Original Article

Association between body mass index and hearing acuity among adults in a rural community: A preliminary survey

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Abstract

Background: The impact of adult nutrition on hearing acuity is poorly researched. This study was designed to examine relationship between nutritional status (using body mass index [BMI]) and hearing impairment.

Methods: Data from the Bayero University Ear and Hearing Health Examination Survey 2017 were used. This was a community-based, cross-sectional descriptive survey of a sample of Tofa community in Kano State. Out of 650 participants, only 103 fulfilled the criteria designed for this study. Pure tone audiometric testing was performed to assess for hearing impairment. Analysis was conducted for associations between hearing impairment and BMI.

Results: Prevalence of hearing impairment among adults in this population is 26.2%. Mean documented age of the participants was 41.6 years (standard deviation: ±18.55). Majority of the participants had low BMI, signifying underweight (n = 89; 86.4%) out of which 21 (23.5%) had a moderate-to-profound hearing loss.

Conclusion: These findings provide some evidence that adults with a low BMI (underweight) may also be at a risk of hearing impairment; however, more research is required. Adult malnutrition also deserves more attention.

Keywords: Adults, body mass index, community survey, hearing acuity, Kano

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INTRODUCTION

Hearing loss is a prevalent sensory disability that is hidden and more often than not, neglected in most developing countries,[1] which can impair communication, social interaction and adversely affect psychosocial well-being and quality of life.[2,3] Delays to medical access for hearing loss (HL) may also result in possible adverse consequences for health and longevity.[4,5] Therefore, HL can be viewed as a potential source of economic burden to individuals and their communities, and by extension affecting their social and economic development.

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Similarly, adults with HL have a much higher unemployment rate and are at risk of psychosocial and cognitive problems, as well as lack of and/or poor educational progress, social stigma and depression. Among those who are employed, a higher percentage of people with HL are in the lower grades of employment compared with the general workforce. This is further compounded by a lack of access to care and a dearth of hearing health professionals to manage this chronic disorder. Following a recent cross-sectional survey, it was estimated that the prevalence of 'disabling' HL in Kano-Nigeria is about 13.2%.[6] To this end,

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identification of potentially modifiable risk factors for HL in our environment is a laudable goal. Agreeably, diseases with modifiable risk factors can be said to be potentially preventable. This has led to a growing body of evidence reporting that higher body mass index (BMI) is associated with poorer hearing sensitivities.[2,7,8] These studies show that as the BMI moves upward from overweight to the obese category, there is a commensurate increase in the risk of HL.

Furthermore, some cross-sectional studies have reported relationships between higher levels of physical activity, higher cardiorespiratory fitness and better hearing sensitivity. They posit that physical activity has beneficial effects in the vascular endothelium of the cochlear, enhance detoxification of free radicals and reduce inflammation.[9,10] Conversely, reports also reveal that an inverse relationship exists between conditions implicated in HL such as diabetes and cardiovascular diseases with higher levels of physical activity.

However, there is limited data in our environment for studies looking at relationships between nutritional status (using BMI) and hearing impairment. Besides, in rural or semi-urban areas, where poverty has greatly affected dietary intake, malnutrition is rife. To our knowledge, studies looking at the impact of nutrition on HL among adults, particularly in a developing country such as ours, are scarce. This study therefore set out to examine the nutritional status of adults in a rural community (using BMI) and determine, if any, the relationship between this and hearing impairment as a basis for fostering integrated research for community development.

METHODS

Study population and data collection

Data from the Bayero University Ear and Hearing Health Examination Survey (BUEHHES) collected in 2017 were used for the analyses. The BUHHES is a community-wide, cross-sectional descriptive survey of a representative sample of Tofa community in Kano State, conducted by the Otolaryngology Research Group (ORG), Department of Otorhinolaryngology, Bayero University Kano, in collaboration with Tofa Youth Development Association and Tofa Local Government Area Council (LGA). Every year, one LGA in Kano State is selected by the ORG, the total number of participants in BUEHHES for 2017 was 650. These data represent the statistics of the population, based on stratified, multistage clustered sampling.

Data were excluded for the present analyses if the participants were <18 years of age (n = 166); do not provide data regarding BMI (n = 139) and hearing assessment (n = 242). As a result, only 103 participants were included in the analysis [Figure 1]. This study was approved by the Medical Department of Tofa LGA.

Sociodemographic, anthropometric and clinical data

Data collected from the participants during the ear and hearing health examination included the following: age (years), sex, BMI (kg/m^2), occupation, audiometry, cause of ear diseases and/or hearing impairment and laterality (hand dominance – right or left), as designed in the WHO Ear and Hearing disorders examination form.

BMI was calculated by dividing the total body weight in kilograms by the square of the participant's height (kg/m^2). Participants were divided into four groups according to their BMI tertiles: low tertile (≤18.4 kg/m^2 – underweight); normal tertile (18.5 –24.9 kg/m^2 – normal healthy weight); a middle tertile (25.0 –29.9 kg/m^2 – overweight) and no high tertile was recorded (≥30.0 kg/m^2 – obese). We also analysed the data using an age-based classification (18–28, 29–39, 40–50, etc.), as BMI has been reported to decrease with age.[11]

Otological physical examinations and pure-tone audiometry were performed by otolaryngologists and audiometricians, respectively. Pure-tone audiometry is considered the gold standard for HL evaluation, this was conducted in accordance with the modified Hughson–Westlake ascending technique. Therefore, in the analyses, pure-tone average (PTAv) hearing thresholds were calculated as PTAv at four frequencies (0.5, 1, 2 and 4 kHz) (Interacoustics Audiometer AD229b with TDH 39 headphones, all calibrated). For both ears of each participant, the PTAvs at 0.5 and 1 kHz were averaged to obtain the low-frequency value and those at 2 kHz and 4 kHz were averaged to obtain the mid-frequency values. We could not average for

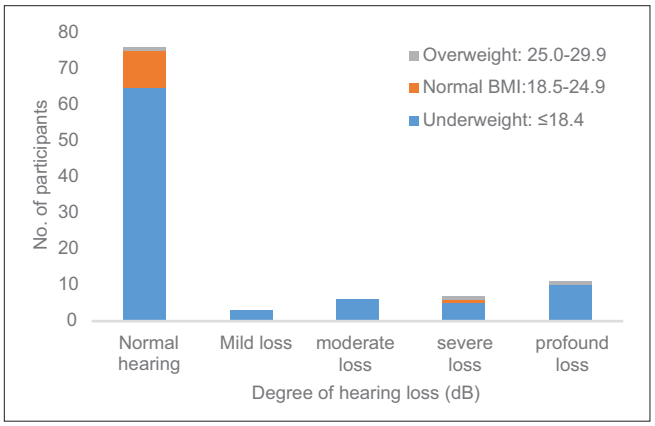

Figure 1: Chart depicting that majority of the participants were underweight

higher frequencies because the data did not have values for 6 kHz and above. Bone conduction assessment and tympanometry were not recorded as this was a screening survey. Audiometric air conduction thresholds were established separately for the left and right ear of each participant, respectively.

Hearing impairment was measured according to the WHO criteria: 25 dB or less normal hearing, 26–40 dB mild HL, 41–60 dB moderate HL, 61–80 dB severe HL and ≥81 dB is considered profound HL; while disabling HL (DHL) refers to HL >40 dB in the better hearing ear in adults (15 years or older).[12]

Potential confounding variables were factors adjudged that could be reliably elicited or determined from parental/significant other interview such as consanguinity and family history of deafness/congenital HL, which were also taken into cognizance from the dataset.

Ethical statement

This study was conducted according to the ethical principles of the World Medical Assembly revised Declaration of Helsinki (2013). All participants provided their written informed consent before participation.

Statistical analysis

The data were analysed using Statistical Package for the Social Sciences for Windows version 20 (IBM Co., Armonk, NY, USA). Descriptive statistics using Excel was used to examine demographic data, BMI and hearing thresholds at different frequencies. Chi-square (tested) crosstabs was used to explore the relationship between categorical variables, while a Wilcoxon signed-rank test for related measures was used to assess difference in the mean audiometric threshold values for the ears. $P = 0.05$ was used for evaluating statistical significance (95% confidence interval).

RESULTS

The overall prevalence of hearing impairment amongst adults in this population is 27 (26.2%). The largest participant group in this study were adults ≤50 years of age (71.9%) and 51 (49.5%) were females, giving a female-to-male ratio of 1.04:1. Mean documented age of the participants was 41.6 years (standard deviation [SD]: ± 18.55), with a minimum age of 18 years and maximum of 100 years [Table 1].

Regarding association between age of participants and their BMI, no trend between these two variables was recorded.

Table 1: Sociodemographic characteristics of the population

Variables	Total (n=103), n (%)
Sex	
Male	52 (50.5)
Female	51 (49.5)
Age groups (years)	
18-28	29 (28.2)
29-39	21 (20.4)
40-50	24 (23.3)
51-61	15 (14.6)
62 and above	14 (13.6)
Occupation	
Trader	35 (34.0)
Civil servant	12 (11.7)
Farmer	13 (12.6)
Retiree	7 (6.8)
Homemaker	24 (23.3)
Student	12 (11.7)
BMI (kg/m^2)	
≤18.4	89 (86.4)
18.5-24.9	11 (10.7)
25.0-29.9	3 (2.9)
Handedness	
Right handed	99 (96.1)
Left handed	4 (3.9)
Hearing threshold (dB)	
0-25 normal hearing	76 (73.8)
26-40 mild loss	3 (2.9)
41-60 moderate loss	6 (5.8)
61-80 severe loss	7 (6.8)
≥81 profound loss	11 (10.7)

BMI: Body mass index

Majority of the participants had low tertile scores signifying underweight (n = 89; 86.4%), out of which 21 (23.5%) had a moderate-to-profound HL (DHL) [Figure 1]. Only two (1.9%) persons were found to be in the overweight category (middle tertile) with severe-to-profound losses, the rest had normal hearing and BMI. Association between hearing impairment and the BMI variable was, however, not statistically significant (Fisher's exact test, $P = 0.295$).

Among the hearing-impaired participants, PTAv in the right ear had a minimum hearing threshold of 20 dB and maximum of 120 dB, and a mean hearing threshold of 73 dB (SD: ±28.60). While PTAv in the left ear for participants with hearing impairment had a minimum of threshold of 11.25 dB and a maximum of 120 dB, with a mean of 67.1 dB (SD: ±30.3). Test to compare the mean between the right and left PTAv thresholds in this cohort revealed no statistically significant difference in the mean of both right and left ear hearing thresholds ($Z = -1.104$, $P = 0.278$).

Regarding potential contributors to hearing impairment, 40 (38.8%) had wax, 9 (8.7%) had foreign body and 27 (26.2%) had otomycosis (fungal infection) in the ear canal.

DISCUSSION

Two-thirds of the sample population lie within the age range of 18–50 years, and their main preoccupation ranged from farming to trading, with a sizeable number of the women being fulltime homemakers. Ninety-six percentage of the participants were right handed and approximately 74% had normal hearing [Table 1].

A high BMI is a risk factor for mortality;[13] our study did not record any obese participant neither did we record any trend in age and hearing impairment in relation to the BMI tertile for either sex, as noted by Jung da *et al.*, even though they reported a trend where age decreased with an increase in the BMI tertile.[14] In that study, following further analyses and adjusted odds ratio for the risk of HL, no significant associations were found between age-related HL and BMI in their three age-based groups for either sex. While other studies have shown that BMI is positively associated with the development of age-related HL,[2,7,15] they argue that hearing threshold is related to vasculopathies in the metabolic problem and that BMI is an important marker for metabolic diseases.[16] Therefore, the increase in BMI may be related to a decrease in hearing impairment. Our contrary finding, therefore, may not be unrelated to a smaller sample size, the Hausa–Fulani genetic make-up, socioeconomic factors (as majority are peasant farmers), and the use of multiple regression analysis featuring complex sampling in the above studies, which was not included in this study.

Majority of the participants were clearly undernourished, with low tertile scores (low BMI), with nearly a quarter (23.5%) of them with a DHL [Figure 1]. A Korean study using data from the Korea National Health and Nutrition Examination Survey[17] also observed a similar finding that a low BMI (<18.5) was associated with inferior hearing, particularly with low- and high-frequency HLs, and this was more among males. Even though their definition of high frequency was higher in range, i.e., high frequency was 3, 4 and 6 kHz and mid-frequency was 3–4 kHz for our study (as we did not measure 6 kHz and there was no sex predilection among participants with a low BMI). Conversely, over the years, several previous studies have reported a high BMI ≥25 as being correlated with HL among adults and as a significant health problem,[2,7,15,18] while only few studies have reported on the relationship between low BMI (underweight) and HL.[17] Even though not significant statistically, this finding raises issues for national concern that requires a concerted government intervention.

There is evidence about the relationship between poverty, low socioeconomic status and undernutrition, and this is a major theme under the millennium development goals of the United Nation up until 2015.[19,20] Adult malnutrition does not get the required attention it needs especially among rural dwellers in most developing countries. Understandably, this stems perhaps from the fact that parents willingly sacrifice their own nutritious feeding for their children at any opportunity. It is evident that if an adult breadwinner becomes malnourished, he/she could fall ill and may be unable to perform his/her role, and in turn children and perhaps the whole household are then at risk of becoming malnourished as well. To make matters worse, in this case, DHL becomes a prominent feature with its associated stigma and these group of people are then at risk of unemployment as well.

The mean hearing thresholds for participants with hearing impairment on the right and left ears were 73.0 dB HL and 67.1 dB HL, respectively, depicting asymmetry in the thresholds, but this was not statistically significant ($P > 0.05$). Given the hypothesis of a preponderance of left-brain–hemispheric dominance with auditory hemispherical dominance for right handed people, it is expected that, the right thresholds should be better than the left among the participants, since most people use, for example, cell phone on their right ear (majority of this cohort are right handed) [Table 1].[21,22] It is therefore possible that prolonged exposure to sound on the right ear may be responsible for this higher value, judging from the present-day communication device usage; however, this is beyond the scope of this study.

Other potential contributors to HL in this survey were few and remediable, but can if left untreated, be a source of morbidity. More than half of all the participants (65%) had wax and fungal ear infection in the ear canal. Several studies have also alluded to the irritating and occlusal effects of these and their relatively high prevalence.[23-25] However, due to a lack of availability and access to ear and hearing care experts, these persons are at the mercy of the consequence of treatable causes of hearing impairment [Figure 2].

Some of the limitations of this study include a small sample size (making it difficult to make population-based conclusions), inability to ascertain causal relationships with HL status, and the degree of deterioration in the nutritional status of the participants for a period of time akin to a longitudinal study. A detailed analysis of the type and quality of food consumed by the participants was also outside the scope of this study. The effect of other confounders cannot be rule out as well, such as delayed HL, noise-related and genetic losses.

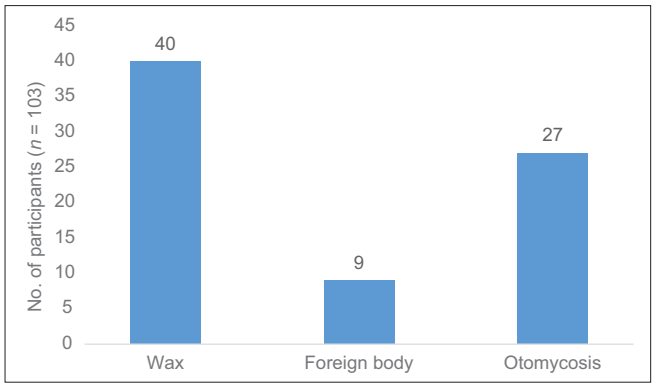

Figure 2: Chart showing other contributors to remediable hearing impairment among the participants

In the future, it will be valuable to examine the potential impact of waist circumference, or body composition analysis on hearing status using bioelectrical impedance analysis or dual X-ray absorptiometry. The causative association between undernutrition, age, sex and DHL remains unclear and merits further investigation.

CONCLUSION

Underweight adults may be at risk of hearing impairment just as evidence has shown overweight/obese adults are at an increased risk. The poor economic situation of the country also contributes to making matters worse. Malnutrition amongst adults in our environment deserves more attention, with dietary fortification, regular education of communities on diversification and food supplementation, so that inadvertently the whole community develops better nutritional indices.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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