

Research Article

Tinnitus Complaint: A Preliminary Study with Brazilian Children and Teenagers

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Abstract

Introduction: Tinnitus is a sound heard without an external sound source. Childhood tinnitus and hearing loss are often underdiagnosed. Therefore, the intervention may be late. The aim of this study was to estimate the prevalence of hearing loss and tinnitus in a sample of school-age-children and to evaluate the association between hearing loss and tinnitus and possible risk factors.

Methods: This is a clinical study approved by the Research Ethics Committee under protocol 3,449,075. A sample of 282 children from two municipal schools in the cities of Boracéia (São Paulo) and Macaíba (Rio Grande do Norte) were included in this study. The sample included children from 6-18 years regularly enrolled in municipal schools; and children whose parents/guardians consented to their participation or those that accepted to participate in the study.

Results: The results showed higher prevalence of unilateral hearing impairment (8.5%) than bilateral hearing impairment. A total of 66.4% of the sample reported presence of tinnitus/noise in the ears. Children who reported using headphones were 1.93 times more likely to have hearing loss in at least one ear.

Conclusion: The present study found a risk of hearing loss in children who use headphones, but no association between tinnitus and hearing loss was found, nor were children with hearing loss identified by teachers or had poor school performance.

ABBREVIATIONS

DPOAE: Distortion Product Evoked Otoacoustic Emissions; SNR: Signal to noise ratio; SPL: Sound Pressure Level.

INTRODUCTION

Tinnitus is the perception of sound in the ear(s) or head without an external acoustic stimulus. Tinnitus can be the result of an abnormal neuronal activity in the central auditory pathway after a peripheral damage through the process of neural plasticity [1]. The most common causes of tinnitus are noise exposure, for example prolonged exposure to noise or acoustic trauma. These conditions can produce substantial and sometimes irreparable damage to outer hair cells and inner ear structures [2,3]. Additionally, tinnitus can be caused by anomalies in the vascular system, chronic hearing loss, illnesses, medications, allergies, dietary changes, stress, or traumatic events [4,5].

Childhood tinnitus is often underdiagnosed and therefore

necessary interventions are delayed. Symptoms may also remain unrecognized for a long time in the pediatric population, with negative consequences for the child's development [6,7].

A study conducted at the University of Helsinki between 2010 and 2015 assessed 112 individuals (45 girls and 67 boys) between 6-18 years old and 80% of them with normal hearing. The mean time from the first tinnitus complaint to the clinical diagnosis was approximately 12 months. The possible causes of the symptom were orthodontic treatment, trauma from leisure noise, middle ear aeration, muscle tension, and skull base fracture. The authors also observed comorbidities with tinnitus, such as sleep disorders, concentration issues, and hyperacusis [8].

A review study found a percentage range of children with tinnitus and normal hearing of 13.3%-90% and another study found a prevalence range between 4.7%-46% [9,10], highlighting the heterogeneity between the studies included and sample characteristics.

Bueno et al. (2015), conducted a literature review on tinnitus in children with normal hearing thresholds and found that childhood tinnitus is associated with learning issues, concentration issues, sleep disorders and anxiety [11]. Smith et al. (2019), suggest that problems related to the impact of tinnitus on quality of life and the feeling of isolation are also relevant aspects to consider in the management of tinnitus [12].

Bartnik et al. (2012), examined 59 children with tinnitus complaints and recommended adding a question on tinnitus during hearing screenings to facilitate early detection and intervention [13]. The findings of Bueno et al. (2015), also showed that children do not voluntarily complain about tinnitus and, therefore, they require intentional inquiries at school, at home, or in specialized clinics [11].

Piotrowska et al. (2017), analyzed the frequency of reported tinnitus in 7 and 12-year-old children attending primary school in Warsaw [14]. A total of 15,199 students from 173 schools in the 2012/2013 academic year were included in the study. All children underwent pure tone audiometry and a tinnitus questionnaire. The prevalence of tinnitus in the study group was 6%. The prevalence was statistically significantly higher in children with hearing loss compared with those with normal hearing. However, another study showed prevalence of tinnitus in children with normal hearing ranging from 0.8%-76.4% and the prevalence in children with hearing loss from 1%-58.6% [10].

The results of one study also suggested that younger children with normal hearing presented tinnitus more often than the older ones [15].

According to "Tinnitus in children: practice guidance" (2015), tinnitus in children is a neglected aspect of clinical services and further research is needed to help professionals identify more effective diagnostic and treatment strategies for children with this complaint [16].

The aim of the present study was to estimate the prevalence of hearing loss and tinnitus in a sample of school-age-children and to evaluate the association between hearing loss and tinnitus and possible risk factors.

MATERIALS AND METHODS

This is a clinical study approved by the Research Ethics Committee under protocol 3,449,075.

Inclusion criteria

- Age group from 6-18 years;
- Children regularly enrolled in municipal schools in the cities of Boracéia, São Paulo, and Macaíba, Rio Grande do Norte;
- Children who agreed to participate in the present study or children whose parents/guardians consented to their participation.

Children who were unable to understand the questions and instructions or to undertake the procedures described below (1 to 6), and those who did not attend the assessment after three consecutive attempts were excluded.

Sample

All students from two municipal schools in the cities of Boracéia and Macaíba were evaluated.

Data collection

Questionnaire for parents/guardians: Two weeks before the beginning of the assessment, a meeting was conducted between researchers and parents to explain the research and deliver the consent forms and a questionnaire about parents' impression regarding hearing health and the presence of tinnitus in their children. After a week, the teachers collected the terms and questionnaires that were not read before the interview with the children.

Teachers

The teachers provided the general school performance of the students and indicated the suspicion of a hearing disorder in a specific file of each student being evaluated.

Interview

A questionnaire was applied to all children, who were supposed to answer "yes" or "no" to the following questions:

- Do you think you have good hearing?
- Do you have tinnitus/noise in your ears?
- Do you feel bothered in the presence of sounds?
- Do you use headphones?

Inspection of the external acoustic meatus

Speech therapists and undergraduate students performed all the inspections of the external acoustic meatus and, if a child presented total obstruction of the meatus, they were referred to the otorhinolaryngologist doctor and wax removal was required.

Audiological assessment

Speech therapists and undergraduate students performed hearing tests in the school environment, in a room away from street and classroom noise, but the room was still not very quiet. The children were evaluated after an interview and an otological inspection.

Screening with tympanometry and distortion product evoked otoacoustic emissions

Tympanometry and distortion product evoked otoacoustic emissions (DPOAE) were performed using the portable automatic equipment Ero-scan pro (Maico), the equipment automatically monitored the noise level; the stimulus linearity during the test; and the correct insertion of probe in the ears. Both procedures are objective, non-invasive and quick to perform.

Tympanometry is a mechanical function test that can determine whether there is fluid in the middle ear, indicating a conductive hearing disorder and the need for treatment. An appropriately sized ear tip was selected to seal the child's external acoustic meatus. The evaluation is an automated pressure scan (from positive to negative) that takes about five seconds in each ear. The pressure range helps to assess the movement of the

ear drum and middle ear by sending sound to the inner ear. The result is displayed on the instrument in terms of “pass” (normal tympanometry) or failure (altered tympanometry) [17].

Regarding DPOAEs, when two mathematically related primary tones (f1 and f2) are presented to the cochlea, the cochlear amplifier mechanisms generate small recordable emissions around the mean of the primary frequencies (the distortion product), depending on the existence of intact outer hair cells [18]. The DPOAE test indicates whether there is a sensorineural hearing loss specific to the frequency region tested. An amplitude equal to or greater than -5 dB and a signal-to-noise ratio equal to or greater than 6 dB in at least three of the tested frequencies are considered as a “pass” result, according to the equipment guide.

Six test frequencies were used: 1.5, 2, 3, 4, 5 and 6kHz. The default setting for SNR “PASS” is 5 dB and the number of frequencies for “PASS” was set to 3, so the test must contain a minimum of 3 frequencies where the emission is at least 5 dB above the noise to indicate “PASS”. The intensities of F1 and F2 were respectively 65 dB SPL (L1) and 55 dB SPL (L2) [19].

For the statistical study, the odds ratio was performed.

RESULTS AND DISCUSSION

A total of 282 participants were included in the sample, with a mean age of 10.7 ± 3.18 years, 124 men (44%) and 158 women (56%). There was a higher prevalence of unilateral hearing loss (8.5%), when compared with bilateral impairment (6.7%). Considering the total number of individuals evaluated, 10.6% had some type of hearing loss on the left side, and 11.3% on the right side, and 66.4% reported the presence of tinnitus/noise in the ear (Table 1).

When evaluating the association between the prevalence of hearing loss in at least one of the ears, and other possible factors, an association was found only when considering the report of the use of headphones. Children who reported using headphones were 1.93 times more likely to have hearing loss in at least one ear [1.01 – 3.70; p = 0.047]. On the other hand, children with hearing loss were not more likely to be identified as hearing impaired by teachers and did not perform poorly at school (p > 0.05). There was also no relation between the presence of tinnitus and the presence of hearing loss (p > 0.05) (Table 2).

The present study demonstrated that from a total of 282 children and adolescents evaluated in a school environment, 15.2% had hearing loss, 8.5% had unilateral hearing loss, and 6.7% had bilateral hearing loss. A study that performed hearing screening on 5,029 school-age-children (6 and 7 years) in the

Table 1: Characteristics of the study population.

Socio-demographic characteristic		n(%)
Gender	Male	122 (44)
	Female	158 (56)
Hearing impairment	Unilateral	24 (8.5)
	Bilateral	19 (6.7)
Tinnitus		186 (66.4)
Age/years (mean SD)		10.7 (3.18)

SD: Standard deviation

countryside of Poland also found a higher rate of children with unilateral hearing loss (7.7%) compared with bilateral hearing loss (3.8%) [20].

Regarding hearing loss in children, consequences such as increased risk for speech, delay in language development, risk of changes in multiple cognitive functions (working memory and executive functions) should be considered [21]. These alarming data suggest the importance of auditory assessment in school-age-children, especially in the literacy age group.

Regarding unilateral hearing loss, Tharpe (2019), suggests that the prevalence in school-age-children may be due to the progression of hearing loss, late onset of hearing loss or failure to detect minimal or mild degrees of hearing loss, since systems in newborn screening programs are not designed to detect such losses (JCIH, 2007) [22,23]. Thus, speech therapists can warn pediatricians and other professionals about this limitation in newborn hearing screening protocols so that they can remain vigilant and attentive to parents’ concerns and perform additional hearing screenings after the neonatal period, when indicated.

Hearing screening plays an important role during children’s education process, and parents and teachers should also be aware of such disorders, as not all hearing losses are identified in the neonatal phase, and some hearing disorders are progressive and of late onset [24]. There is still a demand to improve the early detection of hearing loss and the presence of tinnitus in children starting school education [25]. The municipal schools where the evaluations were carried out are in small cities in the interior of the states of São Paulo and Rio Grande do Norte and do not have auditory monitoring.

In this study, the association between hearing loss and use of headphones indicated a 1.93 times greater risk of impairment in at least one of the ears. The use of personal headphones begins in childhood, from the age of 3. In a sample of more than 10,000 Canadian children and adolescents, the prevalence of headphone use was >29% at the age of 6; 59% at the age of 9; 80% at the age of 12, and 85-95% between 12-19 years [26].

Table 2: Association between hearing impairment in at least one of the ears and the presence of tinnitus, poor school performance, use of headphones and perception of the student’s hearing.

Tinnitus		Use of headphones		Perception of the student’s hearing		Poor school performance	
Odds Ratio (95%CI)	p-value*	Odds Ratio (95%CI)	p-value*	Odds Ratio (95%CI)	p-value*	Odds Ratio (95%CI)	p-value*
0.894 (0.450 -1.78)	0.750	1.93 (1.01 - 3.70)	0.047	0.512 (0.203 -1.29)	0.149	1.27 (0.665 - 2.41)	0.471

*X² Test

Excessive use of headphones may contribute to the presence of tinnitus and cause hearing loss [27]. AlQahtani et al. (2022), conducted a study in Saudi Arabia to assess the level of awareness of the relation between headphone use and hearing loss; 1086 participants between 18 and 55 years answered a questionnaire with 37 questions [28]. The authors concluded a low level of awareness, with 60.5% using headphones and 15.5% using them for more than five hours/day.

In addition to the hearing question, the children were asked about the presence of tinnitus, and 66.4% of the sample answered affirmatively to the perception of the symptom (Table 1). Even though the high percentage found and the report of the children themselves seem to be a very subjective measure, some researchers believe that considering the experience of patients with tinnitus complaints can validate the symptom for them and lead to a more humanized care [29].

A previous review of the literature showed the percentage range of children with tinnitus and normal hearing between 13.3% and 90% and highlighted the high heterogeneity between the percentages found in different studies. However, the study pointed out the need to recognize the symptom in children, even in the absence of ear pathology [9].

In a study conducted by Tegg-Quinn et al. (2021A), a conceptual framework was generated describing aspects of the lives of children and adolescents with chronic tinnitus [30]. The opinions of the 32 study participants (tinnitus patients and tinnitus patients' caregivers) identified aspects affected by the symptom: emotional well-being, academic performance, social performance and auditory/cognitive processing. The authors suggest that the experience of tinnitus in childhood is not restricted to sound perception, but it can also affect other aspects of life.

The results of the hearing screening were complemented with information from the questionnaire answered by the parents, from the students' evaluation by the teachers, and from the students' responses regarding hearing. Children who had hearing loss were not identified by the teachers and did not perform poorly at school (Table 2).

In the present study, no relationship was found between hearing loss and tinnitus, and recent studies suggest that even patients with normal hearing may present tinnitus. Melcher et al. (2013), found that high frequency hearing loss was also associated with the development of tinnitus [31]. Schaette and McAlpine (2011), reported that patients with a normal audiogram, but with reduced wave I amplitude in the auditory brainstem responses, namely hidden hearing loss, developed tinnitus [32].

After analyzing the database of 22 adult patients with asymmetric hearing loss, Lee et al. (2021), showed that unilateral tinnitus can be found in the ear with better or worse hearing, depending on the time of symptom experience and auditory extension [33]. In this study, no investigation was conducted on the side of the tinnitus, but 8.5% of children presented unilateral tinnitus.

Researchers suggest that counseling has positive results in the intervention of tinnitus in children [34]. However, a recent

systematic review investigated different treatments for subjective tinnitus in children and found some studies that showed results for counseling, while performing Tinnitus Retraining Therapy, although the review found a high risk of bias between the studies included and difficulty in determining the effectiveness of the treatments studied [35].

Previous research found that the impact of tinnitus for children may be different from that for adults, being influenced by the interaction between the sound they hear, its interpretation, and the physical and emotional effects they experience in association with tinnitus. Thus, the strategies to manage tinnitus in childhood must be designed specifically for this age group [36]. Currently, there is a lack of knowledge about children's strategies before seeking clinical care and how they perceive the benefit of these strategies.

There is a range of estimates of tinnitus prevalence supported by the different criteria used to define the symptom, different ages of the children evaluated, variety of questionnaires used to interview the children, different procedures and statistics used to analyze the results [37]. Other standardized methods and data collection protocols play a critical role in determining risk factors, symptoms and consequences of tinnitus in children more effectively.

This study participants were evaluated before the COVID 19 pandemic, but Swain (2021), alerts to the importance of audiological investigation as well as investigation of the presence of tinnitus in children who were infected during the pandemic [38].

CONCLUSION

The present study found a potential risk for children who constantly use headphones to develop hearing loss, but the results showed that teachers were unable to identify children with potential signs of hearing loss. Therefore, the development of hearing screening programs and teacher guidance may be positive solutions to this issue. Additionally, further research on the topic addressed in this study is needed to explain the association between tinnitus and hearing loss in the population studied and their school performance.

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