected vision, ametropia, and near stereop-

Table 1. The 6- to 12-Year-Old Group With Different Sex Groups With CP

Sex	Person	Eye	Subjective Far Vision (logMAR)	Objective Vision (logMAR)	Corrected Far Vision (logMAR)	Ametropia (D)	Near Stereopsis (″)
Male	42	84	0.30 (0.22, 0.40)	0.10 (0.07, 0.22)	0.10 (0.00, 0.10)	−1.00 (−2.50, 0.50)	100 (100, 500)
Female	30	60	0.30 (0.10, 0.40)	0.10 (−0.02, 0.30)	−0.10 (0.00, 0.10)	−1.75 (−2.50, 0.50)	100 (100, 600)
Z			−0.637	−0.055	−1.190	−1.344	−0.054
P			0.524	0.956	0.234	0.179	0.957

Values are median (Q_1, Q_3).

Note: 70 eyes of male and 54 eyes of female were examined for subjective far vision, 78 eyes of male and 58 eyes of female were examined for objective vision, 62 eyes of male and 46 eyes of female were examined for corrected far vision, 76 eyes of male and 52 eyes of female were examined for ametropia, 64 eyes of male and 46 eyes of female were examined for near stereopsis.

Table 2. The 13- to 18-Year-Old Group With Different Sex Groups With CP

Sex	Person	Eye	Subjective Far Vision (logMAR)	Objective Vision (logMAR)	Corrected Far Vision (logMAR)	Ametropia (D)	Near Stereopsis (″)
Male	86	172	0.40 (0.02, 0.50)	0.22 (−0.08, 0.30)	0.10 (0.00, 0.22)	−0.50 (−3.63, 0.50)	150 (100, 400)
Female	88	176	0.40 (0.02, 0.50)	0.22 (−0.08, 0.30)	−0.10 (0.00, 0.10)	−0.63 (−2.31, 0.50)	150 (100, 400)
Z			−0.056	−0.011	−0.670	−0.336	−0.105
P			0.956	0.991	0.503	0.737	0.917

Values are median (Q_1, Q_3).

Note: 80 eyes of male and 80 eyes of female were examined for subjective far vision, 86 eyes of male and 86 eyes of female were examined for objective vision, 80 eyes of male and 80 eyes of female were examined for corrected far vision, 82 eyes of male and 88 eyes of female were examined for ametropia, 80 eyes of male and 80 eyes of female were examined for near stereopsis.

sis among various degrees of intellectual disabilities ($P < 0.017$) (Table 3; Supplementary Table).

There were 176 eyes in the 13- to 18-year-old group, the median and quartile of which were 0.4 (0.02,0.50) for subjective distant vision, 0.22 (−0.08,0.30) for objective vision, 0.10 (0.00,0.10) for corrected vision, 150″ (100″, 400″) for near stereoacuity, and −0.50 (−2.50, −0.50) for ametropia. There were significant differences in subjective far vision, objective vision, and corrected vision among various degrees of intellectual disabilities ($P < 0.017$) (Table 4; Supplementary Table).

Table 3. The 6- to 12-Year-Old Group With Different Degrees of Mental Retardation

Different Degrees	Person	Eye	Subjective Far Vision (logMAR)	Objective Vision (logMAR)	Corrected Far Vision (logMAR)	Ametropia (D)	Near Stereopsis (″)
Light	32	64	0.22 (0.10, 0.30)	0.00 (−0.08, 0.10)	0.00 (−0.06, 0.10)	−2.13 (−2.50, 0.50)	100 (100, 100)
Moderate	16	32	0.30 (0.30, 0.37)	0.10 (0.10, 0.19)	0.10 (0.10, 0.10)	−1.75 (−2.88, −1.00)	400 (400, 600)
Severe	24	48	0.40 (0.40, 0.52)	0.30 (0.13, 0.52)	0.30 (0.10, 0.52)	0.50 (0.13, 0.88)	550 (100, 1000)
H			72.898	71.350	39.053	41.304	58.456
P			0.000	0.000	0.000	0.000	0.000

Values are median (Q_1, Q_3).

Note: 64 eyes of light, 32 eyes of moderate and 28 eyes of severe were examined for subjective far vision, 64 eyes of light, 32 eyes of moderate and 40 eyes of severe were examined for objective vision, 64 eyes of light, 32 eyes of moderate and 12 eyes of severe were examined for corrected far vision, 64 eyes of light, 32 eyes of moderate and 32 eyes of severe were examined for ametropia, 48 eyes of light, 30 eyes of moderate and 32 eyes of severe were examined for near stereopsis.

Table 4. The 13- to 18-Year-Old Group With Different Degrees of Mental Retardation

Different Degrees	Person	Eye	Subjective Far Vision (logMAR)	Objective Vision (logMAR)	Corrected Far Vision (logMAR)	Ametropia (D)	Near Stereopsis (″)
Light	48	96	0.40 (0.00, 0.52)	0.22 (−0.08, 0.30)	0.10 (0.00, 0.22)	−0.50 (−4.00, 0.50)	150 (100, 400)
Moderate	24	48	0.22 (0.00, 0.50)	0.00 (−0.08, 0.28)	0.00 (0.00, 0.10)	0.25 (−1.75, 0.69)	250 (100, 400)
Severe	19	38	0.40 (0.40, 0.43)	0.22 (0.22, 0.47)	0.10 (0.10, 0.22)	−1.50 (−4.00, −0.50)	150 (100, 400)
H			10.246	16.425	18.934	7.275	0.181
P			0.006	0.000	0.000	0.026	0.913

Values are median (Q_1, Q_3).

Note: 82 eyes of light, 48 eyes of moderate and 30 eyes of severe were examined for subjective far vision, 88 eyes of light, 48 eyes of moderate and 36 eyes of severe were examined for objective vision, 82 eyes of light, 48 eyes of moderate and 30 eyes of severe were examined for corrected far vision, 90 eyes of light, 48 eyes of moderate and 38 eyes of severe were examined for ametropia, 82 eyes of light, 48 eyes of moderate and 30 eyes of severe were examined for near stereopsis.

Table 5. Comparison of Children in Different Age Groups

Age (Years)	Person	Eye	Subjective Far Vision (logMAR)	Objective Vision (logMAR)	Corrected Far Vision (logMAR)	Ametropia (D)	Near Stereopsis (″)
6–12	86	172	0.30 (0.22, 0.40)	0.10 (0.00, 0.22)	0.10 (0.00, 0.10)	−1.00 (−2.50, 0.50)	100 (100, 600)
13–18	88	176	0.40 (0.02, 0.50)	0.22 (−0.08, 0.30)	−0.10 (0.00, 0.10)	−0.63 (−2.31, 0.50)	150 (100, 400)
Z			−1.199	−1.106	−0.493	−0.085	−0.206
P			0.231	0.269	0.622	0.932	0.837

Values are median (Q_1, Q_3).

Note: 124 eyes of 6- to 12-year-old group and 160 eyes of 13- to 18-year-old group were examined for subjective far vision, 136 eyes of 6- to 12-year-old group and 172 eyes of 13- to 18-year-old group were examined for objective vision, 108 eyes of 6- to 12-year-old group and 160 eyes of 13- to 18-year-old group were examined for corrected far vision ,128 eyes of 6- to 12-year-old group and 176 eyes of 13- to 18-year-old group were examined for ametropia, 110 eyes of 6- to 12-year-old group and 160 eyes of 13- to 18-year-old group were examined for near stereopsis, LogMAR represents the logarithm of the minimum resolution angle.

Table 6. Comparison of Visual Functions Between Normal Children in Different Age Groups

Age (Years Old)	Person	Eye	Subjective Far Vision (logMAR)	Objective Vision (logMAR)	Corrected Far Vision (logMAR)	Ametropia (D)	Near Stereopsis (″)
6–12	131	262	0.10 (0.00, 0.10)	0.00 (0.00, 0.00)	0.00 (0.00, 0.00)	0.25 (0.25, 0.50)	100 (60, 200)
13–18	83	166	0.10 (0.00, 0.30)	0.00 (0.00, 0.22)	0.00 (0.00, 0.00)	0.25 (−0.50, 0.50)	100 (60, 100)
Z			−2.446	−0.324	−0.987	−0.763	−1.769
P			0.014	0.746	0.323	0.445	0.077

Values are median (Q_1, Q_3).

Note: All of the normal children were examined for visual function.

Characteristics of Different Age Groups With CP

There was no significant difference in subjective far vision, objective vision, corrected far vision, ametropia or near stereopsis acuity between the 6- to 12-year-old group and the 13- to 18-year-old group ($P > 0.05$) (Table 5; Supplementary Table).

Visual Function and Eye Disease With Healthy Children

A total of 214 healthy children (428 eyes) aged 6 to 18 years with the median and quartile being 10 (8, 14) that recruited as a control group for visual function, including 116 males and 98 females. Among these healthy children, there are 131 in the 6 to 12 age

Table 7. Comparison of Visual Function Between Children With Intellectual Disabilities and Those Without

	Person	Eye	Subjective Far Vision (logMAR)	Objective Vision (logMAR)	Ametropia (D)
Children with CP	160	320	0.30 (0.10,0.40)	0.10 (0.00,0.30)	−0.75 (−2.50,0.50)
Normal children	214	428	0.10 (0.00,0.22)	0.00 (0.00,0.10)	0.25 (−0.25,0.50)
Z			−10.370	−7.603	−7.014
P			0.000	0.000	0.000

Values are median (Q_1, Q_3).

Note: There were 284 eyes of children with CP and 428 eyes of normal children examined for subjective far vision, 308 eyes of children with CP and 428 eyes of normal children were examined for objective vision, and 304 eyes of children with CP and 428 eyes of normal children were examined for ametropia.

group and 83 in the 13 to 18 age group. The comparison of visual function in normal children of different age groups is as follows: There were significant differences in subjective far vision between the 6- to 12-year-old group and the 13- to 18-year-old group ($P = 0.014 < 0.05$).There was no significant difference in objective vision, corrected far vision, ametropia or near stereopsis acuity between the 6- to 12-year-old group and the 13- to 18-year-old group ($P > 0.05$) (Table 6; Supplementary Table).

All of their Children's Wechsler Intelligence Scale scores were greater than 80, the median and quartile of which were 0.10 (0.00, 0.22) for logMAR subjective distant vision, 0.00 (0.00, 0.10) for logMAR objective vision, 0.00 (0.00, 0.00) for logMAR corrected vision, 100″ (100″, 100″) for near stereoacuity, and 0.25 (−0.25, 0.50) for ametropia. Ametropia was found in 150 eyes (35.05%), astigmatism in 96 eyes (22.42%), hyperopia in 36 eyes (8.41%), myopia in 56 eyes (13.08%), amblyopia risk factor in 8 eyes (1.87%), strabismus in 6 eyes (2.80%), color perception weakness in 2 eyes (0.93%), and abnormal eyelid in 2 (0.93%). There were 65 people with glasses (the correction rate was 86.67%), 20 eyes needed glasses correction but were not corrected (the uncorrected rate was 13.33%). The means of subjective far vision, objective vision, near stereoacuity, and corrected far vision of children with normal intelligence were better than those of children with CP and intellectual disability, and ametropia shifted to hyperopia, with a statistically significant difference ($P < 0.001$) (Table 7; Supplementary Table).

Discussion

Owing to their limited subjective expression abilities and poor cooperation with examination protocols, it is challenging to evaluate visual function in children with intellectual disabilities, resulting in low reliability of measured data. In this study, objective vision was evaluated using the German Roland electrophysiological scanning VEP (S-VEP). In this procedure, a signal generated by the retina in response to stimulation from a black-and-white bar is transmitted through the visual pathway, and the electrical signal corresponding with visual stimulation of the visual centre of the cerebral cortex is recorded on the surface of the skull skin. Objective vision is obtained through computer processing, providing a reference to diagnose damage to the visual pathway. This method does not require subjective expressions of the person being examined, making it ideal for evaluating the visual acuity of children with intellectual disabilities. Regan[11] was the first to use graphic VEP for visual acuity measurement in 1973. In pattern VEP, waveforms with different spatial frequencies, a typical VEP response wave with the highest spatial frequency was recorded as the subject's VEP visual acuity. Later, this approach was replaced by 10 different-sized bars with different spatial frequencies. Black-and-white bar scanning VEPs are more accurate and convenient than graphic reversal VEPs. We found that children with intellectual disabilities have an objective visual acuity significantly higher than their subjective visual acuity. The influence of cognitive and expression abilities can result in a perceived visual acuity that is typically lower than the actual visual acuity.

CP is often complicated by strabismus and ametropia. The rates of visual dysfunction in 2007 and 2008 were approximately 28.2% to 47.0%.[12,13] Katoch et al.[14] studied 149 patients with CP, including 78 patients with strabismus, representing a 52.3% incidence rate. The National Symposium on pediatric CP classifies CP into five subtypes: spastic type, involuntary movement type, hypotonia type, mixed type, and ataxia type. The spastic type is the most common form of CP. According to Gulati and Sondhi,[15] the three different types of CP are spastic, dyskinesia, and ataxia. Patients with hypotonic CP typically show signs of the condition from early infancy, which may develop as spastic type, dyskinesia type, or ataxia type CP during maturation. Reid et al.[16] reported that incidences of CP in children with intellectual impairment were between 40% and 65%. There was no statistically significant difference in objective vision, corrected vision, refractive error, or near stereoscopic vision among healthy children of different age groups, except for subjective farsightedness. The reason is that as age increases, the incidence of myopia in older age groups increases, leading to a decrease in subjective farsightedness. The results of this study showed that 232 eyes (76.33%) of children with CP and intellectual disabilities had refractive errors, with 8 people wearing glasses and a correction rate of 6.90%. There were 192 eyes that needed glasses correction but were not corrected, with an uncorrected rate of 93.10%. There were 65 people in the healthy children group who wore glasses, with a correction rate of 86.67%. There were 20 eyes that needed correction but were not corrected, with an uncorrected rate of 13.33%. The uncorrected refractive errors and other eye diseases in special needs children are significantly higher than those in healthy children, and the corrective treatment rate is much lower than that of ordinary children. Because most children cannot independently express themselves, parents or guardians usually pay more attention to physical development and learning abilities, but ignore visual impairments. Differences in subjective far vision, objective vision, corrected vision, ametropia, and near stereopsis acuity between the various aetiologias and degrees of intellectual disability were significant. Findings from these tests did not exhibit marked differences between sexes. Most children with CP who also had severe intellectual disabilities owing to craniocerebral diseases had high levels of astigmatism and amblyopia. Differences in children's subjective far vision, objective vision, and near stereopsis acuity were significant. Children with these challenges require a heightened level of care.

In this study, children with CP and intellectual disabilities exhibited poor expression abilities and could not cooperate or communicate effectively. The visual acuity result was used as a reference; it was not the primary factor used to determine whether or not the patients had amblyopia. Approximately 15.91% of the children examined had objective vision of less than 20/40, an incidence significantly higher than that among healthy children. Approximately 5.26% of these children exhibited amblyopia-related risk factors. In addition, a considerable number of children with special needs (10.65%) did not have any organic diseases in their eyes, the fundus optic nerve and pupil response to light were both normal, the improvement in corrected vision was not obvious, there were no amblyopia-related risk factors, and there was insufficient evidence for the diagnosis of amblyopia. Some experts believe these children may have visual pathway damage, a condition known as central visual impairment (CVI).[17] Currently, CVI is the most common cause of visual impairments among children in developed countries. According to the World Health Organization, the proportion of children in developing economies who are blind or have significant visual impairments owing to anomalies in their central nervous systems is approximately 20%.[18] Owing to advances in perinatal medicine, the survival rate of preterm infants has been increasing, and concurrently, the prevalence of CVI in developing countries is also increasing. The most common aetiology of CVI in premature infants is ischemic and hypoxic encephalopathy, particularly brain nerve damage. The lesions primarily occur in the posterior visual pathway of the geniculate body and related areas of the occipital visual cortex, leading to severe visual impairment or blindness. Patients with CVI typically also experience a decrease in vision and walking abilities and demonstrate social communication disorders and autism, among other characteristics. Children with intellectual disabilities are categorized as having premature asphyxia, congenital intellectual disability, birth injury, craniocerebral disease, and other unknown conditions based on their medical history and underlying conditions. Thus, it has been hypothesized that some children with CP and intellectual disabilities have poor vision owing to damage to the optic nerve pathway. A quick diagnosis of amblyopia is difficult without first inquiring about the patient's medical history, determining whether they are at risk of amblyopia, and performing magnetic resonance imaging of the brain. In this study, the CP children's objective vision, as measured by electrophysiological scanning VEP was lower than that of healthy children of the same age without amblyopia risk factors and organic lesions of the ocular structure. Because the examined children might have had CVI, we were more cautious regarding the diagnosis of amblyopia. The examination of children's subjective expressions, such as visual acuity, was only used as a reference and was primarily combined with objective visual acuity examination. To diagnose amblyopia, it was necessary to assess whether the patient had anisometropia, high ametropia, form deprivation, strabismus, and other amblyopia risk factors.

Owing to the limitations of the conditions and difficulties in performing certain examination procedures, such as visual field examination, and because some of the children did not cooperate or effectively express themselves, we were unable to collect comprehensive data on the visual function of children with CP and intellectual disabilities to investigate the causes of their poor visual functions. In addition, this study only focused on the Chaoyang District in Beijing. The economic status and medical treatment access of individuals in this area are superior to those in rural and mountainous areas; hence, the sample may be susceptible to selection bias. Expanding the sample size, increasing the number of geographical options and enhancing the number of inspections could yield more reliable data and findings. This study successfully examined the objective vision of children with CP. Different black and white stripes generated by scanning electrophysiological instruments were used to stimulate the retina and obtain different electrograms, representing the objective vision and objectively reflecting the visual function status of children with CP.

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References

1. Sadowska M, Sarecka-Hujar B, Kopyta I. Cerebral palsy: current opinions on definition, epidemiology, risk factors, classification and treatment options. *Neuropsychiatr Dis Treat*. 2020;16:1505–1518, http://doi.org/10.2147/NDT.S235165.
2. Michael-Asalu A, Taylor G, Campbell H, Lelea LL, Kirby RS. Cerebral palsy: diagnosis, epidemiology, genetics, and clinical update. *Adv Pediatr*. 2019;66:189–208, http://doi.org/10.1016/j.yapd.2019.04.002. Epub May 15, 2019.
3. Sewell MD, Eastwood DM, Wimalasundera N. Managing common symptoms of cerebral palsy in children. *BMJ*. 2014;349:5474.
4. Hollung SJ, Vik T, Lydersen S, Bakken IJ, Andersen GL. Decreasing prevalence and severity of cerebral palsy in Norway among children born 1999 to 2010 concomitant with improvements in perinatal health. *Eur J Paediatr Neurol*. 2018;22:814–821.
5. Pascolini D, Mariotti SP. Global estimates of visual impairment: 2010. *Br J Ophthalmol*. 2012;96:614–618. Medline:22133988, http://doi.org/10.1136/bjophthalmol-2011-300539.
6. Johnston MV. Cerebral palsy. In: Kliegman RM, St Geme JW, III, Blum NJ, et al., eds. *Nelson textbook of pediatrics*, 21st ed. Philadelphia: Elsevier; 2020:3168–3172.
7. WHO Mental Retardation, Meeting in the challenge[R]. Geneva: WHO offset Publication; 1985.
8. Chinese Association for Pediatric Ophthalmology and Strabismus, Pediatric Ophthalmology and Strabismus Group of Chinese Ophthalmologist Association. Expert consensus on prevention and treatment of amblyopia in children[J]. *Chin J Ophthalmol*, 2021;57(5):336–340, http://doi.org/10.3760/cma.j.cn112142-20210109-00014.
9. Donahue SP, Arthur B, Neely DE, et al. Guidelines for automated preschool vision screening: a 10-year,evidence-based update. *J AAPOS*. 2013;17:4–8.
10. Tsao W-S, Hsieh HP, Chuang YT, Sheu MM. Ophthalmologic abnormalities among students with cognitive impairment in eastern Taiwan: the special group with undetected visual impairment, *J Formos Med Assoc*. 2016;116:345–350, http://dx.doi.org/10.1016/j.jfma.2016.06.013.
11. Regan D. Rapid objective refraction using evoked brain potentials. *Invest Ophthalmol Vis Sci*. 1973; 12:669–679.
12. da Cunha Matta AP, Nunes G, Rossi L, Lawisch V, Dellatolas G, Braga L. Outpatient evaluation of vision and ocular motricity in 123 children with cerebral palsy. *Dev Neurorehabil*. 2008;11(2):159–165, http://doi.org/10.1080/17518420701783622.
13. Lagunju IA, Oluleye TS. Ocular abnormalities in children with cerebral palsy. *Afr J Med Med Sci*. 2007;36(1):71–75.
14. Katoch S, Devi A, Kulkarni P. Ocular defects in cerebral palsy. *Indian J Ophthalmol*, 2007;55(2): 154–156.

15. Gulati S, Sondhi V. Cerebral palsy: an overview. *Indian J Pediatr*. 2018;85(11):1006–1016, http://doi.org/10.1007/s12098-017-2475-1. Epub November 20, 2017.
16. Reid SM, Meehan EM, Arnup SJ, Reddihough DS. Intellectual disability in cerebral palsy: a population-based retrospective study. *Dev Med Child Neurol*. 2018;60(7):687–694, http://doi.org/10.1111/dmcn.13773.
17. Wei Zhang. Paying attention to cerebral/central visual impairment[J]. *Chin J Ophthalmol*, 2021;57 (5):321–325, http://doi.org/10.3760/cma.j.cn112142-20210201-00062.
18. Pizzarello L, Abiose A, Ffytche T, et al. VISION 2020: the right to sight: a global initiative to eliminate avoidable blindness. *Arch Ophthalmol*. 2004;122(4):615–620.