Hearing impairment and socioeconomic factors: a population-based survey of an urban locality in southern Brazil

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ABSTRACT

Objective. *To provide the first population-based data on deafness and hearing impairment in Brazil.*

Methods. *In 2003, a cross-sectional household survey was conducted of 2 427 persons 4 years old and over. The study population was composed of 1 040 systematically chosen households in 40 randomly selected census tracts (dwelling clusters) in the city of Canoas, which is in the state of Rio Grande do Sul, in southern Brazil. Hearing function was evaluated in all subjects by both pure-tone audiometry and physical examination, using the World Health Organization Ear and Hearing Disorders Survey Protocol and definitions of hearing levels. The socioeconomic data that were gathered included the amount of schooling of all individuals tested and the income of the head of the household.*

Results. *It was found that 26.1% of the population studied showed some level of hearing impairment, and 6.8% (95% confidence interval (CI) = 5.5%–8.1%) were classified in the disabling hearing impairment group. The prevalence of moderate hearing loss was 5.4% (95% CI = 4.4%–6.4%); for severe hearing loss, 1.2% (95% CI = 0.7%–1.7%); and for profound hearing loss, 0.2% (95% CI = 0.03%–0.33%). The groups at higher risk for hearing loss were men (odds ratio (OR) = 1.54; 95% CI = 1.06–2.23); participants 60 years of age and over (OR = 12.55; 95% CI = 8.38–18.79); those with fewer years of formal schooling (OR = 3.92; 95% CI = 2.14–7.16); and those with lower income (OR = 1.56; 95% CI = 1.06–2.27).*

Conclusions. *These results support advocacy by health policy planners and care providers for the prevention of deafness and hearing impairment. The findings could help build awareness in the community, in universities, and in government agencies of the health care needs that hearing problems create.*

Key words Deafness; hearing loss; Brazil.

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For many years in Brazil, health providers involved in the area of deafness and hearing impairment have needed to be made aware of the extent of the problem. The use of estimates makes planning difficult and has hindered efforts to obtain funding and other support for projects involving the prevention and rehabilitation of deafness or to validate the needs of this part of the population. According to data for 2001 from the World Health Organization (WHO) (1) and from the Global Burden of Hearing Loss study (2), 250 million persons worldwide have disabling hearing impairments. Although they represent only 4.2% of the world's population, two thirds of these persons live in developing countries.

This study is a result of contact among the *Christoffel-Blindenmission* (Christian Blind Mission),[7] the WHO Prevention of Blindness and Deafness Program, and the *Universidade Luterana do Brasil* (Lutheran University of Brazil). The study of deafness and hearing impairment has been a common pursuit among these institutions for many years due to their interest in its prevention and rehabilitation.

The combined efforts of those three groups paved the way for research to determine how prevalent deafness and hearing impairment were, starting with an urban locality in southern Brazil. Objectives of this survey-based research were threefold: to determine the magnitude of the problem of ear and hearing disorders in the survey population; to provide the first population-based data on deafness and hearing impairment anywhere in Brazil; and to offer information useful to health workers and policymakers in establishing prevention programs.

MATERIALS AND METHODS

This cross-sectional study was conducted between November 2002 and June 2003 in the city of Canoas, which is part of the metropolitan area of Porto Alegre, the capital of the state of Rio Grande do Sul, in southern Brazil. As of 2001, Canoas had a population of some 306 000 inhabitants, distributed among 391 census tracts (3).

The sample size for the study was calculated by estimating a 10% prevalence of deafness and other hearing disorders with a precision of 1.4%, a 95% confidence level, a design effect of 2.0, and a 10% increase for possible losses (4). The final sample number necessary for our study was 3 858 participants. According to census data from the Brazilian Institute of Geography and Statistics for 1991 (3)—the only available source at the time of the project—there would be an average of 3.71 persons per household in the city. To obtain the number of participants required, 1 040 households would need to be visited. To this end, 40 of the 391 census tracts in Canoas were randomly chosen.

To visit the households, there were 10 teams of two persons each, with an audiologist and a medical student. These testers were trained by otorhinolaryngologists, audiologists, and lecturers at the Lutheran University of Brazil. To begin the random household selection, one street block was randomly selected in each of the 40 census tracts, and one street corner in this block was also randomly selected. Starting out from this corner, 26 households were systematically chosen and then visited. Everyone living in these households was included in the survey.

Those who refused to participate, those still absent after a third visit, and those who were ill and could not be included in the survey were considered nonrespondents. The WHO Ear and Hearing Disorders Survey Protocol for a Population-Based Survey of Prevalence and Causes of Deafness and Hearing Impairment and Other Ear Diseases was used as a guide (5). To find out if socioeconomic determinants played a part in the health problems studied, questions about the individual schooling and the income of the head of the household were added to the WHO protocol. Hearing loss was established according to the WHO classification values: average of 500, 1 000, 2 000, and 4 000 Hz: 0–25 decibels (dB): no impairment; 26–40 dB: slight impairment; 41– 60 dB: moderate impairment; and 61– 80 dB: severe impairment. All subjects with ear disease or hearing loss were offered care and rehabilitation.

"Disabling hearing impairment in adults" was defined by WHO as a permanent unaided hearing threshold level for the better ear of 41 dB or greater. "Disabling hearing impairment in children [under the age of 15 years]" was defined as a permanent unaided hearing threshold level for the better ear of 31 dB or greater. For both definitions, "hearing threshold level" was understood as the better ear average hearing threshold level for the four frequencies of 500, 1 000, 2 000, and 4 000 Hz (6). Although the WHO definition currently refers to *permanent* hearing threshold levels, this survey and the WHO protocol include the gathering of data on nonpermanent hearing loss, such as may be caused by otitis media.

Procedures

Ambient noise was measured using an MSL-1351C IEC 651, type II sound level meter (MINIPA, São Paulo, São Paulo, Brazil) immediately before the audiometry. Subjects were correctly fitted with headphones. Then, they were instructed to raise their hand every time they heard the sound emitted, even if very faint. The presentation of sound started at 60 dB hearing level (dB HL) at 1 kHz. If there was no response at this threshold, it was raised in 10-dB increments until the subject responded to sound. When the subject responded to a sound, the hearing threshold was then obtained, decreasing thresholds by 10-dB steps and increasing by 5-dB steps, until the threshold was established and confirmed on three consecutive occasions.

These thresholds were established in the same manner at 2 kHz and 4 kHz, and then back to 1 kHz until they

[7] Based in Bensheim, Germany, the *Christoffel-Blindenmission* (Christian Blind Mission) (CBM) is one of the leading international development agencies. CBM supports the provision of services to persons with visual and other disabilities in more than 1 000 projects in 113 developing countries.

were within 5 dB of the original measurement at 1 kHz. If not, the entire procedure was repeated. The equipment used was an AS208 screening audiometer (Interacoustics, Assens, Denmark).

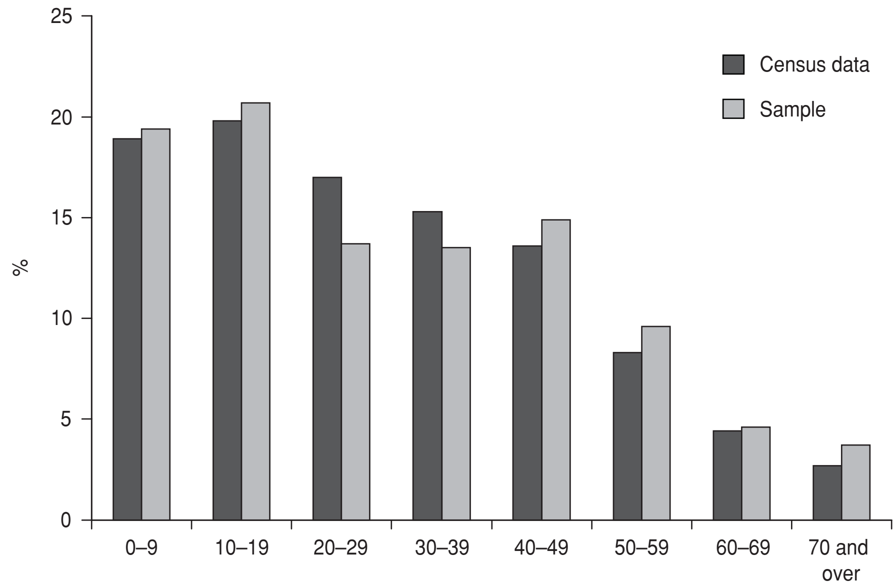
The study was approved by the Ethical Committee of the Lutheran University of Brazil, under protocol number 049/2002. All participants signed an informed consent form.

For data quality control, 11.3% of the households were recontacted, with three questions being asked: what was the relationship to the head of the household, if an otoscopy had been performed, and if headphones had been used. The measurements were reliable (kappa = 0.93). Otological examinations were calibrated according to standard procedures, and the diagnoses by all the field workers were compared to the gold standard (kappa = 0.74–1.0). Ten patients in the Otorhinolaryngology Department of the Independência University Hospital were examined in order to standardize the procedures for otological examinations. Audiometers were also calibrated according to standard procedure. Data were processed through the Earform program (World Health Organization, Geneva, Switzerland) and analyzed using the Statistical Package for Social Sciences version 10.0 (SPSS, Chicago, Illinois, United States of America), using standard statistical procedures. Statistical methods used were chi-square and odds ratio (OR) for the association between categorical variables, analysis of variance (ANOVA) for the differences between means, and logistic regression for the multivariate model.

RESULTS

During the study it became apparent that there were, on average, only 3.2 persons per household. Therefore, it would be possible to examine only 3 328 subjects, a number lower than originally planned. By the end of the survey, 2 609 individuals had been examined, corresponding to 78.4% of the possible number. Subjects 4 years old or over numbered 2 427 and were tested by pure-tone audiometry.

FIGURE 1. Age distribution (year ranges) for the male sample in study of hearing impairment, 2003, compared to the male population registered in census data, Canoas, Rio Grande do Sul, Brazil



Of the 1 040 households visited, 98 refused to participate, or no one was found at home on a third visit. It was not possible to establish the number of individuals living in 44 of the 98 households. In the remaining 54 of the 98, the number of individuals ranged from 1 to 8 per household. Of the 615 residents who were identified but did not participate in the survey, 66.7% (*n* = 410) refused, 30.7% (*n* = 189) were absent, and 2.6% (*n* = 16) were ill. The nonrespondents were distributed among the various census tracts.

The survey sample was chosen in two stages. First. the clusters (census tracts) and then the households were randomly selected. This may introduce a bias because it is probable that a greater homogeneity exists inside the clusters than in a simple random sample. This bias is known as the design effect (7). The number of people 40 years old and above identified in the sample was larger than expected, according to the information on the city's age structure shown in the available census data. Concerning men between the ages of 20 and 39, the number identified was smaller than expected, according to the age structure shown in the same census data. To cope with this problem, a weight was attributed to each age and sex subgroup, mirroring the age and sex distribution in the city's general population. The design effect and the attributed weight were taken into account when the data were analyzed through the CSAMPLE module of the Epi Info 6.04b program (Centers for Disease Control and Prevention, Atlanta, Georgia, United States of America) in order to ascertain the true prevalence in the entire population.

A pure-tone audiometry test was performed with 2 427 subjects at home. Figure 1 and Figure 2 describe the age distribution of the men and women, respectively, as compared with the city census data. Men constituted 46.1% of the sample; 21.5% of the subjects were 0–14 years old, and 11.4% were 60 years old and over. A little less than one third (31.1%) of the subjects had more than 8 years of formal schooling, and slightly more than half (52.7%) of the heads of household

FIGURE 2. Age distribution (year ranges) for the female sample in study of hearing impairment, 2003, compared to the female population registered in census data, Canoas, Rio Grande do Sul, Brazil

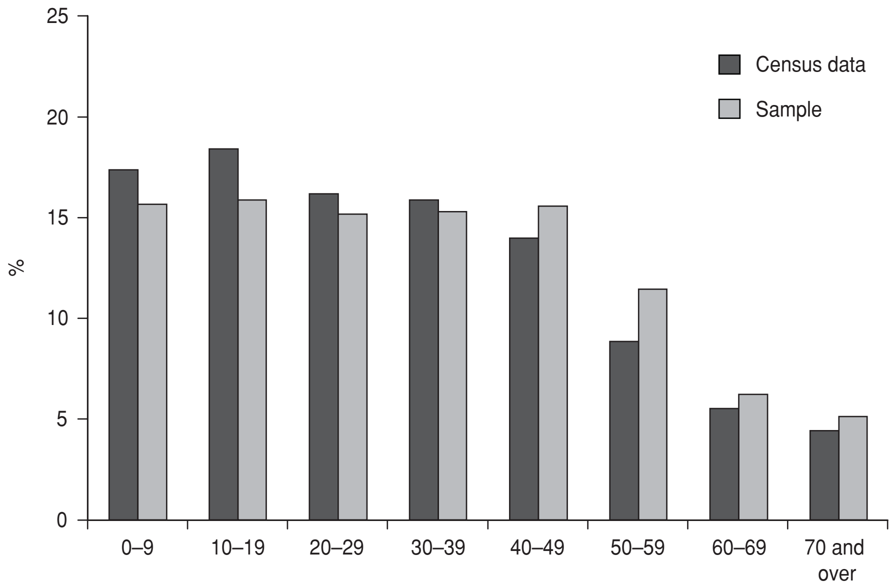


TABLE 1. Mean ambient noise (dBA), with 95% confidence intervals (CIs), according to levels of hearing impairment, Canoas, Rio Grande do Sul, Brazil, 2003[a]

Level of impairment	No.	Mean (dBA)	95% CI
No impairment	1 742	50.69	50.22–51.16
Slight impairment	502	53.48	52.52–54.44
Disabling hearing impairment	183	54.02	52.39–55.66
Total/Overall	2 427	51.52	51.11–51.93

[a]The analysis of variance technique showed a statistically significant difference ($P < 0.001$) in the average ambient noise experienced among the three groups: without any hearing loss, with mild hearing loss, and with disabling hearing loss. However, the difference between the two last groups was not statistically significant.

earned less than US$ 200 per month. The average level of ambient noise was 51.5 dBA (decibels expressed in sound pressure level as measured on the A-weighted scale of a sound level meter filtering network, used in the measurement of environmental noise) (95% CI = 51.11–51.93). Application of the ANOVA technique showed a statistically significant difference ($P < 0.001$) in the average ambient noise experienced by the three groups: without hearing loss, with mild hearing loss, and with disabling hearing loss. The difference between the two last groups was not statistically significant (see Table 1).

Of the total number of subjects evaluated, 26.1% showed a slight level of impairment, and 6.8% (95% CI = 5.5%–8.1%) were classified in the disabling hearing impairment category (the unweighted prevalence of disabling hearing impairment found was 7.5%). The prevalence for moderate hearing loss was 5.4% (95% CI = 4.4%–6.4%); for severe hearing loss, 1.2% (95% CI = 0.7%–1.7%); and for profound hearing loss, 0.2% (95% CI = 0.03%–0.33%).

Table 2 presents the distribution of subjects tested, according to their age and the audiometry results for the better ear. Table 3 shows the sex and age distribution of subjects with disabling hearing impairments (DHIs). The table clearly shows that hearing impairment increases with age. It also indicates a difference between men and women in the proportion of DHI; however, the difference was not statistically significant by the chi-square test ($P = 0.597$).

With the goal of better understanding the population of deaf and hard-of-hearing individuals from the point of view of socioeconomic factors, two variables were studied: years of schooling and income of the head of the household (in US$). Both were included in a multivariate analysis with age and sex. Age was carried over to

TABLE 2. Proportion (%) of persons, by age group, with indicated hearing level in the better ear, Canoas, Rio Grande do Sul, Brazil, 2003

				Disabling hearing impairment		
Age group (yr)	No.	No impairment (0–25 dB)	Slight impairment (26–30 or 40 dB)	Moderate (31 or 41–60 dB)	Severe (61–80 dB)	Profound (> 80 dB)
4–9	283	88.0	6.7	4.9	0.4	0.0
10–19	493	92.9	4.9	2.0	0.2	0.0
20–29	426	87.3	11.5	0.9	0.2	0.0
30–39	407	79.2	17.6	2.9	0.0	0.0
40–49	353	63.6	30.4	5.1	0.9	0.2
50–59	217	47.9	42.9	8.8	0.5	0.0
60+	218	18.8	44.5	24.3	10.6	1.8
Total/Overall	2 397	73.9	19.2	5.4	1.3	0.2

TABLE 3. Proportion (%) of persons with disabling hearing impairment (DHI), by sex and age groups, Canoas, Rio Grande do Sul, Brazil, 2003 (weighted data)

	DHI (%)		
Age (yr)	Male	Female	Overall
4–9	4.8	5.8	5.3
10–19	1.6	2.8	2.2
20–29	1.4	0.9	1.2
30–39	3.7	2.8	3.2
40–49	8.0	4.0	6.0
50–59	11.8	7.0	9.3
60+	39.3	34.6	36.2
Overall	7.1	6.7	6.8

the model in three levels (4–14 years, 15–59, and 60 and above). The model adjusted all variables for each other. Table 4 shows that the groups at higher risk for hearing loss were men (OR = 1.54; 95% CI = 1.06–2.23); those 60 years of age and above (OR = 12.55; 95% CI = 8.38–18.79); persons with fewer years of formal schooling (OR = 3.92; 95% CI = 2.14–7.16); and those in the lower income bracket (OR = 1.56; 95% CI = 1.06–2.27).

DISCUSSION

This study is the first in Latin America using the WHO Ear and Hearing Disorders Survey Protocol, and it is one of the very few conducted as house-to-house research in a population. The survey examined 2 427 subjects who were 4 years old and older, in order to establish the prevalence of disabling hearing impairment.

The prevalence of disabling hearing impairment found was 6.8% (5.4% moderate, 1.2% severe, 0.2% profound). Possible explanations for high DHI prevalences include a meningococcal meningitis epidemic (8), meningitis (9), congenital rubella syndrome (10, 11), respiratory infections (12), the use of ototoxic antibiotics without medical control (13), and noise exposure (14). However, the literature shows that in discussing the etiology of hearing impairment, a definite cause cannot be established in a substantial number of cases (15–17).

When compared with the results from other studies using the same methodology (Oman, 2%; Indonesia, 5%; Vietnam southern provinces, 5%), the Brazil study found a higher prevalence. However, the results were comparable with those found in India (6%), Myanmar (8%), Sri Lanka (9%), and Vietnam's northern provinces (7.8%) (18).

Regarding ambient noise, it was found that even though the noise level was higher than ideal, it did not affect results in the classification between mild impairment and disabling hearing impairment.

Among the limitations of the study, the nonrespondent rate of 22% should be pointed out. As compared to the population of the city, the study population included fewer males and fewer individuals under 40 years of age. This could have increased the prevalence found because the older population was overrepresented. To minimize this bias, a weighted analysis was performed. However, this mathematical procedure may give rise to limitations because people who were not examined may have had a different hearing pattern from those examined.

The city of Canoas, a typical mid-sized urban community, is part of the greater metropolitan area of Porto Alegre. This means that part of the population commutes to and from different areas every day. This factor may have

TABLE 4. Disabling hearing impairment (DHI), according to demographic and socioeconomic variables, with odds ratio (OR) and 95% confidence interval (CI), Canoas, Rio Grande do Sul, Brazil, 2003 (weighted data)[a]

Variable	No.	DHI prevalence (%)	Crude OR	Adjusted OR OR (95% CI)
Sex				
Female	1 216	6.7	1.00	
Male	1 038	7.1	1.07	1.54 (1.06–2.23)
Age group (yr)				
4–14	485	4.3	1.00	
15–59	1 513	3.7	0.85	1.59 (0.92–2.78)
60+	256	36.2	14.70	12.55 (8.38–18.79)
Years of schooling				
9+	702	2.0	1.00	
0–8	1 552	9.1	5.00	3.92 (2.14–7.16)
Head of household income (US$)				
200+	1 067	5.0	1.00	
0–199	1 187	8.9	1.55	1.56 (1.06–2.27)

[a]All the variables were adjusted for each other.

contributed to the loss of participants among working men. Another possibly relevant aspect is the high level of violence in Brazil, especially in the metropolitan areas. It hinders research of this type because of people's fears of making themselves accessible to strangers. The fact that a consent form had to be signed may have also contributed to the losses. In addition, people may have refused to participate because this study required home visits and the introduction of largely unfamiliar examination procedures they could have found burdensome. Others may have found the presence of field workers to be a potential invasion of their privacy.

Our finding that men had a higher probability of disabling hearing impairment may be consistent with studies that have found a higher prevalence of deafness in men (19–21). The higher risk at older ages is biologically plausible because of the expected diminution of hearing acuity due to presbycusis. The association with fewer years of formal schooling may be the result of reverse causality since there are few adequate educational institutions available for individuals with disabling hearing impairments, and this may hinder opportunities for educational advancement. The association of hearing loss with lower income may be due to the fact that lower income is in turn associated with various causes of hearing disorders, such as systemic infectious processes, ear infections, congenital hearing loss, ototoxic drugs, and poor access to health care. On the other hand, the association could also be the result of poor access to gainful employment due to the hearing loss.

The results of this survey research should be valuable for planning actions in the prevention of deafness and hearing impairment and for raising awareness of the subject in the community, in universities, and in government agencies.

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RESUMEN

Deficiencia auditiva y factores socioeconómicos: estudio de base poblacional en una localidad urbana del sur de Brasil

Objetivo. Presentar los primeros datos de un estudio de base poblacional sobre sordera y deficiencia auditiva en Brasil.

Métodos. Se realizó una encuesta transversal de hogares en 2003 en la que participaron 2 427 personas de 4 años de edad o más. La población de estudio estuvo compuesta por 1 040 hogares escogidos de manera sistemática en 40 sectores censales (conglomerados de viviendas) escogidos al azar en la ciudad de Canoas, estado de Rio Grande do Sul, en el sur de Brasil. Se evaluó la función auditiva de los participantes mediante audiometría tonal liminar y examen físico, según el Protocolo para el Estudio de Trastornos Óticos y Auditivos y las definiciones de niveles auditivos, ambos de la Organización Mundial de la Salud. Entre los datos socioeconómicos colectados estaban los años de escolaridad de las personas estudiadas y los ingresos del jefe del hogar.

Resultados. Se encontró que 26,1% de la población estudiada mostró algún grado de deficiencia auditiva y 6,8% (intervalo de confianza de 95% [IC95%]: 5,5% a 8,1%) se clasificó en el grupo con deficiencia auditiva incapacitante. La prevalencia de pérdida auditiva moderada fue de 5,4% (IC95%: 4,4% a 6,4%); de pérdida auditiva grave, 1,2% (IC95%: 0,7% a 1,7%); y de pérdida auditiva profunda, 0,2% (IC95%: 0,03% a 0,33%). Los grupos en mayor riesgo de pérdida auditiva fueron los hombres (razón de posibilidades [*odds ratio*, OR] = 1,54; IC95%: 1,06 a 2,23); los participantes de 60 años de edad o más (OR = 12,55; IC95%: 8,38 a 18,79); los que tenían menos años de escolaridad formal (OR = 3,92; IC95%: 2,14 a 7,16); y los que tenían menores ingresos (OR = 1,56; IC95%: 1,06 a 2,27).

Conclusiones. Estos resultados respaldan las recomendaciones de los planificadores de políticas sanitarias y de los proveedores de servicios de salud sobre la prevención de la sordera y la deficiencia auditiva. Además, pueden contribuir a aumentar el nivel de conciencia de la comunidad, las universidades y las agencias gubernamentales acerca de las necesidades de atención sanitaria que generan los problemas auditivos.

Palabras clave Sordera, pérdida auditiva, Brasil.