

RESEARCH ARTICLE

Correlation between hemoglobin levels and visual memory among an older adult population in Chennai

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ABSTRACT

Background: The older adults constitute a considerable part of the Indian population and due to advancements in the medical field, this population is fast growing. Low hemoglobin (Hb) level is a potential contributing factor for cognitive impairment in older adults. **Aim and Objective:** The present study focuses on the correlation between Hb levels and visual memory among the older adult population in Chennai. **Materials and Methods:** The present study was conducted in Sri Ramachandra Hospital outpatient department (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 the inclusion criteria – age (50–65 years) -matched subjects were selected. Visual memory assessment, which is a subtest from the Wechsler memory scale – III, consists of four diagrams which will present to the subject for 10 s, and after the presentation, the subjects will be asked to draw the diagram from their memory for immediate visual memory score. After laps of 20–30 min, the subjects will be again asked to draw the picture from their memory to obtain the delayed recall memory. **Results:** The immediate visual memory in males is higher when compared with the females, this difference is statistically significant ($t = 8.111$ and $P = 0.000$). The delayed visual memory in males is higher when compared with the females, this difference is statistically significant. ($t = 7.618$ and $P = 0.000$). All the scores of the normal Hb group were higher than the low Hb group and the results were statistically significant ($P = 0.000$). **Conclusion:** In this study, we were able to observe that lower Hb levels were associated with decreased cognitive functions in the domains of visual memory among the older adult population in Chennai.

KEY WORDS: Hemoglobin; Cognitive Function; Wechsler Memory Scale – III

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. Cognitive decline is considered as the main precursor of dementia and it has become a serious human, social, and economic burden among the elderly. It is estimated that the numerical size of the older population is estimated to increase from 606 million in 2000, to about two billion in 2050. Anemia is considered as one of the important medical condition associated with the cognitive decline in the process of pathological aging. Other parameters such as age, sex, racial differences, literacy, region, diabetes mellitus, hypertension, hyperlipidemia, coronary heart disease, cerebrovascular diseases, depressive symptoms, tobacco and alcohol use, and renal functions also play a significant role in the cognitive outcome in the elderly population.

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Low hemoglobin (Hb) level is a potential contributing factor for progressive decline cognitive in older adults, and the value of blood counts and Hb may be a significant marker for identifying and qualifying conditions secondary to hypoxia, ischemia, and/or oxidative stress.^[1] The prevalence of anemia is approximately about 24% among elderly. Incidence of anemia is more common in the older population than middle aged and it becomes more so as age advances. Decreased Hb levels and the presence of anemia have also been found to be risk factors for deprived mobility, increased fatigability, and decreased executive function in women. The relationship between cognitive function, Hb levels, and gender has largely been neglected by research, despite rare studies reporting gender differences in episodic memory. Women are usually associated with lower Hb level. The WHO criteria for anemia are gender specific and hence the relationship between Hb and cognitive function may be variable based on gender.^[2] Aging-related manifestations of cognitive impairments may be noticeable in a number of domains, including long-term memory (visual and verbal), but memory performance of the elderly population is compliant.^[3]

For many researchers in experimental psychology, the topic of considerable interest is in assessing the cognitive processes underlying recognition memory. “Familiarity and recollection” have been proposed as the forms of memory which support recognition memory by many physiologists to account for a broad spectrum of behavioral findings that vary in their speed of operation and the specificity of the retrieved information. Many studies have suggested that based on functional neuroimaging studies, familiarity and recollection are supported by distinct neural mechanisms. As a consequence of aging, memory loss and cognitive decline interfere with the daily routines.

Cognitive changes related to human aging rely on multiple factors such as structural and functional changes in prefrontal cortex, temporal lobe regions, white matter tracts^[4] and ultrastructurally mitochondrial function, autophagy, insulin growth factor signaling, mammalian target of rapamycin signaling, sirtuin functions, and autophagy. However, much remains unknown of the pathways with which normal aging effects and pathological factors affect cognition. The present study aims are to analyze the immediate and delayed memory status among 50–65 years older adults with differing levels of Hb. The primary objective is to assess the memory status and Hb level among 50–65 years older adults. The secondary objective is to find the relationship of memory functions and Hb levels.

MATERIALS AND METHODS

Institutional Ethical Committee clearance was obtained (REF. NO: CSP/11/AUG/18/43). Informed written consent was taken before the study from all subjects, and then a structured questionnaire was administered.

Study Design

This was a cross-sectional study.

Study Population

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

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.

Inclusion Criteria

Age (50–65 years) matched subjects were selected.

Exclusion Criteria

Subjects with neurological disorders, Alzheimer’s disease, and dementia were excluded using a mini-mental state examination. People with poorer health, less education, and less control of their environment considered to have more memory problems; hence, we have designed this study to exclude the subjects with ill health by doing a screening test using the standardized mini-mental state assessment questionnaire. Subjects with satisfactory results alone were accepted to participate in the study.

Data Collection

The study was performed on older adults fulfilling the inclusion criteria. A complete blood count was performed to evaluate Hb. Cognitive test for visual memory assessment was performed after Hb assessment. The Hb levels were correlated with the results obtained from the cognitive tests and statistical analysis was performed on the same.

Hb assessment

Using sterile technique, phlebotomists collected the blood sample in 3 ml sterile violet-colored vacuum tubes containing ethylenediaminetetraacetic acid. Specimens were transferred to Sri Ramachandra Medical Centre central laboratory for a complete blood count evaluation using a Sysmex X T 2000 I fully automated processor, and results were obtained in 45 s. According to this method, the normal range of Hb for males is 13–17 g/dl and for females, it is 12–15 g/dl.

Visual memory assessment

This is a subtest from the Wechsler memory scale – III. The test consists of four diagrams which will present to the subject for 10 s and after the presentation, the subjects will be asked to draw the diagram from their memory for immediate visual

memory score. After laps of 20–30 min, the subjects will be again asked to draw the picture from their memory to obtain the delayed recall memory.

Statistical Analysis

Statistical analysis was performed with SPSS software 15.0. $P < 0.05$ was considered to be statistically significant.

RESULTS

The study was conducted in a total number of 304 individuals. The minimum age included was 50 years, the maximum age was 65 years [Table 1]. In the present study, the mean age contributed to be 58.65 years with $\pm$ SD of 4.37 [Figure 1], when we compared to study the different age group among both sexes [Table 2], the mean age group of male contributed around 57.34 with $\pm$ SD to 4.13 and the mean age group among females contributed to be 58.45 and SD of 4.35. When we compared between the Hb levels between both sexes [Table 3], most of the males had normal Hb levels when compared to females; this difference is statistically significant when a student *t*-test was done ($t = 9.839$ and $P = 0.000$) [Figure 2].

The immediate visual memory in males is higher when compared to the females [Table 4], this difference is statistically significant ($t = 8.111$ and $P = 0.000$) [Figure 3]. The delayed visual memory in males is higher when compared to the females, this difference is statistically significant

Table 1: Age of the participants

Variable	<i>n</i>	Minimum	Maximum	Mean	SD
Age	304	50	65	58.65	4.37

Table 2: Age of the participant's gender wise

Variable	Sex	<i>n</i>	Mean $\pm$ SD	<i>t</i>	<i>P</i>
Age	Male	152	57.34 $\pm$ 4.13	0.443	0.658
	Female	152	58.45 $\pm$ 4.35		

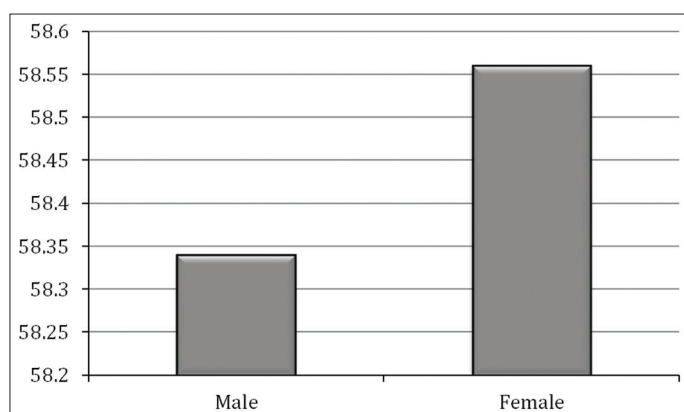


Figure 1: Mean age of the participants by sex wise

($t = 7.618$ and $P = 0.000$). The immediate and delayed visual memory scores of the normal Hb group were comparatively higher than the low Hb group and the results were statistically significant ($P = 0.000$) [Table 5].

DISCUSSION

The research studies involving the elderly population with mean ages of 60 or more are relatively sparse, only a limited

Table 3: Hemoglobin levels in male and female participants

Sex	Mean	<i>t</i>	<i>P</i>
Male	13.184 $\pm$ 1.27	9.839	0.000*
Female	11.568 $\pm$ 1.57		

Table 4: Performance on visual memory tests by male and female participants

Variables	Sex	Mean	<i>t</i>	<i>P</i>
Visual memory immediate	Male	94.30 $\pm$ 3.52	8.111	0.000*
	Female	85.89 $\pm$ 12.28		
Visual memory delayed	Male	91.03 $\pm$ 3.62	7.618	0.000*
	Female	78.25 $\pm$ 20.36		

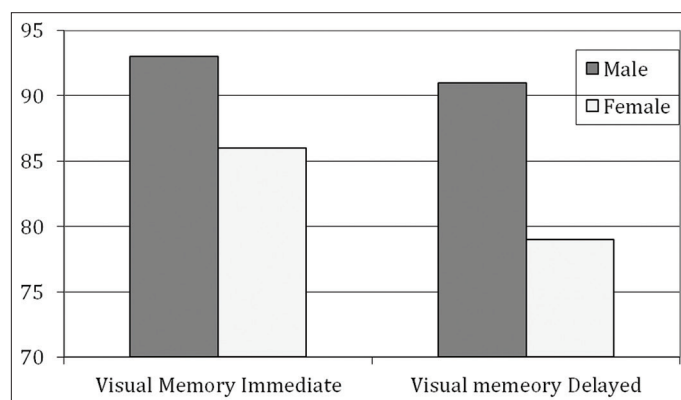


Figure 2: Performance on various memory functions sex wise

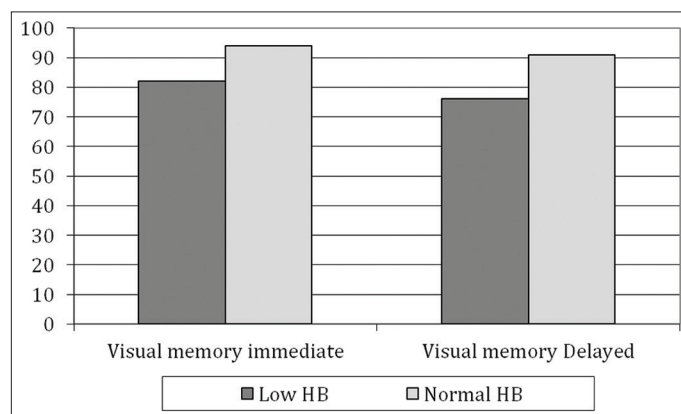


Figure 3: Performance on memory function by low and average hemoglobin group

Table 5: Performance of visual memory test by low and normal level of Hb

Variables		Mean	<i>t</i>	<i>P</i>
Visual memory immediate	Low	85.21±11.82	-9.887	0.000*
	Average	95.04±3.08		
Visual memory delayed	Low	77.47±19.98	-8.841	0.000*
	Average	91.91±1.87		

number of researches have analyzed adults across the entire range of adulthood on parameters of cognitive functioning. Moreover, the available research papers are concurrent in finding that increased age is associated with a more declining cognitive change.^[5] In our study also we were able to obtain similar results. The dysregulation of iron metabolism is correlated with increased oxidative stress-induced injury to the brain. This may be the reason for the deprivation of cognitive, social, and physical activities among elderly individuals with low Hb levels.^[2]

Elderly individuals are an ideal population to explore the role of cognitive functions in self-referencing because resources can be limited and differ widely across individuals.^[6] As age advances, the physical health and cognitive functions decline but still the frequency of negative affect decreases throughout most of the adulthood and levels off around age 60.^[7] The most widely acknowledged psychological change with age is the decline in cognitive functions, especially memory. However, it is observed not all cognitive functions decline with age not even all types of memory. In tune with these observations, this study was designed to explore the various domains of memory functions among the older subjects, between 50 and 65 years, with varying levels of Hb.

There may be an important influence of gender in association with Hb to cognition; the explanation for why women are commonly associated with low Hb compared to men is not clearly understood. Additional studies in the aged population, community-dwellers with a bigger sample size will be required to know the higher impact of gender on the link between Hb levels and cognition. Studies done elsewhere have found that men and women have vital variations in specific cognitive functions, what are more the males outmatch women on a visuospatial task and women outmatch men on tests of verbal fluency.^[1] In tune with this, our study has conjointly found that males had higher immediate visual memory compared with the females, this distinction is statistically important. Once we compare the delayed visual memory, the males had statistically important higher delayed visual memory compared to the females. Anemia may be a common drawback within the aged that accounts for important morbidity and mortality. It causes a negative impact on the standard of life which may result in medical complications, like impaired cognitive feature.^[7] We tend to find that low Hb was associated with specific domains of memory, the exact

nature of this differential impact is uncertain. Our findings are consistent to previous studies that anemia to be related to low performance on cognitive tests.

Hypoxia is the usual concerned issue to clarify alterations in cognitive performance, significantly in patients with internal organ or pneumonic failure; the results of acute graded hypoxia on higher integrative functions are well documented by experimentation in humans. Hypoxia impairs brain functions by incompletely outlined mechanisms. Hypoxia impairs memory and judgment, decreases neurotransmitter (ACh) synthesis, however, not the degree of nucleotide (ATP) or the adenylate energy charge. Any rationalization of the brain's sensitivity to a decrease in oxygen availability should embrace the alterations within the metabolism of the amino acid neurotransmitters similarly as a neurotransmitter.^[8] The pathophysiologic basis behind hypoxia and brain response to that is complicated. In mild to moderate hypoxia, in distinction to severe hypoxia and to anemia, the availability of energy for the brain is not impaired; cerebral levels of nucleotide (ATP) and adenylate energy charge are going to be normal. In distinction, the turnover of many neurotransmitters is modified by mild hypoxia. Neurotransmitter synthesis is reduced proportionately to the reduction in macromolecule oxidization, this relationship is tried *in vitro* and with many *in vivo* models of hypoxia,^[9] equally this study was conjointly document changes in cognitive feature functions associated with Hb levels.

Functional neuroimaging analysis has shown that the activity in numerous regions of the brain is examined throughout the performance of a cognitive feature task because it permits brain activity to be joined to cognitive performance at the time when the task is being performed; it conjointly provides distinctive and valuable data. Still, there may be many complications related to the interpretation of purposeful neuroimaging measures in analysis on aging.^[5] One vital question is that progress in age is usually related to lower performance in varied cognitive performance tasks and consequently there might be many alternative patterns mature variations in purposeful activation. Moreover, the advancing age is usually related to lower levels of performance, and purposeful activation will change in step with the amount of performance within the cognitive task.^[5]

While the decrease in brain volume with advancing age is well-documented, reasons for age-related decreases in brain volume are not totally clear. As antecedently postulated, loss of neurons does not seem to be the main issue contributive to the amount; however, there might be shrinkage of the nerve fiber arbor and of cell bodies, decrease in conjugation density, loss of interstitial tissue cells, reduction of myelination, and probably decreases in biological process. Partially due to the uncertainties regarding the character and causes of brain volume reduction is characterized as "the crudest of biology metrics."^[5]

It is difficult to interpret the link between brain volume and cognitive performance if the reduction in volume means

atrophy and loss of valuable neural parts, then it ought to be related to poorer performance on cognitive tests. However, if the increase in brain volume reflects pathological processes, like reactive gliosis or failure to dispose of the unnecessary elements of the neural networks, then the hyperbolic volume is predicted to be associated with higher cognitive performance. Despite the uncertainty regarding its nature, the relationship between brain volume measures and advancing age or measures of cognitive functioning is reported in several studies.

Limitations

The main limitation of this study is that the study was conducted and analyzed with all the observations at identical purpose in time, and so models in varied spectrum in terms of region and alternative causative relations are not simply distinguished. Alternative structural and physiological characteristics such as thickness of cortex, cerebral blood flow, concentration of brain metabolites, neurotransmitters or receptor sites, range of neurons, and density of synapses or spines, were not analyzed during this study.

CONCLUSION

Our work suggests that low Hb levels are a potential contributing factor among older adults who are evaluated for cognitive decline, the ability to translate the cognition measures into terms that are useful for clinical practice would require further research. In this study, we were able to observe that lower Hb levels were associated with decreased cognitive functions in the domains of immediate and delayed visual memory.

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