



Hearing Aids and The Quality of Life of Children with Hearing Loss

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Abstract

Hearing loss in children may cause social isolation and poor communication skills, potentially affecting mental disorders and quality of life. Hearing aids (HA) provide auditory stimuli that can improve children's speech ability and influence their quality of life. A cross-sectional study in three special schools-B (SLB-B) in Semarang was carried out. A total of 82 children (7-12 years old) with severe hearing loss with or without hearing aids were included. Quality of life was assessed by the Hearing Environments and Reflection on Quality of Life (HEAR-QL) questionnaire. The results showed that 48 (58.54%) subjects used hearing aids, and 34 (41.46%) did not use hearing aids. The average subject's age was 10.77 ± 1.56 years old. Hearing-aid use was associated with a good quality of life of children with hearing loss ($p < 0.001$). Good quality of life was found in 68.8% of children with hearing aids compared to only 2.9% in children without hearing aids. Duration of hearing-aid use ($p < 0.001$), mother education ($p < 0.006$) was associated with good quality of life of children, whereas gender ($p = 0.49$), number of siblings ($p = 0.06$), and socioeconomic status ($p = 0.63$) were not. The quality of life of children who use hearing aids is better than without hearing aids.

Introduction

Hearing loss in children that is not immediately treated can harm speech, language, academic, emotional, and psychosocial development (Madell, 2014). With the maturity process, the auditory function, and lasts speech development. A person's speech and language proficiency can only be achieved when sensory and motor input are normal. Speech development is closely related to the stage of hearing development (Suwento et al., 2017). Severe sensorineural hearing loss can cause more severe impairment in language and speech development, especially in the pre-lingual phase (Sobreira et al., 2015).

According to WHO, as many as 360 million people (approximately 5% of the world population) experience hearing loss, and nearly 32 millions of them are children (World Health Organization, 2016). Based on 29

countries' data, Stevens and colleagues (2013) reported that 1.4% of children and 9.8–12.2% of suffer hearing loss, whose prevalence is high, especially in low- and middle-income countries (Stevens et al., 2013). Sensorineural hearing loss (SNHL) is a result of damage to the auditory nerve or the hair cells of the inner ear and may be acquired, genetic or idiopathic. About 1–4 per 1000 babies are born with SNHL (Prosser et al., 2015). At the Ear, Nose, and Throat (ENT) outpatient clinic of Dr. Kariadi Hospital Semarang, there were up to 60 children visits monthly due to speech delay, in which nearly 50% had moderate-to-severe hearing loss. Hearing loss can cause social isolation and poor communication skills, which eventually may affect mental health and quality of life, (Azizi et al., 2013).

Quality of life that refers to individual health is called health-related quality of life

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(HRQoL) (Gustafson SJ, Davis H, Hornsby BWY 2015). Health-Related Quality of Life (HRQoL) can be defined as "how well a person functions in their life and how well-being is perceived in the physical, mental, social, and health dimensions." Person function is the individual's ability to carry out activities before. While well-being refers to the subjective feelings of the individual. HRQoL is those aspects of self-perceived well-being that are related to or affected by the presence of disease or treatment (Karimi 2016).

The impact of a particular health condition on a person's life is not sufficient only to be assessed from physical measurements alone. Evaluating HRQoL is very important for a complete understanding of the effect of health conditions on individuals (Haverman L et al., 2016). Hearing impairment may decrease their quality of life (Sumardiyono et al., 2019). Hearing impairment in children causes psychointellectual disorders and social development disorders due to children's difficulty interacting with the surrounding environment. Children with hearing loss have a higher incidence of mood disorders, poorer social relationships, and higher psychological distress. Children with hearing loss are reported to avoid participating in social activities (Gustafson SJ, Davis H, Hornsby BWY 2015). A study conducted a study on 255 students in class 7-12 with hearing impairment, aged 11-19 years, using health-related quality of life adolescent's questionnaire, it was found that the quality of life of students with mild hearing loss was better than students with severe hearing loss, female have a better quality of life than male (Borujeni et al., 2015). A systematic review and meta-analysis study on quality of life in children with hearing impairments found that children with hearing impairments have a lower quality of life than children with normal hearing (Roland et al., 2016).

A validated quality of life hearing-related questionnaire can help a doctor determine when an intervention should be made to improve the overall well-being of the child, whether it is beneficial, and whether one intervention is better than another. Quantitative HRQoL measurements can use general instruments and/or specific diseases (Said 2017). A study

found that health is related to the quality of life of individuals (Nugraha & Aprillia 2020). The general HRQoL questionnaire cannot describe the quality of life for specific health conditions, the validity, or insufficient sensitivity in subgroups with special conditions such as children with hearing loss. The quality of life for children with hearing loss can be assessed by the HEAR-QL (Hearing Environments and Reflection on Quality of Life) questionnaire designed to determine how children with hearing loss experience social and emotional effects, especially in an environment that has a significant impact on children's quality of life (Umansky et al., 2011).

A study evaluating the quality of life of children with hearing loss in association with the use of hearing-aid, especially in school-age children, is lacking. This study aimed to evaluate the association of hearing-aid use and the quality of life of children with hearing loss and to evaluate the effect of length of hearing aid use, gender, number of siblings, mother's education, and socioeconomic status on quality of life of children with hearing loss.

Methods

This was a cross-sectional study conducted in three Special School B (SLB-B) in Semarang from November 2018 until January 2019. Subjects were 7-12 years old children with moderate-to-severe hearing loss since birth, with a hearing threshold of >70dB determined by Brainstem Evoked Response Audiometry (BERA) examination. Subjects with the perforated tympanic membrane at ear examination, cerebral palsy, Down syndrome, craniofacial malformation, autism, or other syndromes were excluded from the study. The research sample was taken by consecutive sampling. After selecting subjects based on inclusion and exclusion criteria, this study included 82 subjects. Recorded age, gender, hearing test results (BERA / Audiometry), age at hearing loss, using hearing aids or not, length of use per day, frequency of speech therapy, mother's education level, average monthly income of parents, total siblings. The research sample was taken by consecutive sampling. After selecting subjects based on inclusion and exclusion criteria, this study included 82

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Quality of life was assessed using the HEAR-QL questionnaire adapted from the quality of life journal for adolescents and children with hearing loss, (Streufert 2010). The HEAR-QL questionnaire consists of 35 items rated on a 3-point scale, wherein 0=no, 1=sometimes, and 2=yes. A linear transformation is used to convert the score to a 0-100 score. Scores are transformed with 0 = 100, 1 = 50, 2=0. HEAR-QL has a sensitivity of 91.2% and a specificity of 92.3% at a cut-off score of 93.5 ($\alpha = 0.97$). The HEAR-QL questionnaire was first validated in the Indonesian national language (Bahasa Indonesia) with Cronbach's Alpha reliability of 0.968. The subjects filled out the questionnaires accompanied by a class teacher. Quality of life was determined as good if the HEAR-QL score was $\geq 60\%$ and poor if the score was $< 60\%$.

The research was approved by the Medical Research Ethics Commission of the Faculty of Medicine, Diponegoro University/ Dr. Kariadi Hospital, Semarang. Descriptive analysis was performed for patient demographic data and normality test to determine the normal distribution of all variables. Inferential analysis was conducted to determine the relationship between hearing aids and the quality of life of children with hearing impairments. Hypothesis testing used bivariate analysis and multivariate logistic regression.

Results and Discussion

The research took place at Special School B Semarang City. Among 82 subjects, 24 children use one side of hearing aids, 24 children use two, and 34 children without hearing aids. The research subjects consisted of children aged 7-12 years. The youngest was seven years old

when the oldest was 12 years old. The subjects' average age was $10.77 + 1.56$. This age group was selected based on the expectation that children in this age group could read independently and was adjusted according to the utility of the HEAR-QL questionnaire. Of the subjects of this study, 57.3% were male and 42.7% female.

ABR results obtained 21 (25.6%) subjects with severe hearing loss and 61 (74.4%) subjects with profound hearing loss. Hearing impairment is obtained from birth when there are no other congenital abnormalities. All subjects did not undergo speech therapy. Each subject performed a routine physical examination ENT. Then the subjects were asked to fill out questionnaires HEAR-QL accordance perceived by the subject. The reading of the questionnaire, especially for children who are not fluent in reading, is carried out by the teacher, but the teacher is not allowed to intervene in the subject's answers. The total average HEAR-QL score in this study was $49.56 + 24.67$. The lowest score was 8.56 when the highest score was 94.29.

Data from each variable is displayed in tabular form according to the type, including hearing aid use, gender, number of siblings, maternal education, socio-economy, quality of life (Table 1). 24 (29.3%) subjects used one hearing aid. 24 (29.3%) subjects used two hearing aids when 34 (41.36%) did not use a hearing aid. The average age was 10.77 ± 1.56 years old. A total of 31 (64.4%) subjects used hearing aids for less than 8 hours per day. 47 (57.3%) subjects were male when 35 (42.7%) were female. Most (91.5%) had siblings. The subjects' mothers with undergraduate education were 19 (23.2%) and 63 (76.8%) not undergraduate. Socio-economy, seen from the monthly income of parents based on the city's minimum wage, the average subject has an income below the city's minimum wage (72%). 48 (58.5%) subjects had a poor quality of life. Subject characteristics can be seen in table 1.

Table 1. Subject Characteristics

Variable	N	%
Hearing aid (HA)		
With HA	48	58.5
Without HA	34	41.5
Duration HA application		
≥ 8 hours	17	35.4
< 8 hours	31	64.4
Gender		
Male	47	57.3
Female	35	42.7
Number of sibling		
Single	7	8.5
Have sibling(s)	75	91.5
Mother's education		
Graduated	19	23.2
Not graduated	63	76.8
Social economic		
≥minimum regional payment	23	28.0
Under minimum regional payment	59	72.0
Quality of life		
High	34	41.5
Low	48	58.5

HA = Hearing Aid

Source = Primary Data, 2019

Bivariate analysis between the factors that may affect the quality of life of children with hearing impairments such as HA used, gender, number of siblings, mother education, and parent income is shown in Table 2. Chi-Square test was performed on these variables. Bivariate results indicate HA application, mother's education, and socio-economic affect the quality of life of children with hearing loss $p < 0.05$ (Table 2). This study analyzed the effect of the duration of HA application on quality of life. The duration of HA application had a significant effect on the quality of life $p < 0.001$

(Table 3).

To determine the relationship of several significant factors to the quality of life of children with hearing impairments simultaneously, a multivariate analysis was performed. The multivariate logistic regression test was performed on variables with a p -value < 0.25 . There are HA applications, number of siblings, mother's education, and socio-economic. The multivariate logistic regression shows that hearing aid application and mother's education had p -value < 0.05 (Table 4).

Table 2. Bivariate Analysis

Variables	Quality of life				P	
	High		Low			
	N	%	N	%		
HA	With HA	33	68.8	15	31.3	<0.001*
	Without HA	1	2.9	33	97.1	
Gender	Male	21	44.7	26	55.3	0.493
	Female	13	37.1	22	62.9	
Number of sibling	Single	1	14.3	6	85.7	0.230
	Have a sibling (s)	33	44.0	42	56.0	
Mother's education	Graduated	17	89.5	2	10.5	<0.001*
	Not graduated	17	27.0	46	73.0	
Social economic	≥minimum regional payment	18	78.3	5	21.7	<0.001*
	Under minimum regional payment	16	21.1	43	72.9	

HA= Hearing Aid

Source = Primary Data, 2019

Table 3.Correlation Between The Duration Of Hearing Aid And Quality Of Life

Group	Quality of Life				Total	P
	High	%	Low	%		
≥ 8 hours	14	82.4	3	17.6	48	<0.001*
< 8 hours	1	3.31	30	97.1		

Table 4.Multivariate Analysis

Variable	p	RP	95% CI
HA	<0.001	23.44	0.01-0.116
Number of siblings	0.059	1.22	0.889-444.89
Mother's education	0.006	3.3	0.003-0.375
Socio-economic	0.627	2.8	0.205-13.81

HA= Hearing Aid; RP= Ratio Prevalence; CI= Confidence Interval

Source = Primary Data, 2019

Hearing impairment is the inability of a partial or total to listen to the sound in one or both ears. Partial hearing loss (hearing impaired) is a state of hearing loss but can still be used to communicate with or without hearing aids. Total hearing loss (deaf) is a state of hearing function that is so disturbed that it cannot communicate even though it is amplified. Congenital hearing loss is a hearing loss that is present at birth. The proper identification and medical management of the child with hearing loss prioritize the minimizing language and speech deficits. As well as avoiding progressive otological disease. The most vital aspect of managing a child with hearing impairment is early identification (Chi & Sabo 2014). Child development is strongly influenced by the presence of severe or profound hearing loss. Children who do not get sufficient sound stimulation have difficulty understanding language (Ramires et al., 2016). In the absence of sound impulses, the brain will rearrange itself to receive input from other senses, especially from the sense of sight, this is called cross-capital reorganization, which affects reduced auditory nerve capacity (Madell & Flexer 2014). Hearing impairment in children can harm speech, language, academic, emotional, and psychosocial development. Children with hearing loss have difficulty, especially in reading and math concepts. Academic achievement of children with mild to moderate hearing loss, at lower levels one to four levels when compared with children with normal hearing (Marlow et al., 2017). Hearing impairment in children causes psychointellectual disorders and social development disorders due to children's

difficulty interacting with the surrounding environment. Children with hearing loss have a higher incidence of mood disorders, poorer social relationships, and higher psychological distress. Children with hearing loss reported avoiding participating in social activities (Gustafson SJ, Davis H, Hornsby BWY 2015). Parents of children with hearing loss reported that their children often complained of being too tired compared to their peers who had normal hearing. These challenges leave children with hearing impairments having academic difficulties and even long-term health problems (McCreery 2015).

Early intervention with hearing aids (HA) and cochlear implants aims to access, stimulate and grow the auditory neural networks penetrating the brain as the foundation for speech and language development, reading, and academics. Neuroplasticity occurs most frequently during the first three and a half years of life. The rapid growth of the infant's brain requires immediate intervention, including amplification and provision of programs that support the development of auditory skills (Madell & Flexer 2014). The use of hearing aids in children who are born hearing impaired is very important to learn to speak and listen to conversations as well as possible. Early restoration of auditory input provided by HAs or cochlear implants (CI) can reverse the adverse effects of hearing loss in children. These treatment methods enable hearing-impaired children to improve not only in audiological aspects but also in other areas of life. Parents note a positive change in their child's lifestyle, academic performance,

psychological wellbeing, behavior, and self-esteem. It is important to evaluate the global effectiveness of HAs or CIs beyond hearing and speech development and, additionally, with more general objectives concerning the quality of life (Pérez-Mora et al., 2012).

A hearing aid system is a device that enables people with hearing loss to maximize the use of residual hearing. It should provide optimal speech intelligibility and capture maximum information with minimal distortion and distortion from unwanted background noise. Hearing aids amplify all sound, including noise, which is amplified along with speech. One of the limitations of hearing aids is the ability to help clarify sounds in noisy environments (Doldouras 2017). Hearing aids must be adjusted optimally. The hearing threshold must be determined as accurately as possible separately for each ear. Several things can affect auditory development in hearing-impaired children. Like the age when the child suffers from hearing loss (related to speech and language development), degree of hearing loss (mild to severe), age when identified, and received intervention, environment. Effective amplification in children is unlikely to succeed without parental support and understanding (Chi & Sabo 2014).

Some factors can limit the use of hearing aids in children. Hearing aids that are not suitable for babies and children make wearing them uncomfortable and difficult. A hearing aid that is not functioning or does not fit is a potential factor that causes hearing aids not to be used all the time by school-age children. Social pressure to "get along" with peers who have normal hearing may also negatively affect hearing aid wear. Hearing-deficient children between the ages of 6 and 11 showed lower self-confidence than their normal-hearing peers. A decrease in the consistency of using hearing aids in hearing-impaired children along with a decrease in self-confidence (Gustafson, 2015).

Quality of life is general well-being consisting of objective descriptions and subjective evaluations of physical, material, social, and emotional well-being, along with the level of personal development assessed by the person (Karimi 2016). Quality of life that refers to individual health is health-related quality of

life (HRQoL) (Gustafson SJ et al., 2015). The impact of a particular health condition on a person's life is not only enough to be assessed with physical measurements, evaluation of HRQoL is important for fully understanding the effect of health conditions on individuals, (Haverman L et al., 2016). The same health condition can result in very different HRQoL ratings in different individuals. Patient reporting results are the best source of information about what patients are experiencing. The HRQoL measurement was developed for a variety of purposes: (1) assessing people's status at specific time points, (2) comparing HRQoL of patients with different health conditions (e.g., the relative impact of heart disease versus cancer), (3) measuring changes in HRQoL over time to time (for example, in clinical trials, observational studies, health care settings or for population surveillance), and (4) predicting future outcomes. (5) provide standardized information to doctors about patient problems to identify and monitor symptoms, evaluate treatment outcomes and support joint decision making (Haverman L et al., 2016).

Several classifications of the HRQoL questionnaire have been made in the literature. One of which is a generic instrument. The generic questionnaire intends to measure all HRQoL dimensions and can be applied to healthy populations. In any clinical population. Regardless of the type of health condition. The advantage of generic questionnaires is that they provide a comprehensive picture of HRQoL and allow comparisons of specific conditions (Haverman L et al., 2016). Glasgow Children's Benefit Inventory (GCBI) is a questionnaire used to retrospectively assess the benefits after an intervention. There are four domains. Namely emotions, physical health, learning, and vitality. Health Utilities Index Mark 3 (HUI3) is a utility-based measuring tool to determine the overall quality of life. There are eight domains. Including vision, hearing, speech, ambulation, agility, emotions, cognition, and pain (Roland et al., 2016). The generic PedsQL 4.0 scale is the questionnaire most frequently used in pediatric HRQoL studies. The PedsQL measurement model can be used for young children aged 5-7 years, children aged 8-12 years, and adolescents aged 13-18 years. PedsQL™ consists of 23

questions covering the dimensional subscale: physical function (8 items), emotional function (5 items), social function (5 items), and school function (5 items) (Haverman L et al., 2016).

The general HRQoL questionnaire is not specific to a specific condition, the validity or sensitivity of specific subgroups such as children with hearing loss may be lacking. Without a proper assessment of the quality of life of children and adolescents, it is difficult to know which interventions are appropriate for their needs. A proper evaluation can effectively evaluate how a child's quality of life is affected by their hearing loss and any further interventions the child may need (Umansky et al., 2011). The Hearing Environments and Reflection on Quality of Life (HEAR-QL) questionnaire focuses on the quality of life of children with hearing impairments, a questionnaire created by (Streufert 2010). The HEAR-QL questionnaire is a specific quality of life measure designed to determine how a child feels the social and emotional effects of hearing loss, particularly in environments where hearing loss has a major impact on the child's quality of life. The HEAR-QL questionnaire contains 35 questions for children aged 7-12 years with hearing impairments and their parents. Each component focuses on situations that affect interactions with family and friends, participation in social and school activities, and the impact of hearing loss on the emotional well-being of children (Streufert 2010).

The measurement of the quality of life of children with hearing loss using the HEAR-QL questionnaire is designed to determine how they feel about social and emotional effects. Especially in their environment (Umansky, 2011). The previous study compared the total quality of life of children with hearing loss and normal hearing using the HEAR-QL questionnaire was lower, 71 + 18 compared to 98 + 5 with $p < 0.001$ (Umansky, 2011). The research reported that the physical and psychological health status of adolescents with hearing loss was negatively affected by their disability and limited access to many services and the fact that they are often excluded from the community due to their difficulty in communication, which caused significant effects in daily life, academic performances, social growth, and

emotional growth; and resulted in a loneliness feeling, isolation, frustration, ultimately causing substantial and permanent damage to the teen itself and their family, (Kirman, 2013) Early intervention with hearing aids and cochlear implants aims to access, stimulate, and grow auditory nerve tissue into the brain as the foundation of speech and language, also reading and academic development. The use of hearing aids in children who are born hearing impaired is very important to learn to speak and listen to conversations as well as possible (Madell, 2014).

The aims of this study were to (1) investigate the relationship between the use of hearing aids and the quality of life of children with hearing impairments, (2) investigate the factors that affect the quality of life of hearing loss children. This study found that 41.5% of children with hearing loss had a good quality of life and poor quality of life as many as 48 (58.5%) subjects. The average total HEAR-QL score was 49.56 ± 24.67 . The quality of life of children with hearing aids (68.8%) was better than children who did not use hearing aid (2.9%). It is consistent with the latest study that found an increase in HEAR-QL scores obtained by the use of hearing aids ($p < 0.001$). The quality of life in children with hearing loss after the application of bilateral hearing aids or bimodal stimulation were high, and both children and parents reported that the quality of life after using hearing aid was similar to children with normal hearing (Pérez-Mora, 2012). Parents feel that hearing aids provide higher educational opportunities for their children, that children are also able to communicate their needs using short language, and enjoy music (Looi et al., 2016).

The duration of hearing aid application is related to the quality of life of children with hearing loss ($p < 0,001$). The latest study found that hearing aid devices have to be used at least 8 hours a day to achieve optimal results (Azizi et al., 2013). The hearing aids usage during most of the waking hours is highly recommended. It tends to produce benefits for children with hearing loss (Muñoz & Hill 2015). Gender was not associated with the quality of life ($p = 0.493$). It is per a study that found no significant association between gender and quality of life

among school-age children and adolescents with hearing loss (Laugen et al., 2016). Gender differences in self-esteem change with age. Boys and girls rate esteem identically until age 12 (Warner-Czyz et al., 2015).

This study found that the number of siblings did not affect the quality of life ($p=0.059$). It is in contrast to previous study that showed families with only one child have more time devoted to children, economic, social, and physical conditions thus had a good influence on children's health status (Kirman & Sari 2013). This variable might be influenced by the occupation of the mother and the total time parents spent to take care of their child, but these two possible factors were not studied in this study.

The mother's education level had a significant effect on the quality of life of children with hearing loss ($p=0.006$). According to a study, the higher the mother's education level, the better care she gives to her children (Kirman & Sari 2013). Maternal education was significantly associated with global psychosocial outcomes for children with HAs. Low maternal education is a risk factor for child behavior problems. Maternal education and socio-economic status affect child language outcomes through maternal speech input that was higher in quantity, lexical richness, and sentence complexity (Wong et al., 2017).

Unfavorable economic conditions can be related to limited access to food, social care, health, and education. Which eventually reduces the quality of life significantly. A recent study reported a relationship between socioeconomic status and perceptions of the quality of life of family members. The lower the socioeconomic status, the worse the perception of the quality of life in all domains except the environment (Nascimento et al., 2016). Individuals from lower social classes are more vulnerable as they are likely to be exposed to more stressful experiences than upper-class individuals. These stressful events may have a comparably more severe impact on their emotional functions than on individuals from the upper class. Children and adolescents in families with moderate and well socioeconomic status experience fewer social limitations related to physical health than children and adolescents

in families with poor economic status (Kirman & Sari 2013). On bivariate analysis, we found that socioeconomic status (SES) was associated with the quality of life ($p<0.05$). But after being analyzed together with other variables, it did not affect the quality of life ($p>0.05$). This study assessed socioeconomic status only from the amount of monthly income. Generally, SES is defined as the position of an individual or a household within a society. It is a combination of occupation, education, income, wealth, and residence neighborhood (Shafiei et al., 2019).

Conclusion

There was a relationship between the use of hearing aid and the quality of life of children with hearing loss. The quality of life of children with hearing loss who use hearing aid was better than those who did not. The duration of hearing aid use, maternal education, and socio-economic status affected the quality of life. Whereas gender and number of siblings did not affect the quality of life of children with hearing impairment. Further studies addressing family support to encourage children with hearing loss to use hearing aid is warranted to improve the quality of life of these children.

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