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Correlation between haemoglobin levels and attention, concentration, learning and memory among older adult population in Chennai

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ABSTRACT

Introduction: The older adults constitute a considerable part of the Indian population and due to advancements in the Medical field this population is fast growing. With the current advancements in treatment modalities there is an increased life expectancy. Low haemoglobin level is a potential contributing factors for cognitive impairment in older adults.

Objective: The present study focuses on correlation between haemoglobin levels and attention, concentration, learning and memory among older adult population in Chennai.

Materials and Methods: The present study was conducted in Sri Ramachandra Hospital OPD, Porur, Chennai. A total of 304 older subjects were included in this study. Older adults of both male and female were selected from the OPD based on theInclusion criteria - Age [50 to 65 years] matched subjects were selected. The Digit Span test,a subtest from Wechsler Adult Intelligence scale is used to assess the subjects attention and concentration. Ray auditory and verbal learning test (RAVLT) is used to measure learning and memory.

Results: The digit span forward test in males is higher when compared with the females, this difference is statistically significant. (t= 9.669 and p=0.000). The digit span backward test in males is higher when compared with the females, this difference is statistically significant. (t= 9.669 and p=0.000).The digit AVLT trial test scores in males is higher when compared with the females, this difference is statistically significant. (p=0.000)All the scores of normal haemoglobin group were higher than the low haemoglobin group and the results were statistically significant. (p=0.000).

Conclusion: In this study, we were able to observe that lower haemoglobin levels were associated with decreased cognitive functions in the domains of attention, concentration, learning and memory among older adult population in Chennai.

1. Introduction

Anaemia is common in older people with an increasing trend as the age advances. The incidence of anaemia and subsequently its implication on health and financial aspects are expected to rise. The prevalence of anaemia is 24% among elderly. Anaemia is strongly associated with poor cognitive function and it is a risk factor for cognitive decrease. Anaemia itself is a cause of morbidity and it can complicate other health conditions. Anaemia is the cause for severe deterioration of quality of life, decline in physical function and a risk factor for death. Better understanding of anaemia in the elderly will lead to improved treatment strategies. Normal levels of haemoglobin are associated with best survival. An increase in haemoglobin would

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be accompanied by significant improvement in cognitive performance of elderly.[1]

Maintaining the cognitive vitality of older persons is particularly important.[2] Worldwide the size of the older population will increase from 606 million in 2000, roughly 10% of the population, to about two billion by 2050, accounting for one in five persons. These demographic changes will increasingly strain the workforce and the social welfare system, especially with regard to pensions and healthcare spending, unless people are able to work longer and their health is maintained. Hypoxia due to lung parenchymal diseases have been associated with decreased cognitive function in many studies.[3] Chronic renal diseases and lung parenchymal diseases due to smoking are associated with decreased production of hypoxia inducible factor and reduced production of erythropoietin levels which may increase the risk of neuronal degeneration in certain cognitive pathways.[4] In animal models of stroke and hypoxia it has been observed that erythropoietin receptors localized in the brain seem to have a neuroprotective effect, and so a reduction in erythropoietin levels may increase the risk of neuronal degeneration in certain cognitive pathways. Iron dysregulation is also seemed to be associated with increased oxidative stress in brain parenchyma.

Older adult's exhibit increased recall when using self generated strategies that rely on personally relevant information relative to other mnemonic strategies.[5]

Ageing leads to memory loss and cognitive slowing that can interfere with the daily routines. The study of cognitive neuroscience of human ageing relies largely on neuroimaging techniques, which relates these cognitive changes to their neural substrates, including structural and functional changes in the prefrontal cortex, medial temporal lobe regions and white matter tracts.[6] Still much remains unknown about how normal ageing affects the neural basis of cognition, but recent research on individual differences in the trajectory of ageing effects is helping to distinguish normal from pathological origins of age related cognitive changes. The aim of the present study is to analyse the correlation between haemoglobin levels and attention, concentration, learning and memory among older adult population in Chennai.

2. Materials and Methods

Institutional Ethical Committee clearance was obtained. Informed written consent was taken prior to the study from all subjects, and then a structured questionnaire was administered.

2.1. Study design

Cross sectional study.

2.2. Study population

The present study was conducted in Sri Ramachandra Hospital OPD, Porur, Chennai. A total of 304 older subjects were included in this study.

2.3. Selection of subjects

Older adults of both male and female were selected from the OPD based on the inclusion criteria and exclusion criteria mentioned below.

2.4. Inclusion criteria

Age- 50 to 65 years, both males and females subjects were selected.

2.5. Exclusion criteria

Subjects with neurological disorders, Alzheimer's disease and dementia were excluded by using central nervous system examination.

2.6. Data collection

During the study, a complete blood count was done to assess hemoglobin status. The association of hemoglobin levels was correlated with the results of cognitive tests. Assessment of cognitive function was done by a spectrum of cognitive function tests.

2.7. Haemoglobin assessment

A standard procedure was used to collect blood samples. Using sterile technique, phlebotomists and nurses skilled in venipuncture collected the blood specimen in 3 ml sterile lavender colored vacutainers containing ethylenediaminetetraacetic acid (EDTA) as anticoagulant. Specimens were transferred to Sri Ramachandra Medical Centre central laboratory for a complete blood count analysis using a Sysmex X T 2000 I fully automated processor, and results were obtained in 45 seconds. According to this method the biological reference range of hemoglobin for males is 13 -17 gm/dl and for females it is 12 – 15 gm/dl.

2.8. Attention and concentration assessment

The Digit Span test is used to assess the subjects attention and concentration, a subtest from Wechsler Adult Intelligence Scale. The test has two parts like Digit Forward and Digit Backward tests. This test requires the examiner to verbally present digits at a rate of one per second. The forward test requires the participant to repeat the digits in reverse order. The number of digits increases by one until the participant consecutively fails two trails of the same digit span length. The test was performed in known languages of the patient.

2.9. Learning and memory assessment: Ray auditory and verbal learning test (RAVLT)

The RAVLT/AVLT is a 15 item list learning task with five learning trials. Between each trial, the target list is re-read to subjects. There is an interference Lisi B (a new list of 15 words) that is read to the subject after the fifth learning trial, and after recall of the interference list is attempted, recall of the original list is undertaken. The RAVLT also has a recognition trial in which subjects are asked to identify words from the 15 item list using a standard target distracter word set. This test was administered and scored in accordance with standardized instructions.

2.10. Statistical analysis

Data entry was done and the data analysis was performed with SPSS software 15.0. P Value of less than 0.05 was considered as statistically significant.

3. Results

The study was conducted on a total of 304 older individuals. The minimum age contributed as 50 years, maximum age is 65 years (Table 1). In the present study the mean age was about 58.45 years with +/- SD of 4.27 (Figure 2), when we compared to a study the different age group among both sexes, the mean age group of male was around 58.34 with +/- SD to 4.03 and the mean age group among females was 58.5 and SD of 4.45. When we compared between the Hb levels between both sexes(Table 2), the males had normal haemoglobin levels when compared with females; this difference is statistically significant. (t =9.839 and p=0.000)

The digit span forward test in males is higher (Figure 2) when compared with the females, this difference is statistically significant. (t= 9.669 and p=0.000). The digit span backward test in males is higher when compared with the females, (Table 4). This difference is statistically significant (t= 9.669 and p=0.000). The digit AVLT trial test scores in males is higher (Figure 3) when compared with the females, this difference is statistically significant. (p=0.000). All the memory scores in the normal haemoglobin group (Table 3) were higher than the low haemoglobin group (Figures 4 and 5) and the results were statistically significant. (p=0.000).

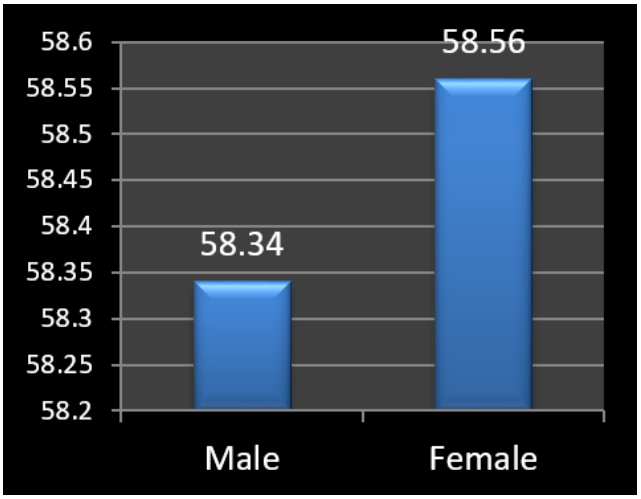

Fig. 1: Mean age of the participants by sex wise

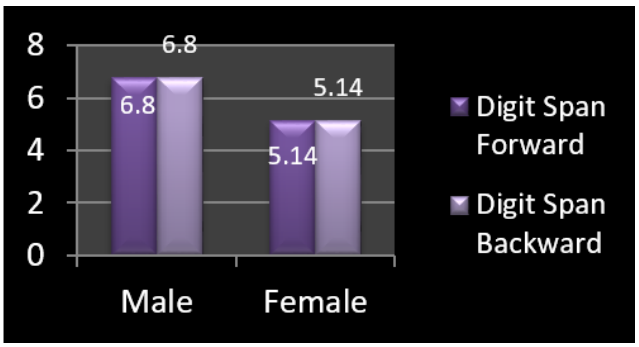

Fig. 2: Performance on digit span test sex wise

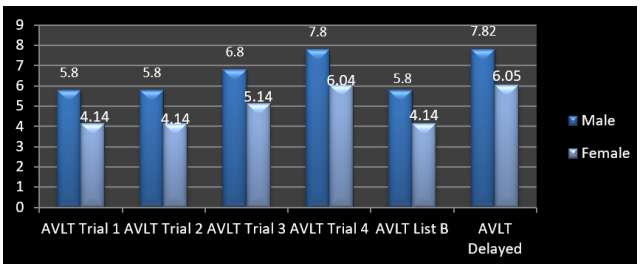

Fig. 3: Performance on learning task based on sex

4. Discussion

Anaemia is common in older people with an increasing trend as the age advances. There are only a limited number of studies that have analysed and compared adults across the entire spectrum of adulthood on parameters of cognitive functioning. The inference of these studies are consistent with the finding that increased age is associated with more negative cognitive change.[7] In our study also we were able to interpret similar results. We were able to observe impairment of cognitive functions in the elderly with reduced hemoglobin level, in par with the results obtained by David Lipschitz et al.[8] The mechanisms relatinghemoglobin levels to deteriorating cognition levels are not fully understood and needs further exploration. Reduced hemoglobin levels may be an indicator for the presence of conditions such as ischemia (via coronary arterydisease), hypoxia (via elevated erythropoietin levels) and/or oxidative stress (via iron dysregulation).[9]

Table 1: Age of the participants

	N	Minimum	Maximum	Mean	Std. Deviation
Age	304	50	65	58.45	4.270

Table 2: Age of the participant's gender wise

	Sex	N	Mean ± SD	T	p
Age	Male	152	58.34 ± 4.09	.443	.658
	Female	152	58.56 ± 4.45		

Table 3: Performance on various neuropsychological tests by low and Normal level of Hb

	Sex	Mean	T	p
Digit Span forward	Low	4.78 ± 1.30	-17.139	.000 *
	Average	7.17 ± 1.12		
Digit Span Backward	Low	4.78 ± 1.30	-17.139	.000 *
	Average	7.17 ± 1.12		
AVLT Trial 1	Low	3.78 ± 1.30	-17.139	.000 *
	Average	6.17 ± 1.12		
AVLT Trial 2	Low	3.78 ± 1.30	-17.139	.000 *
	Average	6.17 ± 1.12		
AVLT Trial 3	Low	4.78 ± 1.31	-17.027	.000 *
	Average	7.17 ±1.12		
AVLT Trial 4	Low	5.68 ± 1.52	-16.177	.000 *
	Average	8.17 ± 1.12		
AVLT List B	Low	3.78 ± 1.30	-17.064	.000 *
	Average	6.17 ± 1.12		
AVLT Delayed	Low	5.71 ± 1.54	-15.913	.000 *
	Average	8.17 ± 1.12		

* p≤ 0.01

Table 4: Performance on various neuropsychological tests by male and female participants

	Sex	Mean	t	P
Digit Span forward	Male	6.80 ± 1.34	9.669	.000 *
	Female	5.14 ± 1.63		
Digit Span Backward	Male	6.80 ± 1.34	9.669	.000 *
	Female	5.14 ± 1.63		
AVLT Trial 1	Male	5.80 ±1.34	9.669	.000 *
	Female	4.14 ± 1.63		
AVLT Trial 2	Male	5.80 ± 1.34	9.669	.000 *
	Female	4.14 ± 1.63		
AVLT Trial 3	Male	6.80 ± 1.34	9.712	.000 *
	Female	5.14 ± 1.63		
AVLT Trial 4	Male	7.80 ± 1.34	9.514	.000 *
	Female	6.04 ± 1.83		
AVLT List B	Male	5.80 ± 1.34	9.626	.000 *
	Female	4.14 ± 1.63		
AVLT Delayed	Male	7.82 ± 1.32	9.628	.000 *
	Female	6.05 ± 1.83		

* p≤ 0.01

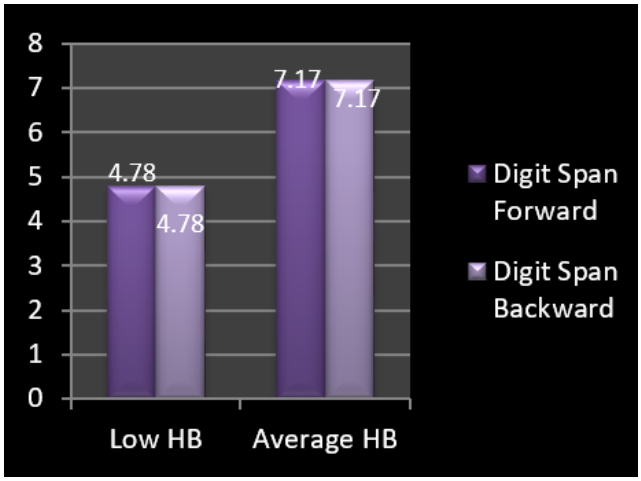

Fig. 4: Performance on learning by low Hb and average Hb group

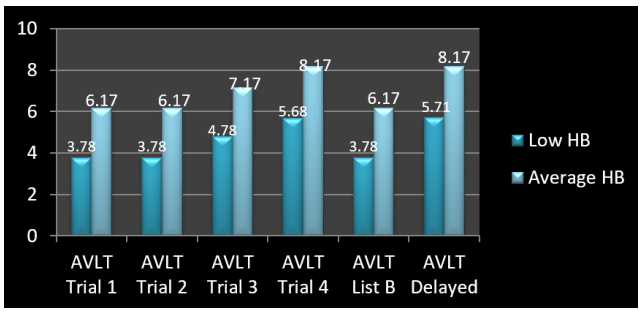

Fig. 5: Performance on learning by low Hb and average Hb group

The gender-specific differences in functional organization of the brain may be due to gender-differences in problem solving strategies or the neurodevelopment; therefore, gender matching or stratification is required for studies of brain function using imaging techniques.[10] The strengths of our study include the systematic, and detailed analysis of all the parameters of cognitive testing and to analyze the association of hemoglobin measures and cognition in a community-dwelling adult population. In our study we were also able to observe that low haemoglobin levels were associated with decreased cognitive performance in older persons, this result is similar to that as observed by Valentina Zamboni et al.[11]

Our work also attribute that reduced hemoglobin levels may need to be considered as a potential contributing factor in older individuals being evaluated for cognitive impairment. The ability to translate a unit change in the cognition measures into terms that are useful for clinical practice will require further investigation. As age advances there will be a decrease in some measure of brain parenchyma (age related atrophic changes), which in turn may lead to a decrease in cognitive functioning. It is rational to expect that the correlation between age and cognitive functioning would be smaller if there were no disparity among the research participants in the brain parenchymal measure.

Even as there are many reports of correlations between brain parameters and cognitive testing factors, several meditational analyses, and a few reports of correlations between brain changes and cognitive changes, only a small number of studies have investigated moderation by determining whether the relations between brain parameters and cognitive testing factors vary as a function of age. This neglect is unfortunate because in some respects results of moderation analyses can be considered to provide the most valuable type of information about the role of age on the relations between brain parenchymal differences and changes and cognitive differences and changes.

Functional neuroimaging research has shown that the activity in different regions of the brain can be examined during the performance of a cognitive test, as it allows brain activity to be linked to cognitive performance at the time the test is being conducted; functional neuroimaging provides unique and valuable information. But it was also observed that there are several complications associated with the interpretation of functional neuroimaging measures in research on aging.

One important concern is that increased age is often associated with lower performance in a wide variety of cognitive tasks, and consequently there could be many different patterns of age differences in functional activation. Further more the increased age is often associated with lower levels of performance, and functional activation can vary according to the level of performance in the cognitive test. Even as the reduction of brain parenchyma (age related atrophic changes) with increased age is well-documented, reasons for age-related shrinkage in brain volume are not fully understood. Differing to earlier views, reduction in number of neurons does not appear to be the major factor contributing to the brain mass, but there could be many other factors like shrinkage of the axons, dendritic structure and of cell bodies, decrease in synaptic activity, loss of neuroglial cells, reduction of myelination, and possibly decreases in vascularization.

5. Conclusion

Our work suggests that reduced haemoglobin levels are a potential contributing factor among older adults for cognitive impairment. The ability to translate a unit change in the cognition measures into terms that are useful for clinical practice would require further investigation. In this study, we were able to observe that lower haemoglobin levels were associated with decreased cognitive functions in the domains of attention, concentration, learning and memory.

6. Source of Funding

None.

7. Conflict of Interest

None.

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