Hearing Profile of Children Below Three Years Old at Jatinangor Integrative Health Care Center, West Java, Indonesia

Fidkya Allisha,[1] Wijana,[2] Sally Mahdiani[2]

[1]Faculty of Medicine Universitas Padjadjaran, Indonesia, [2]Department of Otorhinolaryngology-Head, and Neck Surgery, Faculty of Medicine Universitas Padjadjaran/Dr. Hasan Sadikin General Hospital, Bandung, Indonesia

Abstract

Background: Hearing function is one of the most important factors affecting children's development process. The first three years of life is a golden period of growth and development of children. This study was conducted to investigate the hearing profile of children below three years old at Jatinangor Integrative Health Care Center (*Pos Pelayanan Terpadu*, Posyandu), West Java, indonesia.

Methods: An observational cross-sectional study was conducted to 86 children below three years old who was selected by using multistage cluster sampling at 12 Posyandu in Jatinangor sub-district by using in-depth interview related to hearing loss risk factors, reaction test, and tympanometry test.

Results: The hearing loss prevalence of children below three years old in the Jatinangor sub-district was 7.0%. Of the 86 children, there were 2.3% (n=2) children with moderate conductive hearing loss, 1.2% (n=1) children with moderate sensorineural hearing loss, and 3.5% (n=3) children with very severe sensorineural hearing loss. Fifty percent of children with sensorineural hearing loss were discovered without any risk factor.

Conclusions: The prevalence of hearing loss in children under three years old at the Jatinangor Integrative Health Care Center is slightly higher than the national prevalence. Fifty percent of children are found without risk factors, therefore Universal Newborn Hearing Examination (UNHS) needs to be implemented at the national level in accordance with the guidelines of the Joint Committee for Infant Hearing (JCIH) in which are integrated with primary health care units, tertiary health care centers otorhinolaryngology, and also the audiological center.

Keywords: Children, early detection, hearing loss, hearing profile

Introduction

The first three years of life is a golden period of growth and development in children in which there is a critical and rapid development of brain plasticity, which is very sensitive to the influence of external stimuli, as well as being flexible to take over the functions of the surrounding cells by forming synapses.[1,2] The critical period of hearing and speech development begins in the first 6 months of life and continues until the age of 3 years.[2] Hearing function plays a significant role in optimizing the growth and development of children in the golden period.

The implementation of periodic monitoring of hearing function in children from birth to three years is very important to ensure the presence of hearing loss from an early age. The Joint Committee on Infant Hearing (JCIH) states that a diagnosis of hearing loss in children should be made at least at three months of age so that appropriate intervention can begin at six months of age.[3,4]

Hearing loss is a problem that is quite commonly found in the national and even global settings. Recent prevalence estimates indicate that in 2015 nearly half a billion people or about 6.8% of the world's population had disabling hearing loss, and the prevalence rates will continue to rise. The World Health Organization (WHO) currently estimates that at least 34 million children under the age of 15 have disabling hearing loss. Based on a 2012

Correspondence: Fidkya Allisha, Faculty of Medicine Universitas Padjadjaran, Jalan Raya Bandung-Sumedang Km. 21 Jatinangor, Sumedang, Indonesia, E-mail: fidkyaallisha@gmail.com

WHO report, approximately 7.5 million of these children were under the age of 5 years.[5] The National Survey of Sight and Hearing Function in 7 provinces in Indonesia[6] from 1993 to 1996 showed that the prevalence of hearing loss and deafness was 16.8% and 0.4%, consecutively, with the main cause often found in children under three years were middle ear infections (3.1%), congenital hearing loss (0.1%), and hearing loss due to the noise exposure.[6] According to WHO, around 50% of children with congenital hearing loss have no risk factors.[7]

Lack of awareness of parents about hearing loss in their infants and children is a challenge that needs to be overcome nowadays.[3] Hearing loss is often ignored because the signs and symptoms that might appear in children are almost invisible, parents are not immediately aware of any hearing loss suffered by their children, sometimes children are considered to have autism or hyperactivity disorder because of their unruly behavior. Parents are only aware of hearing loss in their children if there is no response to loud noises or speech delays.[4]

In Indonesia, public health centers (*Pusat Kesehatan Masyarakat*, Puskesmas), as the frontline in promoting and implementing community health programs have an important role in monitoring and promoting childrens' growth and development, including monitoring the development of hearing function and hearing loss in children, given the lack of parental awareness to detect hearing disorders. To carry out this role, the Puskesmas organizes a program called the integrated healthcare center (*Pos Pelayanan Terpadu*, Posyandu). Posyandu could carry out one of its basic functions as a monitor unit for child development.[8] According to data obtained from the Central Bureau of Statistic of Sumedang district (*Badan Pusat Statistik Kabupaten Sumedang*), Jatinangor was the first most populous sub-district in Sumedang district in 2016, with a population of 113,234.[9,10] Therefore, this study was aimed to determine the hearing profile of children under three years old at the Jatinangor integrated healthcare center.

Methods

This study was an observational study with a cross-sectional design conducted at 12 Posyandu in Jatinangor subdistrict from July to September 2018. After obtaining ethical approval from the Ethics Committee of Universitas Padjadjaran No. 787/UN6.KEP/EC/2018, the research was conducted. The research subjects were children under three years old who were registered in 12 Posyandu in 6 villages in Jatinangor subdistrict. Posyandu were selected through the Multistage Cluster Sampling technique with a minimum sample size of 72 children under three years old who met the inclusion criteria including children aged 0–36 months, registered at Posyandu in 6 villages in Jatinangor subdistrict, and parents' willingness to include their children in this study. Exclusion criteria in this study were children with acute ear infections, acute upper respiratory infections, and cerumen impaction in one or two ears. Physical examination of ears, nose, and throat by using an otoscope, nasal speculum, tongue spatula, and the head lamp was carried out before the hearing examination was carried out on the subject.

The examinations conducted were in-depth interviews with parents related to hearing loss risk factors, reaction tests to determine the degree of hearing loss in children, and tympanometry tests to determine the condition of the childs' middle ear to predict the type of hearing loss that might occur in children. In-depth interviews of parents were performed by the main researcher as a medical student. The reaction test was conducted by using the horn to distinguish very severe hearing loss and using six grains of rice shaken in a ping pong ball to distinguish moderate hearing loss.

Positive reaction to sound stimuli included reflexive responses such as head or limb reflexes, whole-body startle, eye blinking or flutter, and suckling reflex in infants; also orientating or attention-type behavior such as the increased or decreased body gesture, eyes widening, searching, localization, quieting, and or vocalizations. Children with a negative reaction to the horn sound stimuli were then classified as children with very severe hearing loss, while children with a positive reaction to the sound of the horn stimuli but have a negative reaction to the sound of six grains of rice being shaken in a pingpong ball were classified as children with moderate hearing loss. Children with positive reactions to both sound stimuli were classified as children with normal hearing function.

In this study, risk factors were grouped into 10 types based on the American Academy Committee on Infant Hearing Statements,[3] the degree of the hearing was grouped into three categories; normal, moderate hearing loss, and very severe hearing loss. The type of hearing loss was classified into conductive

and sensorineural hearing loss based on the interpretation of the tympanometry test results.

Sensorineural hearing loss could be assumed if children with hearing loss showed normal tympanometry graph type A, whereas children with hearing loss with tympanometry other than type A graph were classified as having conductive hearing loss.

The data obtained were then recorded on a research form which was then recapitulated and presented in tabular form. The descriptive statistic analysis was used to process and present the data.

Results

Of the 101 children who met the inclusion criteria, 15 were excluded. Thus, 86 children who met the inclusion and exclusion criteria. The age of the children examined in this study ranged from 3 to 36 months with the most age group was 24–<36 months (39.5%), and the sex ratio was 1:1. The prevalence of hearing loss was 7.0%. Of the 6 cases of hearing loss, 4 (4.7%) were moderate and 2 (2.3%) were very severe. Both sensorineural and conductive hearing loss were presented equally in children below three years old (Table).

Of the 4 children with sensorineural hearing loss, 2 children (50%) were found without risk factors, 1 child (25%) was found to have a risk factor for TORCHS infection, and 1 child (25%) was found to have a risk factor of low birth weight. The female group suffered more conductive hearing loss whereas the male group suffered more from sensorineural hearing loss (Table).

Discussion

Our study shows that the prevalence of hearing loss in children in the Jatinangor subdistrict is 7%, indicating that the prevalence of hearing loss in the Jatinangor subdistrict is higher compared to Indonesia's prevalence. According to WHO, Indonesia with a hearing loss prevalence of 4.2%, is one of the countries with high hearing loss prevalence in Southeast and South Asia, besides Nepal (16.6%),

Table Hearing Profile of Children Below Three Years Old at Jatinangor Integrative Health Care Center

Characteristic	Normal		Conductive Hearing Loss				Sensorineural Hearing Loss				Total	
			Moderate		Very Severe		Moderate		Very Severe			
	n	%	n	%	n	%	n	%	n	%	n	%
Gender												
Male	40	46.5	1	1.2	-	-	1	1.2	1	1.2	43	50
Female	40	46.5	2	2.3	-	-	-	-	1	1.2	43	50
Age (months)												
<6	7	8.1	-	-	-	-	-	-	1	1.2	8	9.3
6–<12	14	16.3	1	1.2	-	-	-	-	-	-	15	17.4
12–<24	27	31.4	2	2.3	-	-	-	-	-	-	29	33.7
24–<36	32	37.2	-	-	-	-	1	1.2	1	1.2	34	39.5
Risk factors of hearing loss												
Perinatal ototoxic	5	5.8	-	-	-	-	-	-	-	-	5	5.8
Low birth weight	3	3.5	-	-	-	-	1	1.2	-	-	4	4.7
Mechanical ventilation assistance for more than 5 days	3	3.5	-	-	-	-	-	-	-	-	3	3.5
TORCHS infection	2	2.3	-	-	-	-	-	-	1	1.2	3	3.5
Severe asphyxia	2	2.3	-	-	-	-	-	-	-	-	2	2.3
Anatomical defect	1	1.2	-	-	-	-	-	-	1	1.2	2	2.4
Congenital hearing loss syndrome	-	-	1	1.2	-	-	-	-	1	1.2	2	2.4
Hereditary	1	1.2	-	-	-	-	-	-	-	-	1	1.2
Hyperbilirubinemia	-	-	-	-	-	-	-	-	-	-	-	-
Bacterial meningitis	-	-	-	-	-	-	-	-	-	-	-	-
None	65	75.6	2	2.3	-	-	-	-	1	1.2	68	79.1
TOTAL	80	93.0	3	3.5	0	0	1	1.2	2	4.8	86	100%

Thailand (13.3%), Bangladesh and Sri Lanka with each of the prevalence was 9%, Myanmar (8%), India and Maldives with each of the prevalence was 6%.[10] This could be caused by the lack of awareness and knowledge about the health of hearing sense, the lack of facilities and infrastructure to prevent, detect, and intervene in hearing loss as early as possible, as well as the lack of cross-sectoral support in overcoming the problem of hearing loss.[11]

Hearing loss in children could be caused by genetic (congenital) and non-genetic (acquired) factors. In this study, 50% of children with sensorineural hearing loss are found without risk factors, despite etiological evaluation, the etiology of SNHL is reported to remain unknown in 25–45% of the cases,[12] which supports our findings in this study. Of all the inheritance patterns, autosomal recessive nonsyndromic hearing loss (ARNSHL) is the most common disease and accounts for approximately 80% of cases in nonsyndromic sensorineural hearing loss.[13,14] Autosomal recessive nonsyndromic hearing loss (ARNSHL) is usually characterized as congenital, nonsyndromic, severe-to profound, and nonprogressive sensorineural hearing loss. Autosomal recessive transmission occurs in 77–93% of cases and is typically prelingual, while autosomal dominant hearing loss accounts for about 10–20% of cases and is most often postlingual. X-linked or mitochondrial inheritance is observed in the remaining.[15] In this study obtained 3 (75%) of 4 children suffering from sensorineural hearing loss are male.

Nongenetic hearing loss (acquired) in children is mostly caused by prenatal infection, such as Toxoplasmosis, Rubella, Cytomegalovirus, and Herpes.[16] In this study, 25% of children suffering from sensorineural hearing loss have risk factors for prenatal TORCHS infection. According to a study of infants in Western Sicily, Italy,[17] TORCH infections indicated independent significant risk factors (p=0.024). All TORCHS infections can cause similar signs before and after birth, such as stunted fetal growth, microcephalus, seizures, mental retardation, visual impairment, and cerebral palsy.[13] In this study, children are found to have a severe degree of sensorineural hearing loss and impaired vision and growth and development. TORCHS infection can cause sensorineural hearing loss directly or indirectly. Directly, infections due to the Toxoplasma gondii parasite and infections due to viruses such as Rubella, Cytomegalovirus, Herpes, and Syphilis can cause damage to the cochlea and cell death in the cortical and stria vascular organs. Meanwhile, indirect hearing loss is caused by a decrease in the ability of the body's immunity, secondary infection, and immune response to antigens.[14]

This study found 1.2% had moderate sensorineural hearing loss and had a risk factor of low birth weight. Low birth weight infants are identified as high-risk infants with associated pathophysiology and usually, the prognosis of low birth weight infants will be worse, especially in the early period of life compared to the normal infants. Direct complications associated with low birth weight has various long-term effects, including developmental disorders, growth disorders, retinopathy, hearing loss, chronic lung disease, and congenital disorders.[18] Delayed myelination process in low-birth-weight infants will result in immaturity and physiological dysfunction of the body, including hearing function. A study of 3675 infants in North Taiwan[19] revealed independent risk factors for hearing loss in a tertiary medical center of VLBW infants who were born with a birth weight <1500 g. Among these hearing-impaired infants, the craniofacial anomalies, the prolonged oxygen use, the PDA ligation history, and the ototoxins usage yielded good predictions of hearing loss.[19]

There are 2.3% of children with moderate conductive hearing loss. A study of 234 Australian infants referred for diagnostic testing from a newborn hearing screening program has shown similar findings, the prevalence of CHL in the newborns according to the study was 2.97 per 1000.[20] Conductive hearing loss in the outer ear could be caused by; atresia of the ear canal, cerumen impaction, otitis externa circumscripta, osteoma of the ear canal, and others. Meanwhile, conductive hearing loss in the middle ear is caused by; cathar tube/eustachian tube obstruction, otitis media, otosclerosis, tympanosclerosis, hemotympanum, and ossicular dislocation.[20] Two children with moderate conductive hearing loss in this study showed the type 'B' curve during the tympanometric test which indicated the presence of otitis media effusion (OME). OME can be caused by allergies and chronic upper respiratory tract infections.

A study of hearing profiles of premature newborns in Poland[21] showed that the most serious problem-permanent-profound sensorineural bilateral hearing deficit (>90 dB) was diagnosed in 1.42% of infants born <28 weeks gestational age (22/1548), in

0.3% of those born between 29 and 32 weeks' gestational age (16/5194) and in 0.02% of infants born <33 weeks' gestational age ($p<0.01$).[21]

The existing public health practices do not provide for screening of high-risk infants either at birth or in subsequent childhood years. Both community-based and school-based health programs were lack of facilities for basic hearing tests. Consequently, diagnosis of hearing impairment is usually delayed and achieved mainly through the complications of the disease when detected by parents, carers, and health workers. This study provided reliable results given the limited resources of the instrument to evaluate the hearing function of children that might be faced by the primary health care service, especially in community-based health centers in the rural areas. The simple method and equipment of hearing function test enable the primary healthcare personnel to implement routine monitoring of children's hearing function so that the hearing impairment could be detected earlier. The effects of early diagnosis were seen in newborns with and without UNHS. In almost all cases, the care of both screened and unscreened and of both early and late confirmed populations in this have different outcomes and is likely to reflect the effect of UNHS and early confirmation of hearing loss.[22]

The limitation of this study was the reaction test implemented in this study is only able to distinguish between moderate and very severe hearing loss, therefore, further study by using advanced audiological screening test needs to be conducted in the tertiary audiological center to provide the result of mild, moderate, severe, and very severe degree of hearing loss in children. Also, in this study, risk factor was only investigated according to the American Academy Committee on Infant Hearing Statements, further study is needed to evaluate other risk factors related to hearing loss.

To conclude, the prevalence of hearing loss in children under three years old at Jatinangor Posyandu is slightly higher compared to the national prevalence. Since fifty percent of the children are found without any risk factor, the Universal Newborn Hearing Examination (UNHS) needs to be implemented at the national level in accordance with the Joint Committee for Infant Hearing (JCIH) guideline. The periodic monitoring of children hearing function as early as possible between the ages of zero and three years is very important to ensure the presence of hearing loss because the signs and symptoms caused by hearing loss might be invisible. The UNHS program should involve coordination between community-based integrative health care centers and otorhinolaryngology health service centers as well as audiological centers.

References

1. Andriani R, Sekartini R, Suwento R, Batubara JR. Peran instrumen modifikasi tes daya dengar sebagai alat skrining gangguan pendengaran pada bayi risiko tinggi usia 0–6 bulan. Sari Pediatri. 2010;12(3):174–83.
2. Hartanto F, Selina H, Zuhriah H, Fitra S. Pengaruh perkembangan bahasa terhadap perkembangan kognitif anak usia 1-3 tahun. Sari Pediatri 2011;12(6):386–90.
3. Joint Committee on Infant Hearing. Year 2007 position statement: principles and guidelines for early hearing detection and intervention programs, Pediatrics. 2007;120:898–921.
4. Vos B, Lagasse R, Levêque A. Main outcomes of a newborn hearing screening program in Belgium over six years. Int J Pediatr Otorhinolaryngol 2014;78(9):1496–502.
5. Neumann K, Chadha S, Tavartkiladze G, Bu X, White KR. Newborn and infant hearing screening facing globally growing numbers of people suffering from disabling hearing loss. Int J Neonatal Screen. 2019;5(1):7.
6. Ministry of Health Republic of Indonesia. Telinga sehat pendengaran baik. 2010. [cited 2021 August 28]. Available from: https://www.kemkes.go.id/article/view/840/telinga-sehat-pendengaran-baik.html.
7. World Health Organization. Deafness and hearing loss. 2021. [cited 2021 August 28]. Available from: https://www.who.int/news-room/fact-sheets/detail/deafness-and-hearing-loss.
8. Agustin A, Rakhmawati W, Nurlita L. Gambaran pengetahuan kader di Posyandu Desa Cipacing tentang perkembangan pada balita. Students E-Journal. 2012;1(1):759.
9. Badan Pusat Statistik Kabupaten Sumedang. 2018. Jumlah Penduduk Kabupaten Sumedang Menurut Kecamatan Tahun 2016. [cited 2021 September 19]. Available from: https://sumedangkab.bps.go.id/statictable/2017/07/05/11/jumlah-penduduk-menurut-kecamatan-di-kabupaten-sumedang-tahun-2016.html.
10. World Health Organization. Situation review and update on deafness, hearing

loss and intervention programmes. 2007. [cited 2021 September 21]. Available from:https://apps.who.int/iris/bitstream/handle/10665/205895/B3177.pdf?sequence=1&isAllowed=y.
11. Nugroho DA, Zulfikar, Muyassaroh. Kemampuan auditorik anak tuli kongenital derajat sangat berat dengan dan tanpa alat bantu dengar. Med Hosp. 2012;1(2):80–2.
12. van Beeck Calkoen EA, Engel MS, van de Kamp JM, Yntema HG, Goverts ST, Mulder MF, et al. The etiological evaluation of sensorineural hearing loss in children. Eur J Pediatr. 2019;178(8):1195–205.
13. Zhang F, Xu L, Xiao Y, Li J, Bai X, Wang H. Three MYO15A mutations identified in one Chinese family with autosomal recessive nonsyndromic hearing loss. Neural Plas. 2018;2018:5898025.
14. Bai X, Zhang C, Zhang F, Xiao Y, Jin Y, Wang H, et al. Five novel mutations in LOXHD1 gene were identified to cause autosomal recessive nonsyndromic hearing loss in four Chinese families. Biomed Res Int. 2020;2020:1685974.
15. Duman D, Tekin M. Autosomal recessive nonsyndromic deafness genes: a review. Front Biosci (Landmark Ed). 2012;17(6):2213–36.
16. Kimberlin DW, Jester PM, Sánchez PJ, Ahmed A, et al. Valganciclovir for symptomatic congenital cytomegalovirus disease. N Eng J Med. 2015;372(10):933–43.
17. Salvago P, Martines E, Martines F. Prevalence and risk factors for sensorineural hearing loss: Western Sicily overview. Eur Arch Otorhinolaryngol. 2013;270(12):3049–56.
18. Cohen BE, Durstenfeld A, Roehm PC. Viral causes of hearing loss: a review for hearing health professionals. Trends Hear. 2014;18:2331216514541361.
19. Wang CH, Yang CY, Lien R, Chu SM, Hsu JF, Fu RH, et al. Prevalence and independent risk factors for hearing impairment among very low birth weight infants. Int J Pediatr Otorhinolaryngol. 2017;93:123–7.
20. Dougherty W, Kesser BW. Management of conductive hearing loss in children. Otolaryngol Clin North Am. 2015;48(6):955–74.
21. Wroblewska-Seniuk K, Greczka G, Dabrowski P, Szyyfter-Harris J, Mazela J. Hearing impairment in premature newborns—Analysis based on the national hearing screening database in Poland. PLoS One. 2017;12(9):e0184359.
22. Pimperton H, Blythe H, Kreppner J, Mahon M, Peacock JL, Stevension J, et al. The impact of universal newborn hearing screening on long-term literacy outcomes: a prospective cohort study. Arch Dis Child. 2016;101(1):9–15.