

HEARING SCREENING OF SCHOOL CHILDREN IN THE PODKARPACIE VOIVODESHIP, POLAND

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ABSTRACT

INTRODUCTION: Hearing screening is an important part of prevention. It allows early detection of hearing disorders, thus the treatment may begin early, and eliminates or minimises negative consequences. Children with hearing impairment often experience delayed speech development and cognitive abilities, which can result in learning disabilities and reduce school progress. Since 1999, the Institute of Physiology and Pathology of Hearing in Poland has provided a hearing screening program for school-age children in the country. The main aim of the program is the early detection of hearing disorders in children starting school, and increase in the awareness among parents of hearing problems.

MATERIALS AND METHODS: Pure-tone air-conduction hearing thresholds were obtained at 0.5–8 kHz. The results of the hearing screening examination were regarded as positive if pure-tone thresholds were higher than 20 dB HL in one or both ears at one or more of the test frequencies. The audiometric results were supplemented by questionnaires completed by the parents. There were 8,091 first-grade children from the Podkarpackie Voivodeship enrolled in the program.

RESULTS: Based on the audiogram, screening showed that hearing impairment was found in 1618 children (20% of the examined children).

CONCLUSION: Our study yielded a large group of children with hearing problems. We recommend that hearing screening in primary schools should be a routine procedure within a general framework of preventive pediatric health care.

Keywords: hearing screening, hearing loss, school screening, pure tone audiometry

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INTRODUCTION

Hearing loss (HL) is the most common sensory impairment. The prevalence of HL among children is estimated to be between 7.7% and 22.5%, depending on the criteria applied (1–3). Hearing screening in schools is used to identify conditions that prevent students from reaching optimal physical and mental levels. Good hearing is fundamental to language development, which is essential for learning when

a child starts school. The early detection of hearing disorders means a child can receive appropriate treatment and education, improving the child's overall well-being. The goal of school hearing screening programs is to identify students with potential hearing deficits at the earliest possible stage so that they can be referred for diagnosis and treatment, if required. However, it needs to be kept in mind that a hearing screening test does not provide a firm diagnosis of HL, only an indication that the child is at risk of having a hearing disorder and requires further assessment by an audiologist or ENT specialist.

According to the European Scientific Consensus agreement, drawn up and signed during the European Federation of Audiology Societies meeting in Warsaw, June 2011, untreated hearing loss of >20 dB can have a negative impact on speech, language, and cognitive development, and subsequently on academic achievements (4). In the light of predicted trends in hearing loss, the World Health Organization underlines the importance of preventative actions; it emphasizes the value of hearing care at the community level as well as of screening and intervention services to high-risk populations, including schoolchildren (5). Even school children with only mild hearing loss, who appear to function normally in everyday situations, are nonetheless at risk of academic, social, and behavioural problems. Identification of even mild hearing loss is therefore important, because it allows effective treatment to be undertaken before significant damage is done (6). School hearing screening programs are an opportunity to reduce the health and economic burden of childhood hearing loss. However, even in regions which have routine neonatal screening programs, childhood hearing loss is still a generally neglected public health problem (7,8).

The Institute of Physiology and Pathology of Hearing, in collaboration with the Polish Agricultural Social Insurance Fund, has performed a screening program for school children from rural areas and small towns in eastern Poland (9), a programme that has subsequently been extended to the western part of the country (10). This paper presents the results of a study in the Podkarpackie Voivodeship of Poland on the number on first-grade children who have HL.

MATERIALS AND METHODS

The number of children included in the program amounted to 8,091 children (4,020 girls; 4,071 boys). Hearing screening tests were carried out among these first grade children at the age of 7 years in 543 general primary schools in rural areas. All schools were located in 21 communes in the Podkarpackie Voivodeship. A considerable difficulty in carrying out the program was the wide dispersal of schools in the regions involved. In the rural regions and small towns (below 5,000 inhabitants) the majority were small schools in which the number of involved children was often less than 20.

The study was approved by the Ethics Committee of the Institute of Physiology and Pathology of Hearing (KB.IFPS:27/5/2018) and conformed to the Declaration of Helsinki. Prior to testing, the child's parents or legal caregivers were informed of the testing procedures and gave written consent before the child entered the study. Information about the programme, together with a booklet about hearing prophylaxis and the examination consent forms, were delivered to schools through local administration units (communes). Teachers distributed the materials to parents at face-to-face meetings.

In this study, the screening examinations were part of an educational campaign directed to parents and their children. The main goal was to broaden knowledge of the potential causes of HL and the options for prophylaxis, diagnosis, treatment, and rehabilitation of hearing disorders. The educational materials were mainly aimed at parents, who are undoubtedly the first and most important "health teacher" for the child (11). In addition, a hearing guide for children was prepared in which the most important principles of caring for hearing were simply set out.

Screening pure-tone audiometry was performed using the Platform of Sensory Organs Examinations (12,13). The platform is built on an internet network, interfacing a central computer system with a series of portable computers (remote clients) that are equipped with audiometric headphones and a response button. The platform makes it possible to perform air conduction audiometric testing on each ear separately over a frequency range 0.5 to 8 kHz and for levels not exceeding 80 dB HL. Tests were carried

out in quiet rooms in accordance with the modified Hughson and Westlake procedure (14,15). A positive test result was considered to be an air conduction threshold of 25 dB HL or more at a minimum of one frequency in at least one ear (12,16,17). Audiometric hearing tests were supplemented by the results of a questionnaire filled in by parents or legal caregivers. The questionnaire included the following questions: *Do you think your child has any problems with his/her hearing? Does your child complain of tinnitus in their ears/head when it is quiet? Has your child been treated for otitis media? Does your child complain about noise at school?*

The data of the hearing tests were sent via an internet connection to the SZOK system and safely stored in a database (13,17). The collected results were marked with a unique identifier which guarantees full protection of personal data in accordance with applicable law. This is a unique solution in the field of telemedicine and e-health. After the results of the tests were transferred to SZOK, incorrect test results (according to fixed criteria) were separated out by an audiologist and an ENT specialist.

The positive results of the screening test were

- ◆ *Low-frequency hearing loss (LFHL)*: for cases presenting a hearing threshold at 500 and/or 1000 Hz above 20 dB HL, while the threshold for the other tested frequencies was normal.
- ◆ *High-frequency hearing loss (HFHL)*: for cases presenting a hearing threshold at 4000 and/or 8000 Hz above 20 dB HL, while the hearing threshold for other tested frequencies was normal.
- ◆ *Other*: cases where the hearing threshold was above 20 dB HL at two or more arbitrary frequencies.

RESULTS

Positive results from the hearing screening, according to the adopted criterion, were obtained in 1618 children (20% of examined children). Unilateral hearing loss was found in the majority of children with a positive result of the hearing screening (68.3%) compared to a smaller number with bilateral hearing loss (31.7%). The distribution of left and right ears was similar. The percentage of positive results was slightly higher among boys than among girls. Detailed results are shown in Table 1.

Table 1. Percentage of students with hearing loss and the frequency of unilateral and bilateral hearing loss divided by sex

Sex	Number of Children Screened	Number of Children with Positive Result	Bilateral	Unilateral	
				Right Ear	Left Ear
Girls	4020	764 (19%)	237 (31%)	527 (69%)	
				261 (49.5%)	266 (50.5%)
Boys	4071	854 (21%)	276 (32.3%)	578 (67.7%)	
				298 (51.6%)	280 (48.4%)
Total	8091	1618 (20%)	513 (31.7%)	1105 (68.3%)	
				559 (50.6%)	546 (49.4%)

classified into two groups: unilateral or bilateral hearing losses. Unilateral hearing loss was recognised when there was normal hearing in one ear and hearing loss in the other with threshold values equal or greater than 25 dB at one or more frequencies (13). Subsequently, according to previously established protocols (12,17), data showing abnormal audiometric patterns was assigned to one of three categories:

Among children beginning education with an abnormal hearing screening result, HFHL was more common, affecting 35.8% (763 ears), than LFHL, which accounted for 23.8% (508 ears). The remaining 40.4% (860 ears) were made up of hearing losses at other frequencies.

The audiometric results were supplemented with a questionnaire completed by 7312 parents (90.4% of all parents of children who took part in the study). Their answers are shown in Table 2. It is in-

Table 2. Results of the questionnaire

Question	Answer	Number of Responses	Hearing Screening Result	
			Negative	Positive
Do you think your child has any problems with his/her hearing?	No	6913	5596	1317
	Yes	399	269	130
Does your child complain of tinnitus in their ears/head when it is quiet?	Very often and often	46	34	12
	Rarely	678	536	142
	Never	6588	5295	1293
Does your child often listen to loud music?	No	6611	5308	1303
	Yes	701	557	144
Has your child been treated for otitis media?	No	5141	4158	983
	Yes	2171	1707	464
Does your child complain about noise at school?	No	6539	5241	1298
	Yes	773	624	149

interesting to compare parents' answers with their children's hearing results.

The results of the questionnaire concerning parents' awareness of hearing disorders showed that when it came to the 1317 children who had positive screening results, 91.02% of their parents did not notice any problems with hearing. However, it should be added that in the majority of cases (68.9%) this concerned unilateral hearing losses. Interestingly, 269 parents said that their child had a hearing problem, but pure tone audiometry did not confirm this. Tinnitus was also considered in the questionnaire. It was observed that 9.9% of children experienced tinnitus: 6.3% experienced it very often or often, and 93.7% rarely. Of the children who had a positive result at the hearing screening examination, 26.1% experienced tinnitus very often or often, compared to 21% who rarely experienced tinnitus.

The questionnaire indicated that 29.7% of the children had previously received treatment for otitis media. In addition, over one-fifth of the children with positive results from the hearing examination had had ear infection in the past.

Moreover, 10.6% of the examined children complained of excessive noise at school. One in five children complaining of noise at school had a positive result at the hearing screening examination.

The data confirm the need to increase the availability of medical services in rural areas, with hear-

ing disorders showing up in a significant percentage of school-age children. Detecting hearing loss in a student starting school, and then treating it, is likely to improve the child's chances of a successful school education and of fulfilling their potential (11).

DISCUSSION

Hearing screening programs have an essential preventive role, being the basic tool of secondary prophylaxis. Screening allows for an early diagnosis of hearing disorders, thus enabling quick treatment and eliminating or minimizing the negative consequences associated with this type of dysfunction. In this study, data were collected from first-grade children from primary schools in rural areas of the Podkarpackie Voivodeship. A positive result was obtained in 1618 children (20% of the examined children). All children with a positive result were referred for further diagnosis to an audiologist or an ENT specialist. This result is comparable with research carried out in Poland in the Warmian-Masurian Voivodeship, which showed that 19% of children from grades I-III of primary schools had a positive result of screening examination (3). In comparison, the prevalence of hearing loss in school-age children from rural areas throughout Poland has been estimated to be 16.4% (17). Data from pilot hearing screening projects, conducted by the Institute of Physiology and Pathology of Hearing in various African countries, have shown a prevalence of hearing loss of 18-34% (16), while in

Asian countries hearing loss was found in the range of 15.9–24.1% (12,13). Govender and Mars (18) assessed 146 ears of students at a school in South Africa and found that 16% (23 ears of 20 children) presented with hearing loss. The variability in prevalence may be explained by different sample numbers, different evaluation protocols, and by the various ages of the children (19). Our findings show that unilateral hearing loss (UHL) was more frequent (68.3%) than bilateral hearing loss (BHL) 31.7%, which is in line with results reported by a previous study in Poland (17). In a study conducted by Sekhar et al. (20), single-sided hearing loss was found to be as high as 88% (59 children from 67 with hearing impairments) in a group of 296 assessed children. Binaural hearing offers the listener several important advantages over monophonic hearing. It has been established that binaural hearing provides better speech perception, better sound localisation, increased loudness perception through binaural summation, and an overall improvement in hearing in both noisy and quiet environments (21).

Low-frequency hearing losses were identified in 23.8% of the ears with positive results. Our result is in line with results from Poland which indicate a similar rate of LFPTA HL (23%) (3). In Nigeria, results of hearing screening indicate that 33.4% of children with positive screening results had a LFHL (167 out of 500 examined children) (22). In some cases, a low-frequency hearing loss may be temporary²³, and, depending on the specifics of the individual case, pharmacological or surgical intervention may be effective. The most common reasons for this kind of hearing loss are cerumen, perforation of the ear drum, tympanosclerosis, and otitis media with effusion²⁴.

High-frequency hearing losses were identified in 35.8% of the ears with positive results. Data reported in another study conducted in Warmian-Masurian Voivodeship indicated an even higher rate of HFHL—43.9% of ears had a positive result. In comparison, hearing screening in Tajikistan found that the percentage of children with HFHL was 25.5% (12). Causes of high-frequency hearing loss in children can be noise, disease, infection, or genetic factors (25). Children with HFHL may appear to be inattentive or distractible due to difficulties understanding speech in noise. Recesses can be very noisy, which can lead to social problems if a child is unable

to hear or misinterprets information in these situations (26). In HFHL, speech disorders and articulation problems can arise. It is important that children with HFHL should be permanently supported in school and in their home environment (27).

Results of the objective hearing screening were supplemented with information from a questionnaire completed by parents. We found that only about 9% of the parents suspected a problem with their child's hearing. This result was lower than the measured prevalence of hearing loss in the children. Moreover, the parents' opinions were not accurate. These results are in line with other researchers' findings (28,29) and show that parents have difficulty in identifying hearing problems in their children and tend to underestimate it.

The screening procedures we used make it possible to detect not only children with hearing loss, but also those with other hearing disorders, such as tinnitus. Tinnitus is becoming a common problem in school-age children. In our study, prevalence of tinnitus was estimated to be 9.9%. This result is in line with a study showing that the incidence of tinnitus in Polish children, aged between 7 and 12 years, ranges from a few percent to 12% or more depending on the child's age and place of residence (30). A similar result was reported from Tajikistan, where the figure was 9% of children (12).

CONCLUSION

Detecting hearing impairments in school-age children is essential. The later a hearing disorder is detected, the greater is the likelihood of poor future outcomes. In view of the significant number of children with positive screening results, we conclude that it is imperative to implement a universal school hearing screening program in Poland. Early diagnosis allows referral to specialists, who can then provide appropriate rehabilitation and thereby minimize or eliminate the negative impacts on a child's cognitive, social, emotional, and communication abilities.

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