# HEARING LOSS IN PRESCHOOL CHILDREN: PREVALENCE AND CHARACTERISTICS IN A RURAL AREA IN VIETNAM

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**Abstract**

**Background:** Data on hearing loss among preschool children aged 2 to 5 years in Vietnam are still limited. This study examined the prevalence and characteristics of hearing loss among preschool children in a rural area in Vietnam. **Methods:** A cross sectional was conducted among 15,201 preschoolers aged 2-5 years in Thai Binh province, Vietnam to determine the prevalence of hearing loss according to the method recommended by the Joint Committee on Infant Hearing (JCIH): a two-step Automated Oto-Acoustic Emissions (OAE) program, completed by an Auditory Brainstem Response (ABR) for the positive diagnosis of hearing impairment. **Results:** The study found 571 children (353 boys, and 218 girls) had hearing impairment, showing that the prevalence of hearing loss among preschool children was 3.75%. Among the hearing loss children, mild hearing loss (21–≤40 dB) accounted for almost half of the children with hearing loss followed by moderate hearing deficit (41- 70 dB) (39,93%). Majority of the hearing loss children was conductive hearing loss (69.88%). **Conclusions**: The study found that hearing loss is common among pre-primary school children in rural area in Vietnam. Routine hearing screening in preschool is recommended for an early detection

**Keywords:** Hearing loss, Preschool children, Hearing impairment, Thai Binh, Vietnam

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## 1. Introduction

The sense of hearing plays a prominent part across the life course, most relied upon to communicate and engage with others. A hearing loss can happen if it has any disorders in parts of the ear or auditory system [1]. The recent World Hearing Report published by World Health Organization (WHO) estimated that more than 1.5 billion people experience some degree of hearing loss. Of these, an estimated 430 million have hearing loss of moderate or higher severity in the better hearing ear. Prevalence of hearing loss varies across WHO regions; the vast majority of people affected live in low- and middle-income countries of the world. It is projected that by 2050, nearly 2.5 billion people have some degree of hearing loss [1]. While other diseases can be detected early on fetal ultrasound, congenital hearing loss as well as genetic hearing loss cannot be detected on common paraclinical tests. Hearing loss can be primarily preventable, meanwhile, it encounters many barriers in launching ear and hearing care. Because kindergartens from 2 to 5 years old begin to strongly develop community communication skills through learning in the classroom and contact with surroundings, children at this stage need special research attention.

According to hearing threshold, hearing loss can be classified into 3 levels: mild (20 to 40 dB), moderate to moderately severe (41 to 70 dB) and severe to profound (71 to 95 dB) [2, 3]. In agreement with causes, hearing loss can be divided into sensorineural, conductive, and mixed hearing loss. Sensorineural hearing loss occurs when there is a problem in function of the inner ear or hearing nerve [4]. Conductive hearing loss owing to injury or defect within the external or middle ear, including the external auditory canal, tympanic, middle ear cavity and ossicles [3]. This type can often be under treatment by medicines or surgery. The combination of the above two types of hearing loss gives rise to another type which is called mixed hearing loss [4].

Otoacoustic emission (OAE) and auditory brainstem responses (ABR) are the two methods which are recommended by Joint Committee on Infant Hearing Loss to screen in hearing program [5, 6]. These methods have widely applied in hearing screening programs worldwide. ABR technology tests the entire hearing pathway from the ear to, and including, the brainstem while OAE technology tests a portion of the hearing pathway from the outer ear to the cochlear. The advantage of the OAE test is it does not require highly technical and experienced staff as well as standard facilities to perform while ABR test is more complicated, taking more time and requiring certified audiologists to measure and explain the results. However, the method has higher precision. Due to these reasons, ABR test is suitable in diagnosis while OAE method is convenient in rapid screening in the community. Some programs use a combination of screening technologies which was called two-stage protocol for the well-baby nursery. In detail, OAE testing for the initial screening, followed by ABR for rescreening [7]. Using this approach, infants who fail an OAE screening but subsequently pass an ABR are considered a screening pass. Joint Committee on Infant Hearing

Loss declared that a protocol was a suitable and and effective, which can minimize initial disposable costs and decrease the fail rate at hospital discharge [5].

Joint Committee on Infant Hearing Loss comes up with 10 risk factors for hearing loss, including low birth weight (<1500g), craniofacial anomalies, hyperbilirubinemia requiring exchange transfusion, ototoxic medication, presence of a syndrome associated with congenital hearing loss, intrauterine infections, low apgar scores (0 – 4 at 1 min or 0 – 6 at min), bacterial meningitis, mechanical ventilation for at least 5 days and family history of hearing loss [8]. On the other hand, some studies have demonstrated that genetic characteristics took up about half of all known causes of these congenital hearing loss cases [9, 10]. Hence, knowing the mutational spectrum of hearing loss in a certain population offers a background data could get a better understanding of the progression and risk of hearing loss in children, ensue come up with an optimal intervention strategy, simultaneously creating comprehensive audiological assessment programme [11-13]. Most children with hearing loss were born to parents with normal hearing [14]. Therefore, it's might be necessary to perform genetic counseling sessions, premarital examination and early genetic screening for next generations [15].

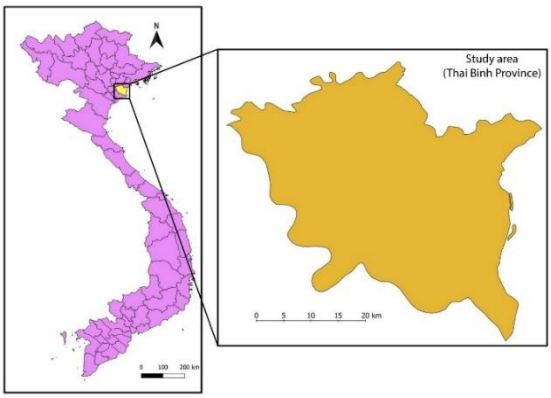
In Vietnam, due to insufficient resources and techniques, hearing screening is not frequently conducted for both infants and pre-school children. This can be done in several hospitals in the capital cities, and through some hearing loss programs. The Vietnam Ministry of Education and Training estimated that 180,000 children under 18 have hearing loss [16]. However, due to lack of hearing screening programs, so the actual number of children who are hearing impaired could be much higher [16]. Children aged 2-5 years should be screened for hearing loss because at this stage, preschool children progressively develop their skills and can perform increasingly complex everyday tasks. Language acquisition and development begin at birth, and their critical establishment period extends up to 5 years old [17]. This process depends on cognitive and neuromotor maturation, auditory system integrity, and social interaction [17]. Several studies have been conducted to estimate the prevalence of hearing loss in Vietnam recent years to show that the prevalence of hearing loss among those groups from 4.4% to 4.7% [18, 19].

Thai Binh is a province in the North of Vietnam. It is about 120 km from Hanoi. Until now, there is no data on the hearing loss situation in children, including children aged 2 to 5 years. The aim of this study was to determine prevalence and characteristics of hearing loss in children from 2 to 5 years at some public nursery schools in Thai Binh, Vietnam.

## 2. Methods

**Study design:** This study is a cross-sectional study.

***Study location:*** The study was conduct Thai Binh province. It is an agriculturally rich area and densely populated. The province is a typical rural province in the south–west of the Red River Delta region (see Figure 1).




## *Participants*

In this study, 15,201 children aged 2-5 years in four preschools in Thai Binh province were screened hearing. Number of children according to age are shown in the Table 1.

**Table 1: Number of children participated in the hearing screening (n=15,201)**

| Age | Number of children | Percentage |
|---|---|---|
| 2 years | 2146 | 14.12 |
| 3 years | 3842 | 25.27 |
| 4 years | 4899 | 32.23 |
| 5 years | 4314 | 28.38 |

### *Sample and sampling:*

Firstly, four districts and city of Thai Binh province were randomly selected, including Thái Binh city, Kien Xuong district, Thai Thuy district, and Vu Thu district. Secondly, lists of the public preschools in each district or city were made. In each district or city five to ten schools were selected for hearing screening. Boys and girls in these preschools were all invited into the study.

### *Inclusion and exclusion criteria*

Inclusion criteria: Preschool children aged from 2 years (24 months) to 5 years (60 months) at the time of screening day attending the public pre-primary schools in the 5 studied districts were invited into the study. In addition, their parents or the caregivers agreed to participate in the screening.

Exclusion criteria: Children had ear infection, otitis media on the day of screening was excluded.

***Time:*** The screening was conducted from May 2018 to December 2019.

### *Hearing screening techniques and procedures*

The hearing screening according to the method recommended by the Joint Committee on Infant Hearing [6], consisting of three steps:

1. Step 1: Detection of bilateral Oto-Acoustic Emissions (OAE).
2. Step 2: For children which the test was positive in one or both ears, a second OAE test was performed, at the earliest 2 days after the first test.
3. Step 3: If the second OAE test was positive for one or both ears, children were referred to the audiological centre at the Vietnam National Children's Hospital, Hanoi for Auditory Brainstem Response (ABR) performance within 4 weeks.

OAE were tested during children' natural sleep. According to the response amplitude and signal-to-noise ratio, the device automatically determined whether the test results were "pass" or "refer." For presence of OAE the response was PASS, and FLACK when absent.

A frequency-specific (toneburst 500, 1,000,

2,000, and 4,000Hz) ABR evaluation was conducted to determine the degree of hearing loss. The average hearing threshold (dB HL) was evaluated according to the threshold of toneburst 500, 1,000, 2,000, and 4,000Hz ABR. Hearing loss was classified as mild (21–40 dB HL), moderate (41–70 dB HL), severe and profound (>70 dB HL) [3]. ABR took place within the audiology laboratory of the Vietnam National Children's Hospital in Hanoi.

All tests were performed by qualified bio-medical staff in the Department of ENT, Vietnam National Children's Hospital, Hanoi.

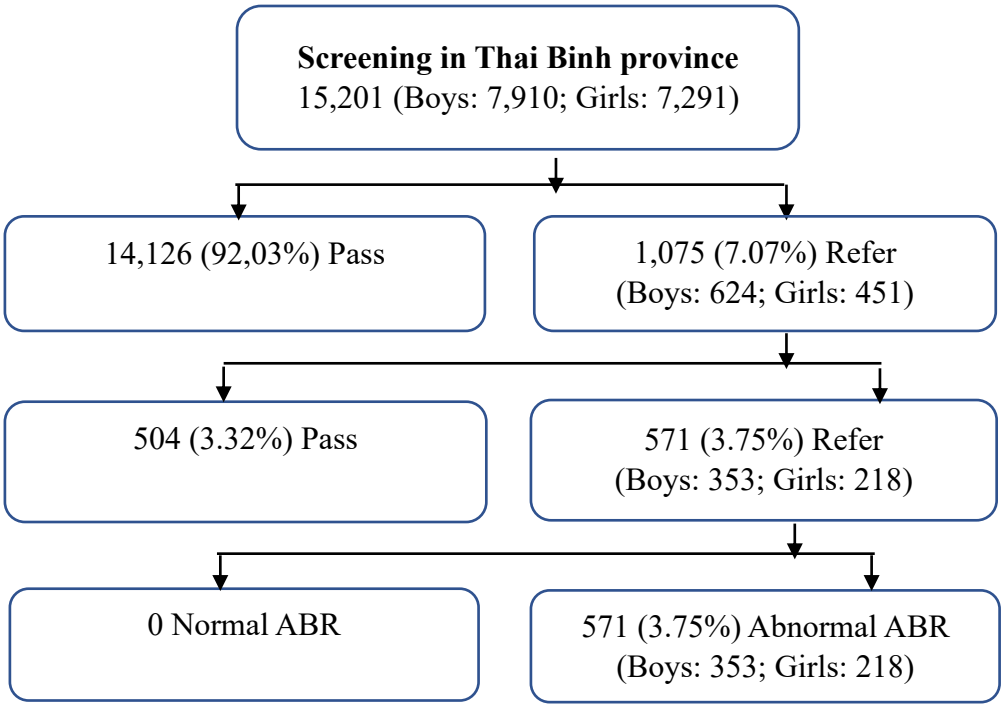
***Data management and analysis:***

Collected data were entered and managed by Epi-data software and was analysed using SPSS 20.0. Descriptive analysis was performed to assess the frequency and percentage of hearing loss, types of hearing loss including sensorineural hearing loss, conductive hearing loss and mixed hearing loss, and hearing loss degrees (mild, moderate, and severe),

***Ethical issue:*** The research protocol of the current study was approved by Hanoi Medical University. Ethical approval was waived by the local Ethics Committee of Hanoi Medical University in view of the retrospective nature of the study and all the procedures being performed were part of the routine screening. Parents and/or the caregivers were informed of the study, and verbal consent was obtained before entering the study.

## 3. Results

**Figure 2: Hearing loss screening results**



The flowchart demonstrated hearing screening results in total 15,201 kindergartens, including 7,910 boys and 7,291 girls in Hanam, Vietnam. After the first OAE test, although 14,126 passed the result, 1075 children tested negative, accounting for 7.07%. Among these negative tested children performed second OAE test, 571 children, equivalence to 3.75%, were determined to have negative result again. All of them continued to be screened at ABR test and were abnormal in all 571 children.

**Figure 3: Prevalence of hearing loss among preschool children in Thai Binh, Vietnam according to age (n=571)**

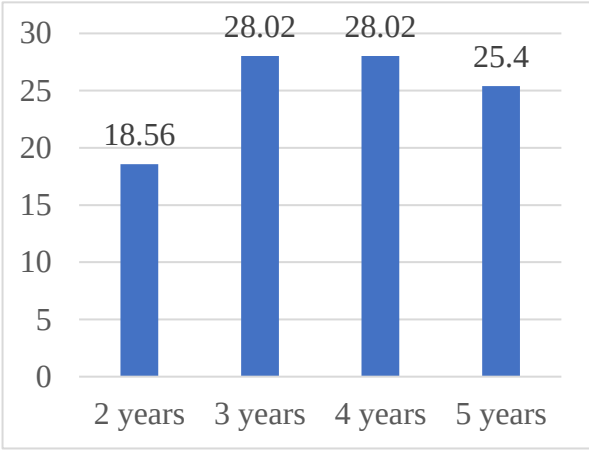



Figure 3 described the prevalence of hearing loss among preschool children according to age after ABR test. 2-year children who have disabling hearing loss stood at the bottom of the chart with 18.56%. The rates were equal among 3 and 4-year children with 28.02% and took the lead, followed by 5-year children with 25.4%.

**Table 2: Severity of hearing loss in children who failed school screening examinations in Thai Binh, Vietnam (n=571).**

| Degree of hearing loss | Boys % | Girls % | Total % |
|---|---|---|---|
| Mild hearing deficit (21 - ≤40 dB) | 49.58 | 47.71 | 48.86 |
| Moderate hearing deficit (41- 70 dB) | 39.94 | 39.91 | 39.93 |
| Severe hearing deficit (>70 dB) | 10.48 | 12.39 | 11.21 |

Table 2 shows the severity of hearing loss in preschool children after ABR test. Among 571 children, the proportion of mild hearing deficit surpassed the rest with 48.86%, followed by moderate hearing deficit with 39.93% and the lowest in severe hearing deficit (11.21%). In comparison between boys and girls, the rates were nearly equal in each degree of hearing loss.

**Table 3: Hearing loss types among the hearing loss children aged 2-5 years in Thai Binh province (n=571).**

| Hearing loss types | n | % |
|---|---|---|
| Conductive hearing loss | 399 | 69.88 |
| Sensorineural hearing loss | 80 | 14.01 |
| Mixed hearing loss | 92 | 16.11 |

Table 3 reports the distribution of hearing loss types among children aged 2-5 years with hearing loss. Conductive hearing loss is the vast majority of hearing loss type among the children (69.88%), sensorineural hearing loss and mixed hearing loss accounted for equal percentage, around 15% each.

## 4. Discussion

In this study, we performed screening on 15,021 children from 2 to 5 years at some

kindergartens in Thai Binh province followed the hearing screening protocol recommended by the Joint Committee on Infant Hearing [6]. The results showed that 571 children, accounting for 3.75%, among the hearing screened children have hearing loss in different levels. Almost 50% the hearing loss children were mild hearing deficit, while moderate hearing loss accounted for 39.9%. In terms of types of hearing loss, 69.88% of hearing loss were conductive hearing loss, sensorineural hearing loss, and mixed hearing loss are similar, accounting for 14.01%, and 16.11%, respectively.

After 2 times OAE test and ABR test, in total 15201 children, we determined that the prevalence of hearing loss was 3,75%. Our findings were higher than previous studies in Saudi preschool children [20]. Al-Rowaily et al. (2012) screened 2547 children found that 1.75% children were hearing loss [20]. Similarly, the study in China aimed to investigate the prevalence of delayed-onset hearing loss in preschool children who previously passed newborn hearing screening in Shanghai, China found that 2.08% were referred for audiology assessment [21]. However, in comparison to the studies in India or in South African, our results were much lower. Study conducted among children of school-entry age, in rural areas of coastal south India indicated that 11.9% children had hearing impairment [22], or in South African pre-school children (18.7%) .

Regarding the hearing loss type, our current results are consistent with previous findings that majority of hearing loss in preschool children are conductive hearing loss (69.88%), followed by sensorineural and mixed type with 16.11% and 14.01%, respectively. Previous studies show that 84.4% and 15.6% of hearing loss among Saudi preschool children are conductive and sensorineural deafness, respectively [20]. In addition, 81.6% of hearing impairment among children of school-entry age in rural areas of India are conductive hearing loss [22].

Similar to the previous research our findings demonstrated that almost 50% of hearing loss children are mild. The study in South Africa preschool children also found that mild and mild to moderate hearing loss accounted for the majority of hearing loss degree, taking up 65.2% [23]. The world hearing report published by World Health Organization indicated that mild hearing loss is the major type of hearing loss in all age groups. It is estimated that hearing loss currently affects more than 1.5 billion people or 20% of the global population. Of them, the majority of these (1.16 billion) have mild hearing loss, the remaining (460 million people) are moderate or higher levels of hearing impairment [1].

The difference of definitions, age-ranges of children studied, extent of evaluation of hearing impairment, measurement methods could lead to the difference of prevalence of hearing impairment across different studies [24]. It can also be attributed to various factors,

including socio-economic status, healthcare infrastructure, access to healthcare services, environmental factors, and cultural practices between Vietnam and other countries. In current study, we performed screening for hearing loss in children using cochlear sound measurement. The integration of OAE and ABR screening methods offers numerous advantages, including comprehensive assessment of the auditory system from cochlea to brain, increased sensitivity and specificity, early intervention, differentiation of hearing loss types, cost-effectiveness, and flexibility [6].

Universal newborn hearing screening has been successfully implemented in many countries [25]. Unfortunately, the majority of children (80 to 90%) with sensory impairments live in low- and middle-income countries, including Vietnam [20, 26, 27]. To date, there is no routine hearing screening of children in most of health institutions in the country [20, 28]. Early detection of hearing impairment is crucial for timely intervention and management, which can significantly impact language development, academic performance, and overall quality of life [1, 29]. We believe that the development of audiological services in school and hospital is needed in terms of continuously implement screening hearing loss for infants, high-risk infants, preschool children, even elementary and secondary school age children. Findings from the current study urge to establish hearing screening for preschool children in Vietnam. In addition, the method for hearing screening presented in this study could be a protocol for future screening programs in preschools as well as in the community in rural areas in Vietnam.

## 5. Conclusion

The prevalence of hearing loss among preschool children in Thai Binh is 3.75%. Half of them were moderate and severe hearing loss and the vast majority of hearing impairment was conductive hearing loss. Hearing screening for preschool children should be routinely performed in the country for an early detection.

**Conflict of Interest:** There are no conflicts of interest or supports for writing and preparing this paper.

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