Original Article

Association between Refractive Error and Hearing Function Threshold among Spectacles Users

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ABSTRACT

Aim: To investigate the correlation between refractive errors and sensory deficits by assessing the hearing thresholds of spectacle users.

Study Design: Cross-sectional study.

Duration and Setting of the Study: The duration of the study was 6 months. The study was conducted at the Sultana Foundation and the Isra University Islamabad Campus.

Methods: A non-probability purposive sampling technique was used for participant selection. Inclusion criteria were age 18 to 25 years, current use of spectacles for any refractive error, and willingness to provide informed consent. Exclusion criteria included a history of ear surgery, head trauma, neurological disorders, active ear infections, use of hearing aids, or congenital hearing loss. Individuals who met the inclusion criteria were interviewed using a self-designed, close-ended questionnaire and their responses were recorded. Otoscopy was performed to examine the status of the ear canal and tympanic membrane. Pure-tone audiometry was conducted for hearing assessment. Refractive error type was determined from the glasses through lensometry. Retinoscopy and subjective refraction were performed by an optometrist. After data collection, the data was pooled, cleaned, and analyzed using SPSS software.

Results: Out of 250 participants, the right ear otoscopy examination shows 89.6% normal External Auditory Canal (EAC) and Tympanic Membrane (TM), 9.2% occluded EAC with wax TM not visible, and 0.2% perforated TM. The left ear otoscopy examination shows 90.0% normal EAC and TM, 9.6% occluded EAC with wax TM not visible, and 0.4% perforated TM. The right ear PTA results show 65.6% normal hearing, 14.4% Conductive Hearing Loss (CHL), 18.4% Sensorineural Hearing Loss (SNHL) and 1.6% have Mixed Hearing Loss (MHL). The left ear PTA results show 68.0% normal hearing, 12.0% CHL, 18.0% SNHL and 2.0% have MHL.

Conclusion: Refractive error was not associated with hearing loss. Other confounding factors may be responsible for their hearing loss.

Keywords: Hearing Thresholds; Hearing Assessment; Spectacle Users.

INTRODUCTION

Hearing and vision are two of the most crucial senses that cooperate to assist us in understanding the environment we live.[1] When there is a disturbance in the sound pathway from the outer ear to the brain, it might lead to hearing loss. The hearing loss is either sensorineural or conductive, and the interruption can occur at any point, either before or after the cochlea. A hearing loss is classified as mixed if it affects both the pre- and post-cochlea sites. It can be acquired at any point after birth or present from birth. Either one or both ears may experience it. It may be short-term or long-term. Hearing impairment is caused by a variety of factors. More than half of hearing loss in children is due to hereditary factors, which are the most prevalent. There are many non-syndromic genetic hearing loss in which patients experience hearing loss but their other functions remain intact.[2] Genetic

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causes include several diseases that have hearing loss as one of their characteristics.

People require glasses due to a common condition known as refractive error, which causes eyesight blurriness.[3] Refractive errors are of following types. Astigmatism, myopia and hypermetropia.[4]

Because the vestibular and visual systems cooperate to stabilize vision, vestibular illnesses frequently result in visual difficulties.[5] The Vestibulo-Ocular Reflex (VOR) is the term used to describe the relationship between the ear and the eye. When the head is moving, the VOR plays a crucial part in maintaining eye movements to counteract the head movement and maintain focus on the object of our attention.[6] Bilateral vestibular dysfunction patients are unable to make eye movements that completely compensate for passive head rotations, such as those made when driving or walking.[7]

People with visual impairment had lower mean audiometric thresholds across all frequencies than people without visual impairment, according to a University of Sydney Human Research Ethics Committee cohort research on the relationship between vision and hearing. The prevalence of hearing loss rises with each individual decline in best-corrected and exhibiting visual acuity. Hearing loss was also more common in older adults with visual impairment.[8] This Scientific Reports study demonstrated that auditory spatial attention is influenced by gaze direction. When participants looked away from sound source, their auditory processing was less efficient indicated by slower reaction times and increased neural effort. This supports the concept that auditory and visual systems work in tandem, especially in spatial attention tasks.[9] A study was conducted in University of Nebraska Medical Center examined Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) among a group of 576 older people seen at the University of Nebraska Medical Center. Vision impairment was defined as a visual acuity of 20/70 or less, and hearing was measured by a whisper test. In this study, 51% of subjects were classified as having a hearing impairment only; 5% had a vision impairment only. Participants with sensory impairments showed diminished functional status as measured by ADL and IADL. Those with combined vision impairment and hearing loss demonstrated the greatest differences in functional status. The sample was not population based.[10]

The purpose of this study was to investigate any possible co-relationship between refractive errors and sensory deficits by assessing the hearing thresholds of spectacle users of age group 18 to 25 years old.

METHODS

A cross-sectional study design was employed to investigate the association between refractive error and hearing function. The sample size was calculated using the Raosoft sample size calculator based on a study population of 710 individuals at the study setting, resulting in a required sample size of 250 participants. A non-probability purposive sampling technique was used for participant selection. Inclusion criteria were age between 1825 years, current use of spectacles for any refractive error, and willingness to provide informed consent. Exclusion criteria included a history of ear surgery, head trauma, neurological disorders, active ear infections, use of hearing aids, or congenital hearing loss. Ethical approval was obtained from the Ethical Committee of Pakistan Institute of Rehabilitation Sciences and the Principal of Sultana Foundation. After informed consent, participants were interviewed, and their answers were recorded using a self-designed, closed-ended questionnaire. Participants answer to the questionnaire and the findings of hearing tests were the main outcome variables. We performed otoscopy on each subject to examine the EAC and TM. Pure-tone audiometry was used to measure hearing thresholds by using a Beltone Model 110 audiometer. Participants with reduced air conduction thresholds were further evaluated using bone conduction testing. Those with normal bone conduction thresholds were classified as having conductive hearing loss, those

with elevated bone conduction thresholds and an air-bone gap of less than 10 dB were classified as having sensorineural hearing loss and those with an air-bone gap greater than 10 dB were classified as having mixed hearing loss. Refractive error type was determined from the glasses through lensometry. Retinoscopy and subjective refraction was performed by an optometrist.

Following data collection, the Statistical Package for the Social Sciences (SPSS), version 21, was used to pool, clean, and analyze all the data. For establishing association chi square test was used. The data was compiled using descriptive statistics.

RESULTS

A total of 250 participant participated in the study. Age range was 18 to 25 year and male participants were 55%. Age 18 had the largest presence (22.4%), followed by age 19 (15.2%). 24% of participants had part-time employment, whilst 76% of participants were full-time students.. Of the participants, 63% had myopia and 43% had hypermetropia. Duration of using spectacles for one to three years was 52%. In noisy environments, nearly half of the participants (46%) said they had trouble hearing. 16% of the participants had a history of ear infections. 13.2% of participants said they had experienced trauma or a head injury in the past. In participants using spectacles for myopia, 66.2% had normal hearing and 33.8% had hearing loss. Among hyperopia users, 64.5% had normal hearing and 35.5% had hearing loss.

Table 1: Duration of spectacle usage

Duration	Frequency
Less than 1 year	20
1 to 3 years	130
4 to 7 years	57
8 to 11 years	31
12 to 15 years	10
More than 15 years	2
Total	250

Right ear otoscopic findings revealed that 89.6 % had a visible TM, while 9.6% had a non-visible TM and 0.8% had a perforated TM. In the left ear, 90% had a visible TM, 9.6% had a non-visible TM, and 0.4% had a perforated TM. Pure tone audiometry of the right ear showed normal hearing in 65.6% of subjects, with 14.4% presenting CHL, 18.4% SNHL, and 1.6% mixed hearing loss. PTA results of the left ear indicated 68% normal hearing, 12% CHL, 18% SNHL, and 2% MHL.

Table 2: Right ear hearing thresholds with refractive error

PTA Right Ear	Reason for spectacles		Total
	Myopia	Hyperopia	
Normal	104	60	164
Conductive HL	25	11	36
Sensorineural HL	26	20	46
Mix HL	2	2	4
Total	157	93	250

HL=Hearing Loss, PTA= Pure-ToneAudiometry

Table 3 Left ear hearing thresholds with refractive error

PTA Left Ear	Reason for spectacles		Total
	Myopia	Hyperopia	
Normal	105	65	164
Conductive HL	21	09	36
Sensorineural HL	28	17	46
Mix HL	3	2	4
Total	157	93	250

HL=Hearing Loss,PTA=Pure-ToneAudiometry

DISCUSSION

This study aimed to test the hypothesis that refractive errors may be associated with hearing impairment. However, the findings did not support this assumption. Our results revealed no significant association between refractive errors and hearing impairment. Non-probability purposive sampling was used in this study, which causes biasness and limits the generalizability of the results.

The result of our study presents that the spectacle users with normal hearing thresholds are about 66.8% and 13.2% participants had wax in ears, so they show mild HL, it's thought to get better after the removal of wax. Participants with SNHL are about 18.2% and MHL is only 1.8 %. Based on results it is decided that may other confounders are causing hearing loss in

spectacle users i.e, Noise exposure, genetic factor, congenital HL and we are not sure to say that their HL is due to visual impairment. As in small duration of time we cannot confirm the hypothesis but according to our study we concluded that the 70% spectacle users have normal hearing.

In a clinical case series conducted by Gogate et al. involving 901 hearing-impaired students aged 4 to 21 years from 14 special education schools, it was found that nearly a quarter (24%) had ocular issues, with refractive errors being the most prevalent (18.5%). Alarmingly, only a small fraction of those affected were using corrective spectacles at the time of presentation. The study also identified other visual conditions such as strabismus (1.3%) and retinal pigmentary dystrophy (0.6%). Importantly, after appropriate interventions, including refractive correction and low-vision aids, the number of students with significant visual impairment (visual acuity <20/80) dramatically decreased. These findings highlight the critical need for routine visual screening in hearing-impaired children, given their increased reliance on visual input to compensate for auditory deficits.[11]

Han et al. did a study to explore the risk factors of refractive errors in hearing-impaired children, involving 500 students aged 612, and reported that refractive error rates were significantly higher in hearing-impaired children, increasing with age, and more common in girls than boys (P<0.05). Genetic factors such as a family history of inbreeding were strongly associated with higher refractive error rates, reaching up to 33.3% (P<0.05, OR=1.514). Additionally, environmental factors including excessive screen time, poor reading posture, insufficient sleep, and lack of outdoor activities were identified as modifiable risks. Left-behind children, who often lack parental supervision, were especially vulnerable. These findings are consistent with previous literature emphasizing the role of both genetic and behavioral factors in myopia development. Protective measures such as regular eye checkups and more than one hour of daily outdoor activity were shown to have a significant preventive effect.[12]

Kangari et al.[13] evaluated 79 hearing-impaired studentsaged 720 years and found that 40.5% had at least one type of refractive error, with astigmatism being the most common (36.7%), followed by amblyopia (15.1%). Latent strabismus (heterophoria) and exophoria were also highly prevalent, affecting 88.6% and 81% of students respectively. Furthermore, amblyopia showed a significant correlation with the severity of hearing loss (P=0.026), highlighting the compounded impact of dual sensory deficits. These results are consistent with previous findings from studies conducted in India and Nepal, which have similarly reported high ocular morbidity in hearing-impaired children, particularly uncorrected refractive errors and strabismus. The inability of these children to effectively communicate their visual difficulties and their increased reliance on vision for communication further underscores the importance of routine ophthalmic screening in this vulnerable group. [13]

As emphasized by Sloan-Heggen et al.[14] early ENT and audiology evaluations, speech and language therapy, and annual ophthalmologic and genetic assessments are critical for comprehensive care. Genetic counseling is strongly recommended, as the syndrome follows an autosomal recessive inheritance pattern, with a 25% recurrence risk among siblings. When SLITRK6 variants are known in a family, carrier testing and prenatal diagnosis can be offered.[14]

Our findings are consistent with the conclusions drawn by Al-Saif et al.[15] in Saudi Arabia, who conducted a cross-sectional study on 40 male students aged 13 to 22 years, including those with visual impairment, total blindness, and normal vision. They reported no statistically significant difference in hearing thresholds between blind/visually impaired students and those with normal vision (P = 0.829), and

interestingly, found the lowest hearing thresholds in the totally blind group.[15]

In contrast to the current study, which found no significant association between refractive errors and hearing thresholds in spectacle users aged 18 to 25 years, Nartey et al.[16] did a comparative study in Ghana among school-aged children demonstrated a markedly higher prevalence of refractive errors in hearing-impaired children (29.6%) compared to those with normal hearing (8.8%). While the current study concluded that hearing loss among spectacle users was largely due to unrelated factors such as cerumen impaction or sensorineural loss without direct linkage to vision status, the Ghanaian study found a statistically significant albeit weak positive correlation between visual acuity and hearing status ($r = 0.249$, $p = 0.01$), indicating that hearing-impaired children are more prone to visual dysfunctions.[16]

The current study, which found no significant relationship between refractive errors and hearing thresholds in young adult spectacle users. Ostadimoghaddam et al.[17] reported a cross-sectional study conducted in Mashhad, Iran. It demonstrated a significantly higher prevalence of ocular conditions including hyperopia, amblyopia, and strabismus among hearing-impaired children compared to their normally hearing peers. Specifically, the Iranian study reported that hyperopia was significantly more prevalent in the hearing-impaired group (57.15%) than in controls (21.5%) and amblyopia was detected in 12.2% of deaf participants versus only 1.2% of controls. While the Iranian findings suggest a strong association between hearing loss and visual disorders during childhood, the absence of a similar trend in the present study may be due to differences in age groups, syndromic comorbidities, and developmental stages. The present study involved non-syndromic young adults (1825 years) and excluded congenital syndromes such as Usher syndrome, possibly accounting for the lack of overlap between sensory impairments.[17] Another study reported nearly 48.7% chance of ocular abnormality in hearing impaired and deaf students.[18]

The current study evaluated hearing thresholds among 250 spectacle users and found that sensorineural hearing loss (SNHL) was present in 18.4% of the right ear and 18% of the left ear, with myopia being the predominant refractive error associated with hearing loss. When comparing our findings with those from a cross-sectional study in Mashhad, Iran,[19] involving 254 hearing-impaired children and 506 controls, several similarities and differences are evident. In the Mashhad study, hyperopia was more prevalent among hearing-impaired children (57.15%), while myopia was less common (5.5%) than in normal children (11.9%). In contrast, our study found myopia to be more prevalent among those with SNHL, highlighting a different pattern of refractive error among spectacle users. This difference could be attributed to sample characteristics, as our study included only those already using corrective lenses, biasing toward myopia, which typically requires earlier and more noticeable visual correction. Moreover, the Mashhad study reported significantly higher rates of amblyopia (12.2%) and strabismus (3.1%) in hearing-impaired children compared to controls, supporting the notion that ocular morbidities are more frequent in children with hearing deficits.[19] A study conducted in Nepal reported refractive error as the most common association (14.94%) in children with hearing impairment.[20]

CONCLUSION

This study concluded that there is no significant association between refractive errors and hearing impairment. However, the method used for assessment lacked standardization. Additionally, the use of non-probability purposive sampling introduced bias, which may have influenced the results.

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Authors' Contributions:

RM: Conceptualization and design of the study, drafting, review and final approval of the final manuscript and agrees to be accountable for all aspects of the work.

SB: Data acquisition, review and approval of the final manuscript and agrees to be accountable for all aspects of the work.

NS: Data analysis, review and final approval of the final manuscript and agrees to be accountable for all aspects of the work.

SH: Data interpretation, review and final approval of the final manuscript and agrees to be accountable for all aspects of the work.

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