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PILOT HEARING SCREENING IN SCHOOLCHILDREN FROM ARMENIA, RUSSIA, KYRGYZSTAN, AND AZERBAIJAN

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Contributions:
A Study design/planning
B Data collection/entry
C Data analysis/statistics
D Data interpretation
E Preparation of manuscript
F Literature analysis/search
G Funds collection

Abstract

Background: A number of pilot hearing screening programs have been started in various countries, promoting hearing-loss detection and treatment of communication disorders in school-age children. The aim of the study was to evaluate the hearing status of schoolchildren from selected schools in Armenia, Russia, Kyrgyzstan, and Azerbaijan.

Material and methods: Hearing screening was performed in 1022 children aged from 6 to 12 years in Armenia, Russia, Kyrgyzstan, and Azerbaijan. The study was carried out with the use of the Sensory Examination Platform. Pure-tone air-conduction hearing thresholds were obtained at 0.5–8 kHz. Hearing loss was defined as a loss of more than 20 dB in one or both ears in at least one of the following: high-frequency pure-tone average (HFPTA) and low-frequency pure-tone average (LFPTA) and others.

Results: Normal hearing was observed in 75.4% of children. Hearing loss was observed in 13.4% of the children unilaterally and 11.2% bilaterally. Overall, the results of screening indicate higher incidence of LFHL in children than HFHL.

Conclusions: The high prevalence of hearing loss in children from the studied countries indicates the need to conduct further hearing screening programs in this part of the world. This would allow earlier diagnosis of hearing problems and enhance the options for introducing proper diagnostic and therapeutic approaches, leading to better outcomes.

Key words: screening programs • hearing • children • school-age • pure-tone audiometry

WYNIKI PILOTAŻOWYCH BADAŃ PRZESIEWOWYCH SŁUCHU WŚRÓD UCZNIÓW W WYBRANYCH KRAJACH AZJATYCKICH

Streszczenie

Wprowadzenie: Pilotażowe programy badań przesiewowych rozpoczęto w różnych krajach, aby promować wczesne wykrywanie zaburzeń słuchu i leczenie zaburzeń komunikacyjnych wśród dzieci w wieku szkolnym. Celem niniejszej publikacji jest ocena częstości występowania zaburzeń słuchu u uczniów w wybranych krajach azjatyckich.

Materiał i metody: Badania przesiewowe przeprowadzono w grupie 1022 dzieci w wieku od 6 do 12 lat w czterech krajach azjatyckich: Armenii, Rosji, Kirgistanie i Azerbejdżanie. Badania wykonano za pomocą Platformy Badań Zmysłów. Wartości progowe dla przewodnictwa powietrznego określono w zakresie częstotliwości 0,5–8 kHz. Nieprawidłowym wynikiem testu była wartość progowa dla przewodnictwa powietrznego wynosząca więcej niż 20 dB HL dla co najmniej jednej częstotliwości w co najmniej jednym uchu. Nieprawidłowe wyniki podzielono na niedosłuch wysokoczęstoliwościowy (HFHL), niskoczęstoliwościowy (LFHL) oraz na inne.

Wyniki: Prawidlowy wynik badania uzyskano wśród 75,4% zbadanych dzieci. Jednostronny niedosłuch wykryto wśród 13,4% zbadanych dzieci, natomiast obustronny u 11,2%. Uzyskane wyniki wskazują, że niskoczęstoliwościowy niedosłuch występował częściej niż wysokoczęstotliwościowy.

Wnioski: Wyniki potwierdzają dużą częstość występowania problemów ze słuchem u dzieci z wybranych krajów azjatyckich. Wskazuje to na potrzebę prowadzenia programów przesiewowych badań słuchu w tej części świata, które pozwoliłyby na wcześniejsze rozpoznanie problemów ze słuchem i zwiększyłyby możliwość wdrożenia właściwego podejścia diagnostycznego i terapeutycznego, co pozwoliłoby na poprawę wyników.

Słowa kluczowe: program badań przesiewowych • słyszenie • dzieci • wiek szkolny • audiometria tonalna

Background

According to global estimates of the prevalence of hearing loss by the World Health Organization (WHO) in 2018, there are 466 million people with disabling hearing loss worldwide, 93% of them adults and 7% children [1]. Between 1990 and 2016, hearing loss was the second most prevalent disability among children younger than 5 years in 195 countries and territories, with the highest prevalence in South Asia in 2016 [1–3].

There are many risk factors for hearing loss, such as exposure to loud sounds in occupational and recreational settings, chronic ear infections, and ototoxicity [1]. The distribution of disabling hearing impairment across different regions of the world and age groups reveals the highest prevalence in South Asia, East Asia, Sub-Saharan Africa, and the Asia Pacific [1,3]. Once again, the highest prevalence of hearing loss in children (0–15 years) is found in South Asia, Sub-Saharan Africa, and the Asia Pacific. There are a number of reasons for the hearing loss in children from these countries, which range from genetic defects related to marriage between close relatives [4], exposure to ototoxic drugs, or a higher prevalence of infectious disease [2].

Children with hearing impairments are likely to show delays in the production of speech as well as in other important aspects of nonverbal development, such as motor control [5]. According to the European Scientific Consensus agreement (defined 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 achievement [6–8].

School-age children with even mild hearing losses, who often appear to function normally in everyday situations, are nonetheless at considerable risk of academic, social, and behavioral problems. Earlier diagnosis of hearing problems in an infant or child enhances options for proper diagnosis and therapy. Timely intervention is an important component of any Early Hearing Detection and Intervention screening program (7,8), so that effective treatments can be undertaken to prevent negative consequences [6].

As a result of the European Scientific Consensus agreement, a number of pilot hearing screening programs were started in various countries, promoting hearing-loss detection and treatment of communication disorders in young school-age children [7]. Pilot hearing screening programs have been carried out in schools in Europe and in Central Asia and Africa (including Poland, Moldova, Romania, Russia, Ukraine, Tajikistan, Kyrgyzstan, Azerbaijan, and Armenia) [6,7,9,10]. However, in developing countries hearing screening programs do not exist. Implementing them is extremely challenging due to long-standing health disparity issues. A major one is a basic lack of funding for health programs [11]. The aim of the current study was to investigate the hearing status of schoolchildren from selected countries (Armenia, Russia, Kyrgyzstan, and Azerbaijan) and, by doing this, to further raise awareness among parents, schools, and governments of the need to conduct hearing screening programs and implement effective treatments.

Material and methods

The hearing assessment took place in public schools in four countries: Armenia, Russia, Kyrgyzstan, and Azerbaijan (Figure 1). In Armenia, the pilot hearing screening took place at one of the schools in the capital, Yerevan. In Russia, the pilot hearing screening was performed at one of the schools in Krasnoyarsk. In Kyrgyzstan, the pilot hearing screening was carried out at three schools in the capital, Bishkek. In Azerbaijan, the pilot hearing screening took place at one of the schools in the capital, Baku. All schools were selected by local coordinators. A school was chosen if a large proportion of parents agreed that their children could take part in the screening, and that it was not a special school. The pilot hearing screening in schoolchildren was performed on 1022 children: 590 aged 6–7 years old (57.7%) and 432 who were 11–12 years old (42.3%) (Figure 2).

The schools were nominated by local authorities and approval from school management was obtained. Significant differences in the socioeconomic levels were the reason for excluding elite private schools. The study was approved by the Ethics Committee of the Institute of Physiology and Pathology of Hearing (KB:IFPS:26/1/2018) and conforms to the Declaration of Helsinki. Prior to testing,

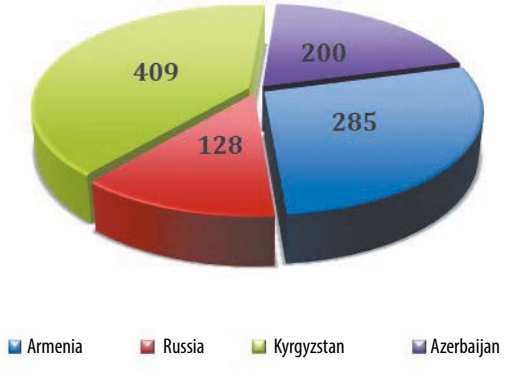

Figure 1. Number of tested children divided by country

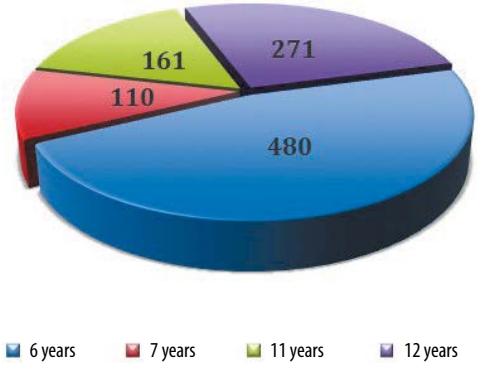

Figure 2. Number of tested children divided by age

Table 1. Results of hearing screening

	Normal audiogram	Abnormal result		
		Overall	Bilateral	Unilateral
Armenia	222 (77.9%)	63 (22.1%)	25 (39.7%)	38 (60.3%)
Azerbaijan	106 (53%)	94 (47.0%)	54 (57.4%)	40 (42.6%)
Kyrgyzstan	331 (80.9%)	78 (19.1%)	30 (38.5%)	48 (61.5%)
Russia	112 (87.5%)	16 (12.5%)	5 (31.3%)	11 (68.8%)
6–7 years old	438 (74.2%)	152 (25.8%)	61 (40.1%)	91 (59.9%)
11–12 years old	333 (77.1%)	99 (22.9%)	53 (53.5%)	46 (46.5%)
Total	771 (75.4%)	251 (24.6%)	114 (45.4%)	137 (54.6%)

the children's parents were informed of the testing procedures and gave written consent for their children to participate in a hearing screening examination. All children whose parents agreed to participation were scheduled for a screening test. The principals of the schools and the parents of the children were informed about the results of the study and advised that they should undergo further clinical assessments to confirm the screening results.

For screening purposes, the Platform of Sensory Organs Examination was used. The Platform is used within the telemedicine model SZOK for screening and testing hearing, which is built on a powerful, central computer system and a number of portable computers equipped with audiometric headphones and a response button for the tested person. Portable computers communicate with the central database via the Internet [12]. Testing was performed by experienced audiologists from the Institute of Physiology and Pathology of Hearing.

For reliable pure tone audiometry results, undisturbed, quiet conditions are required. Hence, all measurements were performed in quiet rooms available in the schools where noise levels were sufficiently low (not exceeding 40 dBA) for testing purposes. The test procedure complied with the standardized protocol applied in previous studies [7,9,10,13].

The platform allows air conduction audiometry testing to be performed for each ear separately over a frequency range of 0.5 to 8 kHz. It is limited to hearing thresholds below 80 dB HL. The data of the hearing tests were sent via an Internet connection to the SZOK system and safely stored in our database.

The eligibility criteria while screening the children's results for the purpose of the current study were: good cooperation with the child, low noise level during the examination, and the ability to measure hearing thresholds at all evaluated frequencies.

Although the definition of disabling hearing loss proposed by WHO refers to hearing loss greater than 40 dB in the better hearing ear in adults (15 years or older) and greater than 30 dB in the better hearing ear in children (0 to 14 years), in hearing screening of schoolchildren the criteria are more restrictive. According to already published studies [2], a positive result of a hearing screening is established if the hearing threshold is over 25 dB at one or more audiometric frequencies in at least one ear. In addition, mild hearing loss was defined as >20 to 40 dB, whereas moderate or worse hearing loss was defined as above 40 dB according to the BIAP classification.

The positive results of the screening test were selected and classified into two groups: unilateral or bilateral hearing losses. Subsequently, positive results of the screening in each group were assigned to three corresponding audiograms according to the previous criteria [9,10,12,13]:

- Low-frequency hearing loss (LFHL) – when the value of the hearing threshold for frequencies of 500 Hz and/or 1000 Hz and/or 2000 Hz was at least 25 dB HL, while the hearing threshold for the frequencies of 4000 Hz and 8000 Hz did not exceed 20 dB HL;
- High-frequency hearing loss (HFHL) – when the value of the hearing threshold for frequencies of 4000 Hz and/or 8000 Hz was at least 25 dB HL, and for the frequencies of 500, 1000, and 2000 Hz it did not exceed 20 dB HL;
- Other – when the hearing threshold exceeded 20 dB HL for at least two different, non-consecutive frequencies.

Results

Positive results of hearing screening, according to the adopted criterion, were obtained in 251 children (24.6%), while the other 771 children (75.4%) had audiometric thresholds equal or below 20 dB. Results of hearing screening for the whole group and according to country and age are shown in Table 1. The frequency of positive hearing screening results ranged from 12.5% in Russia to 47% in Azerbaijan. The distribution of positive results was similar for 6–7 years and 11–12 years of age.

In general, unilateral hearing loss was found in the majority of children with a positive result of hearing screening (54.6%). Only in Azerbaijan was this not the case, where bilateral hearing loss was found in 57.4% of children. Positive results in one ear were more frequent in younger children (59.9%) than in older children (46.5%).

Overall, the rate of LFPTA HL was estimated to be 32.6%, while the ratio of HFHL was 29.9%. However, in Russia and Kyrgyzstan HFHL was more frequent than LFHL

Table 2. Frequency of different types of audiograms among ears with a positive hearing screening result

	Ears with positive result	LFHL	HFHL	Other
Armenia	88	31 (35.2%)	31 (35.2%)	26 (29.6%)
Azerbaijan	148	72 (48.6%)	24 (16.2%)	52 (35.2%)
Kyrgyzstan	108	9 (8.3%)	44 (40.8%)	55 (50.9%)
Russia	21	7 (33.3%)	10 (47.6%)	4 (19.1%)
6–7 years	213	71 (33.3%)	63 (29.6%)	79 (37.1%)
11–12 years	152	48 (31.6%)	46 (30.3%)	58 (38.1%)
Total	365	119 (32.6%)	109 (29.9%)	137 (37.5%)

(Table 2). The estimated prevalence of HL type was similar among children aged 6–7 years and older.

The prevalence of mild hearing loss (>20 dB) was 7.6% and was more common than moderate or worse HL (0.8% of tested children) for each PTA.

Discussion

Based on our findings, the countries tested seem to be characterized by a high prevalence of hearing loss, which accords with WHO estimates [1]. Importantly, based on data from previous hearing screening tests [10, 14], the rate of positive hearing screening was the highest among all countries evaluated so far.

HFHL was the most common type of HL among children tested in Russia and Kyrgyzstan. A high prevalence of HFHL was also found in a study by Niskar et al. [16], where this type of HL was also the most common in children aged 6–19 years in the United States. On the other hand, LFHL was the most common type of hearing loss among tested children in Azerbaijan, similar to data from schoolchildren in Africa [10]. This situation may be because the research in Azerbaijan was carried out in the autumn, when there is an increased incidence of upper respiratory tract infections. More than 60% of upper respiratory tract infection episodes are complicated by acute otitis media (AOM) [17,18]. AOM can lead to conductive LFHL [17,18], which may explain the encountered differences.

Regarding the laterality of HL, unilateral hearing loss was found in the majority of children who had positive results of hearing screening. Only in Azerbaijan was bilateral hearing loss more prevalent. So far, we have found no reason to explain this difference. Nevertheless, in general our data are in line with previous results on HL laterality. According to Kuppler et al. [20] and Ross et al. [21], sensorineural hearing loss is the most prevalent form of hearing loss, affecting approximately 77% of positive screening school-aged children. Also, Niskar et al. [16) found that almost 82% of the positive screening children in the USA with HL presented unilaterally and Skarżyński et al. [7] reported the prevalence of unilateral hearing disorders in Tajikistan in 50% of all HL cases. It is worth mentioning that unilateral hearing loss is challenging to recognise by children, parents, and teachers, which underlines the important role of screening programs in its effective detection.

According to Naeem and Newton [4], children in Asia are at increased risk of sensorineural hearing loss and the reasons for that are complex. Hearing loss can be caused by hereditary and non-hereditary genetic factors or by certain complications during pregnancy and childbirth, which includes maternal rubella, syphilis, or certain other infections during pregnancy, low birth weight, birth asphyxia (lack of oxygen at the time of birth), inappropriate use of ototoxic drugs (such as aminoglycosides, cytotoxic drugs, antimalarial drugs, and diuretics) during pregnancy, and severe jaundice in the neonatal period, which can damage the hearing nerve in newborns [1]. Moreover, it is worth mentioning that in countries such as Armenia, Azerbaijan, Kyrgyzstan, and Russia, ototoxic drugs are widely used without audiological monitoring [15].

Also, excessive noise (e.g. during school breaks), meningitis, medications (ototoxic drugs), and congenital syphilis are among the many possible causes of sensorineural hearing loss in children [16]. Noise-induced hearing loss is the most common cause of the HFHL and is a growing problem among schoolchildren [16,19]. Exposure to very loud noise may explain why more children in Russia and Kyrgyzstan had hearing loss at high frequencies than at low frequencies [19].

Our findings showed that mild HL was much more frequent than moderate or worse HL, which is in line with previous research by Bess and Niskar [16,22). In our study, mild HL was found in 7.6% of the children, rates that are higher than Feder [23] reported [3.6–5%].

Finally, it must be mentioned that the differences in the prevalence of hearing loss, especially in countries where only pilot studies have been carried out, could be affected by the choice of schools in which the survey was conducted.

This study was solely a pilot screening; however, it has shown the need to conduct hearing screening programs in these countries. This research has raised many questions that require further investigation: e.g. whether the prevalence of hearing losses is actually as high as we have found.

Conclusion

The high incidence of hearing loss in children from the four selected countries indicates the need for conducting hearing screening programs in this part of the world, which would allow for earlier diagnosis of hearing disorders. In

essence, screening has the goal of identifying individuals at risk of hearing disorders and refer them for otorhinolaryngological and audiological assessment to increase the possibility of introducing a proper diagnostic and therapeutic approach leading to the best results.

Acknowledgements

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Limitations

The present study was conducted in the chosen schools and it is difficult to generalize findings to the whole pediatric population in these countries. In addition, only air conduction thresholds were measured, without performing bone conduction, otoscopy, tympanometry, or otoacoustic emissions.

References

1. World Health Organization. Addressing the rising prevalence of hearing loss. WHO: Geneva, 2018.
2. Olusanya BO, Davis AC, Wertlieb D, et al. Developmental disabilities among children younger than 5 years in 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Glob. Health, 2018;6:e1100–21.
3. Bright T, Mactaggart I, Kuper H, Murthy GV, Polack S. Prevalence of hearing impairment in Mahabubnagar District, Telangana State, India. Ear Hear, 2019;40:204–12.
4. Naeem Z, Newton V. Prevalence of sensorineural hearing loss in Asian children. Br J Audiol, 1996;30:332–9.
5. Engel-Yeger B, Weissman D. A comparison of motor abilities and perceived self-efficacy between children with hearing impairments and normal hearing children. Disabil Rehabil, 2009;31:352–8.
6. Skarzyński H, Piotrowska A. Screening for pre-school and school-age hearing problems: European Consensus Statement. Int J Pediatr Otorhinolaryngol, 2012;76:120–1.
7. Skarzyński PH, Świerniak W, Piłka A, et al. A hearing screening program for children in primary schools in Tajikistan: a telemedicine model. Med Sci Monit, 2016;22:2424–30.
8. Moeller MP. Early intervention and language development in children who are deaf and hard of hearing. Pediatrics, 2000;106:e43–e43.
9. Skarżyński PH, Świerniak W, Piłka A, et al. Pilot hearing screening program in children from primary schools in Tajikistan. Nowa Audiofonologia, 2013; 2(5): 42–7.
10. Skarżyński PH, Świerniak W, Piłka A, Ludwikowski M, Gos E, Skarżyńska MB. Pilot hearing screening in school-age children from different countries in Africa. Nowa Audiofonologia, 2018;7(4): 29–34.
11. Thomas TL, DiClemente R, Snell S. Overcoming the triad of rural health disparities: how local culture, lack of economic opportunity, and geographic location instigate health disparities. Health Educ J, 2014;73:285–294.
12. Skarżyński PH, Świerniak W, Piłka A, Skarżyńska MB, Włodarczyk AW, Kholmatov D et al. A hearing screening program for children in primary schools in Tajikistan: a telemedicine model. Med Sci Monit, 2016; 22: 2424–30.
13. Śliwa L, Hatzopoulos S, Kochanek K, et al. A comparison of audiometric and objective methods in hearing screening of school children. A preliminary study. Int J Pediatr Otorhinolaryngol, 2011;75(4):483–8.
14. Skarżyński PH, Kochanek K, Skarżyński H, et al. Hearing screening program in school-age children in Western Poland. Int Adv Otol, 2011;7(2):194–200.
15. Harris T, Peer S, Fagan JJ. Audiological monitoring for ototoxic tuberculosis, human immunodeficiency virus and cancer therapies in a developing world setting. J Laryngol Otol, 2012;126:548–51.
16. Niskar AS, Kieszak SM, Holmes A, Esteban E, Rubin C, Brody DJ. Prevalence of hearing loss among children 6 to 19 years of age: the Third National Health and Nutrition Examination Survey. JAMA, 1998; 279(14): 1071–5.
17. Stockmann C, Ampofo K, Hersh AL, et al. Seasonality of acute otitis media and the role of respiratory viral activity in children. Pediatr Infect Dis J, 2013;32:314–9.
18. Pettigrew MM, Gent JF, Pyles RB, Miller AL, Nokso-Koivisto J, Chonmaitree T. 2011. Viral–bacterial interactions and risk of acute otitis media complicating upper respiratory tract infection. J Clin Microbiol, 49:3750–5.
19. Harrison RV. The prevention of noise induced hearing loss in children. Int J Pediatr, 2012;473541.
20. Kuppler K, Lewis M, Evans AK. A review of unilateral hearing loss and academic performance: is it time to reassess traditional dogmata? Int J Pediatr Otorhinolaryngol, 2013;77(5):617–22.
21. Ross DS, Holstrum WJ, Gaffney M, et al. Hearing screening and diagnostic evaluation of children with unilateral and mild bilateral hearing loss, Trends Amplif, 2008; 12(1): 27–34.
22. Bess FH, Dodd-Murphy J, Parker RA. Children with minimal sensorineural hearing loss: prevalence, educational performance, and functional status, Ear Hear, 1998; 19: 339–54.
23. Feder KP, Michaud D, McNamee J, Fitzpatrick E, Ramage-Morin P, Beauregard Y. Prevalence of hearing loss among a representative sample of Canadian children and adolescents, 3 to 19 years of age. Ear Hear, 2017; 38: 7–20.