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Hearing and sex: An analytical study

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ABSTRACT

Introduction: Auditory differences among male and female is an underexplored topic. Sex-specific process of evolution has lead to differences in the physiology of male and female. For a long time, health equity has been confronted due to unawareness among health care providers that the findings are usually derived from research conducted among male. The objective of this study was to find differences in hearing threshold among healthy male and female.

Materials and methods: This was a hospital-based cross-sectional study conducted on age-matched male and female groups. Independent student's t-test was used to compare hearing thresholds at different frequencies between males and females.

Results: There were 23 males, and 23 age-matched females recruited in the study. The mean age of male participants was 52.65±14.41 years, and that of female participants was 51.41±11.34 years. The differences in hearing threshold were not statistically significant at 250 Hertz, 500 Hertz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz and 8000 Hz of both ears. However, a higher threshold was observed in females at most frequencies.

Conclusions: Although the hearing threshold was higher among females, observed differences in the hearing threshold between males and females were not significant.

Keywords: Audiometry; hearing loss; sex

INTRODUCTION

The term sex is a biological variable that exists at the molecular to organ levels. The fundamental sex difference owes to the genetic makeup of the absence or presence of the Y chromosome that encodes for SRY genes that encode for the formation of testes. The testosterone hormone produced by testes permutes cell expression, which underlines sex-specific physiology.(1,2) The differences are from the pathophysiological and pharmacological aspects.(3) Similarly, there are differences in male and female auditory system.(4) Females have shorter cochlear length,altered micromechanics of outer hair cell (otoacoustic emission), shorter auditory brain stem response latencies, and greater activation of auditory cortical areas. For a long time, females were regarded as vulnerable subjects for unexpected fear of teratogenic risk. The one-size-fits-all practice based on researches done generally on male participants and then extrapolated to female, has been challenged. US National Institutes of Health (NIH) thus devised guidelines to endorse fair female participation in clinical trials and researches to discourage findings of male outcomes to serve as proxies for females.(5,6)

Thus, it becomes imperative to find the role of gender in the disease process to accurately assess clinical features of disease specific to sex, perhaps set up targeted treatment and establish a sex-based protocol for audiological disorders.(4) There is, in a way, a patchwork quilt quality to women's health in Nepal. For a long, this has been a neglected domain with a lack of understanding and interventions targeting the health of a female.(7) Hearing loss, which is generally considered a stigmatized trait, is more disadvantageous in the female when compared to male and needs special attention from policy makers.(8) However, few studies have considered finding an association between hearing loss and sex, especially in the Nepalese context. We conducted this study to find an association between hearing loss and gender.

MATERIALS AND METHODS

A secondary analysis of data collected at the Department of Otorhinolaryngology, Tribhuwan University Teaching Hospital was done. This was a hospital-based cross-sectional analytical study. Ethical clearance was obtained from the Institutional Review Committee (IRC) of the Institute of Medicine.Subjects with hypertension, diabetes mellitus, history of consumption of ototoxic drugs, history of ear surgeries affecting hearing, history of ear infections, history of ear and head trauma were excluded from the study to minimise confounders. Subjects with audiogram findings other than sensorineural hearing loss were also excluded. Participants were explained the details of the study methods and consenting participants were recruited.

Otoscope examination and tuning fork test (512 Hz) was conducted and the participants were then subjected to audiometric assessment to evaluate hearing status. Audiometric assessment was performed by using Amplaid 137 plus or Amplaid 177 in a sound-treated room at Audiometry Lab of the Department of ENT-Head and Neck Surgery. The test was conducted by a licensed and experienced audiologist. The audiometer was appropriately calibrated. The pure tone hearing threshold for both air conduction and bone conduction was analyzed in 250Hertz (Hz), 500 Hz, 1000 Hz, 2000 Hz, 3000 Hz, 4000 Hz, and 8000 Hz. Audiograms with the finding of asymmetrical, non-bilateral, and non-sensorineural hearing loss were excluded.The average pure tone threshold of 500 Hz, 1000 Hz, 2000 Hz, and 4000 Hz of air conduction was calculated,and it was considered pure tone average.

We used IBM SPSS Statistics for MacBook, version 23 for statistical analysis. Continuous variables were expressed in mean ± SD. Percentage and proportions were used to express categorical variables. Independent student's t-test was used to compare hearing thresholds at different frequencies between males and females. A p-value less than 0.05 was considered to be significant.

RESULTS

There were 23 males and 23 age-matched females recruited in the study. The mean age of male subjects was 52.65±14.41 years, and that of females was 51.41±11.34 years (p= 0.75). The age range of males was 28 - 73 years, and females ranged from 30 - 71 years. Out of a total of 46 subjects, 14 subjects were elderly of age group more than 60 years.

Overall, the hearing threshold was higher in females in both the ears, but all the differences were found to be not statistically significant (Tables 1 and 2, Figures 1 and 2).

Table 1: Comparison of the hearing threshold of the left ear between male and female

Hearing frequency (Hertz, Hz)	Hearing threshold of male (dB)	Standard deviation	Hearing threshold of female (dB)	Standard deviation	p-value
250	14.38	5.49	15.227	6.80	0.63
500	13.69	5.04	13.86	7.05	0.91
1000	15	6.74	13.86	7.05	0.58
2000	13.69	7.86	15.68	9.28	0.44
3000	16.95	8.35	20.45	8.43	0.17
4000	22.17	11.75	23.18	13.58	0.79
8000	30.00	11.67	33.40	17.27	0.44

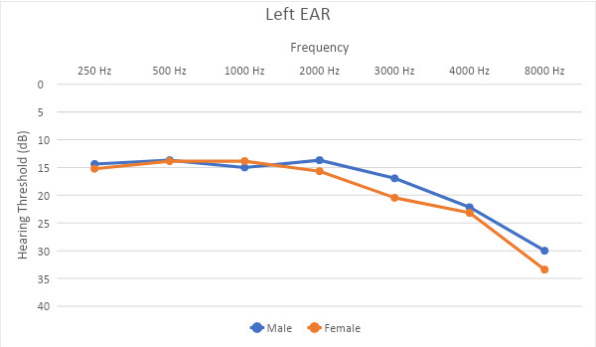

Figure 1: Comparison of the hearing threshold of the left ear between male and female

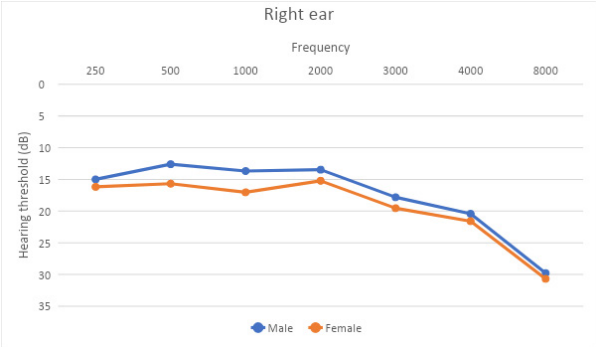

Figure 2: Comparison of the hearing threshold of the right ear between male and female

Table 2: Comparison of the hearing threshold of the right ear between male and female

Hearing frequency (Hertz, Hz)	Hearing threshold of male (dB)	Standard deviation	Hearing threshold of female (dB)	Standard deviation	p-value
250	15.00	5.22	16.18	4.76	0.23
500	12.61	4.22	15.68	6.77	0.74
1000	13.69	4.81	17.04	8.11	0.09
2000	13.47	5.92	15.22	7.15	0.37
3000	17.82	8.50	19.54	8.00	0.48
4000	20.43	11.76	21.59	13.92	0.76
8000	29.78	17.15	30.68	14.74	0.85

DISCUSSION

On examining the hearing status of the participants, we did not find gender differences in the hearing threshold. This finding was supported by the preceding study by Asghari et al., conducted in Iran, who also did not find any significant gender differences in the prevalence of hearing loss. (9) Hearing impairment prevalence did not significantly correlate with gender according to the study's multiple regression model, which included age and sex as variables. Females had a higher pure tone threshold than males, in accordance with a study by Amedofu et al.(10) Yet in most studies, males had significantly poorer pure tone audiometry threshold than females.(11–13) Based

on the Framingham cohort study, gender did not appear to affect changes in hearing with age, but males showed greater changes in hearing.(14)

Kim et al. reported that males often experience a greater change in the hearing threshold above 2000 Hz with ageing.(15) A possible reason for worse hearing sensitivity in males could be to higher chances of noise exposure. Park et al. and Kim et al did not include subjects with a history of noise exposure, yet pure tone audiometric findings of males were more afflicted.(12,15) Jerger et al argue of "gender reversal ", which is that females have better hearing sensitivity at frequencies above 2000 Hz accompanied by poorer hearing capacity at frequencies below 1000 Hz.(13) At 250 Hz, gender differences were most noticeable, while no gender difference was found at 1000 Hz. Participants were over 50 years old.The hearing threshold of males and females in the non-noise exposed group was compared in order to rule out the possible effects of noise. At 2-4 Khz, hearing sensitivity was better in males versus overall, but gender reversal remained. Women with low-frequency hearing loss have been referred to as metabolic presbycusis. Poor blood flow causes atrophy of the stria at the apex because of metabolic presbycusis.

Findings from a study by Park et al12 demonstrated that gender differences in hearing threshold change due to ageing was maximum at 4000 Hz.(12) This was contested by Kim et al who observed the largest hearing threshold change due to ageing at 8000 Hz.(15) we could not analyze the association of gender and change in hearing threshold due to age. This could be a novel approach in understanding the role of gender in hearing. The Baltimore Longitudinal Study of Ageing recruited 681 white males and 416 white females to find an association between age-related hearing loss and gender. The study revealed that a) decline in hearing sensitivity was twice as fast in males throughout all ages and frequencies; b) by the age of 30, degradation in hearing capacity was observed in men throughout all frequencies from 500 Hz to 8000 Hz; and c) hearing capacity was better in women at frequencies greater than 1000 Hz. However, men had better hearing at frequencies below 1000 Hz.(16) Hedestierna et al. suggested that estrogen might have a protective role against hearing loss.(17) Theauthor reported that the hearing threshold was poorer in postmenopausal women withouthormone replacement therapy (HRT) when compared with peri-menopausal women or postmenopausal women with HRT. But the significant difference was noted only at 2,3 and 8 KHz. A similar dip in audiometric findings at 2 and 3 kHz is often noted in hypogonadal females with Turner syndrome. A turner mouse was studied for ear problems showed swollen stria vascularis and dilated nerve endings of afferent nerves. The study also mapped the presence of estrogen receptors in the inner ear. (18) Truner mouse showed a greater increase in hearing threshold with an increase in age when compared with healthy control.(19) Kiligdac et al. found that postmenopausal women on estrogen therapy had statistically better air conduction thresholds than control postmenopausal women on low frequencies (250 Hz, 500 Hz, 1000 Hz, 2000 Hz).The postmenopausal women on estrogen therapy had significantly better hearing than the postmenopausal women on combined hormonal therapy on higher frequency (4 KHz, 6 KHz, 8 KHz, 10 KHz, 12 KHz, 14 KHz, 16 KHz) testing. Authors suggested that progesterone may have an attenuated effect ofestrogen on hearing.(20) A longitudinal study was done on 20 healthy women to evaluate hearing status during different phases of the menstrual cycle showed that the hearing threshold was increased in the luteal phase with 20% of the participant with abnormal audiological findings during the luteal phase compared to none during the follicular phase.(21) Women during the menstrual cycle were also investigated to see if hearing thresholds changed.Findings indicated premenopausal women taking oral contraceptives (OCP) had better hearing thresholds when compared with women who were not taking OCP and males. A significant decrease in the hearing threshold was seen during the early follicular and late luteal phases in females, when the pure tone threshold was high. This phenomenon was not replicated in controls.(22)

The current study did not align with the majority of findings on literature, which could be due to the role of other possible confounders such as menstrual cycle, nutritional state, and genetics. Using auditory brainstem response data from 40 healthy Nepalese women, Upadhyay et al. explained that hearing improved during the post-ovulatory phase, that progesterone better modulates hearing. (23) In the context of very few similar studies have been conducted in Nepal, this research might add some knowledge to the existing understanding of the association of sex hormones and the auditory system.The current study had some limitations

related to the small sample size due to the nature of the study. Classification of subjects according to age groups, longitudinal study to find the role of multiple confounders on gender differences in hearing might help us draw better conclusions.

CONCLUSION

There was a higher hearing threshold in females, but we did not find a significant difference in hearing thresholds between the sexes. Such a finding is important for devising policies related to disability ratings for males and females.

CONFLICT OF INTEREST

None.

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