



Comparative Evaluation of Cognitive Function among Indian Obese and Non-Obese Middle-Aged Subjects

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Background: Obesity has become one of the common problems encountered by people of the present day. This condition is often accompanied by cardiovascular problems like hypertension, hyperlipidemia, is chemic heart disease. Also, that the relationship between obesity and cognitive impairment plays an important role in the development of neurodegenerative disorders. But reports on the association between obesity and working memory lack scientific evidence. So, the present study planned to assess the influence of obesity on cognitive functions and compare among obese and non - obese individuals.

Objective: This study evaluated the changes in cognitive functions comparative between samples of obese and non-obese individuals from India.

Methods: Based on the Body Mass Index (BMI), the participants were classified into 2 groups. Cognitive screening was done using MINI MENTAL STATE EXAMINATION and the parameters like level of orientation, registration, recall, language, copy art skills were analyzed and scores were calculated. The data was statistically analyzed using SPSS version 23 and the independent sample t test was used to analyze the differences in cognitive functions.

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Results: The study reported that there was statistically significant decline in language, recall and copy art skills in obese individuals compared to non-obese group.

Conclusion: The study concluded an innovative finding that obesity is associated with impaired cognitive performance pertaining to recall, language and copy art and overall decreased MMSE scores indicating that accelerated cognitive decline and neurodegenerative pathologies such as dementia in later life is influenced by changes in body weight. Interventions that target mid-life obesity may be helpful in reducing the cognitive risks associated with obesity.

Keywords: Obesity; cognitive loss; risk; innovative finding; MMSE score.

1. INTRODUCTION

Obesity is a disease involving an excessive amount of fat in the body. Obesity is a serious community concern in today's global world. This problem progressively affects all kinds of income states, especially the urban population [1]. All over this global world 1.9 billion are overweight in 18 years and 650 million are obese [2]. 41 million under the age of 5 are over-weight and adolescent aged 5 - 19 are overweight globally [3,4].

When a person's body mass index is 25 or greater then, it leads to obesity. Causes for obesity are genetic, behavioral, metabolic and hormonal influences on body weight. Certain aspects of personality are associated being obese [5,6]. Neuroticism, impulsivity and sensitivity are more common in people who are obese while conscientiousness and self-control are less common in people who are obese. Loneliness is also a risk factor [7,8]. Obesity is also found in hypothyroidism, hypogonadism and Cushing's syndrome which are known as endocrine factors of obesity[9]. Obesity is also common during puberty, pregnancy, menopause, suggesting endocrine glands must be a factor. An injury to the hypothalamus after a head injury may lead to obesity as the hypothalamus cannot regulate the satiety center [10,11]. It is a medical problem that increases risk of serious health problems including heart disease, strokes, diabetes, certain cancers, sleep apnea [12]. A period of strenuous growth because of greater amount of activity and the development of physical and cognitive functions requires a balanced nutrition [13].

A major change in lifestyle of families with eating habits, environment, genetic changes and increasing hours in playing video games, social media and computers has played a vital role in increasing body weight among people[14]. Obesity is classified based on the body mass index - NON - OBESE : [BMI >25]

and OBESE : [BMI >30] (5). There are 3 types of obesity. BMI is 30.0 to 34.9 in low-risk obesity,[15]BMI is 35.0 to 39.9 in moderate risk obesity[16]. BMI is equal to or greater than 40.0 in high-risk obesity. The best way to treat obesity is to eat a healthy, reduced calorie diet and exercise regularly [17,18]. Our team has extensive knowledge and research experience that has translate into high quality publications[19–23].

Obesity is a preventable disease that leads to the cause of death worldwide with increasing rates in adults and children [24,25]. In 2015, 600 million adults (12%) and 100 million children were obese in 195 countries [16,26]. Obesity is one of the more common diseases in women than in men. In 2013, including the American Medical Association and several medical societies classified obesity as a disease [27]. Obesity is often accompanied by cardiovascular problems like hypertension, hyperlipidemia, ischemic heart disease, but reports on the association between obesity and working memory were not reported and lack scientific evidence [28]. So, the present study planned to assess the influence of obesity on cognitive functions and compare among obese and non-obese individuals [29,30].

2. MATERIALS AND METHODS

Normal healthy adults (sample = 20) (sample size is based on the cost, time, or convenience of collecting the data and this sample size was used to represent the whole population) in the age group of 45 to 55 years of both genders with no history of neurological conditions or Alzheimer's disease were chosen for the study. The method of sampling is random sampling. The participants were categorised into two groups.

Group 1 - obese (BMI - 30 to 39.9)

Group 2 - non-obese (BMI - 18.5 to 24.9).

The cognitive assessment was made using mini mental state examination and the parameters like

orientation, registration, recall, copy art, language was evaluated, and scores were calculated. calculated scores were tabulated in the excel sheet and analysed. Higher the score of MMSE indicates good level of cognition. Data entered in the SPSS software and the results were analysed using an independent sample test and represented in the bar graphs.

3. RESULTS

The present study reported that level of orientation was lower in population of obese than non - obese. It is statistically non - significant ($p < 0.05$) (Fig 1). Level of registration was lower in population of obese than non - obese. It is statistically non - significant. ($p < 0.05$) (Fig 2). Level of recall was lower in population of obese than non - obese. It is statistically significant.

($p < 0.05$) (Fig 3). Level of language was lower in population of obese than non - obese. It is statistically significant ($p < 0.05$) (Fig 4). Level of copy art was lower in population of obese than non - obese. It is statistically significant. ($p < 0.05$) (Fig 5). The total MMSE scores was significantly lower in obese than non - obese. It is statistically significant. ($p < 0.05$) (Fig 6) (Table 1).

Fig. 1. Bar graph depicts the association between the obese and non-obese. X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups. It is observed that there is non-obese subjects had a better level of orientation compared to obese groups but the value was not statistically significant as in independent t test. P value = 0.54 ($p > 0.05$).

Table 1. Represents the scores of Mini mental state examination on obese and non-obese individuals

MMSE	Groups	Mean	P value
Orientation	Obese	10.50 ± 1.080	P value = 0.54 ($p < 0.05$)
	Non - obese	13.70 ± 0.949	
Registration	Obese	4.80 ± 0.789	P value = 0.80 ($p > 0.05$)
	Non - obese	8.50 ± 0.707	
Recall	Obese	11.50 ± 1.080	P value = 0.12 ($p > 0.05$)
	Non - obese	14.40 ± 0.699	
Language	Obese	4.50 ± 0.850	P value = 0.02 ($p < 0.05$)
	Non - obese	7.80 ± 0.422	
Copy art	Obese	1.50 ± 0.527	P value = 0.03 ($p < 0.05$)
	Non - obese	2.80 ± 0.422	
MMSE score	Obese	32.80 ± 2.898	P value = 0.04 ($p < 0.05$)
	Non - obese	47.20 ± 1.476	
BMI	Obese	35.43 ± 2.561	P value = 0.03 ($p < 0.05$)
	Non - obese	22.22 ± 2.113	

The values are expressed as mean ± standard deviation representing the scores of mini mental state examination in obese and non- obese middle-aged subjects

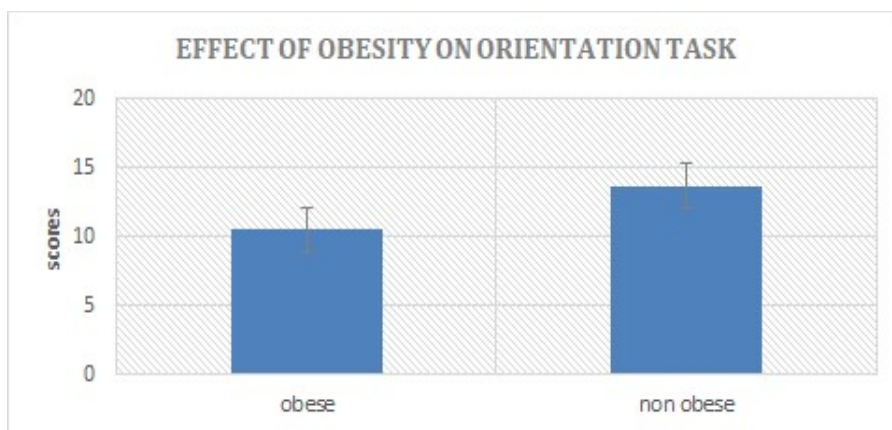


Fig. 1. Scores obtained for level of orientation in obese and non obese groups

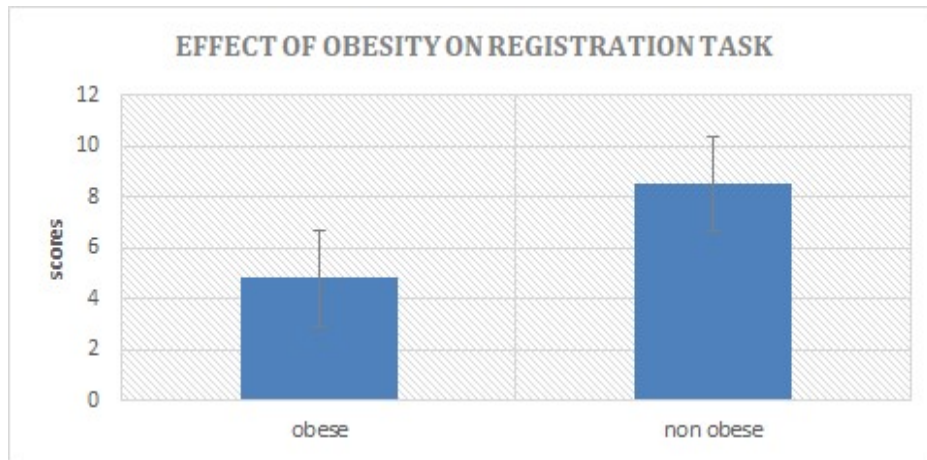


Fig. 2. Scores obtained for the level of registration in obese and non-obese groups

Fig. 2. Bar graph depicts the association between the obese and non-obese. X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups.

It is observed that there are non-obese subjects had a better level of registration compared to obese groups but the value was not statistically significant as in independent t test. P value = 0.80 ($p > 0.05$).

Fig. 3. Represents the scores obtained for Level of recall in obese and non-obese groups. Bar graph depicts the association between the obese and non-obese. X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups. It is observed that there is non-obese subjects had a better level of recall compared to obese groups but the value was not statistically significant as in independent t test. P value = 0.12 ($p > 0.05$).

Fig. 4. Represents the scores obtained for Level of language in obese and non-obese groups. Bar graph depicts the association between the obese and non-obese. X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups. It is observed that there are non-obese subjects had a better level of language compared to obese groups and the value was statistically significant as in independent t test. P value is 0.02 ($p < 0.05$).

Fig. 5. Represents the scores obtained for Level of copy art in obese and non-obese groups. Bar graph depicts the association between the obese and non-obese groups. X axis represents obese and non - obese groups and Y axis represents

scores obtained by obese and non - obese groups. It is observed that there are non-obese subjects had a better level of copy art compared to obese groups and the value was statistically significant as in independent t test. P value is 0.03 ($p < 0.05$).

Fig. 6 represents the scores obtained for total MMSE scoring in obese and non-obese groups. Bar graph depicts the association between the obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups. It is observed that non-obese subjects had a better level of MMSE scoring compared to obese groups and the value was statistically significant as in independent t test. P value is 0.04 ($p < 0.05$).

4. DISCUSSION

Ageing is a process accompanied by significant changes in cognitive decline and is the main risk factor for the development of neurodegenerative disorders, including Alzheimer's disease.[31,32].

Previous research reports also showed that early to mid-adulthood obesity might have an immediate detrimental negative impact on cognitive functioning.[33,34].

In the present study, Obesity is associated with impaired cognitive performance pertaining to recall, language and copy art and overall decreased MMSE scores indicating that accelerated cognitive decline and neurodegenerative pathologies such as dementia in later life is influenced by changes in body weight.[18,35].

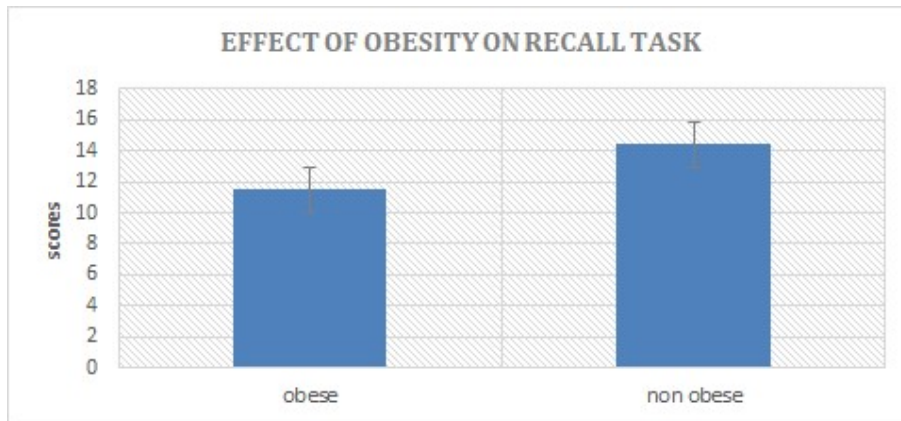


Fig. 3. Scores obtained for the recall task in obese and non-obese groups

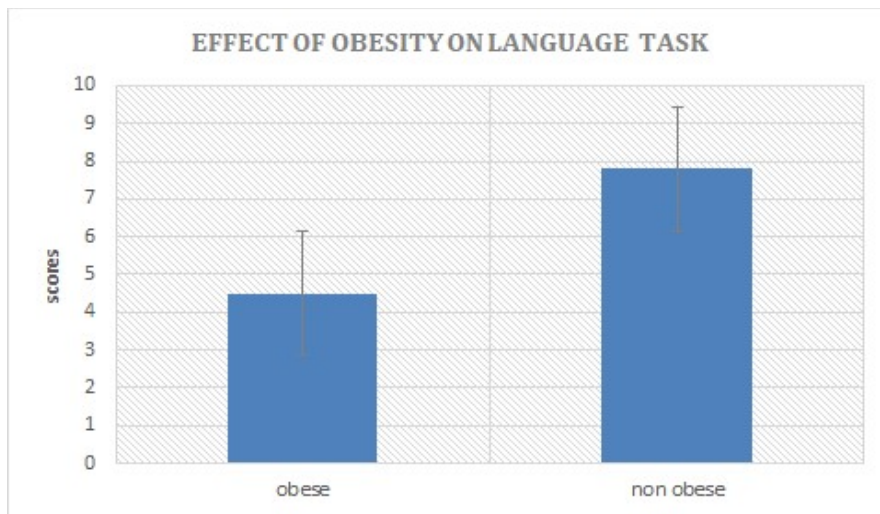


Fig. 4. Scores obtained for the language task in obese and non-obese groups

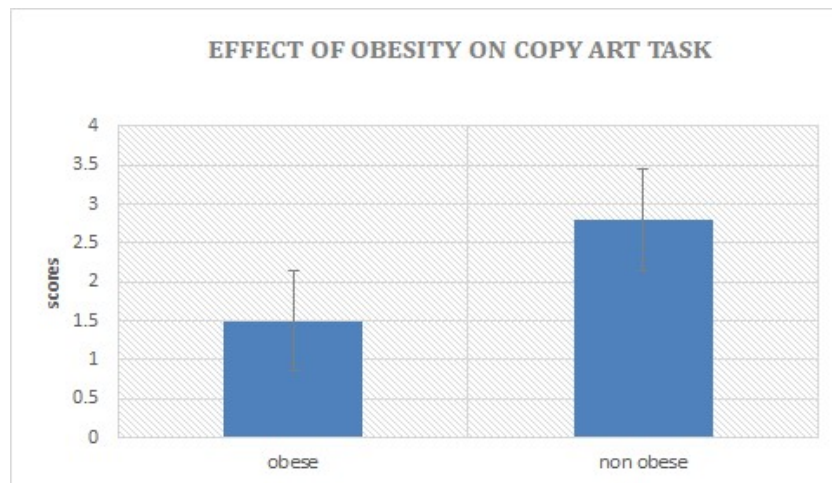


Fig. 5. Scores obtained for the copy art task in obese and non-obese groups

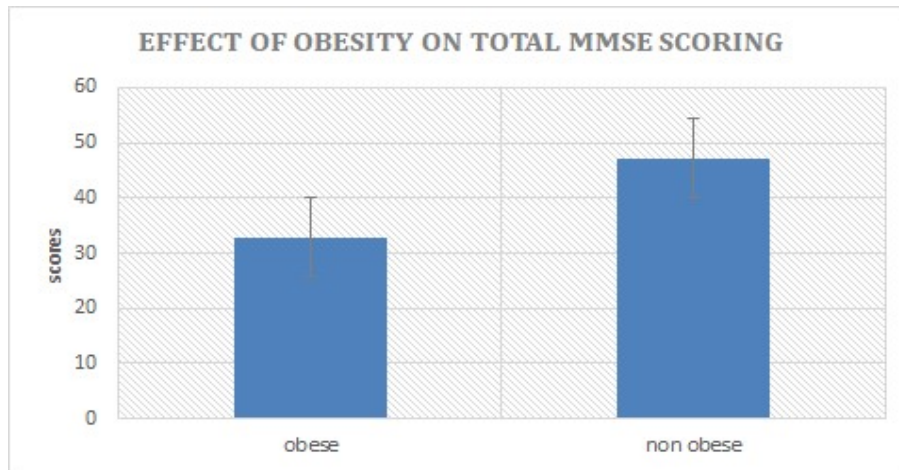


Fig. 6. Scores obtained for the total MMSE in obese and non-obese groups

Reports suggested a negative association between anthropometric measures of obesity like BMI with a number of cognitive domains.[27,35] Obesity is related to impaired performance on tasks that relate to episodic memory, Verbal learning, followed by delayed recall and recognition of words.[36][37].

Few studies also reported that Impaired working memory performance has been exhibited in overweight and obese young adults compared with healthy weight controls.[38].

Certain studies also stated that decrease in executive functions of concept formation and set shifting was more predominant when measured using Wisconsin card sorting test in obese subjects relative to normal weight subjects.[39][40]/ Research reports suggest that Obesity has been associated with increase in brain age, particularly in respect to cerebral white matter atrophy[41]. This area has shown more atrophy in middle-age[42][38].

5. CONCLUSION

Our study concluded that obese individuals showed a moderate decline in cognitive functions, and based on that we emphasize the importance of proper and personalized interventions that are targeting mid-life obesity may be helpful in reducing the risk for these conditions by focusing on reducing the level of obesity through a healthy lifestyle.

6. LIMITATIONS OF THE STUDY

The study population was confined only to a small group. If more sample size is added the results would have been statistically significant.

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CONSENT

As per international standard or university standard, patients' written consent has been collected and preserved by the author(s).

ETHICAL APPROVALS

We conducted our research after obtaining proper IEC approval.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obesity Reviews* 2016;17:95–107.

2. Available: <https://doi.org/10.1111/obr.12334>
Singh GK. Childhood Obesity in the United States, 1976-2008: Trends and Current Racial/ethnic, Socioeconomic, and Geographic Disparities; 2010.
3. Bagchi D. Global Perspectives on Childhood Obesity: Current Status, Consequences and Prevention. Academic Press; 2010.
4. Santhakumar P, Roy A, Mohanraj KG, Jayaraman S, Durairaj R. Ethanolic Extract of Capparis decidua Fruit Ameliorates Methotrexate-Induced Hepatotoxicity by Activating Nrf2/HO-1 and PPAR γ Mediated Pathways. Indian Journal of Pharmaceutical Education and Research 2021;55:s265–74.
Available: <https://doi.org/10.5530/ijper.55.1s.59>.
5. Saraswathi I, Saikarthik J, Senthil Kumar K, Srinivasan KM, Ardhanaari M, Gunapriya R. Impact of COVID-19 outbreak on the mental health status of undergraduate medical students in a COVID-19 treating medical college: a prospective longitudinal study. PeerJ. 2020;8:e10164.
Available: <https://doi.org/10.7717/peerj.10164>.
6. Vivekanandhan K, Shanmugam P, Barabadi H, Arumugam V, Daniel Raj Daniel Paul Raj D, Sivasubramanian M, et al. Emerging Therapeutic Approaches to Combat COVID-19: Present Status and Future Perspectives. Front Mol Biosci. 2021;8:604447.
7. Shabgah AG, Ezzatifar F, Aravindhan S, Zekiy AO, Ahmadi M, Gheibihayat SM, et al. Shedding more light on the role of Midkine in hepatocellular carcinoma: New perspectives on diagnosis and therapy. IUBMB Life 2021;73:659–69.
Available: <https://doi.org/10.1002/iub.2458>.
8. Tahmasebi S, Qasim MT, Krivenkova MV, Zekiy AO, Thangavelu L, Aravindhan S, et al. The effects of oxygen-ozone therapy on regulatory T-cell responses in multiple sclerosis patients. Cell Biol Int. 2021;45:1498–509.
9. Barabadi H, Mojab F, Vahidi H, Marashi B, Talank N, Hosseini O, et al. Green synthesis, characterization, antibacterial and biofilm inhibitory activity of silver nanoparticles compared to commercial silver nanoparticles. Inorganic Chemistry Communications. 2021;129:108647.
Available: <https://doi.org/10.1016/j.inoche.2021.108647>.
10. Gul A, Fozia, Shaheen A, Ahmad I, Khattak B, Ahmad M, et al. Green Synthesis, Characterization, Enzyme Inhibition, Antimicrobial Potential, and Cytotoxic Activity of Plant Mediated Silver Nanoparticle Using Ricinus communis Leaf and Root Extracts. Biomolecules. 2021;11:206.
Available: <https://doi.org/10.3390/biom11020206>.
11. Sridharan G, Ramani P, Patankar S, Vijayaraghavan R. Evaluation of salivary metabolomics in oral leukoplakia and oral squamous cell carcinoma. Journal of Oral Pathology & Medicine 2019;48:299–306.
Available: <https://doi.org/10.1111/jop.12835>.
12. Bray GA. Obesity in Perspective: A Conference; 1975.
13. Obesity paradox. Integrative Obesity and Diabetes 2015;1.
Available: <https://doi.org/10.15761/iod.1000114>.
14. Kiess W, Marcus C, Wabitsch M. Obesity in Childhood and Adolescence. Karger Medical and Scientific Publishers; 2004.
15. J PC, Pradeep CJ, Marimuthu T, Krithika C, Devadoss P, Kumar SM. Prevalence and measurement of anterior loop of the mandibular canal using CBCT: A cross sectional study. Clinical Implant Dentistry and Related Research 2018;20:531–4.
Available: <https://doi.org/10.1111/cid.12609>.
16. Clarizia G, Bernardo P. Diverse Applications of Organic-Inorganic Nanocomposites: Emerging Research and Opportunities: Emerging Research and Opportunities. IGI Global; 2019.
17. Bharath B, Perinbam K, Devanesan S, AISalhi MS, Saravanan M. Evaluation of the anticancer potential of Hexadecanoic acid from brown algae Turbinaria ornata on HT–29 colon cancer cells. Journal of Molecular Structure 2021;1235:130229.
Available: <https://doi.org/10.1016/j.molstruc.2021.130229>.
18. Egbuna C, Mishra AP, Goyal MR. Preparation of Phytopharmaceuticals for the Management of Disorders: The Development of Nutraceuticals and Traditional Medicine. Academic Press; 2020.
19. PradeepKumar AR, Shemesh H, Jothilatha S, Vijayabharathi R, Jayalakshmi S, Kishen A. Diagnosis of Vertical Root Fractures in Restored Endodontically

- Treated Teeth: A Time-dependent Retrospective Cohort Study. *J Endod.* 2016;42:1175–80.
20. Dhinesh B, Isaac Joshua Ramesh Lalvani J, Parthasarathy M, Annamalai K. An assessment on performance, emission and combustion characteristics of single cylinder diesel engine powered by *Cymbopogon flexuosus* biofuel. *Energy Convers Manage.* 2016;117:466–74.
 21. Lekha L, Kanmani Raja K, Rajagopal G, Easwaramoorthy D. Schiff base complexes of rare earth metal ions: Synthesis, characterization and catalytic activity for the oxidation of aniline and substituted anilines. *J Organomet Chem.* 2014;753:72–80.
 22. Soh CL, Narayanan V. Quality of life assessment in patients with dentofacial deformity undergoing orthognathic surgery—A systematic review. *Int J Oral Maxillofac Surg.* 2013;42:974–80.
 23. Krishnan V, Lakshmi T. Bioglass: A novel biocompatible innovation. *J Adv Pharm Technol Res.* 2013;4:78–83.
 24. Meyer MW, Robinson JM. *The Nag Hammadi Scriptures: The Revised and Updated Translation of Sacred Gnostic Texts Complete in One Volume.* Harper Collins; 2010.
 25. Wadhwa R, Paudel KR, Chin LH, Hon CM, Madheswaran T, Gupta G, et al. Anti-inflammatory and anticancer activities of Naringenin-loaded liquid crystalline nanoparticles in vitro. *Journal of Food Biochemistry* 2021;45.
Available: <https://doi.org/10.1111/jfbc.13572>.
 26. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic.* World Health Organization; 2000.
 27. Rajakumari R, Volova T, Oluwafemi OS, Rajesh Kumar S, Thomas S, Kalarikkal N. Grape seed extract-soluplus dispersion and its antioxidant activity. *Drug Development and Industrial Pharmacy* 2020;46:1219–29.
Available: <https://doi.org/10.1080/03639045.2020.1788059>.
 28. Mudigonda SK, Murugan S, Velavan K, Thulasiraman S, Krishna Kumar Raja V. Non-suturing microvascular anastomosis in maxillofacial reconstruction- a comparative study. *Journal of Cranio-Maxillofacial Surgery.* 2020;48:599–606.
Available: <https://doi.org/10.1016/j.jcms.2020.04.005>.
 29. Kamath SM, Manjunath Kamath S, Jaison D, Rao SK, Sridhar K, Kasthuri N, et al. In vitro augmentation of chondrogenesis by Epigallocatechin gallate in primary Human chondrocytes - Sustained release model for cartilage regeneration. *Journal of Drug Delivery Science and Technology.* 2020;60:101992.
Available: <https://doi.org/10.1016/j.jddst.2020.101992>.
 30. Wahab PUA, Abdul Wahab PU, Madhulaxmi M, Senthilnathan P, Muthusekhar MR, Vohra Y, et al. Scalpel Versus Diathermy in Wound Healing After Mucosal Incisions: A Split-Mouth Study. *Journal of Oral and Maxillofacial Surgery.* 2018;76:1160–4.
Available: <https://doi.org/10.1016/j.joms.2017.12.020>.
 31. Greenwood PM, Parasuraman R. Brain Aging and Cognitive Aging. *Nurturing the Older Brain and Mind.* 2012;19–48.
Available: <https://doi.org/10.7551/mitpress/9780262017145.003.0003>.
 32. R H, Hannah R, Ramani P, Ramanathan A, Jancy MR, Gheena S, et al. CYP2 C9 polymorphism among patients with oral squamous cell carcinoma and its role in altering the metabolism of benzo[a]pyrene. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology.* 2020;130:306–12.
Available: <https://doi.org/10.1016/j.oooo.2020.06.021>.
 33. Xu WL, Atti AR, Gatz M, Pedersen NL, Johansson B, Fratiglioni L. Midlife overweight and obesity increase late-life dementia risk: A population-based twin study. *Neurology.* 2011;76:1568–74.
Available: <https://doi.org/10.1212/wnl.0b013e3182190d09>.
 34. Nambi G, Kamal W, Es S, Joshi S, Trivedi P. Spinal manipulation plus laser therapy versus laser therapy alone in the treatment of chronic non-specific low back pain: a randomized controlled study. *Eur J Phys Rehabil Med.* 2018;54:880–9.
 35. Bland KI, Suzanne Klimberg V. *Master Techniques in General Surgery: Breast Surgery.* Lippincott Williams & Wilkins; 2012.
 36. Whitmer RA, Gunderson EP, Barrett-Connor E, Quesenberry CP Jr, Yaffe K. Obesity in middle age and future risk of dementia: a 27 year longitudinal

- population based study. BMJ. 2005;330:1360.
37. Razay G, Vreugdenhil A. Obesity in middle age and future risk of dementia: Midlife obesity increases risk of future dementia. BMJ. 2005;331: 455.1. Available:<https://doi.org/10.1136/bmj.331.7514.455>.
 38. Conforto RM, Gershman L. Cognitive processing differences between obese and nonobese subjects. Addict Behav.1985; 10:83–5.
 39. Lokken KL, Boeka AG, Yellumahanthi K, Wesley M, Clements RH. Cognitive performance of morbidly obese patients seeking bariatric surgery. Am Surg.2010;76:55–9.
 40. Cavedini P, Bassi T, Ubbiali A, Casolari A, Giordani S, Zorzi C, et al. Neuropsychological investigation of decision-making in anorexia nervosa. Psychiatry Res. 2004;127:259–66.
 41. Prakash AKS, Devaraj E. Cytotoxic potentials of S. cumini methanolic seed kernel extract in human hepatoma HepG2 cells. Environmental Toxicology 2019;34 :1313–9. Available:<https://doi.org/10.1002/tox.22832>
 42. Fotenos AF, Snyder AZ, Girton LE, Morris JC, Buckner RL. Normative estimates of cross-sectional and longitudinal brain volume decline in aging and AD. Neurology 2005;64:1032–9. Available:<https://doi.org/10.1212/01.wnl.000154530.72969.11>.

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