Original Research Paper

Volume-9 | Issue-12 | December - 2019 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Physiology

COGNITIVE CONSEQUENCES OF VITAMIN-D DEFICIENCY IN SENIOR CITIZENS OF BANGALORE CITY

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ABSTRACT The older population is at a high risk of Vitamin-D deficiency due to decreased cutaneous synthesis and dietary intake of Vitamin-D. In recent years, emerging evidence has linked Vitamin-D not only to its known effects on calcium and bone metabolism, but also to neurocognitive functions. Aging is a natural process and preserving intact cognition plays a very important role in healthy aging. Hence there is a need to evaluate whether Vitamin-D deficiency affects memory in the elderly. The objectives of this study is to assess Serum 25(OH) Vitamin-D in the elderly, and to assess Cognitive functions in the elderly with different levels of Vitamin-D. This study involved 80 healthy elderly subjects with consideration of inclusion and exclusion criteria. Written informed consent was taken. For each subject, fasting blood sample of 4ml was collected for Serum 25(OH) Vitamin-D assessment. Anthropometric measurements were taken. 24-hour dietary recall, General history questionnaire and Spreen & Stauss Neuropsychology battery of tests were administered. Results were compiled and statistically analyzed. The results show that Elderly with Vitamin-D deficiency had statistically significant low scores in all parameters ($P < 0.05$), especially with executive function & processing speed. It can be concluded that Low 25(OH)D levels were associated with worse global cognitive function and greater decline in psychomotor speed and executive function.

KEYWORDS : Vitamin-d, Cognition, Memory

INTRODUCTION

Indian aged population is presently the second largest in the world. The absolute number of the over 60 population in India is expected to increase to 137 million 2021 (Jay prakash Indira, WHO). In 2019 pan-India study found that 70-90 per cent of Indians are deficient of the sunshine vitamin, and the deficiency can have adverse consequences not only on bone health in elderly but also on other non-skeletal functions.

As people get older, skin thickness and 7-DHC content decrease, leading to decreased capacity of the skin to produce vitamin D. The skin loses more than 50% of its ability to produce vitamin D at 70 years of age compared with 20 years of age. These risks may be further exacerbated in certain racial or gender groups due to excess comorbidities, differences in nutritional requirements, and variation in dietary intakes. Aging is a natural process and preserving intact cognition plays a very important role in healthy aging. Cognitive decline and dementia are common in older adults, although their causes remain unclear. Vitamin D has been implicated as being important for maintaining cognitive function in old age. (Perez L et al 2011, Amer M et al 2012).

Hence there is a need to evaluate whether Vitamin-D deficiency affects cognition in the elderly of Bangalore city, who are genetically different from the group of subjects referred in the literature.

OBJECTIVES

A. To assess Serum 25(OH) Vitamin-D in the elderly.
B. To assess Cognitive functions in the elderly with different levels of Vitamin-D.

MATERIALS & METHODS

In this case control study after procuring the ethical clearance, 80 elderly aged more than 60 years were recruited from an enrichment center in Bangalore. To be included in this study the subjects were 1) to have no history of Alzheimer's hepatic disorders, renal disorders, Bone related Disorders, Chronic Systemic disorders, intake of vitamin D or Calcium supplements or drugs known to influence Vitamin D metabolism and sleep, 2) Possessing Verbal communication skills necessary to understand and respond to questions, 3) to be able to care for themselves independently (Informed consent was taken from all subjects or their families if the subject was unable to read or write), 4) to be non-alcoholic and non-smokers, 5) more than High school level education.6) H/o Diabetes Mellitus, Hypertension, Stroke, Myocardial Infarction, Thyroid dysfunction, and head injury. The study was done during the period of June to August 2019 which is neither winter nor summer in Bangalore city. After explaining the entire procedure, Written Informed consent was obtained. General Physical examination and systemic examination was done. Demographic characteristics, past medical history and use of medications were collected via structured questionnaire. Height and weight were measured, and BMI calculated using Quetlet's Index (wt in kg/ Height in m2).

MEASUREMENT OF SERUM VITAMIN D LEVELS:

This study measured serum 25-hydroxyvitamin D, which is the best indicator of vitamin D conditions in the body [Norman AW]. Specimens were kept frozen until they were analyzed by fully automated chemiluminescence immunoassay method. This study used 20 ng/mL as the cut-point for serum vitamin D deficiency. Less Than 20ng/dl were categorised as Cases and more than 20ng/dl as controls.

COGNITION DOMAINS:

Cognition domains assessed were psychomotor speed using digit symbol substitution test, sustained attention using digit vigilance test, executive functions which grades the semantic memory by Category fluency test and verbal memory (short and long term) by a passage test [Spreen & Strauss, 1998;Lewis RE ,1998;Raghavan DV, 2016].

STATISTICAL ANALYSIS:

Data entry and analysis was done on SPSS software version 17. Results of continuous measurements are presented in mean SD and results of categorical measurements are presented in number (%). Statistical test applied are student t test (two tailed, independent) and Pearson's Chi- square test and p value of less than 0.05 was considered as significant.

RESULTS

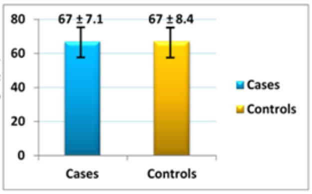
After procuring the results of serum analysis, all the parameters were tabulated, and statistical treatment was given to the data and represented in appropriate charts, graphs, and tables. Serum 25(OH) D levels of all the subjects were measured. Based on Vitamin D concentration subjects were classified into cases and controls.

STUDY SAMPLE:

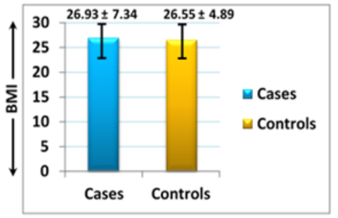
CASES: 60 Subjects with decreased Vitamin-D levels
CONTROLS: 20 Subjects with normal Vitamin-D levels.

The baseline characteristic of the participants is shown in Graph 1, Graph 2 and Graph 3. Age distribution of participants is shown in Graph 1.

GRAPH – 1 Average age of subjects



GRAPH – 2 Bmi of subjects



Graph 2 shows The BMI of subjects ranged from 14.46 to 52.36. Both males and females had BMI within WHO said limits of Normal to Overweight category. None of them were obese.

GRAPH – 3 Dietary habits of subjects

The subjects consisted of 43 Vegetarians (54%) and 37 Non-Vegetarians (46%). All the subjects consumed the same diet every day. The dietary calcium intake was 978 mg per day. The energy intake from 24hr diet was 1810 kcal per day. Vitamin D intake was negligible through food., even in the non-vegetarian group of subjects, as they hardly consumed non vegetarian food.

GRAPH – 4 Comparison of 25(OH)D levels in cases and controls of the study groups

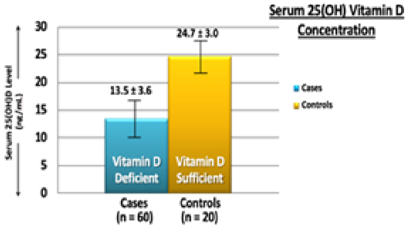


TABLE – 1 Analysis of cognitive domains in Cases (Vitamin D deficient) and Controls (Vitamin D Sufficient)

Domain	Test	Score (Cases)	Score (Controls)	P-Value
Speed	Digit Substitution Test	5.8 ± 1.9	7.2 ± 1.6	0.008 **
Attention	Digit Vigilance Test	9.3 ± 4.9	10.2 ± 3.1	0.423
Executive Function Tests	Category Fluency Test	9.3 ± 2.8	11.6 ± 3.4	0.009 **
	Verbal Working Memory 1 Back	8.3 ± 4.7	11.7 ± 5.5	0.015 **
	Verbal Working Memory 2 Back	8.2 ± 4.8	11.4 ± 6.1	0.027 **
Learning & Memory	Passage Test	6.0 ± 2.0	6.2 ± 2.1	0.65
	Auditory Verbal Learning – IR	10.3 ± 3.4	10.9 ± 2.9	0.502
	Auditory Verbal Learning – DR	6.6 ± 3.7	7.0 ± 3.9	0.684
	Complex Figure Test	4.7 ± 2.6	5.4 ± 2.2	0.355

DISCUSSION

In this Case Control study, 80 elderly citizens of age more than 60 years who met the inclusion and exclusion criteria were recruited for the study after obtaining the ethical committee clearance. Serum 25(OH) D were estimated and all the results were tabulated, statistically treated and expressed in appropriate graphs and tables. Age distribution of participants is shown in Graph 1. The Mean ± SD age of subjects ranged from 65 to 91 years with a mean age (±SD) of 67 (±7.1) years for cases and 67 (±7.1) years for controls. Wortsman et al in their study have proven that vitamin D bioavailability is affected by obesity. Graph 2 shows average BMI of the subjects which was 25.59 (±6.46) kg/m2. The average BMI of female subjects was 26.78 (±6.78) kg/m2 whereas the average BMI of male subjects was 23.90 (±5.48) kg/m2. Both the groups were not obese, thus nullifying one of the confounding factors that would have affected this study. Graph 3 shows the dietary habits of the subjects. There were 46% nonvegetarians and 54% vegetarians in the study. All subjects consumed the same diet every day. Vitamin D intake was almost negligible through vegetarian food. Moreover, the non-vegetarians in the group hardly consumed any non-vegetarian food.

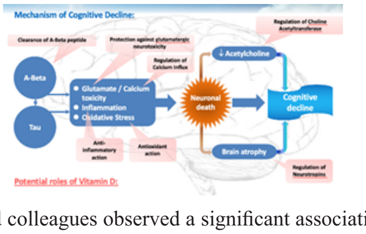
SERUM VITAMIN D LEVELS:

Graph 4 shows comparison of serum 25(OH)D levels of Cases and Control study groups. Several previous studies like Fradinger et al and Holick MF et al have reported low serum 25(OH)D levels in the older population. Older adults are at a risk of lower vitamin D due to decr eased cutaneous synthesis, decreased dietary intake, and decreased intestinal absorption. In this study the dietary intake of vitamin D was negligible. This was in accordance with study done by Omdahl et al. With advancing age, a gradual vitamin D deficiency becomes evident. This is due to a reduction of the concentration of 7-dehydrocholesterol in the epidermis, typical during aging, and to a consequent decrease of synthesis under UV irradiation. On the other hand, a decreased exposition to UV light is frequent in the elderly people. In addition, a low nutritional intake of vitamin D is present.

COGNITIVE DOMAINS:

It has long been known that calcitriol (1,25-dihydroxycholecalciferol), the bioactive form of 25 (OH)D, plays a crucial role in phosphate homeostasis, bone mineralization and regulating levels of calcium. However, accumulating evidence suggests previously unsuspected roles for vitamin D in brain development and neuroprotection. Low levels of serum 25(OH)D may be associated with an increased risk of neurologic diseases such as multiple sclerosis, and Parkinson disease. (Newmark 2007,Munger KL 2006). Vitamin D receptors are present in a wide variety of cells, including neurons and glial cells, and genes encoding the enzymes involved in the metabolism of vitamin D are also expressed in the brain.(McCann JC 2008) .In a study by Buell and Dawson-Hughes it is emphasized that vitamin D may be neuropr otective through antioxidative mechanisms, immuno modulation, neuronal calcium regulation, detoxification mechanisms, and enhanced nerve conduction. Vitamin D may play a role in brain detoxification pathways by reducing cellular calcium, inhibiting the synthesis of inducible nitric oxide synthase, and increasing levels of the antioxidant glutathione. Vitamin D stimulates neurogenesis and regulates the synthesis of neurotrophic factors, which are important for cell differentiation and survival. Vitamin D is also an immuno suppressor and may inhibit autoimmune damage to the nervous system. Calcitriol stimulates β-amyloid phagocytosis and clearance while protecting against apoptosis. (Buell JS et al, 2008; Garcion et al 2008;Masoumi et al, 2009)

FIGURE– 1 Mechanism of Cognitive Decline



Llewellyn and colleagues observed a significant association between low levels of 25(OH)D and increased odds of cognitive impairment. Similarly, Buell and colleagues observed a positive association between 25(OH)D levels and tests of executive function and processing speed, but not memory. Likewise, Lee and colleagues observed a significant positive association between 25(OH)D levels and a test of sustained attention, but not with memory or visuospatial ability. Similar to these findings, results of the current study suggest that low serum 25(OH)D level is associated with cognitive dysfunction. Low levels of 25(OH)D may be particularly detrimental to Speed, attention and executive functions, whereas other cognitive domains such memory may be relatively preserved.

CONCLUSION

In conclusion, limited yet growing literature indicates that Vitamin D deficiency is a potential risk factor for cognitive decline. Current study provides an important extension to the existing literature. Based on the results of this study, Cognition can be improved in the elderly by making them aware of the importance of nutrition and providing regular examinations checking their Serum Vitamin-D levels, and supplementing Vitamin-D to the elderly to enhance cognition and thus the quality of life.

REFERENCES:

1. World Health Organisation. Jayprakash Indira : Ageing in India. Available from: https://apps.who.int/iris/bitstream/handle/10665/65965/WHO_HSC_AHE_99.2.pdf;jsessionid=1C595FA379AEE4922B81B96158322599?sequence=1
2. Give me some sunshine: Most Indians have vitamin D deficiency [Internet].2019. Available from: https://economictimes.indiatimes.com/magazines/panache/give-me-some-sunshine-most-indians-have-vitamin-d-deficiency/articleshow/70890677.cms?from=mdr
3. Perez-L ´ opez FR, Chedraui P, Fern ´ andez-Alonso AM. Vitamin D and ´ aging: beyond calcium and bone metabolism. Maturitas 2011;69:27–36
4. Amer M, Qayyum R. Relation between serum 25-hydroxyvitamin D and C-reactive protein in asymptomatic adults (from the continuous National Health and Nutrition Examination Survey 2001 to 2006). Am J Cardiol 2012;109:226–30
5. Patricia AT, Margie EL (2006). Telephone assessment of cognitive function in adulthood: the Brief Test of Adult Cognition by Telephone. Age Ageing. 35(6): 629-632.
6. Spreen O, Strauss E. A compendium of neuropsychological test. 2nd Ed. New York, USA: Oxford university press;1998.
7. Lewis RE, Kelland DZ, Kupke T. A normative study of the repeatable cognitive-perceptual-motor battery. Arch Clin Neuropsychol 1990;5(2):187.
8. Raghavan DV, Shanmugiah A, Bharathi P, Jeyaprakash R. P300 and neuropsychological measurements in patients with schizophrenia and their healthy biological siblings. Indian J Psychiatry 2016; 58(4):454–8.
9. Wortsman J, Matsuoka LY, Chen TC, Lu Z, Holick MF.Decreased bioavailability of vitamin D in obesity. Am J Clin Nutr. 2000 Sep;72(3):690-3.
10. Body Mass Index.[Internet] 2015[cited 2015 May 2015] Available from: http://www.euro.who.int/en/health-topics/disease-prevention/nutrition/a-healthylifestyle/body-mass-index-bmi
11. Fradinger EE, Zanchetta JR.Vitamin D and bone mineral density in ambulatory women living in Buenos Aires, Argentina. Osteoporosis Int. 2001;12:24-7.
12. Holick MF Siris E, Binkley N. Prevalence of Vitaamin D inadequacy among postmenopausal North American women recieving osteoporosis therapy. J Clin Endocrinol metab. 2005;90:3215-24.
13. Holick MF. The Vitamin D deficiency pandemic: a forgotten hormone. Public health reviews. 2010;32:267-83. 16. Holick MF.. Vitamin D : A delightful solution for health. J Investig Med. 2011;59(6):872-80
14. Maclaughlin J A, Holick M F. Aging decreases the capacity of human skin to produce Vitamin D3. Journal of clinical investigation. 1985;76:1536-8.
15. Omdahl JL. Nutritional status in a healthy elderly population:Vitamin D. The American journal of clinical nutrition. 1982;36:1225-33.
16. Munger KL, Levin LI, Hollis BW, Howard NS, Ascherio A. Serum 25-hydroxyvitamin D levels and risk of multiple sclerosis. JAMA. 2006;296(23):2832–2838.
17. Newmark HL, Newmark J. Vitamin D and Parkinson's disease–a hypothesis. Mov Disord. 2007;22(4):461–468
18. McCann JC, Ames BN. Is there convincing biological or behavioral evidence linking vitamin D deficiency to brain dysfunction? FASEB J. 2008;22(4):982–1001.
19. Buell JS, Dawson-Hughes B. Vitamin D and neurocognitive dysfunction: preventing "D"ecline? Mol Aspects Med. 2008;29(6):415–422
20. Garcion E, Wion-Barbot N, Montero-Menei CN, Berger F, Wion D. New clues about vitamin D functions in the nervous system. Trends Endocrinol Metab. 2002;13(3):100–105.
21. Masoumi A, Goldenson B, Ghirmai S, et al. 1alpha,25-dihydroxyvitamin D3 interacts with curcuminoids to stimulate amyloid-beta clearance by macrophages of Alzheimer's disease patients. J Alzheimers Dis. 2009;17(3):703–717.
22. Llewellyn DJ, Langa KM, Lang IA. Serum 25-hydroxyvitamin d concentration and cognitive impairment. J Geriatr Psychiatry Neurol. 2009;22(3):188–195
23. Lee DM, Tajar A, Ulubaev A, et al. EMAS study group Association between 25-hydroxyvitamin D levels and cognitive performance in middle-aged and older European men. J Neurol Neurosurg Psychiatry. 2009;80(7):722–729. [PubMed] [Google Scholar]
24. Buell JS, Scott TM, Dawson-Hughes B, et al. Vitamin D is associated with cognitive function in elders receiving home health services. J Gerontol A Biol Sci Med Sci. 2009;64(8):888–895. [PMC free article] [PubMed] [Google Scholar]
25. Dhesi JK, Jackson SH, Bearne LM, et al. Vitamin D supplementation improves neuromuscular function in older people who fall. Age Ageing. 2004;33(6):589–595. [PubMed] [Google Scholar]
26. Przybelski R, Agrawal S, Krueger D, Engelke JA, Walbrun F, Binkley N. Rapid correction of low vitamin D status in nursing home residents. Osteoporos Int. 2008;19(11):1621–1628.
27. Annweiler C, Schott AM, Berrut G, Chauvire V, Le Gall D, Inzitari M, Beauchet O. Vitamin D and ageing: neurological issues. Neuropsychobiology 2010;62:139–50.
28. Vitamin D signaling and the differentiation of developing dopamine systems. Pertile RA, Cui X, Eyles DW. Neuroscience. 2016;333:193–203.
29. The role of vitamin D3 in the development and neuroprotection of midbrain dopamine neurons. Orme RP, Middleditch C, Waite L, Fricker RA. Vitam Horm. 2016;100:273–297