

Relationship Between Visceral Fat Content And Cognition of An Individual- A Narrative Review

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Abstract-

Background- This visceral fat performs the functions of maintaining the metabolic activity and structural integrity of the internal organs, various deleterious effects of visceral fat accumulation around the internal organs constitute excessive release of Free Fatty Acids from the surrounding adipose tissues which in turn affects the resistivity of the insulin within the body, reducing the functioning of the tissues or internal organs surrounding such as liver, pancreas, intestines, etc and thus hampering the activity of releasing of fatty acids in the blood through subcutaneous tissues. Cognition is a broad umbrella term which incorporates various activities and tasks of daily life which are associated with both sustenance of life and for maintaining the quality of this life. However, we lack some evident studies which suggest statistically that there exists a strong correlation between the reduction of enhancement of visceral fat in specific to the cognitive domains.

Material & Methods- Through various filters and readings, it was found that 10 articles met the inclusion criteria of the review and thus were obtained to conclude the final result of the study. The inclusion criteria for selection of any article was defined as any article which includes any treatment strategy or observational deliverances to find out direct or indirect correlation between accumulation of visceral fat and cognition in individuals of any age group or with or without any impairment/ disability.

Results- The major findings of the review suggested that articles which have performed interventions on visceral fat had also considered cognition as a secondary outcome in their studies which stated the importance of conducting this review as it will enlighten the readers regarding a possible and underrated correlation between the two.

Discussion- Cognition is said to be correlated to various physiological processes of human body which include all the visceral patterns and functioning. Any abnormality in declining cognitive performance or abnormal cognitive balance may lead and overall and general degradation of the quality of life of an individual. Especially the areas in and

around hippocampus, putamen, and cerebellum are highly specific areas are found to be of high significance in various studies to be associated with visceral fat reduction and its effect to be seen at the cognitive functionings. This study thus suggests that in future more studies which involve readings of an Electroencephalogram (EEG) and exercise training in specific to reduce visceral fat must be conducted to establish a clinically and statistically significant correlation among the two domains

Keywords- Visceral fat accumulation, Cognition, Quality of life, Cognitive performance

I. INTRODUCTION

The type of fat accumulation around the superficial areas of the body and that around the viscera or the internal organs has been proved to be of different constituents and different functions. The amount and layer of fat deposition around internal organs guarding and in worst case scenarios harming the functioning of the internal organs are termed as Visceral fat deposition.¹ This visceral fat is mainly composed of adipocytes with several other important cells which can be heterogenous in nature and functionality depending upon the internal organ they are surrounding or the region of abdomen they are present in. among these adipocytes, viscera is generally lined with a persistent layer of white adipose tissue.² The percentage of visceral fat accumulation in males is comparatively higher than in females with higher prevalence in elderly population.¹ This visceral fat performs the functions of maintaining the metabolic activity and structural integrity of the internal organs when present in required and limited norms. Once this tissue gets hypertrophied or increases its growth drastically, it produces several metabolic, immunological and functional disorders in human beings³

The various deleterious effects of visceral fat accumulation around the internal organs constitute excessive release of Free Fatty Acids from the surrounding adipose tissues which in turn affects the resistivity of the insulin within the body, reducing the functioning of the tissues or internal organs surrounding such as liver, pancreas, intestines, etc and thus hampering the activity of releasing of fatty acids in the

blood through subcutaneous tissues.³This may even lead to severe disorders like development of cancers.⁴Prolonged exposure of the human body towards these excessive fat accumulations results as seen in cases of obesity which further may be a predisposing factor of individuals up taking diabetes mellitus type II which is strongly associated with the deposition of fat and altering mechanisms of metabolic functions. There are studies which also suggest that gaining of weight or increasing in fat content of an individual has an impact over the person's cognitive functions.⁵These metabolic dysfunctions may or may not have a severe impact over the other domains of body functioning as well which include hormonal and cognitive domains, thus increasing the horizon of cognitive domains and dysfunctions in populations specifically with higher BMIs.⁶

Cognition is a broad umbrella term which incorporates various activities and tasks of daily life which are associated with both sustenance of life and for maintaining the quality of this life. It is not a general term referred to brain modulations or activities, it sums up the various functions of brain which includes memory, reasoning, intellectual abilities, inhibition or activation of substances or hormones, reaction times, etc.⁷ studies have shown there is a significant effect of metabolic functioning on the perseverance of cognitive functions in individuals. Articles suggest that any abnormality in the functioning or disruption in the anatomical structural integrity of the gastro-intestinal tract or the cardio-pulmonary system is believed to have a significant effect on the functioning of the brain of that individual.⁸However, we lack some evident studies which suggest statistically that there exists a strong correlation between the reduction of enhancement of visceral fat in specific to the cognitive domains. We also lack the literature that there exists a strong reason why obese individual in process to undergo enhancement of their quality of life need cognitive training along side other medical and physiotherapeutic regimes. The need of this review suggests to establish a strong scenario for individuals and researches working in this field.

II. MATERIALS AND METHODS

A thorough research was performed for collecting the articles relevant to visceral fat and cognition. Authors searched for articles through databases like PubMed, Web of Science and, Google Scholar which yielded a total of 215 articles which when subjected to removal of duplication yielded a total of 192 articles. This search strictly followed the PRISMA statement considered ideal for conducting a review.

Through various filters and readings, it was found that 10 articles met the inclusion criteria of the review and

thus were obtained to conclude the final result of the study. The inclusion criteria for selection of any article was defined as any article which includes any treatment strategy or observational deliverances to find out direct or indirect correlation between accumulation of visceral fat and cognition in individuals of any age group or with or without any impairment/ disability. The articles which were excluded were those which were either not available freely, were paid articles, articles which were not clinical or randomized trials or trials which did not involve human subjects and were performed on animals or were bench side researches.

The MESH terminologies which were used for extracting articles were Visceral fat, FAT accumulation, Fat deposition, Superficial and Visceral fat, Cognition, Perception, Cognitive abilities, Cognitive Impairments along with the Boolean AND. The most results were yielded after a search of (Visceral Fat) AND (Cognition) expression in all the databases. After removal of duplication of the articles selected for the review process, segregation of the articles was performed based on Clinical trials, human studies, online available PDFs of the articles which were openly accessible and then the final number of articles was decided to be 10. The review included all the clinical trials which were concerned with visceral fat and cognitive domains on human subjects whether they involved treatment strategies of medical, physiotherapeutic or observational designs.

III. RESULTS

Among the 215 articles which were extracted from the databases, 192 articles were segregated as potential articles for review process after removal of duplicate articles collected from various databases. Out of these 192 articles, 42 were segregated as relevant in the form of establishing correlation between visceral fat and cognition in individuals. Among these 42 articles, 29 articles were performed on human subjects and were included in the trial. Out of these 29, 18 articles were either randomized clinical trials or were cross sectional interventional studies. Among these 18 studies, a total of 10 articles were finalized for conducting this review.

The major findings of the review suggested that articles which have performed interventions on visceral fat had also considered cognition as a secondary outcome in their studies which stated the importance of conducting this review as it will enlighten the readers regarding a possible and underrated correlation between the two. Authors came across that only a few studies in the relevant area have been performed within a span of 5 years which were majorly concerned with the human trials. The findings of the review are stated in the table given below:

AUTHOR S	JOURNAL & YEAR	COUNTR Y OF TRIAL	INTERVENTI ONS	RESULTS
Kullmann S, Goj T, Veit R, et.al ⁵	JCI Insights, 2022	Germany	8-week aerobic training exercise program on 21 sedentary obese patients	Exercise instigated metabolism, behaviour, insulin resistivity, better cognitive flexibility
Raine LB, Khan NA, Drollette ES. Et.al ⁶	Journal of Pediatrics, 2017	Boston	9-month physical activity intervention was evaluated in both obese and healthy weighted individuals	Reduction in adipose tissue concentration with better cognitive abilities of the participants
Agarwal SM, Panda R, Dookhan AC. et.al ⁹	Translational Psychiatry, 2021	Canada	Metformin 1500 mg/day was rendered for 4 months in patients with schizophrenic disorders and prediabetic or type II diabetes	Enhanced insulin sensitivity along with significant weight loss and reduced symptoms of psychosis spectrum were evident
Lauridsen NMH, Nielsen ST, Mann SP. Et.al ¹⁰	Journal of Applied Physiology, 2016	Denmark	Evaluation of effectiveness of alternate day caloric restriction after 8 consecutive days	Stated that physical inactivity and dietary abnormalities result in accumulation of visceral fat and decreased cognition
Kullmann S, Heni M, Veit R. et.al ¹¹	Scientific Reports, 2017	Germany	160 U intranasal insulin was rendered to lean and healthy individuals	Better hypothalamic functions and connectivity within brain structures evident with facilitated weight loss and better homeostasis of the brain
Myers JS, Manson A, Billinger SA. Et. Al ¹²	Oncology Nursing Forum, 2022	Kansas	6 months personalised education, aerobic and resistance exercise and nutritional coaching followed for 3 months	Consequent decrease in visceral adiposity but non-significant changes in visuospatial organization and other cognitive domains
Kargaran A, Abedinpo ur A, Saadatmeh r Z. et. Al ¹³	Physiology & Behaviour, 2021	Iran		Effect of dual motor task training on 24 healthy volunteers for 8 weeks
Moh MC, Low S, Mg TP. Et. Al ¹⁴	Microcirculation, 2019	Singapore		Cross sectional analysis of subjects with age more than 55 years and type II diabetes
Levin NZ, Bishara TF, Militianu D. et.al ¹⁵	Journal of Clinical Endocrinology Metabolism , 2009	Israel		Estrogen/ progesterin replacement therapy subjected to 14 women suffering from Turner’s syndrome with oral 1.5 mg methyl testosterone (ART) for 1 year
Chiba I, Lee S, Bae S. et.al ¹⁶	Journal of Nutrition, Health and Aging, 2020	Japan		Cross sectional study to evaluate prevalence of visceral fat accumulation and effect on cognition and its type

IV. DISCUSSION

Cognition is said to be correlated to various physiological processes of human body which include all the visceral patterns and functioning.¹⁷ Any abnormality in the physiological process of any system within human directly or indirectly affects the behavioural pattern and responses of an individual towards any situation. This abnormal behavioural pattern in general terms is referred to have arrived from various physiological and immunological deprivations.⁸Any abnormality in declining cognitive performance or abnormal cognitive balance may lead and overall and general degradation of the quality of life of an individual. This may induce a sense of depression or a sense of hypersensitivity towards social and psychological domains which in turn can provoke severe cognitive behaviours.⁶ Thus studying cognitive

domains and their actual correlations tends to be a crucial yet an ignored stream due to its vague nature and fragile goals. Researchers tend to lack basic concepts and devices which are considered as gold standard for conducting such trials.

The major reasons behind the abnormalities of any cognitive behaviour is understood in broader aspect of brain mapping. It has been stated that, the pre-frontal cortex, hypothalamus, anterior medial cortex and hippocampal activities are considered to be playing a significant role in determining cognitive abilities of an individual which includes hunger, reaction time, intellectual functions, memory, etc. These regions are also significantly associated with fluctuations in the level and absorption of insulin in blood which makes it easier to understand the concept behind insulin resistance and reduced cognitive functions.¹¹ Hippocampal activity in specific is relevant to various changes undergone within the body's physiology with respect to exercise and enhanced blood flow volume.¹⁰

Functions of a brain are a representative of the healthy vasculature and healthy structural integrity. Blood supply to various anatomical structures makes it crucial to study various functioning components of the brain. Especially the areas in and around hippocampus, putamen, and cerebellum are highly specific areas are found to be of high significance in various studies to be associated with visceral fat reduction and its effect to be seen at the cognitive functionings.¹⁴ To further understand the working of cognition and its functioning it is necessary to understand the role of Brain derived Neurotrophic factor (BDNF) which is responsible for not only synaptic activity and sustainability but also suggest that these BDNF capable of enhancing synaptic and plastic activities of the brain can be triggered or hampered through extremity musculoskeletal system as well. This factor can be increased in the hippocampal region of the brain through inducing various exercise regimes.¹³ A study suggested that due to decline in visceral fat accumulation around internal organs there was a mild evident result stating that even reaction time enhanced, along with this the participants also showed improved verbal memory and visuospatial organization between the experimental and control groups which evidently stated that visceral fat reduction leads to enhancement of these specific cognitive domains.¹²

Not only in individuals with obesity, individuals with cognitive impairments have been rendered with standard medical and physiotherapeutic regimes to identify the potential effects of these physical and medical parameters working on reducing weight of the individuals in cognitive impairments like Schizophrenia. Researches suggests better

results when weight loss regimes are combined with standard drug therapy and cognitive training in such patients.⁹ A study on children stated that if students had lesser visceral fat accumulation it will tend to sharpen their cognitive skills by enhancing their reaction time, memory, abstract thinking and productivity which will enhance their quality of life in the longer run.⁶ These studies thus conclude that how necessary it becomes to actually study the correlation between the cognition and visceral adiposity because this brings to our knowledge that since visceral fat accumulation slower the mental abilities, it might also trigger anxiety and carelessness towards one's health and thereby ignoring the obesity and its potential risk factors¹⁸

The strength of this study is that it evaluates and brings into light various possibilities and various processes involved in accumulation of central fat along with its ability to degrade the cognition of an individual. However, there are some limitations of the study, this study did not focus on one type of intervention to be rendered to patients who are either obese or cognitively ill. Secondly, the authors were unable to find a clinical trial which through cognitive training evaluated only the visceral fat reduction strategy which might be also because of its measurement disadvantages. Thirdly, there have been lesser studies which involved and tested purely motor and cognitive domains in healthy individuals which will separate the results from overall fat accumulation in body (including both superficial and visceral). This study thus suggest that in future more studies which involve readings of an Electroencephalogram (EEG) and exercise training in specific to reduce visceral fat must be conducted to establish a clinically and statistically significant correlation among the two domains. There also must be studies which involve more cognitive training domains apart from motor training and aerobic exercise regimes in physiotherapy to meet the goals of reducing Visceral fat and enhancing cognition.

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