Abstract

Objective: to estimate the prevalence of deafness in children 3-6 years old in day-care centers of São José do Rio Preto, SP, Brazil.

Methods: we used free-field audiometry to screen 103 children from 8-selected day-care centers. Children with abnormal examination results were referred to the speech therapy outpatient service to undergo pure-tone conventional audiometry. We adopted the WHO classification for degree of deafness.

Results: audiometric dysfunctions were present in 10 children (9.70%; SD=0.96) with one boy showing left ear mild conductive hearing loss (mean LE=35 dB), while 9 children (8.73%; SD=2.78) showed alterations in air-conduction threshold in 4000, 6000 or 8000 sharp frequencies. Out of 102 children (99.03%; SD=0.96), 55 boys (53.39%; SD=4.9) and 47 girls (45.64%; SD=4.9) presented no hearing loss according to the WHO criteria.

Conclusions: the prevalence of 9.7% audiometric dysfunctions found in this study indicates that deafness prevention programs should be organized.

Introduction

The pathological dysfunctions affecting the auditory apparatus, which may have an impact on hearing, are caused by specific organic and/or functional alterations. Defining terms such as deafness, hypoacusis (partial hearing loss) and hearing impairment is essential so that these terms can be correctly applied to define the degree of hearing impairment, therefore avoiding the psychosocial effects and possible errors in diagnosis and treatment due to misclassification. The World Health Organization (WHO) employs the terms hearing impairment and hypoacusis as synonyms to describe difficulties in hearing not involving major compromise of communication. The term deafness is used to identify more advanced cases of hearing impairment, in which no advantages can be obtained from sound amplification, leading to difficulties in communication and affecting the individual’s social life.1,2

In 1986, the WHO established the Prevention of Deafness and Hearing Impairment Programme, in order to prevent the main avoidable causes of deafness and hearing impairment and to reach the most needy populations in terms of basic hearing care, as an integral part of the basic health care provided to these populations.3 With this program, a Hearing Impairment Table was defined according to the degree of hearing loss, in decibels, to ensure the use of adequate terminology (Table 1).

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Hearing evaluation in children... - Piatto VP et alii

In its most recent document, the WHO estimates that there are 42 million people older than 3 years who are affected by moderate and severe hearing impairment. Approximately 35 to 50% of the cases of congenital deafness are genetic; one third involve the etiologies associated with risk factors and one-third of the cases are idiopathic. Close do one in each on thousand newborns presents deafness, and one in 1,000 children present deafness during the first 3 months of life. This justifies an investigation not only when the child is born, but also during the first years of life.

The objective of the present study was to evaluation hearing and to investigate the prevalence of hearing impairment in a sample of 3 to 6 year-old children in city day care centers and pre-school settings in São José do Rio Preto, state of São Paulo, Brazil.

### Patients and methods

Between March, 1996, and July, 1997, we assessed hearing in children of both sexes in eight day care centers and pre-school settings in São José do Rio Preto, state of São Paulo. The children participated as volunteers. The institutions selected were housed in buildings presenting good conditions and noise levels, and were located in a city zone with the lowest possible level of environmental noise.

One-hundred and three children were evaluated in a pilot study to estimate the proportion (p) of hearing impairment in this initial sample. After the proportion (p) was determined, the statistical formula “sizing of samples with known population” was applied to the proportion, resulting in the final size of the sample (n) required to represent the total population of children enrolled in the 16 institutions selected (Np = 1,544 children).

Inclusion criteria were: a) age between 3 and 6 years; b) enrollment in municipal day care centers and pre-schools in the city of São José do Rio Preto; c) authorization of the day care center or pre-school principals to carry out the study; d) written authorization signed by the parents.

Exclusion criteria included: a) being non-cooperative; b) presence of complaint or acute otologic disease (cerumen occlusion, otorrhea, otitis media, external otitis) at the moment of the specific otoscopic examination.

The study was carried out in two stages: screening and conventional tone audiometry, as described below. The study protocol was approved the Research Ethics Committee at the São José do Rio Preto School of Medicine.

### Table 1 - Hearing Impairment Table according to WHO criteria

<table>
<thead>
<tr>
<th>Classification</th>
<th>Hearing Impairment (dB)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal hearing</td>
<td>0 through 25†</td>
</tr>
<tr>
<td>Mild hearing impairment</td>
<td>26 through 40</td>
</tr>
<tr>
<td>Moderate hearing impairment</td>
<td>41 through 60</td>
</tr>
<tr>
<td>Severe hearing impairment</td>
<td>61 through 80</td>
</tr>
<tr>
<td>Extremely severe hearing impairment, including deafness</td>
<td>81 or higher</td>
</tr>
</tbody>
</table>

* Mean of air-conduction limiar threshold at 500, 1,000 and 2,000 Hertz (Hz).
† Also considered normal up to 20 decibels (dB).
**First stage: Screening**

The 103 children in the sample were submitted to an otoscopic examination carried out by one of the authors employing a HEINE otoscope (Optotechnik GmbH & Co KG, Herrsching am Ammersee, Germany). After that, children who presented no apparent otoscopic alterations were submitted to free-field tone audiometry with a JC 29 audiometer (Widex-Brasitom Ltda., São Paulo, Brazil). This examination was carried out in a previously arranged silent room in the day care center or pre-school, in ambient temperature, one child at a time, after registration in an identification file.

The exam was started with a frequency of 1,000 Hz, as first stimulus, and intensity of 60 dB. This intensity was decreased at 10 dB intervals until the hearing acuity limit of the child for the frequency of 1,000 Hz was determined. After that, other high frequencies - 2,000, 4,000 and 6,000 Hz, and the - 500 Hz, were tested in the same manner, in this sequence. These measurements were carried alternately out in both ears, starting with the right ear.

Altered audiometric data were defined as audiometric examinations above 20dB for any of the frequencies tested in one or both ears.

**Second stage - Conventional tone audiometry**

A conventional tone audiometry was carried out (air and bone conductance and speech audiometry, in a sound booth) in the children screened in the first stage of the study within seven days of the screening, at the Speech Therapy Clinic, São José do Rio Preto School of Medicine. The exam was carried out at all times by the same speech therapist, after a second otoscopy with no apparent alterations, carried out by both authors employing a diagnostic audiometer (MAICO MA 41, Maico Hearing Instruments INC, Minneapolis, U.S.A.).

The WHO’s hearing impairment table (Table 1) was used to classify the children. Those who presented some degree of hearing deficiency in one or both ears were referred for etiologic diagnosis and adequate treatment by a multidisciplinary team.

**Statistical analysis**

To calculate the final sample (n), a formula for sizing samples with a known population was used,19 with the following parameters: p=0.01 (defined in the pilot study); q=0.99; \( zc=3.00 \) (99.74% confidence); \( e=0.03 \) (3% estimation error); \( Np=1,544 \) (size of the population).

The results were analyzed using the S-PLUS software version 3.3. Percentages and means (with standard deviations) were calculated, and the results were expressed as \%(SD_\text{p})\) and (DP M), respectively. To verify the homogeneity between the proportions of the results found for both sexes the Fisher exact test was used, with a significance level of 0.05.

**Results**

From a total of 103 children, 56 (54.36%, SD\_p=4.90) were male and 47 (45.64%, SD\_p=4.90) were female. Eighty-four children (81.55%, SD\_p=3.82) were white and 19 (18.45%, SD\_p=3.82) were black. Mean age was 5.53 years (SD \( =0.097 \)) for boys and 5.22 years (DP \( =0.091 \)) for girls.

From the sample of 103 children, 78 (75.73%, SD\_p=4.22) presented normal audiometries and 25 (24.27%, SD\_p=4.22) presented altered audiometries on screening; these were referred to conventional tonal audiometry.

Alterations in hearing were observed in 10 children (9.70%, SD\_p=2.92%). From these, one boy (0.97%, SD\_p=0.96) presented conductive hearing impairment in the left ear (LE=35 dB), according to WHO criteria \( \text{[mean (M) of air-conduction hearing thresholds at } 500, 1000 \text{ e } 2000 \text{ Hz}\] 3 \). No alterations were found in the right ear (RE=15 dB). The audiometric results obtained are presented in Table 2. Nine children (8.73%, SD\_p=2.78), five boys (4.85%, SD\_p=1.44) and four girls (3.88%, SD\_p=1.44), presented alterations in air-conduction hearing thresholds (levels above 20 dB), in one or both ears at high frequencies (4,000, 6,000 and/or 8,000 Hz).

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>RE (dB)</th>
<th>LE (dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>20</td>
<td>45</td>
</tr>
<tr>
<td>500</td>
<td>20*</td>
<td>35†</td>
</tr>
<tr>
<td>1,000</td>
<td>10*</td>
<td>30†</td>
</tr>
<tr>
<td>2,000</td>
<td>10*</td>
<td>35†</td>
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<tr>
<td>4,000</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>6,000</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>8,000</td>
<td>10</td>
<td>15</td>
</tr>
</tbody>
</table>

*RE=15 dB, †LE=35 dB.
RE=mean for right ear, LE=mean for left ear.
Hz=Hertz, dB=decibels.

\( n = \frac{zC^2 \times P \times Q \times N_p}{e^2 \times (N_p - 1) + zC^2 \times P \times Q} \)
Higher thresholds were obtained at a frequency of 6,000 Hz, varying from 25 dB to 55 dB (Table 3). The difference between the proportion of alteration in these frequencies, for both sexes, was not significant (P=1.00).

One hundred and two children (99.03%, SD=0.96%), 55 boys (53.39%, SD=4.90%) and 47 girls (45.64%, SD=4.90%), did not present any hearing impairment according to WHO criteria. The difference between the proportion of hearing impairment between sexes was not significant (P=1.00).

One girl presenting a normal conventional tonal audiometry was referred to neurologic evaluation because she showed difficulties in concentrating during the performance of the tests. This examination revealed that this dysfunction resulted from absence crises.

### Discussion

The present study was carried out to assess hearing in children between 3 and 6 years of age, in selected daycare centers and preschools in the city of São José do Rio Preto, state of São Paulo. Open field, air-conductance tone audiometry was used for screening; selected children were submitted to air and bone conductance tone audiometry and to speech audiometry in an sound booth. Previous otoscopic tests were carried out during both stages.

In the present sample, 0.97% of the children presented mild hearing impairment according to WHO criteria. This result is in agreement with data from the U.S. Health and Welfare Department, which reports hearing impairment of less than 1.0% in 6 to 11 year old children. The methodology employed was similar to that employed in the present study, except for the screening, which was performed through a questionnaire answered by the parents in the cases of the U.S. study. We did not employ questionnaires because our intention was not to evaluate children with a recognized hearing difficulty. Similarly, due to the relationship between presence of otitis and hearing loss, the audiometric examinations were not carried out in these children, since they would certainly be classified within altered thresholds, one of the exclusion criteria. Our intention was to underscore the fact that some children, carriers of recurrent otitis media or serous otitis media, even if not in an acute stage, already present alterations in their hearing threshold that are not perceived by the parents or teachers, allowing early and timely detection.

The observation of the parents must be considered, and the pediatricians must suspect hearing impairment until a diagnosis is made. The delay between a suspicion and diagnosis decreases irreversibly the possibilities of treatment and rehabilitation of these children, since, if early intervention does not occur there will be compromise in communication, which may affect the child in social activities and cause the individual to miss future professional opportunities. There is a causal relationship between serous otitis media and hearing impairment associated or not to speech and learning disorders. This type of otitis, which affects children most frequently, rarely causes hearing losses of more than 20 dB to 30 dB; a variation in threshold is common in the presence of colds, acute otitis media, and with changing seasons, therefore increasing the hearing loss during these events. In advanced stages, serous otitis media, sometimes reaches thresholds that are equal to or higher than 40 dB-50 dB, negatively affecting hearing capacity and, as a result, learning.

In the present paper, after the assessment of 103 children in our sample, 25 (24.27%) were selected for the second stage, a result that is similar to that of Seligman.
adolescents and young adults. The initial audiometric impairment, even though it is a risk factor for children, is related to environmental noise on hearing and evolution of hearing loss, so that these factors would not interfere with the tests were carried out so as to avoid rainy, cold or dry seasons, with as little external noise as possible; also, the selected institution offering good building condition in which the examinations were carried out, being more marked already at 6,000 Hz. Further studies are required to evaluate this result, so as to investigate the causes of these changes.

Speech audiometry was carried out with 25 children selected for the second stage of the study. This test, especially in children, is extremely important, since, in addition to confirming air-conduction tone thresholds it is useful to diagnose phonetic switches with or without associated hearing impairment. The combination of tonal audiometry and phoneme recognition allows a correct evaluation of children. When the results are normal, especially in the case of children with learning disabilities or other alterations that involve concentration, it is important that these children be referred to specialists to establish a correct diagnosis, as was the case in the present study.

The results of the present study, obtained with the method employed, are in accordance with the criteria established by the American Speech-Language Hearing Association (ASHA) and by the WHO, which state that a definitive diagnosis of hearing impairment should not be made taking into consideration the data obtained only in screening tests, without follow-up by specialized services. The children who presented alterations on screening audiometry must be submitted to a second complete audiometry in an sound booth, carried out exclusively by a speech therapist, and only after that a definitive diagnosis of hearing impairment can be obtained. Still according to the WHO, after a diagnosis of hearing impairment, the adequate orientations concerning the degree of loss must be followed, the WHO Table for classification of hearing impairment, as in the present study.

The current trend in relation to hearing impairment is based on diagnosis, etiology and treatment with the range of otologic and neurologic disorders found in pediatric patients, in addition to neonatal and childhood screening tests, aiming at an early hearing rehabilitation.

The high prevalence observed in the present study, 9.70% of alterations in hearing, underscores the need for prevention and early diagnosis of hearing impairment in children who do not have access to specialized services. Such programs would allow the dimension of the problem to be determined in different regions, and would be useful to warn the population, health professionals - especially pediatricians and otorhinolaryngologists - school professionals, parents and authorities, so as to ensure immediate care and a dignified life for these children.

Conclusions

1) The observed prevalence of mild conduction airway impairment, of 0.97%, and of hearing alterations in high frequencies, of 8.73%, indicates the presence of hearing morbidity in the study population.

2) Further studies should be carried out to assess children presenting alterations in hearing thresholds at 4,000, 6,000 and/or 8,000 Hz.

3) New programs must be implemented to allow early diagnosis and prevention of hearing impairment and of its etiologies and, if possible, the need to raise the level of conscienciousness of parents, of the general population and of health professionals.
Acknowledgements

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References


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