The Journal of International Advanced Otology

J Int Adv Otol 2022; 18(2): 106–111 • DOI: 10.5152/iao.2022.21164

Original Article

Results of Hearing Screening in School-Age Children from Rural Areas of the Kujawsko–Pomorskie Region in Poland

Elzbieta Gos[1], Piotr Henryk Skarzynski[1,2,3,4], Natalia Czajka[1], Monika Matusiak[2], Wojciech Kazmierczak[1,6], Joanna Janiak-Kiszka[2], Katarzyna Beata Cywka[1,2], Henryk Skarzynski[2]

[1]Teleaudiology and Screening Department, World Hearing Center, Institute of Physiology and Pathology of Hearing, Kajetany, Warsaw, Poland
[2]Oto-Rhino-Laryngology Surgery Department, World Hearing Center, Institute of Physiology and Pathology of Hearing, Kajetany, Warsaw, Poland
[3]Institute of Sensory Organs, Kajetany, Warsaw, Poland
[4]Heart Failure and Cardiac Rehabilitation Department, Medical University of Warsaw Faculty of Medicine, Warsaw, Poland
[5]Department of Sensory Organs Research, Department of Health Sciences, Ludwik Rydygier, Collegium Medicum, Nicolaus Copernicus University, Bydgoszcz, Poland
[6]Department of Otolaryngology and Laryngology Oncology with the Audiology and Phoniatrics Subdivision, University Hospital, Bydgoszcz, Poland

ORCID IDs of the authors: E.G. 0000-0003-3173-3867; P.H.S. 0000-0002-4978-1915; N.C. 0000-0003-1203-6679; M.M. 0000-0003-1138-3425; W.K. 0000-0001-8176-1802; J.J.K. 0000-0002-2593-4999; K.B.C. 0000-0003-1224-1074; H.S. 0000-0001-7141-9851.

Cite this article as: Gos E, Skarzynski PH, Czajka N, et al. Results of hearing screening in school-age children from rural areas of the kujawsko–pomorskie region in poland. *J Int Adv Otol.* 2022;18(2):106-111.

OBJECTIVE: There is a need for regular surveillance of the hearing of children, no matter what their age. Screening of the hearing of school children can be done quickly and cheaply using teleaudiology. The primary aim of this study was to identify children who showed a suspected hearing impairment from rural areas of the Kujawsko–Pomorskie region and refer them for further audiological testing. A secondary aim was to estimate the prevalence of hearing loss in those children.

METHODS: There were 4754 children, made up of 1840 children aged 6–7 years old and 2914 children aged 12–13 years old. Pure-tone air conduction thresholds were obtained at 0.5–8 kHz. Audiometric test was supplemented by results of a brief questionnaire filled in by parents.

RESULTS: Of the 4754 children, 618 (13%) failed screening and were referred for detailed audiological diagnostics. The prevalence of hearing loss was estimated to be 7% and was significantly higher (OR = 2.12) in the group aged 6–7 y/o (10.1%) than in the group aged 12–13 y/o (5.0%). In our study the estimated prevalence of HL was twice as high in children aged 6–7 y/o (10.1%) than in children 12–13 y/o (5.0%). This difference was also evident in another study of Polish children from rural areas, where the prevalence of HL was 11.4% in younger children (6–9 y/o) and 5.5% in older children (12–13 y/o).

CONCLUSION: Large numbers of school-age children in rural areas have hearing problems. It is recommended that a hearing screening program in primary schools based on e-health solutions should be adopted.

KEYWORDS: Hearing loss, hearing screening, pure-tone audiometry, school-age children, school screening

INTRODUCTION

In Poland, all newborns undergo routine hearing screening, but unfortunately, there is no universal hearing screening for preschool and school children, even though it is known that hearing loss (HL) can develop at any stage after birth. Estimates of the prevalence of hearing disorders in children vary from about 7% to about 17.5%.[1] Hearing deficits in childhood can interfere with language development, communication, and ability to learn.[2,3] Impaired children are likely to be at a disadvantage emotionally and socially.[4] It is therefore crucial that hearing screening be available not only for newborns but also for older children. The need for routine hearing screening throughout childhood has been stressed by many researchers and clinicians,[5-7] as well as by numerous professional organizations—the American Academy of Audiology,[8] American Speech–Language–Hearing Association,[9] and the European Federation of Audiology Societies.[10]

Corresponding author: Piotr Henryk Skarzynski, e-mail: p.skarzynski@ifps.org.pl

Received: January 5, 2021 • **Accepted:** June 26, 2021
Available online at www.advancedotology.org

In a similar vein, the European Consensus Statement reached in 2011 is still currently implemented. The statement encourages the relevant authorities in European countries to implement hearing screening programs for pre-school and school-age children.[7]

Early detection of hearing impairment remains a challenge, particularly in rural areas. Rural inhabitants, even in developed countries, still experience health disparities.[11] Regarding hearing, they rely upon limited accessibility to audiological services, shortage of Ear, nose, and throat specialists and trained audiologists, and limited availability of appropriate equipment and infrastructure.[12] Elpers et al[13] showed that in rural areas, parents experience various barriers in obtaining timely hearing healthcare for their children, generally, low socioeconomic status, education level, insurance cover, problems with transport, and ability to obtain outpatient testing. Some of these concerns could be addressed by routine school hearing screening and implementation of e-health solutions. Teleaudiology makes it possible to perform quick, low-cost screening in remote locations with long-distance expert back-up.[14]

As mentioned above, hearing screening is not mandatory for primary school students in Poland at a nationwide level, although some of the gaps are filled locally. The Institute of Physiology and Pathology of Hearing has had experience with hearing screening since 1992, and from then until 2020, over 1 million children have been tested. In 2008, in collaboration with the Agricultural Social Insurance Fund, a hearing screening program was put in place for Polish school children in rural areas and small towns (below 5000 inhabitants).[15] The goals of the program were 2-fold: (1) to detect hearing disorders and (2) to educate parents, children, and teachers about the symptoms of hearing disorders, the importance of detecting such problems early on, and the options for prophylaxis, treatment, and rehabilitation. The program included nearly 300 000 children in the years 2008-11 and nearly 70 000 additional children in 2016-17.

For the purposes of the present work, we analyzed a portion of the data obtained in 2017 from children in the Kujawsko–Pomorskie region of Poland. From the point of view of clinicians, healthcare providers, and health policymakers, it is important to gauge the extent of hearing disorders in the pediatric population of a specific region so that planning can be done and adequate resources can be provided. This study aimed to identify children with suspected hearing impairments from rural areas of the Kujawsko–Pomorskie region, refer such children for further audiological testing, and to estimate the prevalence of HL in the region.

MATERIALS AND METHODS

Organization of Hearing Screening

Between February and June 2017, hearing screening was conducted in 230 primary schools in all 19 districts of the Kujawsko–Pomorskie Voivodeship. Local and school authorities were informed about the project, and information letters were sent to schools that had registered for the program. Prior to testing, teachers and parents were provided with educational materials explaining how to recognize and prevent hearing disorders. The children's parents were informed of the testing procedures and signed a consent form for their children to participate in hearing screening. The parents were also asked to fill in a short audiological questionnaire. The study was approved by the Institutional Ethics Committee and conforms to the Declaration of Helsinki.

Measures

Pure-Tone Audiometry

Trained examiners performed pure-tone audiometry on the children in quiet classrooms in their schools. Air conduction thresholds were measured for both ears at 0.5 kHz, 1 kHz, 2 kHz, 4 kHz, and 8 kHz in accordance with the modified Hughson and Westlake procedure.[16,17] Testing began with the ear in which a child is perceived to have better hearing. It was performed using the Sense Examination Platform, a system developed by the Institute of Sensory Organs in collaboration with the Institute of Physiology and Pathology of Hearing; it has been tested in screening programs in many countries.[18,19] The platform works over the Internet, with a central computer and portable remote computers equipped with audiometric headphones and a response button. The audiometric results are sent via the Internet to the SZOK (System Zintegrowanej Operacji Komunikacyjnej; Integrated Communication Operation System) system and safely stored in the database with a unique identifier. The platform is an advanced solution within the field of telemedicine. The SZOK system is shown in Figure 1.

A hearing screening result was regarded as positive ("refer") if the hearing threshold was above 20 dB at 1 or more frequencies in at least 1 ear. To estimate the prevalence of HL, the following pure-tone averages were calculated based on the audiograms: (1) 4-frequency pure-tone average (FFPTA) for 0.5 kHz, 1 kHz, 2 kHz, and 4 kHz; (2) low-frequency pure-tone average (LFPTA) for 0.5 kHz, 1 kHz, and 2 kHz; and (3) high-frequency pure-tone average (HFPTA) for 4 kHz and 8 kHz. Hearing loss was established if there was a pure-tone average higher than 20 dB HL in at least 1 of the 3 pure-tone averages.

Audiological Questionnaire

An audiological questionnaire gauged the parent's perception of their child's hearing and the child's risk factors for HL. The questionnaire consisted of 5 yes/no questions: Do you think your child has any problems with his/her hearing? Does your child complain of tinnitus in their ears/head when in quiet? Does your child often listen to loud music? Has your child been treated for otitis media? Does your child complain about noise at school?

Participants

Data from 4993 children were recorded. All these children underwent pure-tone audiometry and their parents completed the audiological questionnaire. None of the children used a cochlear implant or hearing aid. Results from 39 children were excluded from further analysis because they did not fully cooperate during the examination or there were technical problems in sending the results over the Internet.

The final study sample consisted of 4754 children (2390 girls and 2364 boys). There were 1840 children aged 6-7 years and 2914 children aged 12-13 years. In the Polish educational system, the first group was starting primary education and the second group was ending it (their sixth year).

Figure 1. The SZOK system.

Table 1. Rates of Positive (Failed) Hearing Screening Outcomes

	N	n	%	95% CI
Total	4754	618	13.0	12.0-14.0
Sex				
Girls	2390	334	14.0	12.6-15.4
Boys	2364	284	12.0	10.7-13.3
Age				
6-7 years old	1840	319	17.3	15.6-19.1
12-13 years old	2914	299	10.3	9.2-11.4

N, study sample size; n, number of participants with the positive result.

RESULTS

The Rate of Failed Hearing Screening Outcomes

The rate of positive results of hearing screening was 13% (95% CI, 12.0%-14.0%). The figure was slightly higher in girls (14%) than in boys (12%), OR = 1.19, and much higher in 6 to 7-year-old children (17.3%) than in 12 to 13-year-old children (10.3%), OR = 1.83. Details are given in Table 1.

Estimated Prevalence of Hearing Loss

The estimated prevalence of HL in children of the Kujawsko–Pomorskie region is given in Table 2.

The estimated prevalence of HL was 7% (95% CI, 6.2%-7.7%) and was higher in girls (7.8%) than in boys (6.1%), OR = 1.31. The rate was double that in children aged 6-7 years old (10.1%) than in children aged 12-13 years old (5.0%), OR = 2.12. In the 331 children with HL, 231 of them had unilateral HL and 100 had bilateral HL.

The prevalence of 4-frequency HL was 3.9% (95% CI, 3.4%-4.5%) and again it was higher in girls (4.7%) than in boys (3.2%), OR = 1.50. It was twice as common in children aged 6-7 years old (5.5%) than in children aged 12-13 years old (2.7%), OR = 2.19.

The estimated prevalence of LFHL was 4.3% (95% CI, 3.7%-4.8%), with the figure being higher in girls (4.8%) than in boys (3.8%), OR = 1.28. It was twice as high in children aged 6-7 years old (6.2%) than in children aged 12-13 years old (3.1%), OR = 2.17.

The prevalence of HFHL was estimated to be 5.9% (95% CI, 5.2%-6.5%) and again it was higher in girls (6.9%) than in boys (4.9%), OR = 1.44. It was more than twice as high in children aged 6-7 years old (8.9%) than in children aged 12-13 years old (4.0%), OR = 2.34.

RESULTS

The questionnaire was completed by 4496 parents. Figure 2 sets out their answers.

Results from the parents were compared in 2 groups: children with HL and children with normal hearing. It was found that:

- parents of children with HL significantly more often suspected problems with hearing in their children (15.8%) than parents of children with normal hearing (5.5%): $\chi^2 = 51.52$; $P < .001$;
- parents of children with HL significantly more often reported tinnitus in their children (21.5%) than parents of children with normal hearing (16.8%): $\chi^2 = 4.70$; $P = .030$;
- parents of children with HL significantly more often reported otitis media in their children (34.7%) than parents of children with normal hearing (23.3%): $\chi^2 = 20.58$; $P < .001$.

The relationship between a child's hearing status and the parent's opinions regarding exposure to loud music ($\chi^2 = 0.90$; $P = .343$) or complaining about noise at school ($\chi^2 = 0.38$; $P = .539$) was not statistically significant.

DISCUSSION

The hearing screening was conducted in 2017 and aimed to identify children in the Kujawsko–Pomorskie region who were suspected of having a hearing impairment and then to refer them for further audiological testing. Of the 4754 children tested, 618 (13%) failed screening and were referred for specialist diagnosis. This percentage is comparable to the 16.4% which has previously been found in a more diverse study of Polish school-age children from rural areas,[1] although it is much lower than rates found in certain Asian and African countries.[18] In our study, the rate of positive results of hearing screening was significantly higher in 6-7 years old (17.3%) than in 12-13 yeas -old (10.3%). All the parents of these children were provided with the information that their child should be referred for further diagnosis.

The secondary aim of the study was to estimate the prevalence of HL in school-age children in the Kujawsko–Pomorskie region. The prevalence of HL was estimated to be 7%, a figure in line with findings from Canadian children and adolescents aged 6-19 years old where the rate was 7.7%.[20] Also le Clerq et al.[21] showed comparable

Table 2. Prevalence of Hearing Loss of Children in the Kujawsko–Pomorskie Region

	FFPTA and/or LFPTA and/or HFPTA HL				FFPTA HL			LFPTA HL			HFPTA HL		
	N	n	%	95% CI	n	%	95% CI	n	%	95% CI	n	%	95% CI
Total	4754	331	7.0	6.2-7.7	187	3.9	3.4-4.5	203	4.3	3.7-4.8	279	5.9	5.2-6.5
Girls	2390	187	7.8	6.7-8.9	112	4.7	3.8-5.5	114	4.8	3.9-5.6	164	6.9	5.8-7.9
Boys	2364	144	6.1	5.1-7.1	75	3.2	2.5-3.9	89	3.8	3.0-4.5	115	4.9	4.0-5.7
6-7 years old	1840	185	10.1	8.7-11.4	107	5.5	4.7-6.9	114	6.2	5.1-7.3	163	8.9	7.6-10.2
12-13 years old	2914	146	5.0	4.2-5.8	80	2.7	2.2-3.3	89	3.1	2.4-3.7	116	4.0	3.3-4.7

FFPTA, 4-frequency pure-tone average; LFPTA, low-frequency pure-tone average; HFPTA, high-frequency pure-tone average; HL, hearing loss; N, study sample size; n, number of participants with hearing loss.

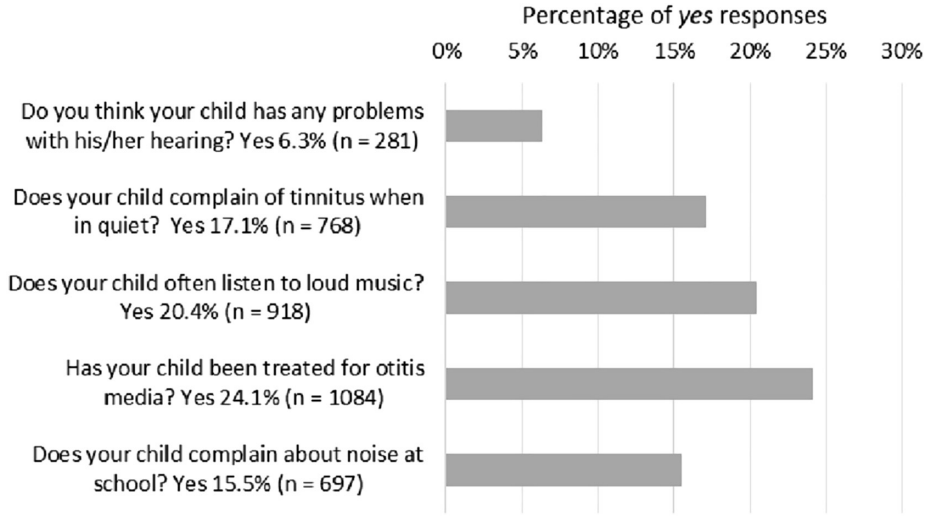

Figure 2. Results of the audiological questionnaire.

results (7.8%) in a population-based cohort of Dutch children aged 9-11 years old. In Taiwanese children of 3-17 years old, the prevalence of HL was found to be 7-8% in the years 2004-2010; here, rural areas had a higher overall prevalence of HL than urban areas in all years, with ratios between rates of 1.01 and 1.09.[22]

In our study, the estimated prevalence of HL was twice as high in children aged 6-7 years old (10.1%) than in children aged 12-13 years old (5.0%). This difference was also evident in another study of Polish children from rural areas, where the prevalence of HL was 11.4% in younger children (6-9 years old) and 5.5% in older children (12-13 years old).[1] Similarly, Feder et al[20] found a higher prevalence of HL in younger children aged 6-11 years old than in older ones 12-19 years old (8.1% and 7.4%, respectively), although the difference was slight. Younger children are more prone to developing middle ear infections while their upper airways are developing, so otitis media following upper respiratory tract infection is more common in younger children. Eustachian tube dysfunction decreases as children become older so that drainage of mucosa and ventilation of the middle ear improve.[23,24]

We found a higher prevalence of HFHL (4.9%) than LFHL (4.3%) and in turn FFHL (3.9%), and these results are consistent with those obtained in Polish children from all rural areas.[1] Our findings are also in line with the results of Feder et al:[20] among Canadian children, HFHL was the most common (6%), followed by LFHL (5.8%), and finally FFHL (4.7%).

Most of the 331 children with HL had unilateral hearing impairment (UHL) (231 out of 331). It is known that bilateral HL in children is associated with poorer speech–language development, but the effect of UHL also needs to be taken into account. Children with UHL have poorer sound localization, speech perception in background noise, and spatial hearing.[25] This can result in worse speech–language scores (language comprehension, oral expression, and oral composite) compared to their siblings with normal hearing. Another study has shown that UHL may qualitatively affect a child's quality of life.[26] Single-sided impairment, especially if it is mild, may not be noticed by parents or teachers, so school hearing screening presents a real opportunity to identify these children.

Our findings showed that 24.1% of the parents reported that their children had been treated for otitis media, which can translate to potential LFHL. One in 5 parents believed that their child often listened to loud music. Exposure to loud music is a known risk factor for noise-induced HL in children and adolescents.[27,28] During the hearing screening, parents were given educational materials informing them of how to prevent hearing disorders, including how to avoid or minimize the harmful effects of noise.

We found that 17.1% of the parents reported their children complained of tinnitus and the rates were higher in children with HL compared to those with normal hearing. In general, the findings concerning the prevalence of tinnitus in children are rather divergent. For example, Rosing et al[29] in their systematic review reported that the prevalence of tinnitus varies from 4.7% to 46% among the general pediatric population. The figures found by Raj-Koziak et al among Polish children were 12.9% in 7 years old and 16.6% in 12 years old.[30]

Our protocol of hearing screening included pure-tone audiometry using teleaudiology which allowed testing to be done quickly and at a low cost. A limitation of the study is a lack of tympanometry or otoacoustic emission measurements. Such measurements would enable middle ear abnormalities or cochlear pathologies to be identified and would allow conductive HL to be differentiated from sensorineural HL.

CONCLUSION

To conclude, monitoring children for HL should not be limited to just neonatal screening but should continue throughout the school years. In the case of younger children, detecting and treating hearing disorders give them a successful start to their education. The need for prophylaxis and diagnosis of hearing impairments is especially clear in rural areas, where it is important to eliminate unequal access to hearing services. A telemedicine model can fill this gap.

Ethics Committee Approval: The study has been approved by the Ethical Committee of the Institute of Physiology and Pathology of Hearing (KB. IFPS:27/6/2018).

Informed Consent: Written informed consent was obtained from children's parents.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – H.S., P.H.S., E.G., N.C.; Design – H.S., P.H.S., E.G., N.C; Supervision - H.S., P.H.S., W.K.; Resources – P.H.S., N.C, M.M., K.B.C.; Materials – E.G., N.C.; Data Collection and/or Processing – E.G., N.C.; Analysis and/or Interpretation – E.G., W.K., J.J-K.; Literature Search – E.G., M.M.; Writing Manuscript – E.G., P.H.S.; Critical Review – W.K., J.J-K., P.H.S., M.M., K.B.C.

Declaration of Interests: The authors have no conflict of interest to declare.

Funding: The authors declared that this study has received no financial support.

REFERENCES

1. Skarżyński H, Gos E, Świerniak W, Skarżyński PH. Prevalence of hearing loss among polish school-age children from rural areas: results of hearing screening program in the sample of 67,416 children. *Int J Pediatr Otorhinolaryngol*. 2020;128:109676. [CrossRef]
2. Moeller MP, Tomblin JB, Yoshinaga-Itano C, Connor CM, Jerger S. Current state of knowledge: language and literacy of children with hearing impairment. *Ear Hear*. 2007;28(6):740-753. [CrossRef]
3. Tomblin JB, Harrison M, Ambrose SE, Walker EA, Oleson JJ, Moeller MP. Language outcomes in young children with mild to severe hearing loss. *Ear Hear*. 2015;36(suppl 1):76S-91S. [CrossRef]
4. Warner-Czyz AD, Loy BA, Evans C, Wetsel A, Tobey EA. Self-esteem in children and adolescents with hearing loss. *Trends Hear*. 2015;19. [CrossRef]
5. Hurley A, Willis M, Guidry M, Bode D, Corneille ML, Mills S. A program review of head start and elementary school hearing screenings. *Lang Speech Hear Serv Sch*. 2020;51(2):345-352. [CrossRef]
6. Watkin P, Baldwin M. The longitudinal follow up of a universal neonatal hearing screen: the implications for confirming deafness in childhood. *Int J Audiol*. 2012;51(7):519-528. [CrossRef]
7. Skarżyński H, Piotrowska A. Screening for pre-school and school-age hearing problems: European Consensus Statement. *Int J Pediatr Otorhinolaryngol*. 2012;76(1):120-121. [CrossRef].
8. American Academy of Audiology. *Childhood hearing screening guidelines.* https://www.cdc.gov/ncbddd/hearingloss/documents/AAA_Childhood%20Hearing%20Guidelines_2011.pdf.
9. American Speech-Language-Hearing Association. Childhood Hearing Screening: Key Issues. https://www.asha.org/PRPSpecificTopic.aspx?folderid=8589935406&section=Key_Issues.
10. European Federation of Audiology Societies. *Working Group for School Hearing Screening*. 2017 http://www.efas.ws/download/EFAS_SHS_report_231113.pdf.
11. Weinhold I, Gurtner S. Understanding shortages of sufficient health care in rural areas. *Health Policy*. 2014;118(2):201-214. [CrossRef]
12. Barr M, Duncan J, Dally K. A systematic review of services to DHH children in rural and remote regions. *J Deaf Stud Deaf Educ*. 2018;23(2):118-130. [CrossRef]
13. Elpers J, Lester C, Shinn JB, Bush ML. Rural family perspectives and experiences with early infant hearing detection and intervention: a qualitative study. *J Commun Health*. 2016;41(2):226-233. [CrossRef]
14. 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;22:2424-2430. [CrossRef]
15. Skarzynski PH, Wlodarczyk AW, Kochanek K, et al. Central auditory processing disorder (CAPD) tests in a school-age hearing screening programme: analysis of 76,429 children. *Ann Agric Environ Med*. 2015;22(1):90-95. [CrossRef]
16. Tyler RS, Wood EJ. A comparison of manual methods for measuring hearing levels. *Audiology*. 1980;19(4):316-329. [CrossRef]
17. Śliwa L, Hatzopoulos S, Kochanek K, Piłka A, Senderski A, Skarżyński PH. A comparison of audiometric and objective methods in hearing screening of school children: a preliminary study. *Int J Pediatr Otorhinolaryngol*. 2011;75(4):483-488. [CrossRef]
18. Skarżyński PH, Piłka A, Ludwikowski M, Skarżyńska MB. Comparison of the frequency of positive hearing screening outcomes in schoolchildren from poland and other countries of Europe, Central Asia, and Africa. *J Hear Sci*. 2014;4(4):51-58. [CrossRef]
19. Skarżyński PH, Świerniak W, Gos E, et al. Results of hearing screening of school-age children in Bishkek, Kyrgyzstan. *Prim Health Care Res Dev*. 2020;21:e18. [CrossRef]
20. 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(1):7-20. [CrossRef]
21. le Clercq CMP, van Ingen G, Ruytjens L, et al., Prevalence of hearing loss among children 9 to 11 years old: the generation R study. *JAMA Otolaryngol Head Neck Surg*. 2017;143(9):928-934.
22. Lin CY, Tseng YC, Guo HR, Lai DC. Prevalence of childhood hearing impairment of different severities in urban and rural areas: a nationwide population-based study in Taiwan. *BMJ Open*. 2018;8(3):e020955. [CrossRef]
23. Leo G, Piacentini E, Incorvaia C, Consonni D. Sinusitis and Eustachian tube dysfunction in children. *Pediatr Allergy Immunol*. 2007;18(suppl 18):35-39. [CrossRef]
24. Pichichero ME. Helping children with hearing loss from otitis media with effusion. *Lancet*. 2018;392(10147):533-534. [CrossRef]
25. Rohlfs AK, Friedhoff J, Bohnert A, et al. Unilateral hearing loss in children: a retrospective study and a review of the current literature. *Eur J Pediatr*. 2017;176(4):475-486. [CrossRef]
26. Borton SA, Mauze E, Lieu JEC. Quality of life in children with unilateral hearing loss: a pilot study. *Am J Audiol*. 2010;19(1):61-72. [CrossRef]
27. Le Clercq CMP, van Ingen G, Ruytjens L, van der Schroeff MP. Music-induced hearing loss in children, adolescents, and young adults: a systematic review and meta-analysis. *Otol Neurotol*. 2016;37(9):1208-1216. [CrossRef]
28. Swierniak W, Gos E, Skarzynski PH, Czajka N, Skarzynski H. Personal music players use and other noise hazards among children 11 to 12 years old. *Int J Environ Res Public Health*. 2020;17(18). [CrossRef]
29. Rosing SN, Schmidt JH, Wedderkopp N, Baguley DM. Prevalence of tinnitus and hyperacusis in children and adolescents: a systematic review. *BMJ Open*. 2016;6(6):e010596. [CrossRef]
30. Raj-Koziak D, Bieńkowska K, Gos E, Włodarczyk E, Skarżyński H, Skarżyński PH. Audiological and psychological profiles of children with tinnitus. *Hear Balance Commun*. 2020;18(2):90-97. [CrossRef]