



Hearing Screening in Infants in the Work Area Community Health Center

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Abstract

The early discovery of hearing impairment among infants leads to essential intervention services which aid proper language and cognitive development. The administration of Otoacoustic Emission (OAE) screening stands as the primary testing method inside newborn and infant hearing screening programs throughout the world. Research on the implementation of Otoacoustic Emission testing in community health environments along resource-limited regions remains insufficient. The research investigated OAE hearing screening outcomes in Padanglampe Health Center infants from 24 months old through Padanglampe Health Center in Pangkep Regency including screening results and age and gender dynamics. The study used a cross-sectional observational approach with nine infants selected from a total group that satisfied the study criteria. OAE testing procedure served to screen the hearing of each participant. The researchers performed both descriptive and inferential analysis of gathered data. Fisher's Exact Test evaluated the relationships between gender data along with screening outcomes and between different age intervals and their corresponding screening results. The calculations of odds ratios enabled investigators to determine how likely refer results occurred between male and female participants. The audiometric test with OAE technology showed positive results for eight out of nine screened infants but produced a refer outcome for the remaining one subject. A female infant under three months of age served as the subject in this refer case. Fisher's Exact Test results demonstrated that gender and screening outcome relationship was non-statistically significant with a p value of 1.000 and results for age-based associations produced no significant findings.

Introduction

Data from the World Health Organization (WHO) in 2007, showed differences in the percentage of hearing loss in East Asia. Indonesia has the smallest percentage of 4.2%, Sri Lanka 9%, Thailand 13.3%, and Nepal 16.6%. Based on this data, there are more than 100 million people suffering from hearing loss in East Asia. The cause of hearing loss, 50% genetic factors, the remaining 50% is caused by environmental factors such as diseases suffered by the mother before or after giving birth, or diseases of unknown cause (Purnami et al., 2018; Kochhar et al., 2007; Brookhouser, 1996; Brent, 2004).

The incidence of hearing loss in neonates ranges from 1-6 per 1000 live births. The 1994-1996 Hearing Health Survey reported an incidence of hearing loss since birth of 0.1%. The incidence increases 10 to 50 times in high-risk neonates. High-risk neonates have one or more risk factors as a cause of hearing loss such as a family history of congenital deafness or deafness since birth, a history of congenital or perinatal infection such as TORCH infection (Choe et al., 2023; Raesi et al., 2022), prematurity, very low birth weight (VLBW) <1500 grams,

hyperbilirubinemia, a history of late-onset sepsis and meningitis, asphyxia, a history of respiratory distress, use of breathing aids, use of ototoxic drugs, such as gentamicin antibiotics for more than 5 days with or without a combination of furosemide, a history of recurrent or persistent ear infections, a history of trauma or temporal bone fractures, a history of measles and mumps infections (Ulung et al., 2015). At Wahidin Sudiro Husodo General Hospital, South Sulawesi Province, it was found that 39 babies treated in the NICU who underwent hearing screening received a referral examination result (44.32%) and 12 babies treated in the perinatology room received a referral examination result (36.37%) out of a total of 88 babies who underwent examination (Hall & Antonelli, 2001).

Otoacoustic Emission was introduced by Kemp in 1997 as the gold standard for newborn screening (Nozza, 2001; Anil, 2019; Anwar & Arifuddin, 2025; Gauvin et al., 2022). The vibration of the tympanic membrane produces an OAE signal, which can be measured with a microphone. The amplification produced by the movement of OHCs in the cochlea is 50 dB, then the residual energy reaching the ear canal is 0-15 dB (Perhati-KL, 2019). According to data released by the Indonesian ENT-KL specialist doctor association in 2019, it was noted that of the medical devices available in a number of hospitals in Indonesia, both central and regional, OAE devices were not all available in hospitals that had ENT-KL specialist doctors (Olusanya, 2015; Sarah, 2017). A child is known to have hearing loss by his family when he is late in speaking compared to children his age (Appelbaum et al., 2018; Magnuson & Hergils, 2000; Hamzah et al., 2021). If it is known too late, of course the obstacles that will be faced will be greater. Hearing loss or deafness from birth will cause speech, language, cognitive, and academic development disorders (Kumar et al., 2017; Lieu, 2013; Lang-Roth, 2014; Brookhouser, 1996).

The Screening-Re-Screening-Confirmation method has been recommended in Universal Newborn Hearing Screening (UNHS) in a phased manner using OAE and ABR. Screening is done in the first four weeks, then repeated along with the immunization schedule in six months and starting appropriate interventions at the age of six months (Nugraha et al., 2022; Delianti et al., 2023). Hearing screening examinations need to be carried out on infants or children before the age of 2 years so that early detection and intervention can be carried out, considering that the best brain development occurs at the age of 2-4 years (Halim et al., 2021).

Methods

The research adopted an observational cross-sectional design to establish an overview of hearing screening results that depended on sex and age groups in infant patients. The research adopted a cross-sectional design since it allows simultaneous collection of both independent and dependent variables at one point in time thereby producing patterns without needing follow-up. This study analyzed two independent variables which were infant age and gender together with Otoacoustic Emission (OAE) test measurements as the dependent variable. The selected approach delivered a time-specific overview of hearing conditions among infants seeking care at a local health facility.

The location of research activities took place at Padanglampe Health Center situated within Pangkep Regency in South Sulawesi Province of Indonesia. The data collection process lasted for twelve months stretching from January 2021 through December 2021. The chosen location worked well because it had easy access and infants regularly attended vaccinations at this center which provided continuous opportunities for recruitment. The health center service area included all infants below 24 months of age. During the research period the accessible population contained infants under 24 months of age who came to the health center for visits. The health facility brought in children with their caretakers for scheduled vaccine appointments which became the moments for recruitment procedures and eligibility screenings.

An accidental sampling approach which goes by the name of convenience sampling was used to pick participants. The researchers chose this sampling approach as an appropriate solution given the health center setting where traditional sampling methods would be too challenging to use because of uncontrolled patient movements. All infants who met the research requirements were invited to join the study as they came to the health center during data collection. All recruited infants must be younger than 24 months and should have been discharged from Padanglampe Health Center. Child participants of the study were excluded if they exhibited congenital hearing assessment hurdles or prior medical procedures linked to hearing loss. The screening followed voluntary procedures while caregivers received informed consent before the examination started.

The Otoacoustic Emission (OAE) device served as the hearing screening instrument because it represents a tested method for non-invasive cochlear function assessment in infants. Sound waves that originate from the cochlea during external stimuli result in indications regarding hearing health through the OAE assessment. The hospital space used for testing included a quiet setting where the infants' condition should be relaxed either during sleep or in a peaceful state to prevent movement-related issues. Staff members inserted a tiny probe which contained both speaker and microphone components into the infant ear canal carefully. A screening device recorded emitted sounds throughout the evaluation process until automatic interpretation of the examination results became available. The test results from screening showed either "pass" when cochlear response was normal and no hearing loss was detected or "refer" when further diagnostics were needed to check potential hearing problems.

Data collection also included recording essential demographic information about the infants which consisted of age along with gender. The assessment team verified all collected data before categorizing it based on the research objectives. The researchers performed descriptive analysis to explore how OAE test results distributed according to female and male infants at different age levels. A manual analysis with basic counting tools like a calculator was applied because the research used a small sample size and descriptive methods. The study displayed its collected data as frequencies and percentages which showed patterns and major trends. The researchers conducted this descriptive study to discover baseline information regarding community-based hearing loss detection in infants and to enhance discussions about hearing screening as a routine practice.

Result and Discussion

Healthcare professionals need to comprehend early hearing screening outcomes because they determine immediate intervention timing especially since routine immunization appointments are often the lone healthcare encounters between families and formal services. OAE screening served as the initial method to evaluate infant auditory function for subjects aged under 24 months. Research results about early hearing disorder identification important for assessing both potential hearing problems and hearing screening implementation within standard child health systems because early hearing trouble detection predicts better language development alongside communication and cognitive growth. This research analyzes results through simple demographic features including gender and age to find distinctive patterns for optimizing screening strategies in related healthcare services.

The findings are presented by giving an overview of the demographic traits shown by infants participating in screening tests. OAE results are subsequently examined through divisions which show data by gender and age-related groups. This evaluation displays significant patterns and variations from the small research group while evaluating its implications through relevant scientific studies about infant hearing quality.

Table 1. Respondent Characteristics

Gender	Percentage (n=9)
Male	44.44% (4)
Female	55.55% (5)
Age	Percentage (n=9)
0-12 Months	88.88% (8)
12-24 Months	11.11% (1)

From the results obtained, there were research subjects consisting of 4 male people (44.44%) and 5 female people (55.55%). The age of the respondents who participated was less than 12 months as many as 8 people and more than 12 months as many as 1 person.

Table 2. Oae Measurement Results

OAE Results	Refer	Pass
Gender		
Male	-	44.44% (4)
Female	11.11% (1)	44.44% (4)
Total	1	8
Age		
< 3 Months		22.22% (2)
3 Months - <6 Months	11.11% (1)	11.11% (1)
6 Months – <12 Months		44.44% (4)
12 Months – 24 Months		11.11% (1)
Total	1	8

The results obtained from OAE measurements based on gender are 1 person with female gender has a refer measurement result and 4 other females have pass measurement results. For male research subjects, there are 4 people all have pass measurement results. For OAE results based on the age of the research subjects, in the age range of less than 3 months there was 1 research subject who had a refer measurement result and 2 people with a pass measurement result. In the age range of 3 to less than 6 months there was 1 research subject who had a pass measurement result. In the age range of 6 months to less than 12 months there were 4 research subjects who had a pass measurement result. In the age range of 12 months to less than 24 months there was 1 research subject with a pass measurement result.

There was 1 child (11.11%) aged less than 3 months who had a referral result. The same thing was also found at the Hearing and Communication Center of the Community ENT Division of the Faculty of Medicine, Airlangga University/ Dr. Soetomo Hospital, Surabaya, identifying outpatients with profound SNHL hearing loss in 2004 aged less than 3 months as many as 191 people and children aged less than 5 months as many as 228 people. In a study conducted by Rini Andriani in 2010, it was found that the group of subjects who experienced hearing loss were male compared to female with a ratio of 2.5:1, where the majority were under 3 months old (57.1%) and had more than 3 risk factors (85.7%).⁽²⁾

In a study conducted by Anthony Stephen Halim in 2021, it was found that out of 872 medical records studied, 558 (64.0%) were boys and 314 (36.0%) were girls. The majority (44.8%) of children with speech delays were in the 2-year-old age group. Children with speech delays accompanied by hearing loss numbered 565 (64.8%) people and those without hearing loss were 307 (35.2%). The majority (48.0%) of children with speech delays had profound hearing loss. There was an increase in children with speech delays without hearing loss compared to those with hearing loss from 1:2.04 in 2017 to 1:1.12 in 2020.

Table 3. Association Between Gender and OAE Screening Outcomes

Gender	Pass (n)	Refer (n)	Total (n)
Male	4	0	4
Female	4	1	5

The research evaluates how male and female subjects perform during auditory screening tests. Four out of four male newborns (100%) succeeded in hearing screening examinations but only one of the five female newborns (20%) was referred. The statistical evaluation disproves the initial appearance of female infants experiencing refer results at a higher rate based on this dataset. The p-value from Fisher's Exact Test reached 1.0 because it showed no statistically significant relationship between gender and hearing screening results for the small sample group. Because the observed data lack strong biological or demographic influences the difference between male and female test results appears to stem from random chance. Initial interest in male infant ear screening with no refer outcomes remains unproven due to insufficient evidence from an unbalanced sample. The outcomes from OAE screening demonstrate no significant gender-related disparities among the patients studied so healthcare providers should continue screening for all demographic groups to prevent any potentially undetected cases.

Table 4. Association Between Age Group and OAE Screening Outcomes

Age Group	Pass (n)	Refer (n)	Total (n)
<3 months	2	1	3
≥3 months	6	0	6

Table 2 analyzes OAE screening results relative to participant age groups where the first category includes subjects under three months and the second one contains participants older than three months. A total of two infants passed while one received a refer result within the younger participant group. Six infants above three months passed the screening audiological test successfully. The p-value from Fisher's Exact Test analysis shows no significant relationship between the screening results and age group of the subjects with a calculated value of 0.33. A single refer test output in the youngest newborn group bears major clinical importance. Neonatal hearing tests often reveal "refer" reactions as natural outcomes since very young infants may show positive results from residual vernix in the ear canal and temporary middle ear fluid and developmentally immature auditory processes which heal naturally. A similar pattern emerged despite failing to reach statistical significance in this research but it supports medical knowledge and professional encounter reports suggesting screening procedures should be considered after initial early neonatal tests.

Table 5. Estimated Odds Ratio: Female vs. Male Infants in Likelihood of Receiving a Refer Outcome

Group	Refer (n)	Pass (n)	Odds (Refer/Pass)
Female	1	4	0.25
Male	0	4	0.00
Odds Ratio	—	—	∞ (undefined)

The analysis calculated an odds ratio to understand the relative chance of female infants receiving refer results instead of their male counterparts. Female infants stood at 0.25 for refer outcomes which means one refer for every four passes whereas no male infant received a refer outcome. An odds ratio shows mathematical infinity based on data where one group demonstrates a non-zero probability of the refer outcome and the other shows no chance of its occurrence. The extremely small sample size and low event rate lead to this dramatic calculation because no male infants received a refer result. With a higher number of subjects a

single male case of refer status would reduce the computed odds ratio becoming easier to understand. Since the calculated odds ratio produces accurate results it technically demonstrates a gender-based difference but should not be understood as detecting substantial discrimination between genders. The single unexpected result in a limited dataset presents risks for interpretational errors unless analysis occurs within strict statistical boundaries and medical carefulness.

Otoacoustic Emissions and the Ethics of Early Hearing Care

Early detection of hearing loss at infancy performs the crucial function of protecting child development beyond clinical procedures. A child's ability to hear remains essential for their mental development as well as their language acquisition and emotional development and their social connections with others. The global healthcare community adopts universal newborn hearing screening (UNHS) because it represents an essential public health strategy (Brookhouser, 1996; Hall & Antonelli, 2001; Olusanya, 2015; Neumann et al., 2022; Kamenov & Chadha, 2021; Jacob et al., 2021). This study joins existing research by conducting an otoacoustic emission (OAE) screening analysis in the public health facilities of Indonesia despite its limited numbers of participants. This study examines the distribution of pass and refer outcomes by age and gender groups to allow both local assessment of screening execution and examination of existing scholarly discussions in early hearing detection and intervention.

The screening outcomes indicate high success with 88.88% of infants passing while 11.11% received a refer result which matches typical expectations for well-baby populations according to Nozza (2001), Lang-Roth (2014), and Kumar et al. (2017). The presence of only one refer case inside a screening sample of nine infants makes a strong statistical impact on the field that aims to detect even one additional hearing loss since this results in forever altered life consequences for the patient. The detection of hearing loss during infancy without proper diagnosis leads to delayed development of speech and language while bringing about lower academic performance along with social detachment according to Lieu (2013), Appelbaum et al. (2018) and Lang-Roth (2014). Early detection and intervention serve as the foundational principle behind UNHS policy since time-sensitive intervention blocks the detrimental consequences of hearing loss (Delianti et al., 2023; Nugraha et al., 2022). The study produced significantly influential data based on the relation between outcome results and participant age groups. The exclusive screening refer outcome occurred in the only infant tested before the age of three months. A high number of similar cases appear in research publications about this condition. The testing method to detect hearing loss during the early postnatal period faces obstacles because vernix blocks the ear canal and middle ear fluid formation and auditory system development in infants may not fully mature (Choe et al., 2023; Raeisi et al., 2022). Scientific research demonstrates that postponing screening for a short time reduces the number of inaccurate positive results (Anil, 2019; Brookhouser, 1996; Wells et al., 2022; Jullien, 2021; Shaukat & Levin, 2022). A philosophical conflict emerges due to this situation because we face the dilemma between testing infants early for screening purposes or deferring testing to avoid unnecessary early referrals. The Joint Committee on Infant Hearing together with WHO guidelines promote established re-screening methodologies and diagnostic testing at a minimum age of three months for proper assessment (Hall & Antonelli, 2001; WHO, 2010; Wen et al., 2022; Mazlan et al., 2022).

The research found no relationship between OAE results and subject age group ($p = 0.33$) although the observed result mainly involved participants from the youngest group which matches clinical observations thus supporting continued screening practice. The established age-related trends lead to important contemplation of fundamental issues. From birth to four months the auditory system experiences rapid myelin development while forming new synapses (Lang-Roth, 2014; Brent, 2004; Kohrman et al., 2021; Moura et al., 2022; Seraji et al., 2024). Children who receive failed results from early hearing tests could simply

demonstrate temporarily delayed responses that will normalize later on. Follow-up testing serves as the only reliable method to differentiate between delayed response and actual medical conditions from pathological issues since the current protocol lacks this distinction. This shortcoming stems from systematic factors rather than clinical needs. The results from the gender-based analysis provided interesting interpretation points. All male infants experienced successful screening results while the single refer case belonged to a female infant which yielded no statistically significant pattern between gender and screening results ($p = 1.00$). The research evidence about gender variations in hearing loss shows no clear patterns. X-linked inheritance demonstrates evidence that leads researchers to believe males are more likely to develop deafness compared to females particularly when the hearing loss presents at birth or progresses overtime according to Kochhar et al. (2007) and Purnami et al. (2018). Research shows that gender traits do not produce substantial variations in the incidence of nonsyndromic sensorineural hearing loss (Appelbaum et al., 2018; Uleng et al., 2015) and do not exhibit significant differences. Our information indicates that male infants without refer outcomes could represent sample sampling issues instead of valid clinical findings. This evidence reinforces the significance of dividing healthcare statistics by sex to maintain equal treatment throughout the examination process.

The rural primary healthcare center requires attention because it has limited audiological service access during the screening implementation. OAE devices do not exist throughout Indonesian hospitals even when ENT specialists work there (Perhati-KL, 2019). To succeed in decentralized screening professionals need to be trained together with equipment along with quality control protocols that integrate well within standard pediatric care practices (Sarah, 2017; Halim et al., 2021). This study shows great merit in using immunization timepoints for screening assessment. The screening method which uses healthcare visits as an opportunistic time for checks fits multiple programs in low- and middle-income countries (LMICs) and has shown both practicality and impact (Olusanya, 2015; Nugraha et al., 2022; Mokaya et al., 2022; Mulure et al., 2024; Smith & Taubert, 2025).

However, with opportunity comes responsibility. OAE screening devices provide only two outputs but healthcare professionals must use their clinical expertise to analyze results and convey decisions to parents (Hamzah et al., 2021; Magnuson & Hergils, 2000). A detection signal emerges from the device but the healthcare system requires a proper reaction. The most reliable screening devices become less effective due to insufficient support systems regardless of their accuracy levels. When audiological diagnostics and early intervention programs lack proper follow-up services screening turns into an ineffective practice known in public health as “screening without service” (Olusanya, 2015).

A small number of participants in this research study limits the capacity to infer statistical values due to methodological restrictions. One refer case affects odds ratios beyond recognition while magnifying effects at the same time it invalidates standard statistical assumptions. The appropriate interpretation of small sample research produces valuable information. The practical model demonstrates actual field operations in public health which enables researchers to study bigger healthcare frameworks (Brookhouser, 1996; Kumar et al., 2017; Calleja et al., 2021; Peterson et al., 2021). The researchers should treat their findings as initial evidence that demands both a cautious scientific approach and immediate ethical intervention. The social context needs to be taken into account by those who provide early hearing detection services. The biological condition of hearing loss runs parallel to interruption of communication flow which creates social isolation and threatens familial and communal bonds (Magnuson & Hergils, 2000; Lieu, 2013). Health problems caused by late diagnosis produce two major effects: cognitive impairment as well as psychological disconnection because children feel unheard. The correct execution of early screening transforms into a meaningful social act

because it brings people into communication. The assessment grants children their fundamental right to experience being observed, heard and receiving understanding.

The present study affirms the value of early hearing screening, even in low-resource settings. The research promotes OAE technology as an accurate preliminary screening instrument while recommending appropriate age intervals for follow-up screening as well as infrastructure preparedness at the system level. The study partakes in worldwide research discussions concerning optimal strategies for offering complete communication opportunities to newborns. The pathway to this promise starts with sound since this is how the system will detect it.

Conclusion

The research evaluated otoacoustic emission (OAE) hearing test outcomes in babies younger than 24 months at a community health center especially regarding their age and gender demographics. The study's limited participant number confirmed the dual importance and multifaceted aspects of early hearing detection practice in primary care. The high overall passing rate and the detection of solitary refer case among infants under three months confirms that universal hearing screening should begin during this period. No chance of missing even a single hearing impairment diagnosis requires immediate detection since it leads to severe developmental impacts that establish early discovery as a vital clinical responsibility. The assessment indications that affect infants who undergo screening before their first three months match what research has shown about difficulties in hearing tests for newborns because of bodily changes. The study emphasizes the need for structured follow-up strategies to distinguish between permanent hearing impairment from temporary auditory development changes because no significant data correlations emerged between age and gender outcomes and screening results. *tutto* in male infants who attain passes in hearing tests should be seen with caution since the sample remains small yet it underlines the requirement for gender-consistent reporting to protect equal screening opportunities for all.

This study reveals important information that goes past statistical data. Community-level hearing screening is feasible and produces meaningful effects in areas with central audiological services because it can be easily integrated into standard immunization services. The effectiveness of the screening process requires complete support mechanisms to provide diagnostic follow-up treatments and educational sessions for caregivers alongside immediate intervention. The data confirm existing approaches yet demand new investments in both infrastructure development and training alongside policy development for turning early hearing detection into concrete developmental results.

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