

The Relationship of Tinnitus with Cognitive Impairment in Normal Hearing Individuals

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ABSTRACT

Objective: To determine the impact of tinnitus on cognitive impairment in normal hearing individuals.

Patients and Methods: This cross-sectional study was conducted at the ENT department of Railway Hospital, Rawalpindi from 1st March 2016 to 1st January 2017. A total of sixty (n=60) patients of both gender between age 18 to 50 years, who had normal hearing (clinically examined by tuning fork test and later on confirmed by pure tone audiometry) with history of unilateral or bilateral tinnitus of more than 3 months' duration were included in the study. Mini mental state examination scale was used to assess cognition.

Results: There were 42% (25/60) males and 58% (35/60) females in the study sample. A total of 53.33% (n= 32) patients were identified with impaired cognition, of which 65.62% (n=21/32) patients were found with mild cognition while 34.38% (n=11/32) patients were found to have severe cognitive impairment. Moreover, it was also observed that the cognitive impairment was more prevalent in people of younger age group ($P<0.05$), office workers ($P<0.05$) and people living in urban area ($P<0.05$).

Conclusion: A significant percentage of patients with tinnitus of more than 3 months' duration were found to have impaired cognition and was more prevalent in people of younger age group, office workers and people living in urban areas.

Key words: Examination, Impaired cognition, Mini mental state, Tinnitus.

Author's Contribution

^{1,2} Conception, synthesis, planning of research and manuscript writing
Interpretation and discussion Data analysis, interpretation, manuscript writing and Active participation in data collection

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Introduction

Tinnitus, defined as the perception of sound in the absence of corresponding auditory stimulation, is a widespread phenomenon. Estimates of the incidence of tinnitus in the general population vary widely.¹ In one of the local study conducted, it was reported that most patients of tinnitus were seen between age of 40 to 60 years and 76.6% patients were male. Hearing loss accompanied tinnitus in 90% patients and 53% patients had tinnitus of moderate intensity.² Tinnitus sufferers frequently struggle with difficulty in sleeping, irritability, and cognitive deficits.³ Tinnitus patients also show

cognitive bias in the way they handle information. Such information processing style suggests either depressive functioning, or anxious vigilance, or both.^{4,5} Some experimental research has appeared in the last few years that have confirmed effects of tinnitus on aspects of selective or divided attention and working or long-term memory.^{6,7} In a recent study Muhammad N et al described that tinnitus impairs working memory, executive attention and selective attention. They also concluded that tinnitus does interfere with working memory and reduces cognition that needed to perform tasks that require

voluntary, effortful or strategic control.⁸ The Mini-Mental State Examination (MMSE) is the most frequently used brief cognitive instrument to track individuals at risk for, or affected by, disorders that impair cognition.^{9,10} Despite significant limitations, the Mini Mental State Exam remains the most frequently used cognitive screening instrument. Its best value in the community and primary care appears to be for the purpose of ruling out a diagnosis of cognitive disorder.¹¹ It is quite evident that the emotional and cognitive effects of tinnitus have a significant impact on patients, their families and their job and merit thorough investigation. Present study was designed to investigate the effects of tinnitus on cognitive functions among our local population. The primary aim of present study was to determine the impact of tinnitus on cognition impairment in normal hearing individuals.

Patients and Methods

This cross-sectional study was conducted at the ENT department of Railway Hospital, Rawalpindi from 1st March 2016 to 1st January 2017. Sample size was calculated through WHO calculator by taking prevalence of tinnitus in general population 17.5%, confidence interval 95% and absolute precision 10%.¹² Calculated sample size was 56 individuals. A total of 60 patients were inducted to exclude the possibility of dropouts. Patients of both gender between ages 18 to 50 years, who had normal hearing (clinically examined by tuning fork test and later on confirmed by pure tone audiometry) with history of unilateral or bilateral tinnitus of more than 3 months' duration were included in the study. Tuning fork test was done on these subjects in a silent room to evaluate the hearing of each ear to confirm the normal hearing of study participants. Mentally handicapped patients were excluded from the study. Mini mental state examination scale was used to assess cognition. Selected patients were interviewed after explaining the study and taking their consent. Mini Mental State Examination (MMSE) questionnaire used to perform this task. MMSE is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. Each assessment area had score to award. The maximum score is 30. A score of ≥ 24 showed no cognitive impairment. A collective score < 24 and ≥ 18 is indicative

of mild cognitive impairment while a score less than 18 is indicative of severe cognitive impairment. All the demographic data and questionnaire results noted on the predesigned preformed and statistical analysis of data was performed using SPSS-version 22. Results were stratified according to demographic profile like age, gender, occupation etc. Chi-square and Fisher exact test (where single cell frequency was < 5) were applied to assess the significance of difference. $P \leq 0.05$ was considered statistically significant.

Results

Among 60 patients, 42% (25) were males and 58% (35) were females. Total of 53.33% (n= 32) patients were identified with impaired cognition, out of which 65.62% (n=21/32) patients presented with mild cognition while 34.38% (n=11/32) patients were found to have severe cognitive impairment. Demographic detail of participants is presented in table 1.

Table 1: Demographic characteristics of participants (n=60)

Characteristics	Frequency	Percentage
Age (Years)		
18-36	41	68.3
37-50	19	31.7
Gender		
Male	25	42
Female	35	58
Occupation		
Office worker	18	30
Factory worker	12	20
Miscellaneous	30	50
Residence		
Rural	18	30
Urban	42	70

As shown in table 2, age, gender and residence had shown significant effect on the level of cognition in respondents. (P value < 0.05).

Discussion

The field of cognitive neuroscience has expanded rapidly, investigating the neural underpinnings of human cognitive activity. Until recently, the role of cognitive functioning has been neglected to a large extent in tinnitus research. People with tinnitus report subjective difficulties in mental concentration and psychological treatments for tinnitus

usually emphasize on concentration difficulties and how to manage them.^{9,13} It is likely that tinnitus disrupts the processing of information and memory system, that monitors the process of interpretation.^{14, 15} Research is ongoing to explore causal relationship between cognition and tinnitus.

Table 2: Cognition level among different classes of respondents (n=32)

Variables	Mild Impairment n (%)	Severe Impairment n (%)	p-value
Age (Years)			<0.05
18-37	16 (76.2)	05 (45.5)	
37-50	05 (23.8)	06 (54.6)	
Gender			<0.05
Male	10 (47.6)	05 (45.5)	
Female	11 (52.4)	06 (54.5)	
Occupation			<0.05
Office worker	11 (52.4)	01 (09.1)	
Factory worker	02 (09.3)	03 (27.3)	
Miscellaneous	08 (14.3)	07 (36.4)	
Residence			<0.05
Rural	09 (42.9)	01 (09.1)	
Urban	12 (57.1)	10 (90.9)	

Results of present study showed that a total of 53.33% (n= 32) patients were identified with impaired cognition, of which 65.62% (n=21/32) patients were with mild cognition while 34.38% (n=11/32) patients were found to have severe cognitive impairment. Moreover, it was also observed that the cognitive impairment was more prevalent in people with younger age group ($P<0.05$), office workers ($P<0.05$) and people living in urban area ($P<0.05$). Our results are comparable with the recent researches on the subject. In a recent systematic review on experimental outcomes of studies exploring the impact of tinnitus upon cognitive function and their implications for clinical management of invasive tinnitus, authors reported that tinnitus impairs cognitive function by way of impact upon executive control of attention. Authors emphasized that clinical management of patients reporting tinnitus and cognitive difficulties requires an understanding of the reciprocal relationship between tinnitus and cognitive function, with additive effects of

other psychiatric and somatic disorders.¹⁶ In studies on reaction time, it is assumed that shorter reaction times to tinnitus related sounds reflect preferential processing of the tinnitus signal.¹⁷ Hallam et al. used a range of neuropsychological tests, and added complexity by presenting them under single and dual task conditions. The authors concluded that cognitive inefficiency in tinnitus patients is related to control of intentional processes, in line with the habituation model.³ In contrast. Waechter S found no differences in terms of cognitive performances between individuals with tinnitus compared to individuals without tinnitus. They concluded that hearing impairment might be the possible confounder in previous studies on hearing-impaired subjects with tinnitus.¹⁸ In another study aimed to investigate the possible impact of tinnitus on the performance of challenging cognitive tasks reported that tinnitus sufferers were no more depressed nor anxious than controls, but they performed less well on both cognitive tasks.¹⁹ Andersson G et al investigated cognitive interference caused by tinnitus, by means of a modified version of the Stroop color-word test. The performances of tinnitus patients and healthy controls with normal hearing were compared on three versions of the Stroop test: the original version, a modified version including physical-threat words, and a tinnitus version for which tinnitus words (descriptors of tinnitus; e.g., peep) were derived empirically. Results showed that tinnitus patients performed significantly slower on all test conditions. In conclusion, the results indicate that tinnitus patients have impaired overall cognitive performance.²⁰ It has been reported in a recent systematic reviews that cognitive behavioral therapy which uses relaxation, cognitive restructuring of the thoughts and exposure to exacerbating situations resulted in a significant improvement in depression score in six studies and quality of life (decrease of global tinnitus severity) in another five studies.^{21,22} In a very recent study Ahmed B, et al investigated the moderating role of gender between perception of tinnitus and psychological adjustments in Pakistani tinnitus patients and reported that females were more prone to anxiety than males. Depression is also perceived more by female tinnitus patients.²³

The limitation of our study is relatively smaller sample size, limited availability of time and resources etc. that will

be overcome in next upcoming researches. We recommend further case control or cohort studies are required in order to establish a definite causal relationship between tinnitus and cognition in normal hearing individuals as well as further studies with larger population are needed to evaluate pathophysiology of cognitive functions and to know that why these functions impair due to tinnitus.

In summary, based on present study results and based on the literature review on the subject the evidence is convincing that tinnitus impairs cognitive function likely by way of impact upon executive control of attention. Clinical management of patients reporting tinnitus and cognitive difficulties requires an understanding of the reciprocal relationship between tinnitus and cognitive function, with additive effects of anxiety, depression, and somatic cognitive bias. Cognitive behavioral therapy reported to have a positive impact on overall quality of life. We recommend further studies to establish the impact of advancing age, hearing loss, anxiety, depression, tinnitus duration and distress upon cognitive function in people with invasive tinnitus.

Conclusion

A significant percentage of patients with tinnitus of more than 3 months' duration were found to have impaired cognition, which was more prevalent in people of younger age group, office workers and people living in urban areas. Outcomes of the study do serve as an understanding of cognitive ailments among tinnitus patients in our local population and will further help the clinicians to recognize and treat them at an earlier stage.

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