

## Association between Obesity and Cognitive Functional Loss: A Short Review

Sridevi G\*

Department of Physiology, Saveetha Dental College and Hospital, 162, Vellapanchavadi, Poonamalle High Road, Chennai, India

### ABSTRACT

Obesity has been identified as a common health problem and is a major global alarm in today's world. A major cause of obesity are changes in lifestyle of families concerning eating habits, lack of physical activity and increased exposure to video games, engaging in social media, and computers have played a noteworthy role in enhancing obesity. Although obesity poses many problems like hyperlipidemia, hypertension and diabetes, dementia and cognitive impairment also seems to be associated with it. There is a growing body of research that has been investigating the relationship between obesity and cognitive impairment, but the results are conflicting in different study populations. Research reports have identified that abdominal obesity is mostly associated with a greater risk of loss of cognitive functions independent of factors like sociodemographic, lifestyle, and health-related comorbid. Possible explanations are excessive accumulation of dietary saturated fats may induce changes in the integrity of the blood-brain barrier, which may consequently allow toxins to enter the brain and directly or indirectly impact the hippocampus. Another explanation is that obesity has an impact on the brain and its blood vessels supplying it. Thereby it promotes atherosclerosis resulting in the development of vascular cognitive impairment. Thus, Aerobic fitness appears to have a positive effect on cognition. The effect of increased physical activity on cognitive function appears to be clearer, resulting in increased gray matter, blood volume and circulation in the hippocampus.

**Key words:** Obesity, Cognitive impairment, Abdominal obesity, Hippocampus, Atrophy

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**Corresponding author:** Sridevi G

**e-mail**✉: adiasdc@saveetha.com

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### INTRODUCTION

Obesity is a condition characterized by excess accumulation of fat in the body. This condition is not only a cosmetic concern but a health concern too. Obesity has been identified as a common health problem and is major global alarm in today's world. The magnitude of this problem of obesity has been progressively affecting the people of urban population including the low, middle, and high income states as well. Major causes of obesity are changes in lifestyle of families concerning eating habits, lack of physical activity and increased exposure of video games, engaging in social media, and computer has played a noteworthy role in enhancing obesity [1]. Cognitive functions, is customarily divided into the various domains of perception, attention, recognition, memory, and executive functions.

Dementia and Cognitive impairment are also age related disorders. Epidemiological data shows that dementia has been a problem that affects 5%–10% of people aged 65 years older in higher-income countries. The occurrence has doubled every 5 years of age after the age of 65 [2].

There is a growing body of research that has been investigating the relationship between obesity and cognitive impairment, but the results are conflicting in different study populations [3]. So, the present review aimed to find the strong association between obesity and cognitive impairment.

Studies by Hou et al., [4] conducted to investigate the relationship between obesity and cognitive impairment among Chinese elderly using comprehensive geriatric assessment. Overweight is greatly associated with a low risk of cognitive impairment in the Chinese elderly, whereas abdominal obesity is mostly associated with an greater risk of loss of cognitive functions independent of factors like sociodemographic, lifestyle, and health-related

comorbid and irrespective of metabolic diseases such as hypertension, hypercholesterolemia and diabetes. Also the findings stated that Even after adjustment for age, education level, hypercholesterolemia, hypertension, and diabetes, abdominal obesity remained significantly associated with an increased risk of cognitive impairment [5].

On literature survey, effect of obesity on cognitive function was studied among school children. The study reported significant impairments in cognitive functions like attention, retention, intelligence, and cognitive flexibility. Cognitive functions like AST-Latency, AST-Incongruent, AST-Percent correct trials, and IED Total errors showed significantly weakened in very markedly obese children and the importance of physical activities to reduce body weight in children, so that it would improve their cognitive functions [6,7].

In recent world, there has been a strong relationship between the prevalence of obesity and dementia. Recent reports have determined the strong association between obesity and loss of cognitive function. A study found this relationship in terms of complex attention, verbal and visual memory to be associated with obesity [8].

The potential mechanisms that link the tendency of being overweight and cognitive impairment are not entirely clear. The possible mechanisms that possibly explains the link between overweight and cognitive impairment in late life have many considerations. First explanation is that the hormone leptin secreted by the adipose tissue, would have played a role as a cognitive enhancer. By regulating the hippocampal synaptic plasticity and amyloid  $\beta$ -processing, leptin has improved learning and memory performance in rodents [9,10].

Second explanation is that the individuals who are obese have a lower mortality risk than individuals who are underweight or with normal weight in the elderly. The increased risk of cognitive loss in subjects with midlife overweight and obesity may be due to the fact that higher BMI in midlife is usually associated with cardiovascular and metabolic risk factors which are again related to an increased risk of cognitive impairment [11,12].

Central obesity is condition with increased fat in the abdomen and internal organs that causes low-grade inflammation, includes symptomatic dyslipidemia, decreased insulin sensitivity, hyperinsulinemia, hyperglycemia, and hypertension. BMI is the weight of an individual in kilograms divided by the square of his or her height in meters. Body mass index (BMI) is a main determinant to categorize a person as overweight or obese. But measurement of waist-to-hip ratio (WHR) is a better marker of disease risk than BM [8].

Another study investigated the relationship between loss of cognitive functions and obesity among hypertensive patients. Cognitive ability was determined by Mini Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA). Obesity was defined based on body mass index (BMI). They observed an increase in mean scores of cognitive batteries as the stages of obesity became higher. Thus, the study showed that Middle aged and elderly hypertensive obese individuals had a better cognitive performance. Age had a negative impact on cognitive functions, regardless of BMI. Mechanisms that explain the association between cognitive function and obesity is not straight forward, rather obesity tends to affect the cognitive function.

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Obesity tends to affect the cognitive function of different people in different ways, particularly depending on their age group. Lower body mass

index BMI was found to be associated greatly with increased incidence of dementia, in elderly people [13-16]. But, in midlife, the higher BMI was associated with increased incidence of dementia [17-19]. But there have been other studies suggesting that underweight during their middle years were associated with an increased risk for dementia later in life [14,15].

Another study examined the association between obesity and cognitive function in healthy premenopausal women. All participants were made to complete the Cambridge Neuropsychological Test Automated Battery (CANTAB) to determine the cognitive performance in three domains: attention, memory, and planning executive function. The Reaction Time test was used to assess motor and mental response speeds; To assess the memory functions, Delayed Match to Sample (DMS), Pattern Recognition Memory (PRM), and Spatial Span (SSP) tests were used to examine the forced choice recognition memory, visual pattern recognition memory, and working memory capacity. Their results showed that Memory span length was significantly lower in overweight and obese women compared to normal weight. Also that healthy premenopausal women, obesity were not affected by cognitive loss governing attention, memory, or planning executive function, whereas morbid obesity had a lower memory span length and was associated with higher latency to correct response on memory-specific tasks [20].

Research led by Elias et al., [21] 2003 showed that cognitive loss in obesity was limited to men but nonobese women and obese women scored better with various cognitive function tests like word fluency, visual reproduction, and digit span. Some studies by Kerwin et al. [22] explored the relationship between body fat distribution (measured by waist-to-hip ratio; WHR) and cognitive function. Their results showed that As the BMI increased, cognitive performance of women with a low waist-to-hip ratio decreased, but cognitive performance of women with a high waist-to-hip ratio increased as the BMI increased.

Central Nervous System Circuits that associates with food intake. Many neural circuits in the brain maintain energy balance that indirectly affect the appetite and thermogenesis [22,23].

The prefrontal cortex (PFC), anterior cingulate cortex (ACC) maintain voluntary activities of eating behaviours and exercising, Insula, striatum, amygdala, hippocampus, hypothalamus are the unconscious rewards centres; insula and amygdala are sensitive to feeding cues to the PFC and ACC. The opioid and cannabinoid system stimulates the dopaminergic neurons that project to the striatum, thus promoting energy deposition by increasing food intake [23,24]. The arcuate nucleus (ARC), in the basal hypothalamus, is involved in forebrain appetite network (PFC, ACC) [25].

The Hippocampus is a brain structure responsible for learning and memory. If the hippocampus decreases in size, this can also cause problems with cognition and dementia. Obesity during mid-life has been linked to a decrease in both the size of the hippocampus and the brain's executive functions. These people will have an inability to perform complex tasks that require knowledge, understanding, thought and experience. This explanation highlighted the relationship between decreased volume of hippocampus and cognitive impairment [24]. Studies correlated that BMI was negatively associated with brain hippocampal volume. People with a higher BMI had a tendency to have greater hippocampal atrophy. A possible explanation is that excessive accumulation of dietary saturated fats may induce changes in the integrity of the blood-brain barrier, that may consequently allow toxins to enter the brain and directly or indirectly impact the hippocampus [26,27]. Another explanation is that obesity has an impact on the brain and its blood vessels supplying it. Thereby it promotes atherosclerosis resulting in the development of vascular cognitive impairment. Another finding is that there is alteration in brain function for obese individuals with increased activity of two specific proteins in the hippocampus namely Amyloid-beta precursor protein (APP) and Tau protein. These proteins are the profound markers of Alzheimer's disease. But the mechanism relating this effect is not properly understood.

#### **Neurological benefits of treating obesity**

Treatment of obesity tends to improve cognitive function. In a randomized, double-blind study, elderly patients who were obese showed improved verbal memory, verbal fluency,

executive function, and global cognition after a calorie-restricted diet [23,28]. In animal studies, resolving obesity results in improved measures of cognitive function [27]. Another study reported that Aerobic fitness appears to have a positive effect on cognition [27,29]. The effect of increased physical activity on cognitive function appears to be clearer, resulting in increased gray matter, blood volume and circulation in the hippocampus [30].

### CONCLUSION

Based on review governing the association between obesity and cognitive functions, that healthy over weight female were not affected with any cognitive impairment related to attention and planning executive function; but morbid obesity is associated with higher latency to correct response on memory-specific tasks and poorer short-term memory. Poor dietary habits and lack of cardiorespiratory fitness had a greater impact on cognitive loss. However aerobic fitness can have a positive effect of cognition.

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