Journal of Cardiovascular Disease Research

ISSN: 0975-3583,0976-2833 VOL 16, ISSUE 5, 2025

COMPARISON OF ADIPOSITY INDICATORS AND COGNITIVE FUNCTION DECLINE

Dr. Mohammad Shahid Raza[1], *Dr. F B Irani[1] ID

Department of Physiology, MGM Medical College, Aurangabad

***Corresponding author**: FB Irani1,
Associate Professor, Dept. Physiology, MGM Medical College, Aurangabad,
driranifb@gmail.com
Mobile no 9922208436

Abstract

Introduction: Obesity is a complex condition that disrupts the balance of energy in the body and is linked to numerous health complications. It has also been found to affect cognitive function negatively. This study focuses on understanding how obesity influences cognitive abilities in younger individuals. To assess obesity, we use various measures, including body mass index (BMI) and waist-to-hip ratio (WHR). Abdominal obesity has been closely tied to imbalances in the autonomic nervous system and an elevated risk of serious health problems. The goal of this study is to examine how central obesity impacts cognitive health, to promote early interventions to help lower the likelihood of developing conditions like dementia or Alzheimer's disease in the future. **Method:** A total of 200 healthcare subjects aged 25–35 years, who met the inclusion and exclusion criteria and provided informed consent, were enrolled in the study. Anthropometric parameters, blood pressure, and cognitive function were assessed and evaluated. **Results & Conclusion**: The findings indicated that increased BMI and WHR were significantly associated with a higher risk of cognitive decline. The study concluded that BMI and WHR can serve as convenient and effective indicators for predicting overweight/obesity and its potential relationship with cognitive decline.

Key words: Cognitive functions, central obesity, BMI, WHR

INTRODUCTION

Obesity is a multifaceted condition that results from an imbalance in energy intake and expenditure, significantly contributing to both acute and long-term health problems, ultimately leading to a reduced life expectancy.[1] Several factors, including changes in economic and social landscapes, increased sedentary behaviour, and the excessive consumption of high-calorie, fatty foods, have driven the rapid rise in obesity rates and its related health complications. Beyond its physical health implications, obesity is also associated with cognitive impairments, motor dysfunction, lower self-esteem, depression, social difficulties, and a higher likelihood of developing Alzheimer's disease.[2]

The energy imbalance that causes obesity also leads to numerous comorbidities, such as hypertension, diabetes, and coronary artery disease. Cardiovascular complications linked to obesity are often the result of autonomic dysfunction. To measure obesity, various anthropometric tools are employed, such as Body Mass Index (BMI), waist-hip ratio (WHR), waist circumference (WC), hip circumference, waist-to-height ratio, and neck circumference (NC). Abdominal obesity, in particular, is closely associated with autonomic imbalances and increased health risks. Visceral fat (VF), the fat surrounding internal organs, serves as an important indicator of obesity and has been linked to sympathovagal imbalance, heightening the risk for cardiovascular diseases.[3,4]

Central obesity can be measured through methods such as the waist-to-hip ratio, BMI, and neck circumference, with the latter providing insight into upper body fat distribution[5]. Obesity has also been shown to cause structural changes in the brain, which may accelerate cognitive decline and increase the risk of dementia.[6] According to the World Health Organization (WHO), BMI is a simple measure used to categorize individuals based on their weight relative to height, with the following classifications: BMI <17.0 indicating thinness, BMI <18.5 being underweight, BMI between 18.5 and 24.9 as normal weight, BMI ≥25.0 as overweight, and BMI ≥30.0 as obesity.[7]

Cognitive function encompasses a range of abilities such as memory, attention, decision-making, and motor skills, and it involves complex processes like planning, regulation, and goal-setting.[8,9] While obesity has been linked to the development of dementia, the exact effects on cognitive performance in individuals without dementia remain uncertain.[10] This study aims to explore the relationship between central obesity and cognitive health, with the goal of supporting early interventions, such as weight management, lifestyle changes, and physical activity, designed to reduce the future risks of dementia and Alzheimer's disease.

MATERIALS AND METHODS

Study Design: This is a cross-sectional observational study. conducted at MGMMC and Hospital at Aurangabad. After the Institutional Ethical Committee clearance was obtained. **Study Duration:** The study duration was April 2024 to January 2025. **Sample Size:** 200. **Sample population:** healthcare students from campus (Male & Female) aged 25–35 years, divided into non-obese (BMI < 25 group-A) and obese (BMI > 25 group-B).

Inclusion criteria: Healthy participants willing to enroll in this program. **Exclusion criteria:** Individuals with anxiety, addiction, medication use, or medical/ neurological disorders.

Anthropometric data was collected, i.e. height was measured by stadiometer, weight by digital weighing scale, waist circumference, hip circumference, by measuring tape and BMI, waist/hip ratio was calculated, BP was recorded by digital sphygmomanometer. BMI is calculated by dividing weight in kilograms by the square of height in meters (kg/m^2).

Cognitive functions were assessed (viz: attentional, perceptual, executive, and working memory) using the online cognitivefun.net program. Attentional tasks were evaluated through Go/No-Go VRT, perceptual tasks were assessed via fast counting (FC), executive tasks were measured using the Stroop Test (ST) for color interference reading, and the working memory task was evaluated through picture 2-back remembering.

STATISTICAL ANALYSIS –

Data was entered in Microsoft Excel and the Mean and SD for quantitative variables was calculated and significance was tested by unpaired T-test. For comparison between anthropometric parameters and cognitive functions in groups, the Pearson correlation coefficient test was used.

OBSERVATION & RESULTS

200 healthcare subjects, Group-A, nonobese (n-100) and Group-B, obese (n- 100) that have satisfied the inclusion and exclusion criteria, were selected.

Table: 1: Comparison of Anthropometric data between the groups

Parameters	Group-A (Mean±SD)	Group-B (Mean ± SD)	t- value	p- value
Age (years)	29.7 ± 4.19	30.49 ± 3.79	1.398	**0.1636**
Gender	M-48, F-52	M-57, F-43		
Height (cm)	171.15 ± 8.42	171.84 ± 7.70	0.605	**0.5460**
Weight (kg)	67.00 ± 8.58	87.71 ± 14.04	12.587	**< 0.0001 (S)**
BMI (kg/m^2)	22.71 ± 1.33	27 ± 2.22	16.577	**< 0.0001 (S)**
WHR	0.77 ± 0.04	0.87 ± 0.04	17.678	**< 0.0001 (S)**
SBP (mm Hg)	111.18 ± 5.60	133.44 ± 4.15	31.936	**< 0.0001 (S)**
DBP(mm Hg)	72.36 ± 2.20	84.38 ± 2.35	37.340	**< 0.0001 (S)**

(S- significant, p< 0.001)

Table: 1 Both groups' subjects were matching age and height wise. Mean Weight, BMI, WHR, SBP, DBP, in Group B was more than group A and it was statistically significant (p< 0.001)

Table no 2. Comparison of Study parameters (cognitive tests) in groups.

Parameters	Group-A Mean ±SD	Group-B Mean ±SD	T-value	P-value
Attention	446.84 ± 66.80	455.67 ± 80.62	0.843	0.4000
Perception	1476.82 ± 287.39	1651.57 ± 323.68	4.056	< 0.0001 **(S)**
Execution	1356.74 ± 219.59	1486.02 ± 233.89	4.030	< 0.0001 **(S)**
Working Memory	1144.1 ± 264.275	1521.23 ± 924.21	3.923	<0.0001 **(S)**

Table-2: Mean duration for cognitive functions (attention, perception, execution, and working memory) was more in group-B as compared to group-A. It was statistically significant for duration of perception, execution and Working Memory.

Table-3 Correlation between anthropometric parameters and cognitive functions test in obese group

	BMI	WHR	SBP (mm Hg)	DBP (mm Hg)	Attention	Perception	Execution	Working Memory
BMI	1	0.000013 **(S)**	0.007474 **(S)**	0.009965 **(S)**	0.034219	0.005254 **(s)**	0.008882 **(S)**	0.00845 **(S)**
WHR		1	0.191505	0.026428	0.02192	0.148625	0.161731	0.001413 **(S)**
SBP (mm Hg)			1	0.996061	0.338021	0.406025	0.147219	0.698593
DBP (mm Hg)				1	0.002512 **(S)**	0.288424	0.307368	0.009467 **(S)**
Attention					1	0.008721 **(S)**	0.61432	0.174085
Perception						1	0.25208	0.019331
Execution							1	0.186452
Working Memory								1

Table-3, Pearson correlation analysis was conducted to evaluate the relationship between different cognitive function domains and anthropometric parameters in the obese group. BMI was significantly positively correlated with the domains of perception, execution, and working memory, although the correlation with attention was not statistically significant. Similarly, WHR showed a significant positive correlation with working memory, but no statistically significant correlation with attention, perception, or execution. Additionally, both systolic and diastolic blood pressure were positively correlated with cognitive function domains in the obese group.

Discussion:

This study aimed to assess the extent of cognitive dysfunction and its relationship with BMI and WHR in young healthcare workers. The findings revealed significant differences in cognitive abilities between obese and non-obese individuals, indicating cognitive dysfunction. Both BMI and WHR showed a positive correlation with cognitive function, with BMI demonstrating a stronger statistical association compared to WHR in obese group. Additionally, systolic and diastolic blood pressure were significantly higher in the obese group, marked by increased sympathetic tone, can cause thickening of the vascular walls and leading to blood vessel narrowing and reduced cerebral perfusion. This diminished blood flow may play a crucial role in cerebrovascular changes contributing to cognitive impairment.

The global rise in excessive fat accumulation and its associated health risks continues to escalate.[11] National Family Health Survey data reveals that twelve percent of men and sixteen percent of women in India are either obese or overweight.[12] Regardless of the underlying causes, obesity is strongly correlated with numerous health complications. Sedentary behavior, combined with the frequent consumption of high-fat, fast foods, has played a major role in the rapid increase in obesity rates and related health issues. However, some individuals are more vulnerable to these changes, becoming overweight more easily. Difficulty in controlling overeating or engaging in binge eating may stem from a decline in cognitive control.[13] Studies have found a link between the consumption of high-fat Western diets and impaired cognitive function.[14]

Obesity in early and middle adulthood, particularly during midlife, has been linked to declines in cognitive abilities such as memory, attention, and executive function. As individuals age, obesity may also contribute to faster cognitive deterioration. Research has shown that excess weight can shrink critical brain regions, including the brainstem and diencephalon, while also reducing overall brain volume. In addition, obesity appears to damage neural health, particularly in the frontal and parietal areas. A higher BMI in midlife has been associated with weakened neuron and myelin integrity, which may impair brain plasticity and suggest that obesity adversely affects brain structure.[15]

Overweight students showed significant challenges in cognitive functions like attention, memory, intelligence, and flexibility, particularly when performing tasks such as the Attention Switching Task (AST) and Intra-Extra Dimensional Set Shift (IED). The study highlights the crucial role of physical activity for adolescents in managing weight and preventing both cognitive and obesity-related issues.[16]

The increasing prevalence of obesity has been connected to metabolic syndrome, which plays a role in cognitive decline. Central obesity, often measured by WHR, triggers inflammation and disrupts brain function. Research by Kharabian et al. highlights a correlation between elevated BMI and a greater risk of dementia.[17] Similarly, Klein et al. found that high-fat diets can impair memory and hinder hippocampal function.[18] Obesity negatively impacts cognition by modifying brain structure and function while also impairing motor behaviour through musculoskeletal decline. It heightens the risk of cognitive decline and dementia, largely due to alterations in the prefrontal cortex and hippocampus. Contributing factors include insulin and leptin resistance, oxidative stress, neuroinflammation, and cerebrovascular changes, all of which lead to deficits in memory, attention, and executive function. [19]

Limitation: This study does not determine how obesity in young individuals contributes to cognitive decline. It also does not explore the potential influence of factors such as hypertension, grip strength training, diet, sleep deprivation, or genetics on cognitive function in obese individuals. Future research with a larger sample size, diverse populations, and comparisons across various age groups would provide more comprehensive insights.

Conclusion:

This study found that obese individuals with higher BMI had lower cognitive abilities and higher blood pressure than those with a normal BMI. Also significant correlation between WHR and cognitive function suggests an increased risk of cognitive decline in obesity. BMI and WHR may serve as simple indicators for assessing central obesity and cognitive risk. These findings highlight the importance of incorporating physical activity into medical students' curricula to manage weight and improve cognitive health.

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