International Journal of TROPICAL DISEASE & Health
7(3): 94-101, 2015, Article no.IJTDH.2015.062
ISSN: 2278–1005

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Demographic and Hearing Related Variables Important for Prediction of Disabling Hearing Impairment: A Community Based Survey

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Authors' contributions

This work was carried out in collaboration between both authors. Author AA did the study design and wrote the protocol. Author FITA did the statistical analysis and literature search while analyses of the study were by both authors AA and FITA. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJTDH/2015/16822
Editor(s):
(1) Giuseppe Murdaca, Clinical Immunology Unit, Department of Internal Medicine, University of Genoa, Italy.
Reviewers:
(1) Ibrahim El-Zraigat, Department of Special Education, The University of Jordan, Jordan.
(2) Anonymous, USA.
(3) Masafumi Ohki, Department of Otolaryngology, Saitama Medical Center, Saitama Medical University, Japan.
Complete Peer review History: http://www.sciencedomain.org/review-history.php?iid=1010&id=19&aid=8720

Original Research Article

Received 15th February 2015
Accepted 25th March 2015
Published 8th April 2015

ABSTRACT

Aim: The aim of this study was to estimate the prevalence of Disabling Hearing impairment and describe socio-demographic and hearing related risk factors as possible predictors of disabling hearing impairment.
Study Design: This was a Cross-sectional and descriptive study
Place and Duration of Study: A semi-urban district called Kumbotso in Kano state, Northern Nigeria. 3rd March 2013.
Methodology: Data came from 58 participants, (39 females, 19 males; age range 5-50 years) who completed audiometric testing during the Ear diseases/Hearing impairment survey. Audiometric testing was performed on the participants, air-conduction hearing thresholds in decibels hearing level (dB HL) were obtained for each ear at frequencies of 0.5-4 kHz. Disabling Hearing loss was

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defined as pure-tone average of air conduction thresholds of ≥ 35dB HL for adults and children while identifying independent risk factors using logistic regression.
Results: Out of 91 subjects, 58 subjects had pure tone audiometry giving a participation rate of 63.7% with a prevalence rate for disabling hearing loss of 31%. Controlling for gender, duration of hearing impairment, family history and relationship with subject with hearing loss, odds ratio for associations with Disabling Hearing impairment were 14.57 (95% CI: 2.14-99.44) for age and 61.55 (5.60-112.82) for aetiology of hearing loss. These variables particularly young age and ear diseases were the strongest predictors.
Conclusion: Age, aetiology of hearing loss particularly, young age and the presence of ear disease are potential indicators for the development of disabling hearing impairment/loss during rural and/or community-based surveys.

Keywords: Disabling hearing loss; predictors; community; age-group; ear disease.

1. INTRODUCTION

Community-based surveys on hearing impairments are scarce in low and middle income countries (LMIC); this is particularly more worrisome in sub-Saharan Africa due to lack of funding and political will. According to the World Health Organization (WHO) estimates, about 5.3% of the world's population is living with "disabling hearing loss" amounting to a staggering 360 million persons across the globe. Ninety one percent (328 million) of these are adults (183 million males, 145 million females) while 9% (32 million) of these are children [1]. The prevalence of disabling hearing loss (DHL) in children and persons over 65 years is greatest in South Asia, Asia Pacific and Sub-Saharan Africa.

These figures as they stand are probably unequally distributed across the world, in sub-Saharan Africa it is currently estimated that DHL in children of both sexes is 1.9% (6.8 million children) while in adult males it is 7.4% (17 million) and 5.5% (13 million) are females [2].

Approximately 15% of the world's adult population has some degree of hearing loss [1]. About one third of those who are affected, have disabling hearing loss. Disabling hearing loss refers to hearing loss greater than 40 dB in the better hearing ear in adults (15 years or older) and greater than 30 dB in the better hearing ear in children (5 to 14 years) of age. However, this definition of DHL was modified by the WHO Global burden of disease (GBD) hearing loss expert group for the purposes of estimating the global burden [3]. Against this background, Stevens et al. [3] estimated the prevalence of six categories of hearing impairment (Table 1) and highlighted the prevalence at ≥35dB (moderate or worse hearing impairment), the level at which intervention is definitively beneficial.

In Nigeria, the above estimates may just be a tip of the iceberg, as the GBD expert group for hearing loss estimate higher hearing impairment prevalence's than were originally reported during the survey in 2001 [3]. Moreover, in many underserved and remote communities in Nigeria, immediate referral following either self-reported hearing impairment and/or detected by a second party may make the difference between appropriate and timely rehabilitation and a lifelong period of "silent misery". It will then seem rational that at the primary health care level, imparting skills to community health officer's and extension workers such as 'history taking skills' regarding identifying persons with disabling hearing impairment can go a long way into helping to reduce the aforementioned burden of hearing impairment. This can well be achieved by asking questions hearing-related questions in addition to basic bio-data documentation. In the long run, this may help to reduce social, psychologic & economic costs of hearing impairment in our localities.

There are several documented risk factors for childhood hearing impairment as postulated by the American Academy of Paediatrics' (AAP) ranging from pre- and perinatal factors, genetic factors and craniofacial abnormalities. Similarly in Belgium, the Flanders universal newborn hearing screening programme also identified personal, environmental and social factors as independent determinants of hearing impairment in neonates [4]. But, in all age groups, studies have also examined other factors such as age (hearing loss is highly age dependent), [3,5,6] gender (variable reports), [7-9] ototoxic medications, familial hearing loss,birth order, educational level, [10,11] otologic or ear diseases, [11] noise, to mention but a few, as independent determinants of 'any' type of hearing loss.

Table 1. Hearing impairment categories as proposed by GBD expert group (frequencies averaged over 0.5,1,2 and 4 kHz) [13]

Hearing impairment category	Better ear hearing level (dBHL)	Hearing in a quiet environment	Hearing in a noisy environment
Unilateral	<20 in the better ear; >/=35 in the worse ear	Does not have problems unless sound is near poorer hearing ear	May have real difficulty following/taking part in a conversation
Mild	20–34	Does not have problems hearing what is said	May have real difficulty following/taking part in a conversation
Moderate	35-49	May have difficulty hearing a normal voice	Has difficulty hearing and taking part in conversation
Moderately Severe	50-64	Can hear loud speech	Has great difficulty hearing and taking part in conversation
Severe	65-79	Can hear loud speech directly in one's ear	Has very great difficulty hearing and taking part in conversation
Profound	80-94	Has great difficult hearing	Cannot hear any speech

Disabling hearing impairment to say the least, may be quite common in rural populations [12] and may indeed be a truly neglected disability especially in poor African regions such as Northern Nigeria. Therefore, the questions to ask is, are there basic socio-demographic and hearing impairment factors that can be utilised as red flags for community based surveys?

This study aims to estimate the prevalence of DHL and describe socio-demographic and hearing related risk factors as possible predictors of disabling hearing impairment.

2. MATERIALS AND METHODS

Data collected from the Ear diseases/Hearing impairment survey carried out in Kumbotso comprehensive health centre, while marking the international Ear care day 2013 was used. Kumbotso Local Government Area is a semi-urban community and one of the 44 local Government Areas of Kano State, Nigeria. Majority of the dwellers are peasant farmers, petty traders, pupils, students, businessmen and civil servants. These dwellers are predominantly indigenous Hausa/Fulani and a small proportion Igbo, Igala, Gwari and Nupe tribes.

This was a Cross-sectional and descriptive survey using WHO/PBD Ear and Hearing Disorders Examination Form version 8.3. Participants were recruited during the international Ear care day 2013 at a semi-urban settlement called Kumbotso, Kano state, Northern Nigeria. Of 91 participants, only 58 (63.7%) had Audiometric testing and completed the audiometric examination aged 5-50 years. Demographic characteristics, including age, tribe, sex, marital status, occupation and educational status were obtained during the interviews.

Testing was performed in the surrounding of the comprehensive health centre of the community, in a quiet room reasonably far from the recruitment area adjudged to have an ambient noise of ≤40dB and maintained before every test (using a sound level meter- Quest 2900 model). Pure-tone audiometry signals were presented to each ear at varying intensities until the threshold at which the participant was just able to perceive the tone was identified. Air-conduction hearing thresholds in decibels hearing level (dBHL) were obtained for each ear at 500; 1,000; 2,000; 4,000 Hz (as recommended by WHO for field surveys) by trained audiometric technicians using calibrated (BS EN ISO 389-4:2004) Amplivox audiometer AD 229B with Audio-cups noise-excluding headset and a biological check was performed on the day of testing. The Pure Tone Average (PTAv) is the average value at these frequencies based on hearing scores of the participants' better ear. The severity of hearing impairment and thus disabling Hearing loss was categorized using the PTA score.

All participants ≥5 years of ageable to be assessed using audiometry testing were included for this studies. While children at or below 4 years were excluded (testing using behavioural audiometry may be unreliable in this setting) as well as some adults who did not consent for audiometry. In order to get accurate and uniformly reproducible analytical data results, we used 35dB as the cut-off for both adult and children for the purposes of estimating Disabling Hearing Impairment as described by Stevens et al. [3] at which stage intervention is usually quite beneficial (Table 1). To complete the Audiometric examination participants also had otoscopy carried out by ENT (Ear Nose & Throat) trainees and specialists.

Eight persons who presented for this survey refused testing, 5 for reasons unrelated to the procedure (did not consent for Audiometry) and the remaining 3 due to fear of the audio-device occluding the ears.

The study was carried out after securing permission and consent from the Local government Authorities and ethical clearance from the institutional research ethics committee. Thereafter, information was passed to the villagers via town-crier, jingles and news media to all those with hearing related problems to present to the health centre. This study conformed to the Code of Ethics of the World Medical Association (Declaration of Helsinki).

2.1 Statistical Analysis

Statistical analysis was performed using IBM SPSS (version 21, for windows) while Descriptive statistics were used to examine demographic data and Audiometric values at different frequencies. Chi-square tested crosstabs were initially used to determine relationship between the contributing factors and possibility of belonging to the normal hearing group or the group with disabling loss. The independent variables (age, gender, occupation, duration of hearing impairment, family history of hearing impairment, relationship with subject with hearing loss, etiology of hearing loss- as Predictors) with significant associations and other potential confounders were then evaluated for the odds of having DHL or normal hearing (dependent variable-disabling hearing loss vs Normal hearing) using Logistic regression analysis. A level of 0.05 was used for evaluating statistical significance (95% Confidence interval).

3. RESULTS

A total of 91 Participants were seen and 58 met the inclusion criteria, with ages ranging from 5-50 years, mean of 20.19 years (SD: 13.33). There were 39(67.2%) females and 19(32.8%) males giving a female preponderance (Female: Male ratio = 2:1). Children between the ages of 5-14 years were 26(44.8%) while adults 15-60 year olds were 32(55.2%) Table 2.

Table 2. Socio-demographic profile of the population

Socio-demographic variables	Frequency (%)
Sex	
Male	19 (32.8)
Female	39 (67.2)
Age-groups (years)	
5-14	26 (44.8)
15-60	32 (55.2)
Occupation	
Undercare	4 (6.9)
Student	30 (51.7)
Housewife	17 (29.3)
Civil servant	2 (3.5)
Business/trader	5 (8.6)
Duration of hearing loss	
Since infancy	26(44.8)
Since Adulthood	11 (19.0)
Uncertain	6 (10.4)
No difficulty	15 (25.9)
Family history of hearing loss	
Yes	10 (17.2)
No	42 (72.4)
Uncertain	4 (6.9)
Not asked	2 (3.5)
Family relationship with subject	
Brother or Sister	6 (10.4)
Child of subject	2 (3.5)
Parent of subject	3 (5.2)
Nil	47 (81.0)
Aetiology of hearing loss	
Normal ear & hearing	19 (32.8)
Ear disease	17 (29.3)
Infectious diseases	6 (10.4)
Genetic conditions	3 (5.2)
Undetermined	13 (22.4)

The overall 'point prevalence' for disabling hearing loss (DHL) in this population is 18(31%) with a mean audiometric threshold of 31.03dBHL (SD: 18.09) and a range of 10- 83.75dBHL (Table 3).

Table 3. Prevalence of disabling hearing loss as seen in this cohort, equivalent to a moderate degree hearing impairment using classification suggested by Murray et al. [13]

Severity of hearing loss (dB)	Number	Percent
Normal (0-19)	17	29.3
Mild (20-34)	23	39.7
Moderate (35-49)	10	17.2
Moderately severe (50-64)	3	5.2
Severe (65-79)	4	6.9
Profound (80-94)	1	1.7
Total	58	100.0

During bivariate analysis, two variables (gender and occupation) did not show significant associations and as such were not included in the regression analysis. Analysis to predict risk of disabling hearing loss for the participants using age, family history of hearing loss, relationship (of subject) with family member who is deaf / has impaired hearing, aetiology of hearing loss, all as independent predictors was conducted. A test of the full model against a constant only model was statistically significant for only two of the predictors (aetiology of hearing loss and age groups), indicating that these predictors as a set reliably distinguished between normal hearing subjects and subjects with disabling hearing impairment (Chi square = 42.54, P< .001 with df = 10).

A Nagelkerke's'R' Square value of 0.545 indicated a moderate relationship between prediction and grouping. Overall Prediction success was 83.5% (89.6% for normal hearing subjects and 66.7% for subjects with disabling hearing impairment). The Wald criterion demonstrated that age group (especially 5-14 yrs) and aetiology of hearing loss (due primarily to Ear diseases and undetermined causes) made significant contributions to the predictions (P = .023 and .001 respectively). The odds ratio [OR: 14.57, 95% CI;2.14–99.44] for age (5-14yrs) is 15 times as large and therefore more likely to belong to the disabling hearing loss group. Similarly, the odds ratio [OR: 61.55, 95% CI;5.60-112.82] for "Ear diseases" is 62 times as large and so more likely to belong to the group with disabling hearing loss (Table 3). The OR: 24.67(95% CI;4.83 –125.90) for "causes unknown" was quite significant as well, with a 25 times likelihood (Table 4).

4. DISCUSSION

The mean threshold value for these subjects was in the mild category (31.03dBHL) and this may account for a high prevalence for all degrees of hearing impairment. A prevalence of DHL of 31% the same as the mean for this sample population may be quite high, females appeared to be higher in number as well. Logistic regression analysis for this survey had sensitivity and specificity of 66.7% and 89.6% respectively.

The prevalence for this study is obviously a far cry from the results in Itajai, Brazil where it is 7%, [5] although this was mostly amongst the 50-year and above age group probably due to pres by acusis. Whereas, in our study it was usually due to ear diseases, infection and sometimes due to unknown causes, within a younger population age-group, 5-14 years. Conversely, in another study age did not influence hearing threshold levels at all [14]. In a recent US survey to examine prevalence of hearing loss among adolescents, it revealed an increase in hearing loss over a ten year period [15], although one can argue this was probably due to other confounding factors such as noise exposure, and was not also strictly a moderate degree of disabling hearing loss, but 'all types' of hearing loss that was surveyed.

Table 4. Predictors of disabling hearing loss after logistic regression

Predictor Variables	df	Sig.	Exp(B)	95% CI for EXP(B)	
Age group					
5-14yrs	1	0.006	14.57	2.14	99.44
Aetiology/causes of hearing loss					
Ear disease	1	0.001	61.55	5.60	112.82
Undetermined causes	1	0.0001	24.67	4.83	125.90

Key: df = degree of freedom; Sig. = Significance; Exp(B) = Odds ratio; CI= Confidence interval

While the global prevalence of hearing impairment (≥35dBHL) among children 5–14 years of age was 1.4% [3]. Our survey found 22.6%, Stevens et al. [3] also allude to the fact that hearing impairment prevalence increases with age but in our study the converse was true, hearing impairment prevalence decreased with age. The significance of this trend is not unconnected to sample size and the fact that majority of the adults males being bread winners, were not present for this survey. Globally, the prevalence of hearing impairment reported (using ≥35 dBHL), for males and females aged 15 years and over was 12.2% and 9.8% respectively [3]. In our study gender was not a predictor however, the prevalence for adults 15years and over was 12.5%. This was similar to but slightly higher than findings for adults in Uganda, Southern and Northern Brazil (11.7%, 6.8% and 3.8% respectively) [16-18]. More so, the prevalence for children (10.2%) in Uganda was twice as small than in our study, this can be explained by the fact that children were among the highest participants in this survey.

According to the Stevens [3] study after age-standardization, hearing impairment (≥35 dBHL) for adults aged 15 years and above, in sub-Saharan Africa was between 11.5–20.3%. Similarly, prevalence of hearing impairment (≥35 dBHL) among children, after standardization, was 1.2–3.0%. These sub-Saharan estimates are in slight agreement with our findings especially for adults (although at the upper boundary- 22.6%). Our survey prevalence (31%) is indeed high when one compares it with the estimated African range given above, this may be due to size of our overall sample as well.

Other studies have highlighted gender as a good predictor of hearing loss generally [10,17]. We did not find a statistically significant prediction using gender, same as another study in Oman [9]. The variations in these results may not be unconnected to sample size.

With regard to the causes/aetiology in this survey, ear diseases and unknown causes were strongest predictors for DHL, this also holds true in many studies especially with regard to ear diseases (Table 4). This is usually due to malnutrition, poverty, lack of access to appropriate healthcare personnel, ignorance and probably lack of established legal acts for compulsory hearing screening especially for pre-school aged children. During a screening survey in 2010, it was discovered that ear infections alone accounted for 32.4% as cause of hearing loss in a rural community [19]. Similarly, in Uganda, ear diseases alone accounted for disabling hearing loss in 17% of adult subjects and 41% of children [16]. In Australia, one study reported ear infections at age 4/5 years among their cohort to be good predictors of hearing problems at age 8/9 years especially among indigenous children [20].

In semi-urban settings where educational level may be low, it is also often difficult to recall circumstances surrounding hearing loss or the inciting event, thereby resulting in documenting causes as unknown. Similarly, infectious diseases such as Mumps, meningitis and Measles are very common causes of disabling, if not, profound hearing impairments, and / or genetic diseases; all are as a result of poverty, poor immunization uptake and lack of awareness to mention but a few, which form a large proportion of these undetermined causes of hearing loss.

Audiometric testing during field surveys has been a source of concern for many Audiologists claiming that conditions cannot be adequate. But we must appreciate, especially in LMIC that mobile soundproof booths are unaffordable and problems of access during field surveys make them an unlikely choice. Several arguments can be made regarding differences in the hearing threshold obtained in field screening and in soundproof booths, especially for epidemiological studies. However, a Hong Kong study tried to compare audiometric test results measured in non-soundproof environments at a worksite, and in a soundproof booth [21]. They found that at 4–8 kHz, the mean of the absolute differences in hearing threshold obtained by these two methods was 2 dB or less. At 4 kHz, the difference between the proportion of subjects with hearing loss as measured in the field and that as measured in the booth was the smallest. Statistically the kappa value was highest at 3 and 4 KHz. They concluded that audiometric test results conducted in non-soundproof environments in the field are comparable to those obtained in a soundproof environment as long as appropriate adjustments are made in the diagnostic criteria.

There are some limitations to this study such as; the size of this sample population may be too small to make population-based inferences but it may well have set up the foundation for future large-scale studies of this nature in resource-

constrained settings such as ours; furthermore, the fact that some hearing losses, especially conductive, are remediable while some other hearing losses are not progressive, thereby contributing to a higher prevalence as suggested in this study.

We acknowledge that the setting for hearing screening may not be ideal especially for threshold testing; therefore results may not be as accurate as using a sound-treated booth. Accurate measurements of mild hearing impairment in particular, is difficult in settings with background noise and no soundproof booth, even though our ambient noise level was kept at 40dB before every test.

In the future, it may be worthwhile to try to assess the quality of life of hearing impaired persons in these semi-urban populations and to try to find means of alleviating them by finding sustainable means of providing support services and rehabilitation to deserving vulnerable groups.

The strength of this survey lies in using the classification proposed by the GBD expert group on hearing loss, which in our opinion and most Hearing Health practitioners will agree, will identify persons with “any type” hearing loss earlier and therefore allowing for access or intervention, before it becomes disabling as against the classification currently in use. Community surveys assessing hearing loss have not been conducted in our area so every opportunity to survey communities should be utilized in order to generate much needed data to help in planning and rehabilitation.

5. CONCLUSION

This study demonstrates associations with risk factors identified by other studies. The findings suggest that age groups, aetiology of hearing loss particularly, young age and the presence of ear disease are potential indicators for the development of disabling hearing impairment / loss during rural and / or community-based surveys. Re-training of low level manpower, such as community health extension workers (CHEW) and community health officers (CHO) about simple ‘red flags and / or predictors’ with regard to disabling hearing loss, to help identify potential target groups for proper hearing screening and further care within certain populations. These variables combined signal poor prognosis for hearing acuity. So much so, that if persons with “any” level of hearing impairment associated with young age, obvious ear disease or hearing impairment, and history suggestive of any vaccine preventable diseases (such as measles, mumps, meningitis etc.) are discovered, the risk of developing disabling hearing loss is indeed, high.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sciencedomain.org/review-history.php?iid=1010&id=19&aid=8720