

COMPARATIVE EVALUATION OF COGNITIVE FUNCTION AMONG OBESE AND NON - OBESE MIDDLE AGED SUBJECTS OF BOTH GENDERS

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, ischemic 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 among obese and non obese individuals.

Methods :

Based on 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.

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

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 overweight 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, behavioural, metabolic and hormonal influences on body weight. Certain aspects of personality are associated with 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).

Obesity is a preventable disease that leads to the cause of death worldwide with increasing rates in adults and children(19,20). In 2015, 600 million adults (12%) and 100 million children were

obese in 195 countries(16,21). 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.(22)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(23).

So the present study planned to assess the influence of obesity on cognitive functions and compare among obese and non - obese individuals(24,25).

Materials and methods :

This is a cross sectional study where 20 healthy adults 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 were evaluated and scores were calculated . calculated scores were tabulated in the excel sheet and analysed. Data entered in the SPSS software and the results were analysed using an independent sample test and represented in the bar graphs.

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)

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

MMSE	Groups	Mean
Orientation	Obese	10.50 \pm 1.080
	Non - obese	13.70 \pm 0.949
Registration	Obese	4.80 \pm 0.789
	Non - obese	8.50 \pm 0.707
Recall	Obese	11.50 \pm 1.080
	Non - obese	14.40 \pm 0.699
Language	Obese	4.50 \pm 0.850
	Non - obese	7.80 \pm 0.422
Copy art	Obese	1.50 \pm 0.527
	Non - obese	2.80 \pm 0.422
MMSE score	Obese	32.80 \pm 2.898
	Non - obese	47.20 \pm 1.476
BMI	Obese	35.43 \pm 2.561
	Non - obese	22.22 \pm 2.113

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

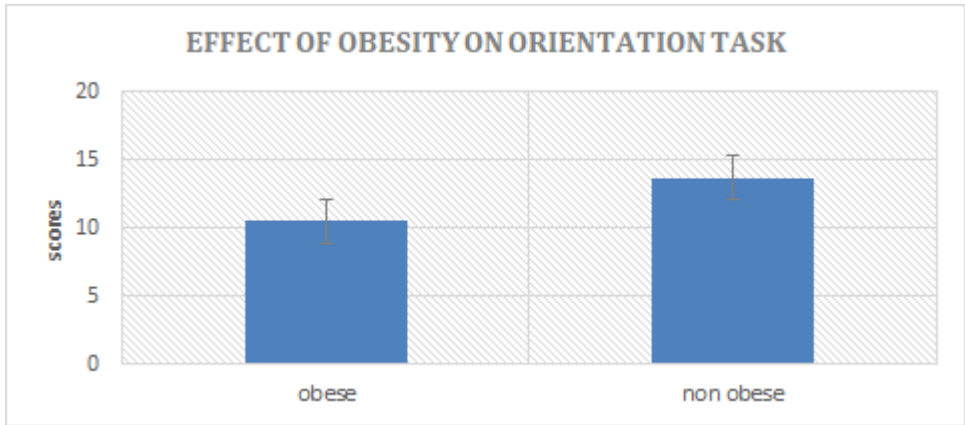


Figure 1 : represents the scores obtained for level of orientation in obese and non obese groups . Bar graph depicts the association between the obese and non obese . X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups . It is observed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



Figure 2 : represents the scores obtained for level of registration 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 registration compared to obese groups but the value was not **statisally** significant as in independent t test. P value = 0.80 ($p > 0.05$)

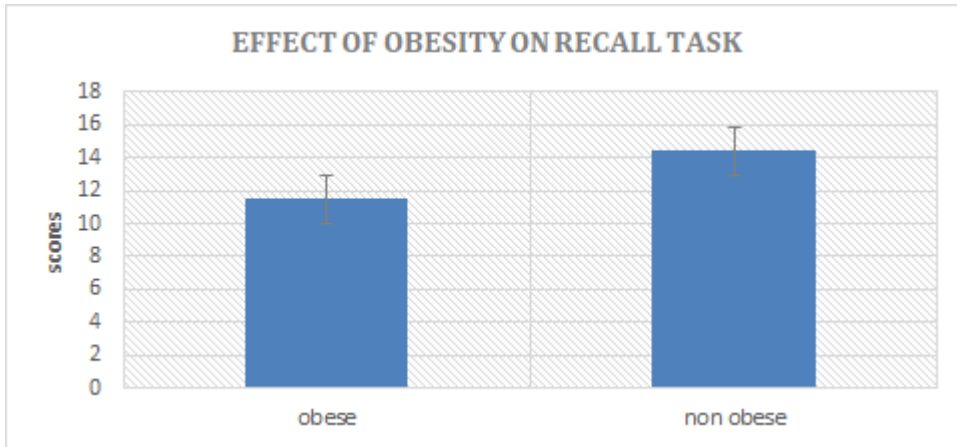


Figure 3 : represents the scores obtained for Level of recall in obese and non obese groups . Bar graph depicts the association between the obese and non obese . X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups . It is observed that 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($p>0.05$)

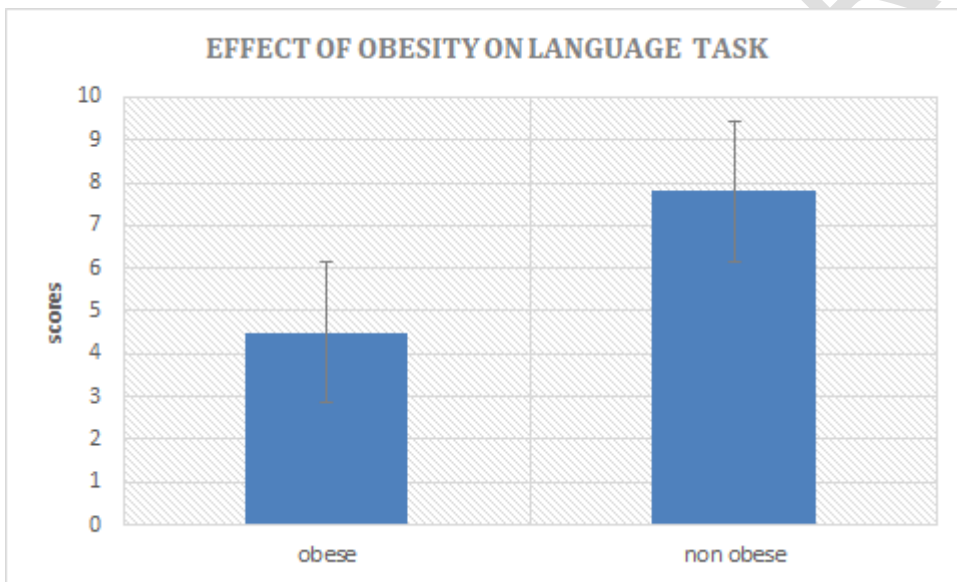


Figure 4 : represents the scores obtained for Level of language in obese and non obese groups . Bar graph depicts the association between the obese and non obese . X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups . It is observed that there is 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 ($p<0.05$)

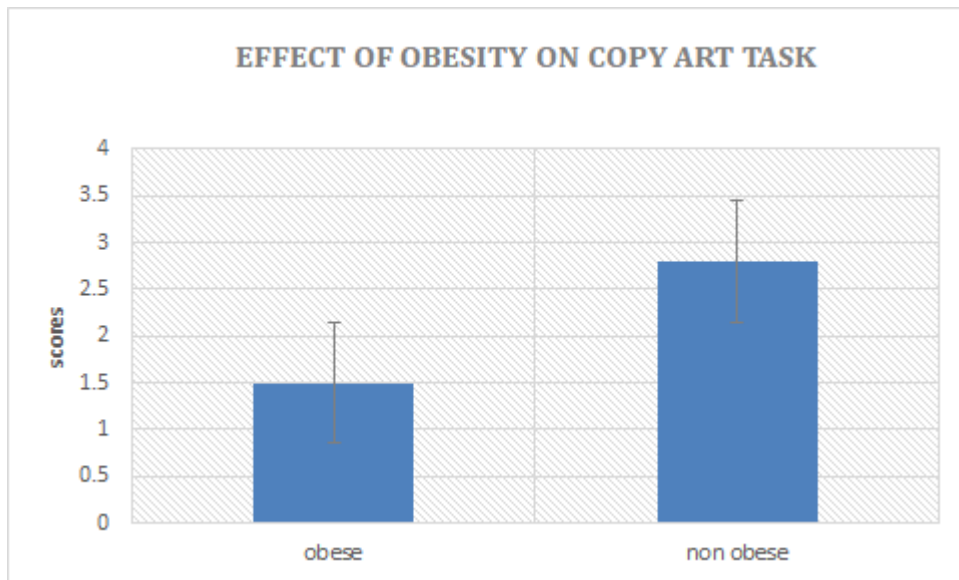


Figure 5: represents the scores obtained for Level of copy art in obese and non obese groups . Bar graph depicts the association between the obese and non obese groups . X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups . It is observed that there is 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 ($p < 0.05$)

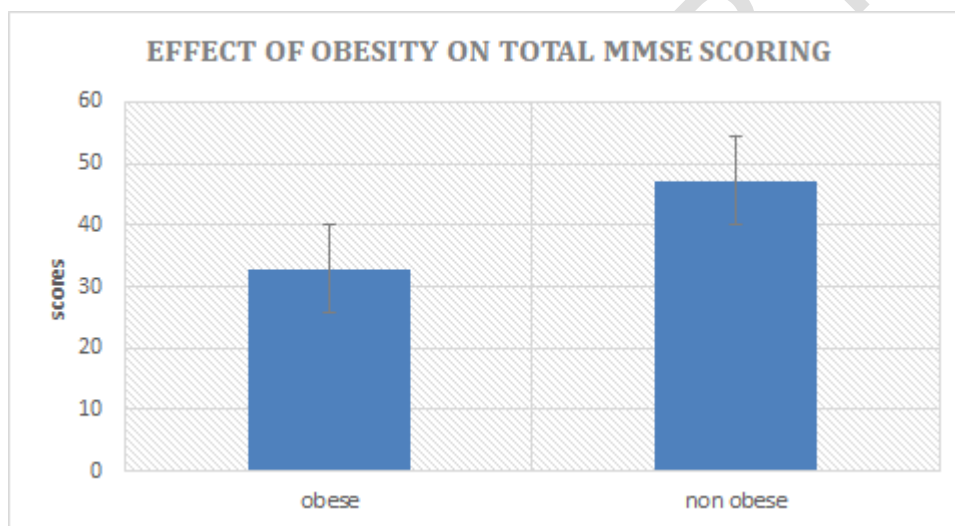


Figure 6 represents the scores obtained for total MMSE scoring in obese and non obese groups . Bar graph depicts the association between the obese and non obese . X axis represents obese and non - obese groups and Y axis represents scores obtained by obese and non - obese groups . It is observed that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

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.(26,27) Previous research reports also showed that early to mid-adulthood obesity might have an immediate detrimental negative impact on cognitive functioning.(28,29)

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.(18,30)

Reports suggested a negative association between anthropometric measures of obesity like BMI with a number of cognitive domains. (22,30)Obesity is related to impaired performance on tasks that relate to episodic memory, Verbal learning, followed by delayed recall and recognition of words. (31)(32)

Few studies also reported that Impaired working memory performance has been exhibited in overweight and obese young adults compared with healthy weight controls. (33)

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. (34)(35)

Research reports suggest that Obesity has been associated with increase in brain age, particularly in respect to cerebral white matter atrophy(36). This area has shown more atrophy in middle-age(37)(38)

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.

Conclusion :

Thus, the study concluded that obese individuals showed a moderate decline in cognitive functions. Interventions that target mid-life obesity may be helpful in reducing the cognitive risks associated with obesity.

COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

References:

1. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis [Internet]. Vol. 17, Obesity Reviews. 2016. p. 95–107. Available from: <http://dx.doi.org/10.1111/obr.12334>
2. Singh GK. Childhood Obesity in the United States, 1976-2008: Trends and Current Racial/ethnic, Socioeconomic, and Geographic Disparities. 2010. 6 p.
3. Bagchi D. Global Perspectives on Childhood Obesity: Current Status, Consequences and Prevention. Academic Press; 2010. 536 p.
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 [Internet]. Vol. 55, Indian Journal of Pharmaceutical Education and Research. 2021. p. s265–74. Available from: <http://dx.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 [Internet]. Vol. 8, PeerJ. 2020. p. e10164. Available from: <http://dx.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 Mar 8;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 [Internet]. Vol. 73, *IUBMB Life*. 2021. p. 659–69. Available from: <http://dx.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 Jul;45(7):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 [Internet]. Vol. 129, *Inorganic Chemistry Communications*. 2021. p. 108647. Available from: <http://dx.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 [Internet]. Vol. 11, *Biomolecules*. 2021. p. 206. Available from: <http://dx.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 [Internet]. Vol. 48, *Journal of Oral Pathology & Medicine*. 2019. p. 299–306. Available from: <http://dx.doi.org/10.1111/jop.12835>
 12. Bray GA. *Obesity in Perspective: A Conference*. 1975.
 13. Obesity paradox [Internet]. Vol. 1, *Integrative Obesity and Diabetes*. 2015. Available from: <http://dx.doi.org/10.15761/iod.1000114>
 14. Kiess W, Marcus C, Wabitsch M. *Obesity in Childhood and Adolescence*. Karger Medical and Scientific Publishers; 2004. 269 p.
 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 [Internet]. Vol. 20, *Clinical Implant Dentistry and Related Research*. 2018. p. 531–4. Available from: <http://dx.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. 237 p.
 17. Bharath B, Perinbam K, Devanesan S, AlSalhi MS, Saravanan M. Evaluation of the anticancer potential of Hexadecanoic acid from brown algae *Turbinaria ornata* on HT–29 colon cancer cells [Internet]. Vol. 1235, *Journal of Molecular Structure*. 2021. p. 130229. Available from: <http://dx.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. 574 p.
 19. Meyer MW, Robinson JM. *The Nag Hammadi Scriptures: The Revised and Updated Translation of Sacred Gnostic Texts Complete in One Volume*. Harper Collins; 2010. 864 p.
 20. 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 [Internet]. Vol. 45, *Journal of Food Biochemistry*. 2021. Available from: <http://dx.doi.org/10.1111/jfbc.13572>
 21. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic*. World Health Organization; 2000. 253 p.
 22. Rajakumari R, Volova T, Oluwafemi OS, Rajesh Kumar S, Thomas S, Kalarikkal N. Grape seed extract-soluplus dispersion and its antioxidant activity [Internet]. Vol. 46, *Drug Development and Industrial Pharmacy*. 2020. p. 1219–29. Available from:

<http://dx.doi.org/10.1080/03639045.2020.1788059>

23. Mudigonda SK, Murugan S, Velavan K, Thulasiraman S, Krishna Kumar Raja V. Non-suturing microvascular anastomosis in maxillofacial reconstruction- a comparative study [Internet]. Vol. 48, *Journal of Cranio-Maxillofacial Surgery*. 2020. p. 599–606. Available from: <http://dx.doi.org/10.1016/j.jcms.2020.04.005>
24. 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 [Internet]. Vol. 60, *Journal of Drug Delivery Science and Technology*. 2020. p. 101992. Available from: <http://dx.doi.org/10.1016/j.jddst.2020.101992>
25. 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 [Internet]. Vol. 76, *Journal of Oral and Maxillofacial Surgery*. 2018. p. 1160–4. Available from: <http://dx.doi.org/10.1016/j.joms.2017.12.020>
26. Greenwood PM, Parasuraman R. Brain Aging and Cognitive Aging [Internet]. *Nurturing the Older Brain and Mind*. 2012. p. 19–48. Available from: <http://dx.doi.org/10.7551/mitpress/9780262017145.003.0003>
27. 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 [Internet]. Vol. 130, *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology*. 2020. p. 306–12. Available from: <http://dx.doi.org/10.1016/j.oooo.2020.06.021>
28. 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 [Internet]. Vol. 76, *Neurology*. 2011. p. 1568–74. Available from: <http://dx.doi.org/10.1212/wnl.0b013e3182190d09>
29. 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 Dec;54(6):880–9.
30. Bland KI, Suzanne Klimberg V. *Master Techniques in General Surgery: Breast Surgery*. Lippincott Williams & Wilkins; 2012. 400 p.
31. 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 Jun 11;330(7504):1360.
32. Razay G, Vreugdenhil A. Obesity in middle age and future risk of dementia: Midlife obesity increases risk of future dementia [Internet]. Vol. 331, *BMJ*. 2005. p. 455.1. Available from: <http://dx.doi.org/10.1136/bmj.331.7514.455>
33. Conforto RM, Gershman L. Cognitive processing differences between obese and nonobese subjects. *Addict Behav*. 1985;10(1):83–5.
34. Lokken KL, Boeka AG, Yellumahanthi K, Wesley M, Clements RH. Cognitive performance of morbidly obese patients seeking bariatric surgery. *Am Surg*. 2010 Jan;76(1):55–9.

35. 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 Jul 15;127(3):259–66.
36. Prakash AKS, Devaraj E. Cytotoxic potentials of *S. cumini* methanolic seed kernel extract in human hepatoma HepG2 cells [Internet]. Vol. 34, *Environmental Toxicology*. 2019. p. 1313–9. Available from: <http://dx.doi.org/10.1002/tox.22832>
37. Fotenos AF, Snyder AZ, Girton LE, Morris JC, Buckner RL. Normative estimates of cross-sectional and longitudinal brain volume decline in aging and AD [Internet]. Vol. 64, *Neurology*. 2005. p. 1032–9. Available from: <http://dx.doi.org/10.1212/01.wnl.0000154530.72969.11>
38. Ezhilarasan D. Critical role of estrogen in the progression of chronic liver diseases. *Hepatobiliary Pancreat Dis Int.* 2020 Oct;19(5):429–34.

UNDER PEER REVIEW