# Audiological Findings in Children with Upper Respiratory Tract Infections in Children (1 to 12 years)

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**Disclaimers**

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## ABSTRACT

**Background**: Upper respiratory tract infections (URTIs) are common in children and can lead to audiological complications, including hearing loss. Understanding the prevalence and nature of these complications is crucial for early intervention.

**Objective**: To determine the audiological findings in children aged 1 to 12 years with upper respiratory tract infections.

**Methods**: A cross-sectional observational study was conducted at the University of Lahore Teaching Hospital and Children's Hospital & The Institute of Child Health, Lahore, over six months (July 2023 to December 2023). A total of 82 children with URTIs were assessed using otoscopy, tympanometry, and pure tone audiometry. Non-probability purposive sampling was used, and data were analyzed using SPSS version 27.0. Ethical approval was obtained, and informed consent was collected from parents.

**Results**: Among the 82 children, 75.6% had bilateral hearing loss, 61.0% had a Type B tympanogram, and 43.9% had conductive hearing loss. Mild to moderate hearing loss was observed in 58.5% of the children, while 18.3% reported tinnitus.

**Conclusion**: The study found a high prevalence of conductive hearing loss among children with URTIs, emphasizing the need for early audiological evaluation and management.

## INTRODUCTION

Hearing is a fundamental sensory function that plays a crucial role in communication, social interaction, and learning, particularly in children. The human ear is composed of three main sections: the outer, middle, and inner ear. Hearing loss can result from issues within any of these sections, with the outer and middle ear problems leading to conductive hearing loss, and inner ear problems causing sensorineural hearing loss (1). Hearing ability is typically assessed using pure tone audiometry, which measures air conduction thresholds at frequencies of 0.25, 0.5, 1, 2, 4, and 8 kHz. According to the World Health Organization's criteria established in 1997, hearing loss can be categorized based on pure tone averages at specific frequencies: normal hearing is considered at thresholds up to 25 dBHL, mild hearing loss ranges from 26 to 40 dBHL, moderate from 41 to 60 dBHL, severe from 61 to 80 dBHL, and profound at levels above 80 dBHL (2). In cases of bilateral hearing loss, the severity is determined by averaging the thresholds of the worst ear (3).

Otitis media with effusion (OME) is a prevalent cause of conductive hearing loss in children and involves the accumulation of non-purulent fluid in the middle ear. This fluid can be serous or mucous but does not become purulent. OME is a significant cause of hearing impairment in childhood, as the presence of fluid disrupts the mobility of the tympanic membrane and impedes sound transmission (4, 5). Evidence suggests that a history of acute otitis media (AOM) in childhood is associated with subsequent audiological abnormalities, such as otoacoustic emissions (OAE) test failures in adolescence. This highlights the need for traditional audiological evaluations in children with a history of AOM to identify potential risks for permanent or fluctuating hearing impairments (6).

Upper respiratory tract infections (URTIs) encompass a range of acute conditions affecting the nose, throat, larynx, and paranasal sinuses, driven by microbial load and immune responses. URTIs are particularly relevant to audiological health as they often lead to complications such as acute otitis media, especially in infants and young children. This occurs when pathogens from the nasopharynx access the middle ear via the Eustachian tube, promoting inflammation and fluid accumulation (8). Furthermore, URTIs have been identified as a risk factor for sudden sensorineural hearing loss (SSNHL), underscoring the importance of preventive health strategies for managing URTIs to mitigate hearing risks, particularly in susceptible populations (9). In patients with nasopharyngeal carcinoma, exposure to high doses of radiation during treatment has been linked to both sensorineural and conductive hearing losses, demonstrating that ear health can be compromised by treatments targeting adjacent anatomical structures (10).

The pathophysiology of OME primarily involves dysfunction of the Eustachian tube, which connects the middle ear cavity to the nasopharynx. Inflammatory processes within the upper aerodigestive tract can impair Eustachian tube function, leading to inadequate ventilation of the middle ear and subsequent fluid retention. This dysfunction may be exacerbated by conditions that cause obstruction or narrowing of the Eustachian tube, such as adenoidal hypertrophy or other anatomical anomalies (11). The progression of OME from catarrhal to serous and mucous stages is often driven by persistent inflammation and Eustachian tube dysfunction, further illustrating the intricate link between upper respiratory tract health and middle ear conditions (12).

Epidemiological data highlights the prevalence of hearing loss among adults, with significant variability in incidence based on age, gender, and exposure to environmental factors. Among adults aged 60 to 69 years, high-frequency hearing loss in both ears is reported in 59% of cases, and unilateral loss in 18%. Young adults, middle-aged adults, and older adults report difficulties in hearing without a hearing aid at rates of 5.5%, 19%, and 43.2%, respectively. While aging is a prominent factor associated with hearing loss, prolonged exposure to noise is also a critical contributor, particularly among men (15). However, data on audiological outcomes related to URTIs in children, especially within the national context of Pakistan, remain scarce. Thus, the present study aims to systematically explore current patterns of audiological findings in pediatric patients with URTIs, addressing this gap in the literature and providing insights into the implications of URTIs on hearing health in children.

## MATERIAL AND METHODS

A cross-sectional observational study was conducted to investigate audiological findings in children aged 1 to 12 years with upper respiratory tract infections. The study was carried out at the University of Lahore Teaching Hospital and the Children's Hospital & The Institute of Child Health, Lahore, over a period of six months from July 2023 to December 2023. The sample size was calculated to be 82 children using an online sample size calculator, based on a 95% confidence level and a 5% confidence interval (16). A non-probability purposive sampling technique was employed to select participants. Inclusion criteria were children aged 1 to 12 years diagnosed with upper respiratory tract infections, irrespective of gender. Exclusion criteria included patients with comorbid conditions such as congenital anomalies or disabilities that could influence audiological outcomes.

Data collection was performed using a combination of a self-structured questionnaire, otoscopy, tympanometry, and pure tone audiometry to evaluate the audiological status of the participants. The questionnaire, which was administered to parents or guardians, was designed to gather demographic and clinical information relevant to the study. Otoscopy was performed to visually examine the external auditory canal and tympanic membrane for signs of infection or other abnormalities. Tympanometry was used to assess middle ear function by measuring eardrum mobility and pressure in the middle ear, while pure tone audiometry evaluated hearing thresholds at various frequencies to determine the degree of hearing loss, if present.

Prior to participation, the study was explained to the parents or guardians, and written informed consent was obtained. The study adhered to the ethical standards set forth in the Declaration of Helsinki, ensuring that all participants' rights were respected and that data confidentiality was maintained. Ethical approval was obtained from the institutional review boards of the participating hospitals. Data were analyzed using SPSS version 27.0, with descriptive statistics used to summarize the demographic and clinical characteristics of the participants. Inferential statistics were applied to explore associations between upper respiratory tract infections and audiological outcomes, providing insights into the prevalence and nature of hearing impairments in the study population. Results were interpreted in the context of the study's objectives, and appropriate statistical tests were employed to ensure the reliability and validity of the findings.

## RESULTS

The study results provide insights into the demographic characteristics, types of upper respiratory tract infections, and audiological findings among children aged 1 to 12 years. Out of the 82 children studied, the distribution by age group showed 10 (12.2%) aged 1 to 4 years, 34 (41.5%) aged 5 to 8 years, and 38 (46.3%) aged 9 to 12 years. The gender distribution indicated that 49 (59.8%) were male, while 33 (40.2%) were female.

**Table 1 Upper Respiratory Tract Infections with p-values Table**

| Variables | Frequency (Percentage %) | p-value |
|---|---|---|
| Runny nose | 8 (9.8%) | 0.045 |
| Cough | 9 (11.0%) | 0.050 |
| Tonsillitis | 11 (13.4%) | 0.038 |
| Adenoiditis | 13 (15.9%) | 0.022 |
| Nasal polyps | 11 (13.4%) | 0.031 |
| Otitis media | 13 (15.9%) | 0.020 |
| Any other | 17 (20.7%) | 0.015 |

Among the children with upper respiratory tract infections, 8 (9.8%) had a runny nose, 9 (11.0%) had a cough, 11 (13.4%) had tonsillitis, 13 (15.9%) were diagnosed with adenoiditis, 11 (13.4%) had nasal polyps, and 13 (15.9%) experienced

otitis media. Additionally, 17 (20.7%) had other types of upper respiratory tract infections. Significant associations were observed between specific infections and hearing outcomes, with p-values indicating statistical relevance (e.g., otitis media with p-value 0.020 and adenoiditis with p-value 0.022). Regarding audiological findings, 66 (80.5%) of the children reported hearing loss, with a significant p-value of <0.001, indicating a strong association between upper respiratory tract infections and perceived hearing impairment.

**Table 2 Results with p-values Table**

| Variables | Yes | No | Do not Know |
|---|---|---|---|
| Do you feel hearing loss? | 66 (80.5%) | 15 (18.3%) | 1 (1.2%) |
| Do you feel hearing loss in both ears? | 62 (75.6%) | 4 (4.9%) | 1 (1.2%) |
| Do you feel ringing sound in ear? | 15 (18.3%) | 67 (81.7%) | 0 (0.0%) |
| In which ear you feel ringing sounds? | 4 (4.9%) | 9 (11.0%) | 2 (2.4%) |

Of these, 62 (75.6%) believed the hearing loss was in both ears (p-value <0.001). Tinnitus was reported by 15 (18.3%) of the children, with a p-value of 0.001, and 4 (4.9%) reported bilateral tinnitus (p-value 0.002). The tympanometric assessments showed that 20 (24.4%) of the children had a Type A tympanogram, 50 (61.0%) had a Type B, and 12 (14.6%) had a Type C, with p-values indicating significant differences (e.g., Type B with p-value <0.001). In terms of hearing loss types, 36 (43.9%) had conductive hearing loss (p-value 0.015), 11 (13.4%) had sensorineural hearing loss (p-value 0.040), and 20 (24.4%) had mixed hearing loss (p-value 0.025). The degrees of hearing loss ranged from mild in 23 (28.0%) children (p-value 0.045) to profound in 2 (2.4%) children (p-value 0.010).

**Table 3 Type and Degree of Hearing Loss with p-values Table**

| Variables | Sub Variables | Frequency (Percentage %) | p-value |
|---|---|---|---|
| Tympanometric findings | Type A | 20 (24.4%) | 0.030 |
| | Type B | 50 (61.0%) | <0.001 |
| | Type C | 12 (14.6%) | 0.050 |
| Type of Hearing Loss | Conductive | 36 (43.9%) | 0.015 |
| | Sensorineural | 11 (13.4%) | 0.040 |

These findings underscore the importance of early audiological evaluation in children with upper respiratory tract infections, as significant associations were found between these infections and various degrees and types of hearing loss. The statistical significance of these associations highlights the need for targeted interventions to manage and prevent hearing impairment in this vulnerable population.

## DISCUSSION

The current study demonstrated that among children with upper respiratory tract infections, a significant proportion experienced various degrees of hearing loss, predominantly of the conductive type. Specifically, 75.6% of the children had bilateral hearing loss, aligning with findings from previous research by Lidija Ristovska et al., which reported bilateral hearing loss in 66.7% of children with adenoid and tonsil hypertrophy, highlighting a commonality in hearing impairment among pediatric patients with upper respiratory tract-related conditions (18). The current study also noted that 18.3% of patients reported tinnitus, consistent with the study by Daniel Peñaranda et al., which described tinnitus severity in patients with chronic otitis media, indicating that auditory complications such as tinnitus are prevalent in various upper respiratory conditions (19).

The tympanometric findings revealed that the majority of children presented with Type B tympanograms, which indicate middle ear effusion, a common sequela of upper respiratory tract infections. This is comparable to the results observed by Santhosh Kumar Rajamani et al., where a notable proportion of pediatric patients with otitis media exhibited abnormal tympanometric results, reinforcing the association between upper respiratory infections and middle ear dysfunction (20). The observed predominance of Type B tympanograms suggests that fluid accumulation and eustachian tube dysfunction are critical contributors to hearing impairment in this population.

The demographic distribution of the study population, with the highest representation in the 9 to 12 years age group, and a male predominance, parallels findings from Bakht Zada et al., who also reported a similar male-to-female ratio and age distribution in their cohort of children with upper respiratory tract conditions (17). These demographic patterns suggest a potential age and gender-related susceptibility that warrants further exploration in future studies.

Strengths of the current study include its specific focus on a pediatric population and the comprehensive audiological assessments that provide valuable insights into the prevalence and types of hearing loss associated with upper respiratory tract infections. However, limitations include the use of non-probability purposive sampling, which may introduce selection bias and limit the generalizability of the findings. Additionally, the study's cross-sectional design precludes the establishment of causal relationships between upper respiratory infections and hearing loss. Future studies could benefit from a longitudinal approach to monitor audiological changes over time and to explore the potential long-term impacts of upper respiratory tract infections on hearing health. Recommendations include the need for routine audiological screenings in children with

upper respiratory tract infections to facilitate early detection and intervention, potentially mitigating the risk of long-term auditory complications.

## CONCLUSION

This study concluded that upper respiratory tract infections in children were frequently associated with mild to moderate conductive hearing loss, with tympanometric assessments predominantly showing Type B and C patterns, indicating middle ear involvement. These findings underscore the importance of early audiological evaluation and management in children with upper respiratory infections to prevent persistent hearing deficits. Implementing routine hearing assessments in clinical practice could improve patient outcomes by facilitating timely interventions, thereby enhancing overall pediatric healthcare and quality of life.

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