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Screening of Hearing and Vision Impairment in Primary School Children in Relation to Grade and Sex

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Abstract

Objective – The aim of the study was to establish the prevalence of hearing and sight impairment, and the differences in relation to school grade and sex in school children in the area of the Jajce municipality. **Materials and Methods** – Screening of sight and hearing impairment in school children took place in 2018 and 2019. Vision screening covered a total of 1002 students from 1st to 5th grades, and hearing screening 768 students from 2nd to 5th grades in all central and district (rural) schools in the area of the municipality of Jajce. **Results** – Of the total number of students covered by the vision screening, in 163 (16%) some impairment was noticed, and they were sent for further diagnostic testing by a specialist. In relation to sex, there was a higher percentage of girls, 60%, than boys, 40%. In relation to screening of hearing, 44 (6%) of the students were sent for further diagnostics, of which 57% were boys and 43% girls. During the vision screening, 5% of the students were wearing dioptric glasses. In relation to age, the largest number of students were in first grade, 14 (27%), then in second grade, 10 students (19%). **Conclusion** – In this study, the results showed that a large percentage of school children were found with hearing and vision impairment, which indicates the pressing need to continue running these preventive programmes.

Key Words: Children ▪ Hearing ▪ Sight ▪ Primary School.

Introduction

Hearing and vision play a very important role in a child's development, in learning and communication (1). Impairment of vision is one of the greatest problems in public health around the world, especially in developing countries, and has a negative effect on the overall development of many countries (2). The World Health Organization (WHO) estimates that globally at least 2.2. billion people have vision impairment, whether short or long sightedness. In at least 1 billion, or almost half of that group, the vision impairment could have been prevented (3). The most common cause of loss of vision in infants or small children, alongside refractive error, is amblyopia (4). In the United States of America, up to 2% of infants and children aged from 6 to 71 months have amblyopia (5). Children today spend more time using digital devices in their free time. This leads to a burden on the visual system, especially the ability to maintain clear vision at close range for a long period of time. Even problems such as small refractive error and the lack of accommodation may cause headache, difficulty concentrating, or poor coordination (6).

Children with poor success in school are most often affected by impairment of visual acuity (7). Performing vision screening in school is an effective means of discovering children with vision problems, and improving their visual function by using glasses (8).

According to a WHO report, more than 5% of the world's population (432 million adults and 34 million children) require rehabilitation for loss of

hearing. It is estimated that by 2050, more than 700 million people, or one in ten people, will suffer from hearing loss. Almost 60% of hearing loss in children is caused by reasons that can be prevented (9). Hearing loss is one of the most frequent sensory deficits, and has serious medical and social consequences (10). Late discovery, and delayed therapy and rehabilitation of hearing disorders have negative consequences for children in the sense of development of language and speech, and their emotional and cognitive development. Also, hearing impairment in early childhood may have a negative effect on the outcome of education and employment in adulthood (11). For these reasons, in many countries universal screening programmes have been introduced in newborns in order to discover hearing loss very early (12).

Screening programmes are one of the most effective ways of preventing and treating diseases, by raising awareness and early diagnosis. This programme in children provides the opportunity to discover a child's hearing status, provide treatment to improve hearing or to limit further loss (13).

The aim of the study was to establish the prevalence of hearing and sight impairment and the differences in relation to school grade and sex in school children in the area of the Jajce municipality.

Materials and Methods

The Area of the Research

The Central Bosnian canton is located in the central part of Bosnia and Herzegovina with an area of 3189 km^2 and a population of 247,100 inhabitants in 2021. The Jajce municipality is in the western part of the Central Bosnian canton, and covers an area of 339 km^2 (Fig. 1.) The population in 2021 was 26,099, of which 3186 were children aged 0-14 years. In 2021, in the area of the Jajce municipality there was a total of 177 newborns, the birth rate was 6.8%, whilst the natural increase rate was 5.0‰ (14).

Fig. 1. *The area of the Jajce municipality is shown in dark blue, the area of the Federation of Bosnia and Herzegovina is in light blue, the area of the Republika Srpska is in pink and the area of the Brčko district is in yellow.*

Subjects

This was a cross-sectional study, and testing of vision and hearing in school children was performed in 2018-2019 in four central and 18 district (rural) schools in the area of the Jajce municipality. The subjects were divided according to the grades of elementary school they attend. Vision screening included a total of 1002 1st to 5th grade students, with 515 girls (51%) and 487 boys (49%), whilst screening of hearing covered 768nd to 5th grade students, with 361 girls (47%) and 407 boys (53%). All students in the 1st to 5th grades of elementary school were invited to take part in the programme for early discovery of vision impairment, and students in the 2nd to 5th grades of elementary school were invited to take part in screening for hearing loss. The children whose parents did not give consent for their participation in these programmes were excluded.

Methods

The aim of the testing of visual acuity was to determine the best possible visual acuity in each eye. In this study, a standardized Snellen optotype was

used (15). The letters on the board decreased in size according to the row they were in, to reveal how well each eye could see. The Snellen optotype consists of the letter E turned in all four spatial directions. The student shows or says which direction the letter E is facing. To pass the screening using the Snellen optotype a child aged 5 and more years must, as a rule, be able to read more than half the symbols in row 0.7 (6/9).

The hearing of school children is tested using a MAICO MA 25 audiometer. Audiometry screening was conducted at frequencies of 500, 1000, 2000, 4000 and 8000 Hz, with a sound level of 20 dB for each ear (9). The first hearing screening of the students was conducted in a quiet environment, i.e. in a quiet classroom provided by the school, and was interrupted when the students were on a break, while the second screening was conducted in ideal conditions in health facilities. The results obtained were drawn into an audiogram. During the second hearing screening test in health institutions, the otolaryngologist (ENT) specialist performed an otoscopy.

The first vision and hearing screening was performed by nurses and technicians, whereas the second vision and hearing screening was performed in a health facility by ophthalmology and ENT specialists. The second vision and hearing screening also included all students/children, that is, those who tested both positive and negative.

Statistical Analysis

The collected data were entered into the Microsoft Excel program package. The statistical program IBM SPSS Statistics 20.0 (Copyright IBM Corporation 1989, 2011) was used for statistical analysis of the data. The distribution of the frequencies of the tested variables was described by descriptive analysis. A comparison was made between the results of the vision and hearing screening in students in relation to the school grade they were attending, their sex, and whether they were from an urban or rural environment. The $\chi 2$-test was used in the statistical analysis. A level of significance of $P<0.05$ and a confidence interval of 95% were used.

Results

Statistical analysis ($\chi^2=27.95$, $P=0.0001$) showed that there was a difference in relation to urban and rural environments. The programme of early discovery of vision impairment in four central schools in the area of the Jajce municipality included N=581 students and 125 (22%) were referred to a specialist. In relation to sex, there was a higher percentage of girls, 74 (59%), than boys, 51 (41%). A certain deviation from the usual values was noticed in 38 of the 421 (9%) students included in 18 district (rural) schools, that is, 24 (63%) girls and 14 (37%) boys.

The results of Screening of Vision in Relation to the School Grade is given in Table 1.

The largest percentage of students with a positive result were from 4th grades, whilst the smallest percentage was from 5th grades.

The results of Screening of Hearing in Relation to the School Grade is given in Table 2.

After the screening of hearing was conducted, the results showed that there were no significant deviations in positive results among students. First grade students were not invited for hearing impairment testing.

During hearing tests in central schools, 23 (5%) were referred to an ear, nose and throat specialist out of 394 children examined, where there was a higher percentage of boys, 15 (65%) compared

Table 1. The Total Number of Students Covered by Vision Screening and Students with Positive and Negative Results in Relation to the School Grade

Grade	Students			P†
	Covered by screening	Positive result*	Negative result	
	N; (%)	N; (%)	N; (%)	
1st	249 (25)	42 (4)	207 (21)	
2nd	190 (19)	16 (2)	174 (17)	
3rd	207 (21)	40 (4)	167 (17)	0.0001
4th	200 (20)	52 (5)	148 (15)	
5th	156 (15)	13 (1)	143 (14)	
Total	1002 (100)	163 (16)	839 (84)	

*Sent for further diagnostic testing; †χ^2 test.

Table 2. The Total Number of Students Covered by Hearing Screening and Students with Positive and Negative Results in Relation to the School Grade

Grade	Students			P†
	Covered by screening	Positive result*	Negative result	
	N; (%)	N; (%)	N; (%)	
2nd	188 (25)	7 (1)	181 (24)	
3rd	201 (26)	9 (1)	192 (25)	
4th	203 (26)	15 (2)	188 (24)	0.2709
5th	176 (23)	13 (2)	163 (21)	
Total	768 (100)	44 (6)	724 (94)	

*Sent for Further diagnostic testing; †χ^2 test.

Table 3. The Number of Students Sent to an Ophthalmologist in Relation to the School Grade and Sex

Grade	Sex		
	Boys	Girls	Total
	N; (%)	N; (%)	N; (%)
1st	16 (25)	26 (27)	42 (26)
2nd	5 (8)	11 (11)	16 (9)
3rd	18 (27)	22 (22)	40 (25)
4th	20 (31)	32 (33)	52 (32)
5th	6 (9)	7 (7)	13 (8)
Total	65 (100)	98 (100)	163 (100)

to 8 girls (35%), while out of the total number of 374 examined, 21 (5%) children from district (rural) schools were referred to a specialist for further examination and diagnostics, of which 10 (48%) were boys and 11 (52%) were girls. The results obtained (χ^2=0.02, P=0.8945) showed that there was no statistically significant difference between urban and rural settings.

The results of screening of vision in relation to the school grade and sex are given in Table 3.

On the basis of the results obtained from the total number of students who did not pass the vision test and who were referred for an examination, there was a larger proportion of girls than boys.

Table 4. The Number of Students Sent to an Ear, Nose and Throat Specialist in Relation to the School Grade and Sex

Grade	Sex		
	Boys	Girls	Total
	N; (%)	N; (%)	N; (%)
2nd	4 (16)	3 (16)	7 (16)
3rd	6 (24)	3 (16)	9 (20)
4th	11(44)	4 (21)	15 (34)
5th	4 (16)	9 (47)	13 (30)
Total	25 (100)	19 (100)	44 (100)

The results of screening of hearing in relation to the school grade and sex are given in Table 4.

In the hearing tests conducted on these school children, the results showed that in the 4th grades there was a higher proportion of boys in comparison to girls sent for further tests, that is, a second screening, whilst in the 5th grades there was a higher proportion of girls in comparison to boys. In this study, there were no children with both impairments.

The total number of students who wore dioptric glasses before the screening of vision was 52 (5%). In relation to the grade they were in, the largest number of students were in first grade, 14 (27%), then in second grade, 10 (19%). Amongst the students covered by the screening of hearing, there were no students who wore a hearing aid.

The results of the second vision screening test are given in Table 5.

The results of the second hearing screening test are given in Table 6.

The results of the second screening test of vision and hearing show high specificity and sensitivity.

Table 5. Results of the Second Vision Screening Test

Test	Clinically positive	Clinically negative	Total
	N; (%)	N; (%)	N; (%)
Positive Test	102 (95)	61 (7)	163 (16)
Negative Test	5 (5)	834 (93)	839 (84)
Total	107 (100)	895 (100)	1002 (100)

Table 6. Results of the Second Hearing Screening Test

Test	Clinically positive	Clinically negative	Total
	N; (%)	N; (%)	N; (%)
Positive Test	14 (93)	30 (4)	44 (6)
Negative Test	1 (7)	723 (96)	724 (94)
Total	15 (100)	753 (100)	768 (100)

Discussion

In this research, the results obtained show that there is a higher proportion of students with vision disorders compared to students with hearing disorders. These are disorders that often go undiagnosed. There was an extremely small percentage of students who wore glasses before the vision screening, while there were no students with hearing aids. The study shows the importance and necessity of early detection of vision and hearing disorders in school children, in order to start adequate treatment for the further proper growth and development of children.

On the basis of the results of the first screening, it was determined that the prevalence of visual impairment was twice as high as in the research conducted in the period of 2017-2018 in Hargeisa, Somaliland, Somalia on a sample of 1204 students (aged 6 to 15). The prevalence was 91 (7%), and only 16 (17%) children wore glasses. Girls had a higher prevalence of visual impairment (4.6%) than boys (2.6%) (16). On the other hand, in the Municipality of Jajce, of the total number of students with a positive result on the vision screening test, the majority were girls (Table 3), while in Ethiopia (Sekela Woreda), more than half were boys (17). Comparing the data with a study conducted in 2003 in the Gombak district, a suburban area near the city of Kuala Lumpur, among school children aged 7 to 15 years, the results showed that the prevalence of uncorrected visual impairment in the total number of 4634 children covered, was 17.1% (18), which is close to the results obtained in our research. When compared to the studies conducted in Ethiopia (Sekela Woreda), where the prevalence of vision impairment was 70 (8.0%) (17) and in Malaysia 7.7% (19), in the study in the area of Jajce municipality, the prevalence is twice as high. A reason for this may be the insufficiently developed awareness of the importance of ophthalmological examinations in children from an early age. The prevalence of uncorrected visual impairment among school children in Brazil was 4.82%, which is significantly lower than the results of our study. Uncorrected refractive error is the most common cause of visual impairment in school children in Brazil (20). Also, in India 236 children were examined for vision, and a higher prevalence of vision impairment was recorded, 21.19% (19.84% of boys and 22.73% of girls) (21) compared to the current study. Research conducted in Tuzla (Bosnia and Herzegovina) measured the prevalence of amblyopia in preschool and school children between 4 and 15 years of age. A total of 7,415 children from eight preschool institutions and twenty-four schools were examined. After the screening, the number of children who were referred to ophthalmologists for further evaluation was 819 (11.04%) (22).

From a statistical point of view, it is easy to conclude that the results of the research show that there is a significant difference in relation to the class attended by the students who have deviations from the usual values. The largest proportion of students with a positive result was in fourth grade, while the smallest were in fifth grade (Table 1). Vision screening in children aged 5 to 13 in Turkey (Canakkale) in 2013, found that the prevalence of reduced visual acuity was the highest in children aged 7-9 years (N=135) 15.3% (23), which is similar to the research conducted in the Municipality of Jajce.

In addition, it is important to emphasize that the statistical analysis showed that there is a difference in relation to the urban and rural environment when it comes to the vision screening test. Deviations from normal values were observed in one quarter of urban students, and more than half were girls, and similar research results were recorded in India, where there were more city school students with mild and moderate visual impairment (24, 25). This could be related to the greater number of activities conducted in a closed space, most

often long-term viewing of television, computers, mobile phones and the like. When it comes to the use of glasses, in our study, a significantly smaller number of students used glasses, compared to the data in a study conducted in Australia among children aged 12 years, where the prevalence of visual impairment was recorded as 10.4% of students, and the use of glasses was recorded in 448 children (19.0%) of the total number of 2353 children (26). Out of the 9867 students who were sent for a second screening in Thailand, 53.96% (27) were supposed to wear glasses.

In Turkey (Istanbul), out of 823 students, 7.9% wore glasses (28), which is similar to the results obtained in our research. When it comes to the prevalence of hearing impairment in this study, it is important to note that it is significantly lower than the results from Nigeria, which show that 46 (19.5%) children aged 5 to 11 had hearing problems. Otoscopy data indicate that the most common hearing disorders were associated with cerumen and inflammation of the middle ear (29). Also, a hearing test in Kyrgyzstan showed a higher prevalence of hearing impairment. Out of the 452 students included, 123 (27.2%) had this impairment (12). After a programme was implemented for early detection of hearing disorders, the results showed that there was no statistically significant difference in relation to the class they attended (Table 2), while in the study in Kyrgyzstan there were statistically significant differences in relation to age. Hearing impairment was more common in younger children (32.2%) than in older children (18.4%) (12).

On the basis of the results of research conducted in the eastern part of the Republika Srpska, which included 408 students, the total prevalence of hearing impairment in children aged 6 to 10 was determined to be 11.7% (30). Our research shows half this prevalence of hearing impairment among students. On the basis of data from a study in South Africa in students from 1st to 3rd grades, the prevalence of hearing loss was 2.2% (31), while in Karachi (Pakistan) 13.6% of students had hearing loss (27). In the municipality of Jajce, out of the total number of students with a positive result from the hearing screening test, more than half were boys, while there were no statistically significant differences in the prevalence of hearing impairment between boys (14.1%) and girls (13.0%) in the aforementioned study (32).

The research shows that, as far as hearing impairment in relation to rural and urban areas is concerned, there was no statistically significant difference in relation to these environments. In the urban environment, the majority of students with positive findings were boys, and in the rural environment, more than half were girls, while a study conducted in China (Jinan) showed that there was a smaller proportion of children aged 6-19 with hearing impairment, 10%, in the urban areas, while in rural areas 20% of school children had impairment (33, 34). In the Municipality of Jajce, there were no students who wore hearing aids, and the same results were obtained in a study conducted in Greenland, which showed that 10% of children were found to have hearing impairments out of the total number of 185 students who were screened, but no student wore a hearing aid (35). After the second screening test of vision and hearing, a slightly lower proportion of students were confirmed to have a positive result, and the results showed high specificity and sensitivity (Table 5, Table 6).

Conclusion

Programmes implemented for the early detection of vision and hearing impairments lead to diagnosis and early treatment of children. In this study, the results showed that there is a need to continue implementing preventive programmes. Early recognition of damage and subsequent proper intervention is very important.

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