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Comparison of influencing factors of refractive error between hearing-impaired children and healthy children

Mengxue Han, Yuexin Liu and Xibin Gao*

Shanghai Normal University, Shanghai Institute of Physical Education
**Corresponding author e-mail: 1079962485@qq.com*

ABSTRACT. To explore the risk factors of refractive errors in hearing-impaired children, and put *forward* some suggestions for the prevention and control of refractive errors in hearing-impaired children. Methods: Stratified cluster sampling was used to select 500 students aged 6 - 12 from Shanghai Deaf school and Shanghai ordinary primary school, respectively, for questionnaire survey and field visual acuity screening. The results showed that : (1) The refractive error rate of hearing impaired children aged 6 - 12 years increased gradually with the increase of age; It is far the most common refractive error in hearing-impaired children, and girls are higher than boys ($P<0.05$); (2) Parental inheritance is an uncontrollable genetic factor for hearing-impaired children. Among them, the refractive error rate of hearing-impaired children with a family history of inbreeding is as high as 33.3%($P<0.05$, OR=1.514); (3) Poor eye habits: Excessive screen time, insufficient sleep, left-behind children are the risk factors for refractive error of hearing-impaired children ($P<0.05$); (4) Scientific wear glasses and check eyesight regularly. Exercising outdoors for more than 1 hour every day has obvious prevention and regulation effect on refractive error of hearing-impaired children ($P<0.05$). Conclusion: The refractive error rate of hearing-impaired children is higher than that of healthy hearing-impaired children. The screen time and exercise time of left-behind children with inbreeding history, poor reading and writing habits are important factors that cause the difference of refractive error between hearing-impaired children and healthy hearing-impaired children.

KEYWORDS: *Hearing-impaired children, Refractive error, Vision, Influencing factors, A comparative analysis*

1. Introduction

Hearing-impairment refers to the occurrence of organic or functional abnormalities in the auditory system's sound transmission and sensing as well as the nerve centers at all levels of sound comprehensive analysis, resulting in varying degrees of hearing loss [1]. Hearing impairment in children is a common physical

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defect, which has a direct impact on children's physical development and brings a lot of mental pressure and burden to individual families and the society. The second national sample survey of disabled people shows that the number of people with hearing impairment is about 27.8 million, accounting for 2.2% of the total population, and the trend is increasing year by year [2, 3]. The study found that in the condition of severe hearing loss, individual dependence on visual significantly increased, thus more likely to create the visual disturbances such as refractive errors [4] refractive errors is refers to the eyes in when not in use to adjust, after refractive effect of parallel light through the eye, unable to form a clear image on the retina, behind or in front of the retina imaging, it includes hyperopia myopia and astigmatism [5]. Existing studies have shown that there is no obvious advantage in the basic visual recognition ability of hearing-impaired children. Deaf classrooms are prone to present the information that cannot be heard through visual stimuli, which may greatly lead to the accumulation of visual stimuli and ultimately lead to the overwhelming burden of vision [6]. Surveys show that the prevalence of refractive error in hearing-impaired children is as high as 60%, and hyperopia, myopia and astigmatism are the most important visual disorders in hearing-impaired children [7, 8].

Studies have shown that compared with other visual impairments, children with hearing impairment have a more common incidence of refractive error, and children with hearing impairment with visual impairment have a very negative impact on their communication and cognitive development [9]. Because most previous studies were descriptive and did not adopt comparative analysis, it was impossible to judge the visual difference between hearing-impaired children and healthy hearing children [10]. Analysis and research are more effective for testing different experimental data. Therefore, this paper compares the refractive error of hearing impaired children and healthy hearing children, finds the rules, and proposes corresponding solutions or mitigation measures on this basis, so as to make contributions to the prevention and control of refractive error of hearing impaired children.

2. Methods

2.1 Selection of subjects and survey methods

Using the method of stratified cluster sampling, 500 students aged 6 - 12 years old from four deaf schools and ordinary primary schools in Shanghai were selected as experimental subjects. A total of 1000 questionnaires were distributed, and the validity of the questionnaire was tested, and the KMO value was 0.862. All input verification questionnaire, eliminate invalid questionnaire 21, keep effective questionnaire 979, efficient 97.9% all students can be divided into two groups: the deaf groups of 483 students (237 boys, 246 girls) average hearing group of 496 students (241 boys, 255 girls) of all test content obtained by children parents support, and sign the informed consent.

ISSN 2616-5783 Vol.3, Issue 8: 70-81, DOI: 10.25236/AJHSS.2020.030807

Consult literature at home and abroad, combining the actual condition, the self-designed questionnaire contents include informed consent, children's basic information (sex, age, with or without hearing impairment, etc.), the influencing factors of survey (parents family of refractive errors, do you have any close relatives marriage history, bad habits, speaking, reading and writing, screen time, exercise time, and whether it is kind of left-behind children, etc.). The questionnaire is issued in an anonymous and fully sealed form, and the survey content and final experimental data are kept confidential.

2.2 Experimental procedure

In order to ensure the objectivity, accuracy and rigor of the test results, 979 subjects were subjected to a comprehensive covered vision test. Two professional optometrists and one sign language teacher were employed. During this period, the research team participated in the whole process of tracking, assisted in the detection and obtained the examination results as soon as possible.First, ABR hearing test was performed on the hearing impaired group to test the degree of hearing impairment. Then the visual acuity was examined by ETDRS visual acuity chart and the approximate range of degrees was determined, and then optometry was used in the state of ciliary paralysis. The subjects' ciliary muscles were relaxed and their eyes were in a static refractive state. 1.0% cyclopentolide eye drops were dropped into the eyes every 5 minutes (twice in total). After waiting for 30 minutes, an automatic refractometer TOPCON RM 8800 was used for optometry, and the final data were recorded. Except for the hearing test, all the testing methods, equipment and personnel in the normal group were the same as those in the hearing impaired group.

Determination criteria: (1) myopia: spherical equivalent (SE= spherical lens degree + 0.5 × cylindrical lens degree) ≤-0.50D; low myopia refers to one eye-3.00D ≤ SE ≤-0.50D; Moderate myopia -6.00d ≤SE < -3.00d;High myopia refers to SE < -6.00D. The diopter of the two is not the same as that of the lower eye. (2) Hyperopia was defined as naked eye vision < 4.9 and SE≥+ 0.50 D, in which one eye myopia and contralateral hyperopia were defined as hyperopia. (3) Astigmatism: any column lens ≥ 0.75 D [11].

2.3 Data processing

Import the data into Excel to establish the database, and use the Graphpad Prism8.0 software to draw the line chart. SPSS 25.0 was used to analyze, X^2 test was used to compare the percentages of multiple samples, and unconditional Logistic regression analysis was used to analyze the influence of refractive errors in the two groups.

ISSN 2616-5783 Vol.3, Issue 8: 70-81, DOI: 10.25236/AJHSS.2020.030807

3. Results

3.1 Comparison of the number of refractive errors between hearing-impaired children and healthy hearing-impaired children aged 6 - 12 at different ages

The incidence of refractive error in children with hearing impairment and children with healthy hearing was increasing with the increase of age. The number of hearing impaired children with hyperopia was the highest and slightly higher than the number of hearing impaired children with myopia. The number of children suffering from hyperopia was less and the number of short-sighted children was more. Because astigmatism is compound myopic astigmatism, compound hyperopia astigmatism, so the number of hearing-impaired children and healthy children is relatively high.As shown in figure 1.

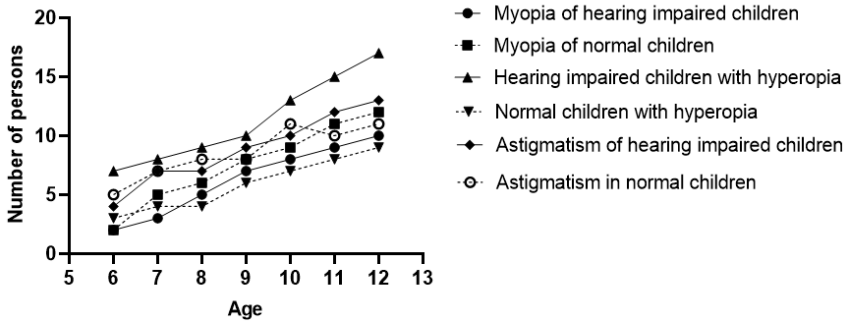

Figure. 1 Prevalence of refractive error in hearing-impaired children and healthy hearing-impaired children aged 6 - 12 years in Shanghai.

3.2 Comparison of prevalence of refractive error between hearing-impaired children and healthy hearing-impaired children aged 6 - 12 years of different genders

In this study, the prevalence of refractive error of hearing-impaired children and healthy hearing-impaired children of different genders were statistically analyzed.The prevalence of myopia in healthy hearing children (6.3% for boys and 7.2% for girls) (X^2=53.286, P = 0.012) is higher than that in hearing impaired children (5.9% male, 6.2% female) (X^2 =32.179, P < 0.05), and the prevalence of myopia in female students is higher than that in male students. The prevalence of hyperopia in hearing-impaired children (10.8% for boys and 12.3% for girls) (X^2 =48.037, P=0.015) was higher than that in healthy hearing-impaired children(5.6% for boys and 5.9% for girls)(X^2 =32.579, P < 0.05). The astigmatism rate of hearing-impaired children and healthy hearing-impaired children was relatively high (X^2 value was 14.344, 8.126, P value was less than 0.05, respectively), which was statistically significant.P values of both hearing impaired children with normal

ISSN 2616-5783 Vol.3, Issue 8: 70-81, DOI: 10.25236/AJHSS.2020.030807

vision and healthy hearing children were greater than 0.05, which was not statistically significant. See table 1.

Table 1 comparison of the prevalence of ametropia between hearing impaired children and healthy children of different genders

Refractive state	Sex	Age	Hearing-impaired children			Normal children		
			Refractive error(%)	X^2	P	Refractive error(%)	X^2	P
Myopia	boys	10.5±2.01	5.9	32.179	0.047	6.3	53.286	0.012
	girls	9.8±3.09	6.2			7.2		
Hyperopia	boys	11.5±2.98	10.8	48.037	0.015	5.6	32.579	0.043
	girls	10.3±3.01	12.3			5.9		
Astigmatism	boys	11.2±2.73	10.2	14.344	0.05	8.7	8.126	0.041
	girls	10.7±2.86	11.1			9.0		
Normal	boys	10.2±3.04	—	—	>0.05	—	—	>0.05
	girls	9.7±3.07	—			—		

3.3 Analysis of influencing factors of refractive error in hearing-impaired children aged 6 - 12 years and hearing-healthy children

In order to exclude the influence of confounding factors, variables with statistical significance in the univariate analysis of subjects in the two groups were combined with Logistic multivariate regression analysis to draw relevant conclusions: Parents with refractive errors, parents with college education or above, and family history of inbreeding are important genetic factors affecting refractive errors in hearing-impaired children (P values were all < 0.05, the OR value > 1.00), among which the hearing-impaired children with a family history of inbreeding have a higher incidence of refractive error (P < 0.01, OR = 1.514); However, parents' refractive errors and father's education level were the risk factors for refractive errors in healthy hearing children (P < 0.05, OR > 1.00), and family inbreeding history was the protective factor (P > 0.05, OR < 1.00), which was not statistically significant.The results showed that inbreeding was an important genetic factor that caused the difference in prevalence rate of refractive error between hearing-impaired children and healthy hearing-impaired children.

By Logistic multivariate regression analysis showed that, in addition to genetic to recognized the important factors influencing the refractive errors in children, wearing glasses, regular check, poor vision science reading and writing habits, screen time every day, sleep time, movement time and class left-behind children, different from traditional left-behind children, statistically significant (P value < 0.05, the OR value > 1.00); Scientific wearing of glasses, regular examination of eyesight, poor reading and writing habits, daily screen time, sleep time and exercise time were the risk factors for refractive error in hearing healthy children (P < 0.05, OR > 1.00). However, there was no statistical significance in the prevalence of refractive error among the left-behind listening children (P > 0.05, OR < 1.00). It was found that left-behind children were an important non-genetic factor that caused

ISSN 2616-5783 Vol.3, Issue 8: 70-81, DOI: 10.25236/AJHSS.2020.030807

the difference in prevalence rate of refractive error between hearing-impaired children and healthy hearing-impaired children. See table 2.

Table 2 Analysis of genetic influencing factors of refractive error in hearing-impaired children

Variable	Option	Children with hearing impairment (refractive error)				
		β	SE	X^2	sig.	OR(95%CI)
Father has refractive error	yes	0.831	0.014	27.312	0.009**	1.537(0.421-0.579)
Mother has refractive error	yes	-0.12	0.091	16.244	0.021*	1.677(0.597-0.891)
Father's education level	Primary schools and below	—	—	—	—	1.00
	Junior high school	-0.144	0.128	7.314	0.059	1.248(0.872-1.252)
	High school	0.186	0.121	6.342	0.067	1.941(0.739-1.107)
	Junior College and above	-0.123	0.089	12.391	0.013*	1.125(1.012-1.358)
Mother's education level	Primary schools and below	—	—	—	—	1.00
	Junior high school	-0.021	0.092	1.259	0.068	0.237(1.121-1.349)
	High school	0.013	0.09	3.281	0.062	0.081(1.132-1.431)
	Junior College and above	0.106	0.147	10.362	0.043*	1.870(0.891-0.931)
Family history of inbreeding	yes	-0.337	0.097	26.358	0.000**▲▲	1.514(0.528-0.615)

Note: * indicates that hearing impairment differs significantly from group to group ($P < 0.05$);

** indicates that the difference between hearing impairment groups is very significant ($P < 0.01$);

▲difference between the hearing-impaired group and the healthy group was significant ($P < 0.05$).

▲▲difference between the hearing-impaired group and the healthy group was very significant ($P<0.01$).

Table 3 Analysis of genetic influencing factors of ametropia in healthy hearing children

Variable	Option	Normal children (refractive error)				
		β	SE	X^2	sig.	OR(95%CI)
Father has refractive error	yes	-0.512	0.147	26.208	0.002*	1.277(0.433-0.759)
Mother has refractive error	yes	-0.532	0.127	19.752	0.012*	1.848(0.803-1.338)
Father's education level	Primary schools and below	—	—	—	—	1.00
	Junior high school	-0.029	0.102	3.215	0.077	1.851(0.603-1.201)
	High school	0.19	0.092	4.492	0.069	1.913(0.716-1.128)
	Junior College and above	-0.122	0.019	8.216	0.033	0.256(0.807-1.091)
Mother's education level	Primary schools and below	—	—	—	—	1.00
	Junior high school	-0.121	0.098	0.511	0.077	0.101(0.518-2.135)
	High school	0.337	0.143	9.127	0.018*	1.230(0.675-2.664)
	Junior College and above	-0.029	0.106	2.124	0.082	0.870(0.784-1.279)
Family history of inbreeding	yes	-0,218	0.158	0.753	1.239▲▲	0.396(1.592-2.417)

ISSN 2616-5783 Vol.3, Issue 8: 70-81, DOI: 10.25236/AJHSS.2020.030807

Note: * indicates that there is a significant difference between the two groups (P < 0.05);

** showed a very significant difference compared with the same group (P < 0.01);

▲difference between the hearing impaired group and the hearing healthy group (P < 0.05).

▲▲difference between the hearing-impaired group and the healthy group was very significant (P <0.01).

Table 4 Analysis of non-genetic influencing factors of refractive error in hearing-impaired children

Variable	Option	Children with hearing impairment (refractive error)				
		β	SE	X^2	Sig.	OR(95%CI)
Scientific wearing glasses	yes	-0.117	0.147	25.371	0.043*	1.829(1.058-1.815)
Regular visual examination	yes	0.281	0.085	58.327	0.000**	2.196(1.547-2.896)
Poor literacy habits	yes	-0.366	0.146	27.625	0.012*▲	1.268(1.075-2.014)
Screen time per day	＜0.5h	—	—	—	—	1.00
	0.5-1h	-0.197	0.227	19.816	0.032*	1.735(0.989-1.348)
	1-1.5h	-0.312	0.139	5.765	0.041*	1.931(1.130-3.314)
	＞1.5h	1.009	0.428	5.542	0.018*▲	1.548(1.022-2.493)
Sleep time per day	＜6h	0.218	0.082	20.295	0.001**	1.538(0.115-1.925)
	6-8h	0.331	0.068	21.374	0.000**	1.609(0.481-0.804)
	＞8h	—	—	—	—	1.00
Daily exercise time	＜1h	0.106	0.143	13.216	0.048*	1.459(1.014-2.573)
	1-2h	-0.417	0.218	10.175	0.039*▲	1.648(1.230-2.291)
	＞2h	—	—	—	—	1.00
Left-behind Children (Different from traditional left-behind children)	Within 6 days	0.013	0.215	4.196	0.046*	1.520(1.148-1.915)
	A week	0.216	0.216	5.129	0.042*	1.743(1.317-2.129)
	For more than a week	-0.037	0.221	12.913	0.037*▲▲	1.772(1.290-2.336)
	everyday	—	—	—	—	1.00

Note: * indicates that there is a significant difference between the two groups (P < 0.05);

** showed a very significant difference compared with the same group (P < 0.01);

▲difference between the hearing impaired group and the hearing healthy group (P < 0.05).

▲▲difference between the hearing-impaired group and the healthy group was very significant (P <0.01).

ISSN 2616-5783 Vol.3, Issue 8: 70-81, DOI: 10.25236/AJHSS.2020.030807

Table 5 Analysis of non-genetic influencing factors of ametropia in healthy hearing children

Variable	Option	Normal children (refractive error)				
		β	SE	X^2	Sig.	OR(95%CI)
Scientific wearing glasses	yes	-0.127	0.138	6.582	0.046*	1.528(1.174-2.439)
Regular visual examination	yes	0.76	0.164	64.614	0.000**	2.129(1.675-2.898)
Poor literacy habits	yes	0.553	0.221	34.452	0.015*▲	1.392(1.067-1.815)
Screen time per day	＜0.5h	—	—	—	—	1.00
	0.5-1h	0.174	0.091	8.931	0.052	1.923(1.142-2.335)
	1-1.5h	0.198	0.131	3.124	0.064	0.735(0.982-1.929)
	＞1.5h	-0.134	0.096	1.186	0.142*▲	1.583(0.987-2.551)
Sleep time per day	＜6h	0.347	0.143	21.418	0.015*	1.874(1.192-2.948)
	6-8h	-0.218	0.089	23.436	0.002*	1.785(1.214-2.647)
	＞8h	—	—	—	—	1.00
Daily exercise time	＜1h	-0.397	0.228	12.139	0.032*	1.435(0.874-2.657)
	1-2h	0.092	0.159	10.214	0.042*▲	1.785(1.179-2.460)
	＞2h	—	—	—	—	1.00
Left-behind Children (Different from traditional left-behind children)	Within 6 days	0.153	0.161	3.127	0.067	0.919(0.979-1.350)
	A week	0.168	0.087	4.261	0.058	0.784(0.917-1.936)
	For more than a week	0.172	0.102	6.237	0.052▲▲	1.136(1.528-2.444)
	everyday	—	—	—	—	1.00

Note: * indicates that there is a significant difference between the two groups ($P < 0.05$);

** showed a very significant difference compared with the same group ($P < 0.01$);

▲ difference between the hearing impaired group and the hearing healthy group ($P < 0.05$).

▲▲difference between the hearing-impaired group and the healthy group was very significant ($P < 0.01$).

4. Discuss

Refractive error is not only a worldwide public health problem, but the onset age is gradually advanced. Refractive error has long been the most common visual impairment in both hearing-impaired children and children with good hearing [12].

This study shows that 30% of hearth-impaired children suffer from refractive error, and hyperopia is the highest detection rate of refractive error in hearth-impaired children. The prevalence of myopia is relatively low, and astigmatism is mostly compound myopic astigmatism combined with hyperopia [13]. The study found that girls with hearing impairment had a higher prevalence of refractive error than boys. It is speculated that girls tend to be quiet and prefer static entertainment, resulting in a significantly higher refractive error rate among girls than boys [14].

ISSN 2616-5783 Vol.3, Issue 8: 70-81, DOI: 10.25236/AJHSS.2020.030807

This survey shows that the risk factors of refractive error in hearing impaired children and healthy hearing children have the same commonness.Children inherit the influence of parental muscle tone and play a decisive role in the occurrence of pathological and highly refractive error [15]. Although scientific wearing glasses can not significantly reduce the incidence of refractive error, it can effectively control the malignant development of refractive error in children with hearing impairment and healthy hearing. Regular visual examination can reflect the changes of children's visual acuity in a timely manner, so that doctors and parents can make timely responses [16]. Hearing impaired children and healthy hearing children whose sleep time is less than 8 hours are more likely to have refractive error, and sleep is the main way to eliminate fatigue.Wang Wen-wen et al. mentioned in their study that long-term sleep deprivation would cause systemic vegetative nerve dysfunction, which would cause local sympathetic nerve imbalance in the eyes, resulting in ciliary muscle regulation dysfunction and refractive maladjustment [17].

Through a series of comparative analysis, this study found that the main factors causing the difference in prevalence rate of refractive error between hearing-impaired children and healthy hearing-impaired children are as follows: (1) There were 18 hearing-impaired children with a family history of inbreeding, and the refractive error rate was 33.3%, while the refractive error rate of healthy hearing-impaired children was less than 1%. China's marriage law explicitly forbids close relatives to get married. Although genetic diseases are mostly inherited by recessive inheritance, in the case of inbreeding, the probability of offspring suffering from recessive genetic diseases is higher than that of the general population [18]. Genetic factors are the biological prerequisite for the occurrence and development of children's refractive error, which can provide the possibility of the development of children's refractive error [19]. (2) Bad eye habits and screen time are important factors that lead to the difference of refractive error between hearing-impaired children and healthy hearing-impaired children.Due to the special physiological defects of hearing-impaired children, they are overly dependent on vision, resulting in different degrees of visual impairment, which is consistent with the results of Yang Fuyi et al. [20]. Too long reading time and too short eye screen distance will directly lead to visual impairment. When the eyes are staring at the same place for a long time, the number of blinking and the number of eye activities will decrease, which will lead to the phenomenon of dry eyes and fatigue, leading to the decrease of focusing function, resulting in poor vision problems such as refractive errors over time [21]. (3) According to the survey, the deaf children is lower than the average hearing children's movement, the refractive error rate and negatively correlated with time hearing impaired children relative isolation with the outside world, may be withdrawn character inferiority don't love with people such as psychological problems, is to cause the deaf children's outdoor activities less time, lack of interest in sport, the study found the important factors involved in more than 1 hour exercise every day can significantly reduce the risk of refractive errors in children [22]. (4) Left-behind children refer to children under the age of 18 who remain in the place where their household registration is registered, but both or one of their parents move to other areas and cannot live with their parents [23]. However, the biggest difference between the objects investigated in this article and left-behind children

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lies in the following: Shanghai is a special area. Although the parents go out to work, most of them are in Shanghai. Due to the large population, long commute and other problems, the parents cannot accompany their children every day, so they are called "left-behind children".The survey showed that the number of hearing-impaired children who could meet with their parents for more than a week was higher, and the refractive error rate was also significantly higher than that of normal children.The research results of Saw et al. are consistent with that in this paper, left-behind children have a high prevalence of refractive error, immature visual development of children, poor self-binding force, and no parental supervision, leading to a gradual increase in the incidence of refractive error [24].

5. Conclusions and recommendations

Based on the above research results, the following Suggestions are put forward: ban marriage between first Cousins to create a good living environment for the next generation; Always pay attention to the physical health of minor children to reduce the prevalence of refractive error; Hearing-impaired children need care and care, so parents should give them more company and care while working. Parents of hearing-impaired children and healthy hearing-impaired children should set an example to prevent and control their own vision, pay attention to the cultivation of good eye use habits, and strictly control the screen time and distance. Schools should have regular vision checks and parents should be aware of their children's eye problems. Ensure adequate sleep every day, improve immunity, reduce the probability of refractive error; Develop the interest in sports for hearing-impaired children and healthy hearing-impaired children, and ensure 1-2 hours of sports and outdoor activities every day.

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