

**THE ASSOCIATION OF PRESBYCUSIS IN ELDERLY WITH
MILD NEUROCOGNITIVE DISORDER**

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ABSTRAK (BAHASA MALAYSIA)

Objektif : Masalah pendengaran di kalangan warga emas and kemerosotan kognitif ringan adalah antara dua masalah utama dalam kalangan warga emas. Masalah gangguan pendengaran di kalangan warga emas adalah gangguan sensitiviti pendengaran yang progresif , melibatkan kedua-dua telinga dan simetri terutamanya di kawasan berfrekuensi tinggi. Kemerosotan kognitif ringan (mNCD) ditakrifkan oleh perubahan ketara dalam kognitif yang dilaporkan oleh pesakit, ahli keluarga atau doktor, bukti objektif kemerosotan dalam satu atau lebih domain, pemeliharaan dalam kebolehan berfungsi, dan tidak demensia dalam DSM-5. Kami menjalankan kajian untuk menentukan prevalensi masalah pendengaran di kalangan warga emas dengan mNCD dan warga emas tanpa mNCD, untuk menentukan kaitan antara masalah pendengaran dan mNCD di kalangan warga emas serta mengkaji kaitan antara tahap keterukan kehilangan pendengaran dan mNCD.

Kaedah: Ini adalah kajian keratan rentas perbandingan. Populasi sumber adalah daripada pesakit warga emas berumur 60 tahun yang disahkan menghidap mNCD yang menghadiri klinik psikiatri Hospital USM dan pesakit warga emas berumur 60 tahun yang menghadiri klinik di Hospital USM telah dipilih secara rawak. Pendengaran diuji menggunakan audiometri nada frekuensi di dalam bilik kalis bunyi.

Keputusan: Seramai 191 peserta; 81 peserta dengan mNCD dan 110 peserta tanpa mNCD mengambil bahagian dalam kajian ini. Kelaziman masalah pendengaran warga emas di kalangan mNCD ialah 98.77%, manakala kelaziman bukan mNCD

ialah 74.55% .Daripada kajian ini, terdapat perkaitan yang signifikan antara masalah pendengaran warga emas dan pesakit mNCD ($p<0.001$). Keterukan kehilangan pendengaran pada frekuensi tinggi paling teruk dalam pesakit mNCD berbanding kumpulan tanpa mNCD dengan 2.4 – 3.7 kali lebih tinggi. Sejarah strok yang lalu dan kehadiran kehilangan pendengaran meningkatkan kemungkinan mNCD sebanyak 4.7 kali ganda dan 29.8 kali ganda, masing-masing.

Kesimpulan : Kajian ini menunjukkan terdapat hubungkait antara mNCD dan masalah pendengaran di kalangan warga emas. Berdasarkan penemuan ini, setiap pesakit kemerosotan kognitif ringan disarankan untuk menjalani ujian saringan pendengaran supaya masalah kehilangan pendengaran dapat dikesan lebih awal dan pelaksanaan langkah pencegahan untuk mengelakkan kemerosotan pendengaran selanjutnya.

THE ASSOCIATION OF PRESBYCUSIS IN ELDERLY WITH MILD NEUROCOGNITIVE DISORDER

ABSTRACT

Objectives : Age-related hearing loss (presbycusis) and neurocognitive disorder are two highly prevalent conditions in the elderly population. Presbycusis is a progressive, bilateral, and symmetrical disorder of hearing sensitivity primarily in the high-frequency region. Mild neurocognitive disorder (mNCD) defined by a noticeable change in cognition reported by the patient, client, or clinician, objective evidence of impairment in one or more domains, preservation in functional abilities, and not demented in DSM-5. We conducted a study to establish the prevalence of presbycusis among elderly with mNCD and elderly without mNCD, determine the association between presbycusis and mNCD among elderly patients and to determine the severity of presbycusis in elderly with mNCD.

Methods : This was a comparative cross sectional study. The source population was from elderly patient with 60 years old diagnosed with mNCD attended psychiatric clinic Hospital USM and elderly patient 60 years old attended outpatient clinic Hospital USM listed and selected randomly. Hearing was tested using pure tone audiometry in soundproof room.

Results: A total of 191 participants; 81 participants with mNCD and 110 participants without mNCD participated in this study. The prevalence of presbycusis among mNCD was 98.77% (95% CI), while the prevalence of non-mNCD was 74.55% (95% CI).

From this study, there was a significant association between presbycusis and mNCD patient ($p < 0.001$). The severity of hearing loss at high frequency is worst in mNCD patient compared to non-mNCD group with 2.4 – 3.7 times higher. Past history of stroke and the presence of hearing loss increases the odds of mNCD by 4.7-fold and 29.8-fold, respectively.

Conclusion : There is correlation between mNCD and presbycusis. With this finding, the hearing status of mNCD patient should be screened for early detection of hearing loss and implementation of the preventive measure to avoid further NCD deterioration could be applied.

Chapter 1:

INTRODUCTION

1.1 INTRODUCTION

Elderly population is one of the most important demographic trends in the 21st century. This is a global phenomenon as the proportion of elderly population relative to the younger generation increases. In Malaysia, the elderly is defined as those who are 60 years old and above, the cut-off age adopted by Department of Statistics, Malaysia.

The Current Population Estimates presents, the composition of population of elderly aged 60 years and over (old-age) account for 3.16 million (10.3 per cent) of Malaysia's total population of 32.6 million in 2019, increased from 10 percent to 10.3 percent than last year .

As population ageing is inevitable in the country, it will pose a major challenge to the Malaysian healthcare system if the latter is not planned carefully with implication for economic and social development (Ambigga et al. 2011).

Thus, ageing is a matter of great concern for the healthcare sector as population ageing will lead to an increase in demand for healthcare and social support, which may consume a large portion of funds allocated for healthcare services (Rechel et al. 2009). Given the escalation of healthcare costs for the elderly, population ageing is becoming a serious concern for both policy makers and researchers. As the percentage of the elderly in Malaysia continues to increase, extensive and up-to-date information concerning this population is vital to plan for their effective healthcare strategies (Wan Ahmad et al. 2014).

Elderly persons are predisposed to a variety of diseases such as metabolic syndrome, which result from a deterioration of physiological functions.

Age-related hearing loss (presbycusis) and mild neurocognitive disorder (mNCD) are two highly prevalent conditions in the elderly population. Presbycusis is a progressive, bilateral, and symmetrical disorder of hearing sensitivity primarily in the high-frequency region and it may be years before you notice the condition.

The Diagnostic Statistical Manual-5 (DSM-5) has updated and replaces the term formally known in DSM-4 as ‘dementia, delirium, amnestic, and other cognitive disorders’ to a subsection named the neurocognitive disorder (NCD). Mild neurocognitive disorder (mNCD) defined by a noticeable change in cognition reported by the patient, client, or clinician, objective evidence of impairment in one or more domains, preservation in functional abilities, and not demented in DSM-5.

Is hearing loss a cause of cognitive decline or only a comorbidity of ageing?. Although many research have found a link, the causality is unclear. Cognitive deterioration is seen as a result of allocating cognitive resources to effortful sensory perception in the sensory-deprivation and information-degradation hypotheses. Cognitive decline is caused by increased perceptual load and a resulting reduction in cognitive reserves. Information degradation can lead to reversible cognitive alterations, whereas sensory deprivation might lead to lasting cognitive abnormalities. Deafferentation and atrophy in the auditory area, which could possibly influence cognitive abilities, are another possible mechanism of the sensory-deprivation hypothesis. The third factor, on the other hand, is proposed by the common-cause

theory; a common ageing brain pathology, such as the loss of brain physiological integrity or widespread neural degeneration (Wayne et al. 2015).

Based on study by Park SY et al (2014), they used 24 mice's and concluded that moderate hearing loss in young mice caused decreases in cognition associated with spatial working and recognition memories in 6 months. These results provide evidence for a causal relationship between hearing loss and cognitive impairment. Further studies on long-term changes of cognition related with hearing loss are needed, along with morphological assessment of the brain and cochlea.

Several studies had shown that older people with hearing loss have higher levels of depression or higher score on the dementia index, as compared to those with normal hearing ability (Koh DH et al. 2015; Herbst KG et al. 1890; Robert P et al. 2009). This means that hearing loss influences elderly persons' cognitive function. In a study done which discussed that the severity of hearing loss was significantly associated with decreased function of the mental and physical components in elderly (Albers et al. 2012).

Elderly individuals with hearing loss have an increased rate of developing cognitive disorder and more rapid decline on Modified Mini-Mental Status Exam scores than their non-hearing impaired counterparts. These findings suggest that hearing impairment may be a marker for cognitive dysfunction in adults aged 65 and older (Gates GA et al. 2008).

The aim of our study was to look for significant association between presbycusis independently associated with decreased cognitive function and increased incident mild neurocognitive disorder.

Till date, there are only a few studies done regarding presbycusis among mNCD in Malaysia, but no studies have been performed specifically mNCD on its prevalence of presbycusis in Malaysia.

The early detection and management of mNCD and its complication is an important part of the mNCD management plan. Hearing loss in mNCD patients may be an often neglected consequence of the disease. Early diagnosis of sensorineural hearing impairment in mNCD patients can help to decrease exposure to risk factors and enhance hearing function to prevent NCD and quality of life. Hence, we carried out this study to test the association of hearing loss in mNCD patient.

Chapter 2:

OBJECTIVES

2.1 General objective

To study on presbycusis among elderly patient with mild neurocognitive disorder compared to elderly without mild neurocognitive disorder .

2.2 Specific objectives

1. To determine the prevalence of presbycusis among elderly with mild neurocognitive disorder and elderly without mild neurocognitive disorder.
2. To determine the association between presbycusis and mild neurocognitive disorder among elderly patient.
3. To determine the severity of presbycusis in elderly with mild neurocognitive disorder.

Chapter 3:

MANUSCRIPT

3.1 TITLE PAGE

The Association Of Presbycusis In Elderly With Mild Neurocognitive Disorder

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3.2 **Abstract**

Objectives : Age-related hearing loss (presbycusis) and neurocognitive disorder are two highly prevalent conditions in the elderly population. Presbycusis is a progressive, bilateral, and symmetrical disorder of hearing sensitivity primarily in the high-frequency region. Mild neurocognitive disorder (mNCD) defined by a noticeable change in cognition reported by the patient, client, or clinician, objective evidence of impairment in one or more domains, preservation in functional abilities, and not demented in DSM-5. We conducted a study to establish the prevalence of presbycusis among elderly with mNCD and elderly without mNCD, determine the association between presbycusis and mNCD among elderly patients and to determine the severity of presbycusis in elderly with mNCD.

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Results: A total of 191 participants; 81 participants with mNCD and 110 participants without mNCD participated in this study. The prevalence of presbycusis among mNCD was 98.77% (95 per cent confidence interval), while the prevalence of non-mNCD was 74.55% (95 per cent confidence interval). From this study, there was a significant association between presbycusis and mNCD patient ($p < 0.001$). The severity of hearing loss at high frequency is worst in mNCD patient compared to

non-mNCD group with 2.4 – 3.7 times higher. Past history of stroke and the presence of hearing loss increases the odds of mNCD by 4.7-fold and 29.8-fold, respectively.

Conclusion : There is correlation between mNCD and presbycusis. With this finding, the hearing status of mNCD patient should be screened for early detection of hearing loss and implementation of the preventive measure to avoid further NCD deterioration could be applied.

Keyword : presbycusis, sensorineural hearing loss, mild neurocognitive disorder, elderly

3.3 INTRODUCTION

Elderly population is one of the most important demographic trends in the 21st century. This is a global phenomenon as the proportion of elderly population relative to the younger generation increases. In Malaysia, the elderly is defined as those who are 60 years old and above, the cut-off age adopted by Department of Statistics, Malaysia.

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Elderly individuals with hearing loss have an increased rate of developing cognitive disorder and more rapid decline on Modified Mini-Mental Status Exam scores than their non-hearing impaired counterparts. These findings suggest that hearing impairment may be a marker for cognitive dysfunction in adults aged 65 and older (Gates GA et al. 2008).

The aim of our study was to look for significant association between presbycusis independently associated with decreased cognitive function and increased incident mild neurocognitive disorder.

Till date, there are only a few studies done regarding presbycusis among mNCD in Malaysia, but no studies have been performed specifically mNCD on its prevalence of presbycusis in Malaysia.

The early detection and management of mNCD and its complication is an important part of the mNCD management plan. Hearing loss in mNCD patients may be an often-neglected consequence of the disease. Early diagnosis of sensorineural hearing impairment in mNCD patients can help to decrease exposure to risk factors and enhance hearing function and quality of life. Hence, we carried out this study to test the association of hearing loss in mNCD patient.

3.4 MATERIAL AND METHOD

This was a cross-sectional comparative study conducted in a tertiary hospital from January 2021 till January 2022. This study was approved by our university Human Research Ethics Committee with code number USM/JEPeM/2009 0478. This study was performed according to Helsinki Declaration and written consent was obtain from each subject.

Based on single proportion formula using PS software, the largest sample size based on the study by Quaranta et al. (2014) required was 133 participants from subject and control group. However, due to study conducted during Covid-19 pandemic era, 81 participants from subject group and 110 participants from control group was recruited within time frame. The participants were selected using random sampling method based on inclusion and exclusion criteria. The inclusion criteria for study group include patient aged from 60 years old and above with clinically diagnosed mNCD, regardless of duration of disease. For control group, inclusion criteria include patient aged from 60 years old and above without mNCD. The subject group have been diagnosed by clinical interview by psychiatrist based on DSM V criteria and full clinical examination including physical, neurological and psychiatric examination. Caregivers of each patient were also interviewed to determine deterioration of patient in social and occupational functioning. Patient's medical records were also reviewed to aid in the diagnosis and to obtain information regarding patient's medical illness and medication used by them. Exclusion criteria for both groups were family history of early onset hearing loss, history of exposure to recreational noise; receive systemic ototoxic drugs; otological operation; ear

infection, hearing loss since childhood and any chronic ear disease detected during ear examination. Only participants fulfilling inclusion, but not exclusion criteria will be recruited for the study.

Written consent was obtained from each participant. Co-sign informed consent form with caregiver will be obtained for elderly with mild neurocognitive disorder that unable to understand. Participation in this study was completely voluntary.

This was followed by ear examination, including otoscopic examination to rule out any ear disease. Finally, pure tone audiometry and tympanometry were performed by qualified audiologists. All demographic data, participants personal histories, examination findings and pure audiometry results will be recorded in patient's proforma.

Audiometry was performed in this study using a semi-automated testing device in sound-attenuating chamber under unaided conditions which met prevailing standards for maximal permissible ambient noise levels during air conduction audiometry. A speech-frequency pure tone average (PTA) of air-conduction threshold at 0.5, 1, 2 and 4 kHz was calculated for each ear, and PTA in the better hearing ear was used for subsequent analyses because this ear would be the principal determinant of hearing and speech perception ability on an everyday basis. All thresholds are expressed in dB HL (ANSI, 1989).

A pure-tone average in decibels hearing level (dBHL) was calculated in the better hearing ear using thresholds from 0.5 to 4kHz. Hearing was categorized into 5

categories following its hearing threshold according World Health Organisation (WHO, 2012): ≤ 25 dB, hearing within the normality parameters; 26-40 dB, mild hearing loss; and 41-60 dB, moderate hearing loss; 61-80 dB, severe hearing loss; 81dB or more, profound hearing loss. According to the WHO's definition of impairment, hearing loss is defined as a PTA of more than 25 dB (the level at which hearing loss begins to impair daily communication).

A diagnosis of diabetes was established based on a fasting glucose $> 125\text{mg/dL}$, a pathologic oral glucose tolerance test, or positive history of a physician diagnosis plus treatment with oral anti-diabetic drugs or insulin. The diagnosis of hypertension was established based on systolic blood pressure >140 and/or diastolic blood pressure ≥ 90 mmHg or treatment with antihypertensive medications. Races, education, smoking status were based on self-report.

The data was analyzed using IBM SPSS version 25.0 software. Categorical data was summarized with frequency and percentages. Pearson's chi-squared test were used to compare the association of the two categorical data, specially the association of mNCD and presbycusis. The level of significant was set at 0.05 level.

3.5 RESULT

A total of 191 subjects were recruited in the present study which comprised 110 control and 81 experimental subjects. The mean age of the study participants was 71 years old; while there were more males (59.16%) than females (40.84%). Majority of the study subjects was Malays (88.48%), followed by Chinese (10.99%), and others (0.52%).

The data obtained was expressed as mean with standard deviation (SD) for numerical variables and frequency(n) with percentage (%) for categorical variables as tabulated in Table 1. The mean age of total sample was 71.08 with standard deviation of 6.26 for non-mNCD group and mean of 72.41 (SD=8.13) for mNCD group studied.

The prevalence of presbycusis among mNCD and non-mNCD was summarized in Table 2. Based on Table 2, the prevalence of mNCD which suffered from presbycusis was more compared to non-mNCD patient (98.77 % vs 74.55%).

In the analysis of PTA among subjects with and without mNCD, subjects with mNCD had 27.3 higher odds of being associated with hearing loss as compared to subjects without mNCD (Table 3).

Table 4 shows the association between the severity of hearing loss in better ear and the mNCD status. Positive and significant associations were found between the two variables. An increment in the severity of hearing loss among the different levels

of sound was found 2.4 – 3.7 times associated with subjects with mNCD than those without mNCD. We also observe how hearing loss is usually very common in higher frequencies (greater than or equal to 4KHz), both for people with presbycusis and for those who maintain hearing within normal parameters.

Table 5 shows the association between different levels of hearing loss in better ear and different types of co-morbidity. Overall, all co-morbidities shows no significant associations with the different levels of hearing loss in better ear, except for stroke. Subjects with strokes showed higher association with higher level of hearing loss.

Table 6 shows the multivariate logistic regression analysis of the variables with P value below 0.250; the pass history of stroke and the presence of hearing loss increases the odd ratio of NCD by 4.7-fold and 29.8-fold, respectively.

Table 1: Demographic data (n=191)

Variable	Total N=191 N (%)	mNCD	
		No (N=110)	Yes (N=81)
Age, year	71.64±7.13	71.08 ± 6.26	72.41 ± 8.13
Gender			
Male	113 (59.16%)	66 (60.00%)	47 (58.02%)
Female	78 (40.84%)	44 (40.00%)	34 (41.98%)
Ethnicity			
Malay	169 (88.48%)	99 (90.00%)	70 (86.42%)
Chinese	21 (10.99%)	11 (10.00%)	10 (12.35%)
Others	1 (0.52%)	0 (0.00%)	1 (1.23%)
Education level			
Pre School	5 (2.62%)	3 (2.73%)	2 (2.47%)
Primary	42 (21.99%)	20 (18.18%)	22 (27.16%)
Secondary	78 (40.84%)	49 (44.55%)	29 (35.80%)
Tertiary	49 (25.65%)	26 (23.64%)	23 (28.40%)
No Education	17 (8.90%)	12 (10.91%)	5 (6.17%)

Table 2: Prevalence of presbycusis among mNCD and non-mNCD

Group	Prevalence of presbycusis (95%CI)
mNCD	98.77% (0.9631; 1.0122)
Non-mNCD	74.55% (0.6628; 0.8281)

Table 3: Association between mNCD and presbycusis

Variable	Total N=191 N (%)	mNCD		P value^b
		No (N=110)	Yes (N=81)	
Normal hearing	29(15.18%)	28 (25.45%)	1 (1.23%)	0.001* ^a
Presbycusis	162 (84.82%)	82 (74.55%)	80 (98.77%)	