International Journal of Health Sciences and Research
Vol.14; Issue: 1; January 2024
Website: www.ijhsr.org
Original Research Article *ISSN: 2249-9571*

Hearing Aid Usage and Its Influence on Cognitive Functions Among Older Adults with Age-Related Hearing Loss

Susmitha C.G[1], Sreevidya R[2], Dhanya S Raj[3]

[1]Assistant Professor, Department of Audiology, Samvaad Institute of Speech and Hearing, Bangalore
[2]Assistant Professor, Department of Audiology, Samvaad Institute of Speech and Hearing, Bangalore
[3]Clinical Audiologist, Sheikh Manaa Bin Hasher Al Maktoum Polyclinic, Dubai

Corresponding Author: Susmitha C.G

DOI: https://doi.org/10.52403/ijhsr.20240119

ABSTRACT

Aim: The current study aimed to analyze the cognitive skills of older adults with age-related hearing loss and the difference in cognitive functions between hearing aid users and non-users among older adults with age-related hearing loss using the Montreal Cognitive Assessment (MoCA)
Method: A total of 90 subjects participated in the study, the control group had 30 normally hearing older individuals, the unaided group had 30 older individuals with hearing loss who were non-users of hearing aids, and the aided group had 30 older individuals with hearing loss who are hearing aid users for more than 2 years. They were further divided into three sub-groups namely Group A:55-60 years, Group B:61-65 years, and Group C: 66-70 years. MoCA is a brief and rapid screening instrument for mild cognitive dysfunction that assesses various cognitive domains like naming, memory, etc. MoCA was administered to all the participants and the results were analysed.
Results: The results indicated that normal-hearing participants had better cognitive scores compared to hearing-impaired individuals. Among the hearing-impaired group, the hearing aid users performed better on cognitive tasks as compared to the non-users which indicated the good impact of hearing aids on cognitive-based skills in the older age. Among the cognitive tasks, it was found that the 'delayed recall' task was difficult for all three groups.
Conclusion: Hearing aids have a positive influence on the cognition of older adults with age-related hearing loss. It is important to incorporate cognitive tasks during the rehabilitation of older adults with hearing loss.

Keywords: Cognitive functions, age-related hearing loss, older adults, MoCA, hearing aids

INTRODUCTION

Age-related hearing loss (ARHL) is one of the most common chronic health conditions affecting elderly individuals. ARHL is an invisible handicap characterized by reduced auditory sensation due to hearing loss, degradation of auditory perception resulting in decreased speech understanding, and changes in non-auditory structures that are responsible for memory, attention, and executive functioning [1]

ARHL is associated with defective underlying mechanisms at the neural, genetic, and molecular levels leading to innumerable behavioral manifestations along with poorer cognitive performance in older adults, and may be a risk factor for accelerated cognitive decline. Hearing loss has been associated with greater declines in cognitive function in older adults than in their counterparts without hearing loss. This link between hearing impairment, cognitive performance, and incident dementia has led

epidemiologic researchers to suggest that hearing loss may be a risk factor for cognitive decline. Effects of age-related hearing loss on the brain and cognitive function were studied indicating compensatory neural resource allocation which can lead to cognitive compensation, with a significant impact on cognitive functioning.[2] Older adults with hearing loss are reported to be at substantial risk of developing cognitive impairment and dementia.[3] Studies found an increased risk of incident dementia in moderate to severe hearing loss subjects when compared with normal hearing adults of the same age group.[4]

Cognitive functions including executive control functions, logical thinking, processing speed, reasoning, memory, etc. are found to be affected due to the cognitive compensation that occurred as a result of compensatory neural resource allocation in ARHL.[2] ARHL mostly affects the audibility at high frequencies making the speech understanding difficult especially in the presence of background noise. [5] The degraded auditory inputs lead to an increased effort to process and understand speech, limiting communication and thus restricting social interaction, an important aspect of everyday life, subsequently resulting in a perceived reduction of Quality of Life (QOL). Various studies reported on the potential effects of auditory rehabilitation on the cognitive status of individuals with ARHL, a statistically significant correlation between hearing loss and depression was reported,[6] where the use of hearing aids reduced the symptoms of depression and found that hearing aid use has a protective effect against reduction in cognitive function thus providing a better quality of life for elderly people. A study was conducted on elderly adults with hearing loss where one group was fitted with hearing aids and reported that the aided group showed significant improvement in social, emotional, communicative, and cognitive functions over four months as compared to the unaided group.[7]

There are various tests and questionnaires available for measuring cognitive functions and cognitive decline in elderly individuals like the Mini-Mental State Examination (MMSE), Addenbrooke's Cognitive Examination (ACE), Montreal Cognitive Assessment (MoCA), etc. MoCA is a 13-item rapid screening tool developed [8] to assess a wide range of cognitive abilities. MoCA was reported to have 90% sensitivity to detect mild cognitive impairment as compared to the 18% sensitivity of MMSE, it is susceptible to detect mild Alzheimer's Disease even when the patients perform in the normal range of MMSE.[8] Studies used MoCA to measure the performance of cognition in hearing-impaired individuals and the effect of hearing intervention on the MoCA scores, they confirmed that people with hearing loss performed worse than those without any hearing loss with a MoCA point disparity up to 1.66. They also found a positive correlation between the percentages of error in the words with respect to their frequency characteristics in MoCA with their frequency of hearing loss. On the pre and post-hearing intervention comparison of MoCA performance, they could observe an improvement in MoCA score by 1.73 with the cochlear implant rehabilitation. [10] MoCA is standardized across various Indian languages, enabling us to better understand cognitive functions across the Indian population.

The current study aimed to find the relation between hearing loss and cognitive functions in older adults with age-related hearing loss and to understand the difference in cognitive functions between older adults with ARHL who are hearing aid users and non-hearing aid users with the help of the Montreal Cognitive Assessment (MoCA).

The objectives of the present study were as follows:

1) To compare the cognitive functions between the older adults with normal hearing and the older adults with ARHL who are hearing aid users and non-users

2) To compare the cognitive functions between the older adults of different age groups irrespective of their hearing status
3) To compare the cognitive functions between the older adults with normal hearing and the older adults with ARHL with respect to their age group
4) To compare the cognitive functions of older adults across different age groups with respect to their hearing status
5) To compare the performance of older adults with normal hearing and older adults with ARHL on different MoCA parameters

MATERIALS & METHODS

Participants

This study collected data from 90 older individuals between the age of 55-70 years who participated in the study. These subjects were divided into 3 main groups as follows:

Group I (Control Group): Older adults with normal hearing

Group II (Unaided Group): Older adults with hearing loss without hearing aid usage.

Group III (Aided Group): Older adults with hearing loss using hearing aids

Each group was further divided into 3 sub-groups based on the age range of the participants.

Group A: 55-60 years, Group B: 61-65 years and Group C: 66-70 years

Ethical clearance was obtained from our Institute's ethical committee, and informed consent was obtained from all the participants of the study before the collection of data.

Selection Criteria

All the subjects were selected based on the following inclusion and exclusion criteria

***Control group*:**

A total of 30 subjects across different age ranges with, (i) normal hearing bilaterally (ii) normal pure tone air- and bone-conduction thresholds from 250 Hz to 8000 Hz (hearing thresholds ≤ 15dB HL between 500 Hz - 4000 Hz and ≤ 25 dB HL at 6000 Hz and 8000 Hz) in both ears, (iii) participants with 'A' type tympanogram with static compliance between (0.5-1.5ml) and tympanometric peak pressure between ± 50 daPa with acoustic reflex present at 1 kHz in both ears were selected for the control group. Those with any neurological problem or previous history of hearing loss were excluded from the study.

***Study groups*:**

For both the aided group and unaided group, 30 participants were selected who met the following criteria; (i) Bilateral sensorineural hearing loss (moderate to severe degree), (ii) post-lingual hearing loss, (iii) Mixed hearing loss with greater sensorineural component, (iv) Gradual onset hearing loss, (v) Duration of hearing loss more than 2 years, (vi) Speech Identification Scores above 80% in both ears. All the unaided group participants were without a history of any amplification usage. All the participants of the aided group were using bilateral hearing aids for a minimum duration of 2 years (with a minimum of 5 hours daily hearing aid usage).

Those participants with sudden sensorineural hearing loss, prelingual/ congenital hearing loss, conductive hearing loss, or any other associated neurological problems were excluded from the study.

Test environment: The study was carried out in private audiology clinics, and hospital OPDs at different parts of Kerala. All the tests were conducted in an air-conditioned, acoustically treated double room. The ambient noise level inside the room was within the permissible limits (ANSI S3.1 1999).

Material:

Montreal Cognitive Assessment (MoCA) [Malayalam version] was used to assess the

cognitive function in both the study groups and the control group. The Montreal Cognitive Assessment (MoCA) was designed as a brief and rapid screening instrument for mild cognitive dysfunction. It assesses eight different cognitive domains like visuospatial/executive function, naming, memory, attention, language, abstraction, delayed recall, and orientation. It takes approximately 10 minutes to assess using MoCA; the total possible score is 30 and a score of 25 and above is considered normal.

PROCEDURE:

1. Patient data sheet was filled before the sample collection which contained the demographic details and history of other problems. The consent form was signed by the participants while filling out the patient data sheet. The data sheet and consent form were documented separately for each subject.
2. Pure tone audiometry was done using Maico MA52 diagnostic audiometer Version 2 with TDH 39 supra-aural earphones housed in MX-41/AR ear cushions for all the subjects to determine the hearing thresholds.
3. Screening tympanometry (Maico, GSI Tympstar) was performed to rule out the middle ear pathology.
4. Montreal Cognitive Assessment (Malayalam version) was administered to all the participants. Subjects were seated in a closed room comfortably and questions and tasks from MoCA were administered. The questions and tasks were clearly described and modeled. A warm-up time for all participants was given before administering the test materials. Scores for each subtest were documented separately for further analysis.

STATISTICAL ANALYSIS

Statistical Package for Social Science (SPSS) software (Version 20) was used for the statistical analysis. The analysis performed was as follows:

(i) Descriptive statistics mean, standard deviation and median were obtained for each group to determine if there was any significant difference in cognition among the three groups.

(ii) A nonparametric Kruskal Wallis test was carried out to see the significant difference across groups (Control group, aided group, unaided group) and age (50-60 years, 61-65 years, 66-70 years).

(iii) Mann Whitney U test was done to see the pair-wise significant difference between groups and age. The statistical p-values were compared with 0.05 and 0.01 level of significance.

RESULTS

The objectives of the study were to compare the cognitive function of older adults with normal hearing to older adults with ARHL and to compare cognitive function in older adults with hearing loss across different age groups. The results obtained are presented as follows:

1) Cognitive function across the control group, unaided group, and aided group

The mean, median, and standard deviation of MoCA scores were calculated for the control and the study groups. A nonparametric Kruskal Wallis test was carried out to see the significant differences among the groups and the results are given in Table 1.

Table 1. Mean, SD, Median, and Mean Rank of MoCA scores across control, unaided, and aided groups

Sub Groups	N	Mean	SD	Median	Mean Rank	$\chi^2(2)$	p-value
Control group	30	22.77	3.48	23.00	60.77	21.86	0.000**
Unaided group	30	18.27	3.40	19.00	29.40		
Aided group	30	20.70	3.47	21.50	46.33		

The result indicated that there was a statistically significant difference between the MoCA scores obtained between the control, aided, and unaided groups [$\chi^2(2) = 21.86$, p =0.000]. The control group performed better with a mean rank of 60.77, followed by the aided group with a mean rank of 46.33, and poor performance was exhibited by the unaided group with a mean rank of 29.40.

Pair-wise comparison of cognitive function across the groups was done for understanding the performance difference on MoCA and the results are given below in Table 2.

Table 2. Pair-wise comparison of MoCA Mean Rank scores across control, unaided and aided groups

Pair Groups	n	Mean Rank	|Z|	p-value
Control group	30	40.52	4.458	0.000**
Unaided group	30	20.48		
Control group	30	35.75	2.347	0.019*
Aided group	30	25.25		
Unaided group	30	24.42	2.710	0.007**
Aided group	30	36.58		

When the control group and the unaided group were compared, the control group outperformed the unaided group [|Z|=4.458, P=0.000]. The same finding was also true when the control group was compared with the aided group in which the control group yielded a better score than the aided population [|Z|= 2.347, P=0.019]. The comparison of the aided group and the unaided group yielded a statistically significant difference and revealed better performance for the aided group as compared to the unaided group [|Z|= 2.710, P= 0.007].

2) Cognitive function across three different age groups irrespective of their hearing status

All the 90 participants were divided into three groups based on their age namely 55-60 years, 61-65 years, and 66-70 years. Kruskal Wallis test was carried out to analyze the differences in cognitive functioning of the three groups and the results were as shown below in Table 3

Table 3. Mean, SD, Median, and Mean Rank of MoCA scores across three age groups irrespective of their hearing status

Age (years)	N	Mean	SD	Median	Mean Rank	$\chi^2(2)$	p-value
55-60	30	22.54	3.30	23.00	59.23	16.54	0.000
61-65	30	19.67	4.13	20.00	39.81		
66-70	30	19.06	3.42	20.00	34.40		

Table 3 findings indicate a statistically significant difference in cognitive functioning across three age groups [$\chi^2(2) = 16.54$, p =0.000]. As expected, the younger age group 55 to 60 years showed a higher mean rank of 59.23. This value was lesser for the group 61 to 65 years with a mean rank of 39.81 and even lesser for the 66 to 70 years age group with a mean rank of 34.40.

Mann Whitney U test was done to determine the pair-wise comparison of cognitive function across age groups 55-60, 61 – 65, and 66 - 70 and results were as given below in Table 4

Table 4. Pairwise comparison of Mean Rank of MoCA scores across different age groups

Age (years)	N	Mean Rank	|Z|	p-value
55-60	35	35.01	2.726	0.006**
61-65	24	22.69		
55-60	35	42.21	3.938	0.000**
66-70	31	23.66		
61-65	24	29.63	0.665	0.506
66-70	31	26.74		

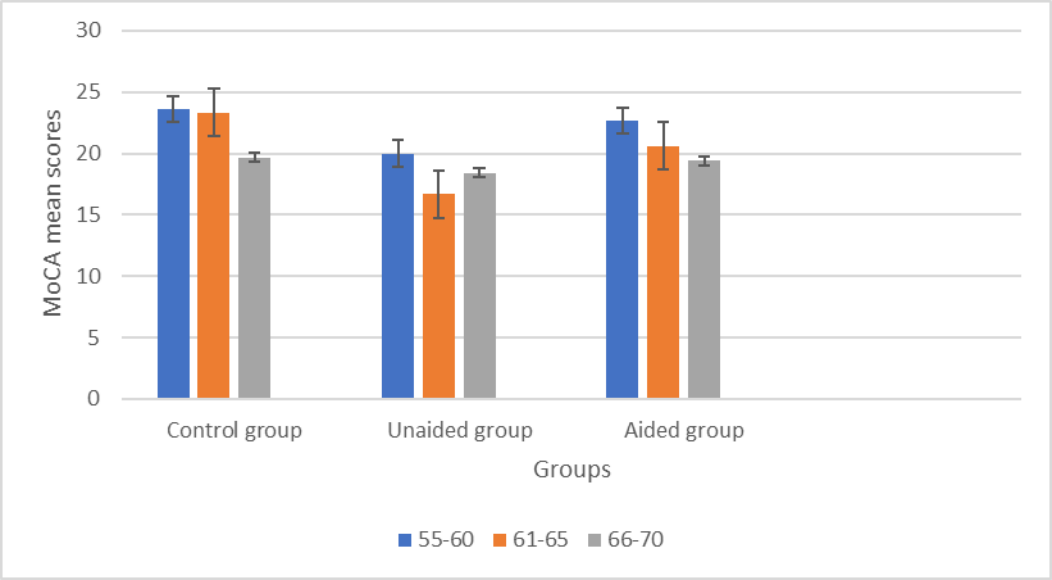
The performance of the younger age group 55 - 60 years was compared with the older groups 61 - 65 years and 66 - 70 years and a significant difference was obtained (P=0.006 & 0.000). But when the older age groups 61-65 years & 66-70 years were compared, no statistical difference (P=0.506) was obtained across the MoCA scores.

The findings showed that age played an important role in cognitive functioning. As the age increased, cognitive skills gradually deteriorated even when the participants had normal hearing.

3) Cognitive function across control group and study groups with respect to age

The mean, median, and standard deviation were calculated for all the groups, and the Kruskal Wallis test was carried out to analyze the differences in cognitive functioning of the three groups across the subgroups and the results were as shown below in Figure 1.

Figure 1. Mean MoCA score comparison across control and study groups with respect to their age category



Among all the three groups, the sub-group of 55 to 60 years obtained a higher mean score. For the control group, the mean score of MoCA for the younger age group was 17.67 which was higher than the other two subgroups 61 to 65 years and 66 to 70 years, but the difference was not statistically significant with a p-value of 0.114. The unaided group also showed the same pattern with the youngest age group scoring high as compared to other age groups, but the differences were statistically not significant with p value of 0.105. Only for the aided group the differences in cognitive function among the subgroups were statistically significant with a p-value of 0.026.

4) Cognitive function across different age groups with respect to hearing status.

Mann Whitney U test was done to see the pair-wise significant difference between the subgroups. The statistical p-values were compared with 0.05 and 0.01 level of significance.

Table 5 ***Comparison of cognitive function across age groups with respect to hearing status***

Age (years)	Groups	N	Mean	SD	Median	Mean Rank	$\chi^2(2)$	p-value
55-60	Control	18	23.61	2.91	23.50	21.33	8.097	0.017*
	Unaided	8	20.00	2.56	20.00	9.19		
	Aided	9	22.67	3.67	23.00	19.17		
61-65	Control	6	23.33	2.50	22.50	18.83	11.379	0.003**
	Unaided	10	16.70	3.05	16.50	7.10		

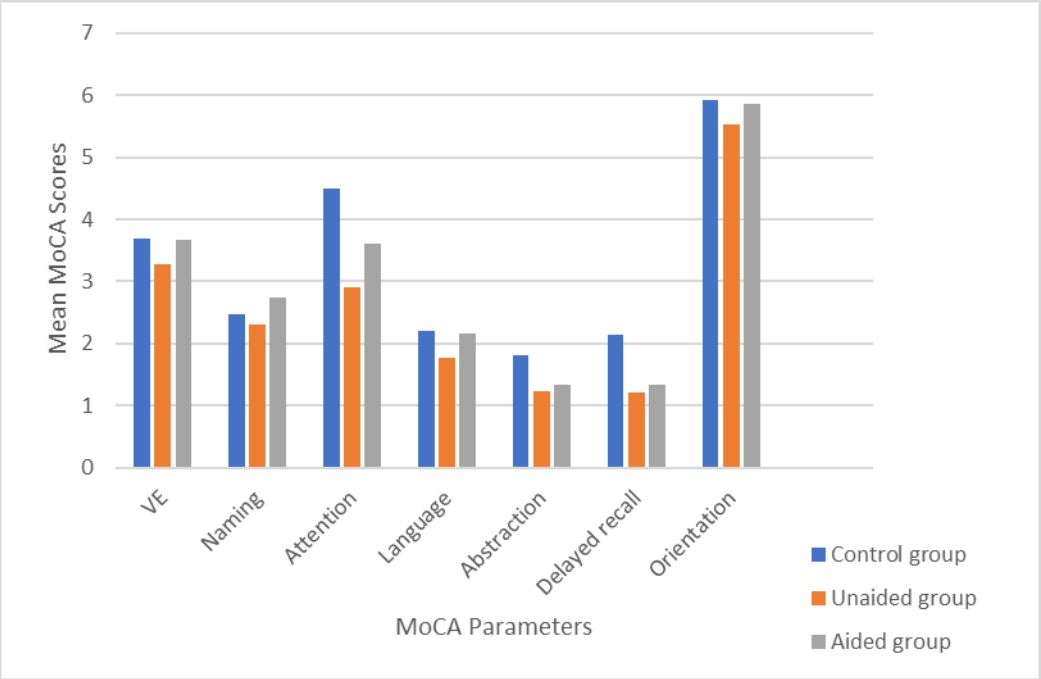
	Aided	8	20.63	3.81	21.50	14.50		
66-70	Control	6	19.67	4.54	20.00	18.17	0.915	0.633
	Unaided	12	18.42	3.77	18.00	14.17		
	Aided	13	19.38	2.63	20.00	16.69		

In the age group 55 to 60 years, the control group showed a high mean rank (21.33) in MoCA scores followed by aided (19.17) and unaided (9.19) groups. Statistical analysis done using the Mann Whitney U test showed a statistically significant difference between the scores across groups with a p-value of 0.017. In the second age group (61 to 65 years), the control group showed a high mean rank (18.83) in MoCA scores followed by aided (14.50) and unaided (7.10) groups. This group also exhibited a statistically significant difference between the scores with a p-value of 0.003. In the age group 66 to 70 years, even though the MoCA score mean value is highest for the control group (18.17) followed by aided group (16.69) and unaided group (14.17), the comparison using Mann Whitney U test showed no statistically significant difference between their scores (P 0.633)

5) Comparison of performance in different MoCA parameters among the control group, unaided group, and aided group.

The performance of all three groups on MoCA parameters was studied using the Kruskal Wallis test and the results were as given below in Figure 2

Figure 2. Mean MoCA scores of the control group, unaided group, and aided group on various MoCA parameters



In all the parameters of MoCA except naming, the control group scored highest followed by the aided group, and lowest by the unaided group. For the naming task, the aided group outperformed even the control group with a mean rank of 52.72, while the mean rank of the control group was 44.43. However, there was no statistically significant difference in MoCA scores for the parameters such as visuospatial & executive functioning and language with p values 0.139 and 0.068 respectively. For the attention task, the control group performed better with a mean rank of 62.67 as compared to the unaided and aided group. The same was true for the abstraction task with a mean rank of 57.00 for the control group. For both attention and abstraction tasks, results indicated a statistically significant difference between the MoCA

scores among groups with p-values of 0.000 and 0.003 respectively. For delayed recall, the average performance of all the groups was poor. However the control group obtained the highest mean rank of 57.98, followed by the aided group (41.75) and the unaided group (37.75). These observations were statistically significant with a p-value of 0.004.

Orientation was the easiest task for all three groups; the control group (51.07) performed better, followed by the aided group (48.13) and the unaided group (37.30) and the findings were statistically significant with a p-value of 0.007.

DISCUSSION

The main aim of the study was to assess the cognitive function in older adults with hearing loss and the differences in cognitive function among hearing aid users and non-users using the Montreal Cognitive Assessment (MoCA). The cognitive performance across the control group, the unaided group, and the aided group was compared to understand the difference in cognitive skills with respect to hearing status. MoCA scores obtained from the control group as well as the study groups were tabulated separately to check which among them performed better. The groups were compared against each other to understand the performance difference on the MoCA test. The results indicated that the control group had better cognitive skills when compared to the study groups. Among the study group, the aided group outperformed the unaided group. This implies the significance of a functional hearing system in processing the tasks which require cognitive abilities whereas hearing impairment poses a barrier in the perception and execution of various cognitive tasks. The result of our study is in coherence with the study done by Maharani & Dawes (2018).[12] They observed a less steep decline in cognition after the usage of hearing aids. Also, they reported a better performance in the normal hearing population when compared to the hearing-impaired population irrespective of the usage of hearing aids. The results obtained in the current study also correlated with the study by Harrison Bush (2015) [11] who found a positive correlation between peripheral hearing and cognition. The above results also correlated with the findings of many researchers [11-13] who reported that cognitive ability is strongly dependent upon a person's hearing ability.

The cognitive skills of the participants were compared across different age groups to understand the effect of age on cognitive function regardless of hearing abilities. The findings showed that age played an important role in cognitive functioning. As the age increased, cognitive skills gradually deteriorated even when the participants had normal hearing. The older age groups had difficulty in domains such as attention, memory & recall. The results indicated that even when the participants had normal hearing or had amplification to overcome reduced sensory input, the skills that require cognition diminished gradually due to the age factor. These findings are in agreement with the study done by Deary & Corley (2009) [14] where they investigated the association between age and cognitive decline and reported a deterioration in memory, executive functions, processing speed, and reasoning due to aging. Similar findings were obtained from a study [15], that investigated the association between age-related cognitive decline and health-related quality of life among Iranian older individuals and reported a strong correlation between age and cognitive function.

The cognitive performance across different age groups in all three main groups was analyzed to understand the impact of age as well as hearing status on the participant's cognitive skills. For all the three age groups studied, the younger age group exhibited the highest performance on MoCA. The present study results indicated that for the control and unaided group, age did not determine the skills that are based on cognition. Only for the aided group, increased age showed deterioration of cognitive functioning.

The cognitive skills of older adults of different age groups across the three main groups namely the control group, the aided and unaided group were analyzed to understand the effect of hearing status in each age group and the results indicated that the hearing status of a person influenced the cognitive functioning upto 60-65 years of age; normal hearing augmented the cognitive performance well, and amplification helped older adults with hearing loss to maintain cognitive functions to an extend as compared to the deteriorated cognitive performance in hearing-impaired older adults without any amplification. The performance of older adults of age range 66 - 70 years was similar in cognitive tasks irrespective of their hearing abilities indicating the increased influence of aging on cognition. Studies from the literature support the fact that aging as well as the use of amplification devices has a greater influence on the cognitive status of an individual. Aging has a negative impact on cognition whereas the use of a hearing aid or any other amplification device has a positive impact on the same. People who wear a hearing aid for age-related hearing problems maintain better brain function over time than those who are non-users. Findings from the study conducted by the University of Exeter and King's College London highly correlate with the current study that hearing aid is an effective tool to protect the brain from developing the risk for dementia as well as to maintain cognitive abilities.[16]

Among the 6 parameters in MoCA, the delayed recall was found to be the most difficult task for all three groups whereas all groups performed better in the orientation task, results show a high performance of the control group for all the parameters except for the naming task followed by the aided group and then the unaided group.

MoCA has proved to be an effective tool to measure cognitive function as it assesses various domains of cognition. Lerch & Benz (2017) [17] assessed and compared the cognitive function of individuals with hearing impairment and normal hearing using MoCA along with MMSE and CERD plus battery (Consortium to Establish a Registry for Alzheimer's Disease). They found both MoCA and CERD plus battery were sensitive to detecting cognitive impairment and suggested including these tests in the routine clinical cognition assessment. Thus, various studies strongly support the findings of the current study and report on the positive impact of hearing aid use on the cognitive skills of older individuals with hearing loss.

CONCLUSION

To conclude, age-related hearing loss is a very frequent condition and its consequences are wide and severe enough to interfere in many aspects of life including cognition and communication. This study reveals that hearing loss along with aging has deleterious effects on cognition. Hearing aid usage proved to help in preserving cognitive skills and prevent the rapid decline in cognitive abilities which is a crucial point to be considered while dealing with a person with hearing loss. The findings of the current study highlight the significance of counseling older adults on the significance of aural rehabilitation and its impact on cognition and quality of life. Thus, it is evident that hearing aids are not only responsible for hearing restoration but also for preserving the skills that are based on cognition.

Declaration by Authors

Ethical Approval: Approved
Acknowledgement: None
Source of Funding: None
Conflict of Interest: The authors declare no conflict of interest.

REFERENCES

1. Eggermont, J.J., The Auditory Brain and Age-Related Hearing Impairment. 1st edition. Canada: Academic Press United Kingdom. 2019.
2. Kate S, Christopher J P, Helen E N. The Effects of Age-Related Hearing Loss on the

Brain and Cognitive Function. Trends Neurosci. 2020;43(10):810-21.
3. Ying G, Zhao G, Xu X, Su S and Xie X Association of age-related hearing loss with cognitive impairment and dementia: an umbrella review. Front. Aging Neurosci. 2023; 15
4. Deal, J. A., Betz, J., Yaffe, K., Harris, T., Purchase-Helzner, E., Satterfield, S. Hearing Impairment and Incident Dementia and Cognitive Decline in Older Adults: The Health ABC Study. J. Gerontol. A Biol. Sci. Med. Sci. J Gerontol A-Biol.2016;72(5):703-9.
5. Ciorba, A., Bianchini, C., Pelucchi, S., &Pastore, A. The impact of hearing loss on the quality of life of elderly adults. Clin Interv Aging.2012; 7:159-63.
6. Cacciatore, F., Napoli, C., Abete, P., Marciano, E., Triassi, M., & Rengo, F. Quality of Life Determinants and Hearing Function in an Elderly Population: Osservatorio Geriatrico Campano Study Group. Gerontology.1999; 45(6):323–8.
7. Mulrow, C. D. Quality-of-Life Changes and Hearing Impairment. Ann. Intern. Med.1990;113(3):188-94
8. Nasreddine, Z. S., Phillips, N. A., Bacdirian, V., Charbonneau, S., Whitehead, V., Collin, I., &Chertkow, H. The Montreal Cognitive Assessment, MoCA: A Brief Screening Tool for Mild Cognitive Impairment. J Am Geriatr Soc.2005;53(4):695
9. Utoomprurkporn, N., Woodall, K., Stott, J., Costafreda, S. G., &Bamiou, D. E. Hearing-impaired population performance and the effect of hearing interventions on Montreal Cognitive Assessment (MoCA): systematic review and meta-analysis. Int. J. Geriatr. Psychiatry.2020;35(9): 962-71
10. Maharani, A., Dawes, P., Nazroo, J., Tampubolon, G., & Pendleton, N. Longitudinal Relationship Between Hearing Aid Use and Cognitive Function in Older Americans. J Am Geriatr Soc.2018;66(6): 1130- 6.
11. Harrison Bush, A.L., Lister, J. J., Lin, F. R., Betz, J & Edwards, J D. Peripheral Hearing and Cognition. Ear Hear.2015); *36*(4): 395-407.
12. Lin, F. R., Metter, E. J., O'Brien, R. J., Resnick, S. M., Zonderman, A. B., &Ferrucci, L.Hearing Loss and Incident Dementia. Arch. Neurol.2011;68(2): 214-20.
13. Ren, F., Luo, J., Ma, W., Xin, Q., Xu, L., Fan, Z.,Wang, H. Hearing Loss and Cognition Among Older Adults in a Han Chinese Cohort. Front.Neurosci. 2019; 13(632):1-11.
14. Deary, I. J., Corley, J., Gow, A. J., Harris, S. E., Houlihan, L. M., Marioni, R. E.& Starr, J. M. Age-associated cognitive decline. Br. Med. Bull.2009; *92*(1):135–152.
15. Kazazi, L., Foroughan, M., Nejati, V., &Shati, M. Association between age associated cognitive decline and health related quality of life among Iranian older individuals. Electron. Physician.2018;10(4): 6663–71.
16. Dr.Anne Corbett, Prof.Clive Ballard. Use of Hearing Aids in Older Adults with Hearing Loss Is Associated with Improved Cognitive Trajectory [Internet]. 2019 [updated 2019 Jul.15; cited 2023 Nov.20]. Available from https://news-archive.exeter.ac.uk/featurednews/title_725112_en.html.
17. Lerch, M., & Benz, N. Montreal cognitive assessment (hearing impaired) (German version) in geriatric cognitive screening. Innov. Aging (suppl_1).2017;1:1095.

How to cite this article: Susmitha C.G, Sreevidya R, Dhanya S Raj. Hearing aid usage and its influence on cognitive functions among older adults with age-related hearing loss. *Int J Health Sci Res.* 2024; 14(1):152-161. DOI: *https://doi.org/10.52403/ijhsr.20240119*

******