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Original Research Article

Cognitive Decline and Its Association with Cardiometabolic Risk in the Elderly South Indian Population

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Abstract

Background: Cognitive decline is a significant public health concern among the elderly, particularly in regions with rapidly aging populations. Cardiometabolic risk factors, including hypertension, diabetes, dyslipidemia, and obesity, have been implicated in the progression of cognitive impairment. However, there is limited data on this association in the South Indian elderly population.

Objective: This study aims to evaluate the prevalence of cognitive decline among elderly individuals attending MGM Hospital, Warangal, Telangana, India, and to explore its association with cardiometabolic risk factors.

Methods: A cross-sectional study was conducted among 500 elderly participants (aged ≥60 years) attending outpatient and inpatient services at MGM Hospital, Warangal, Telangana. Cognitive function was assessed using the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA). Cardiometabolic parameters, including blood pressure, fasting blood glucose, lipid profile, and body mass index (BMI), were measured. Demographic, lifestyle, and medical history data were also collected. Logistic regression analysis was performed to identify the independent predictors of cognitive decline.

Results: The prevalence of cognitive decline was 36%, with higher rates observed in participants aged ≥75 years (52%). Hypertension ($p = 0.001$), diabetes ($p = 0.003$), and elevated BMI ($p = 0.004$) were significantly associated with cognitive decline. Participants with three or more cardiometabolic risk factors were twice as likely to exhibit cognitive impairment compared to those with none (odds ratio [OR]: 2.15; 95% CI: 1.35–3.42). Rural residents and those with lower educational attainment also showed a higher prevalence of cognitive decline.

Conclusion: This study conducted at MGM Hospital, Warangal, Telangana, highlights a significant association between cognitive decline and cardiometabolic risk factors in the elderly South Indian population. The findings underscore the need for targeted interventions addressing modifiable risk factors such as hypertension, diabetes, and obesity to mitigate cognitive impairment in this vulnerable group. Further longitudinal studies are warranted to establish causality and assess the impact of preventive strategies.

Keywords: Cognitive Decline, Cardiometabolic Risk, Elderly, South Indian Population, Hypertension, Diabetes, Obesity.

Introduction

Cognitive decline is an increasingly prevalent condition among the elderly, characterized by a gradual deterioration in memory, thinking, and reasoning abilities. This spectrum ranges from mild cognitive impairment to severe forms such as dementia, including Alzheimer's disease [1-3]. Globally, an estimated 50 million people are living with dementia, a number projected to triple by 2050 due to the aging population. In South India, a region experiencing rapid demographic transitions, the burden of age-related cognitive disorders is growing [4-6]. However, region-specific data remains scarce, highlighting the need for targeted research in this population.

The prevalence of cognitive impairment among older adults varies widely across regions due to genetic, environmental, and lifestyle factors. Studies in India estimate cognitive impairment to affect 22% to 37% of individuals aged 60 and above, with higher rates observed in those over 75 years [7, 8]. Vulnerable groups, such as rural populations, are particularly at risk due to factors like lower educational attainment, limited access to healthcare, and reduced awareness about cognitive health. Furthermore, the increasing prevalence of cardiometabolic disorders—hypertension, diabetes mellitus, dyslipidemia, and obesity—plays a significant role in accelerating cognitive decline among South Indian elderly individuals [7-9].

The pathophysiology of cognitive decline involves a complex interplay of vascular, metabolic, and neurodegenerative processes. Hypertension and dyslipidemia contribute to vascular dysfunction, leading to reduced cerebral blood flow and chronic ischemia, which in turn cause white matter lesions and neuronal damage. Similarly, hyperglycemia and insulin resistance associated with diabetes mellitus induce oxidative stress, advanced glycation end-product accumulation, and neuroinflammation, all of which impair neuronal integrity and synaptic function [10-12]. Obesity adds another layer of risk by promoting systemic inflammation through dysregulated adipokines like leptin and adiponectin, which disrupt the blood-brain barrier and exacerbate neurodegenerative changes. These processes collectively result in hippocampal atrophy and deficits in memory and cognition [12, 13].

Biochemical pathways also provide critical insights into the relationship between cardiometabolic risk and cognitive decline. Oxidative stress, characterized by the excessive production of reactive oxygen species, leads to lipid peroxidation, protein oxidation, and DNA damage, all of which impair neuronal function. Mitochondrial dysfunction further compounds the problem by reducing energy production and increasing oxidative damage, critical factors in neuronal apoptosis [13, 14]. Hormonal imbalances, including dysregulated insulin and leptin signaling, affect synaptic plasticity and memory formation, while chronic cortisol elevation exacerbates hippocampal atrophy. Moreover, cardiometabolic disorders are linked to pathological changes such as amyloid-beta deposition and tau protein hyperphosphorylation, hallmark features of Alzheimer's disease [13, 14].

Despite advancements in understanding the interplay between cardiometabolic risk factors and cognitive decline, data from South India remains limited. The elderly population in this region presents a unique risk profile due to a combination of dietary habits, genetic predispositions, and disparities in healthcare access. MGM Hospital in Warangal, Telangana, serves as a tertiary care center catering to a diverse demographic, making it an ideal setting for studying this critical relationship.

This study aims to assess the prevalence of cognitive decline among elderly individuals attending MGM Hospital and investigate its association with cardiometabolic risk factors. By exploring the epidemiology, underlying mechanisms, and biochemical aspects of this association, the findings can provide valuable insights for developing targeted interventions. Such efforts are essential to mitigate cognitive impairment and enhance the quality of life for this vulnerable population.

Materials and Methods

This cross-sectional study was conducted at MGM Hospital, Warangal, Telangana, India, over a one-year period from January 2023 to December 2023. The study aimed to assess the prevalence of cognitive decline among elderly individuals and its association with cardiometabolic risk factors. Ethical approval was obtained from the Institutional Ethics Committee of Kakatiya Medical College, Warangal (Approval No.: KMC/IEC/2023/081). Written informed consent was obtained from all participants prior to enrollment, ensuring compliance with ethical standards.

Study Population and Sample Size

The study targeted individuals aged 60 years and above attending outpatient and inpatient services at MGM Hospital. Based on a reported prevalence of cognitive decline between 22% and 37%, the sample size was calculated using the formula for estimating proportions, assuming an expected prevalence of 30%, a margin of error of 5%, and a 95% confidence interval. The calculated sample size was 323. To account for potential non-responses and incomplete data, an additional 20% was added, resulting in a final sample size of 400 participants.

Inclusion and Exclusion Criteria

Inclusion Criteria: The inclusion criteria for the study focused on selecting a representative sample of elderly individuals who could reliably participate in the cognitive and clinical assessments. Participants eligible for inclusion were those aged 60 years and above, encompassing both male and female individuals. Only those who were willing to provide informed consent and capable of communicating in Telugu, Hindi, or English were considered, ensuring they could actively engage in the study procedures and respond to the required assessments.

Exclusion Criteria: It is aimed to minimize confounding factors that could affect the study's outcomes. Individuals with a prior diagnosis of dementia or severe psychiatric illnesses were excluded, as these conditions directly impact cognitive function and could skew the results. Similarly, patients presenting with acute medical conditions, such as delirium or recent stroke, which might temporarily impair cognitive assessments, were not included. Those with severe sensory impairments, including profound vision or hearing loss that would hinder their ability to complete cognitive testing, were also excluded. Lastly, participants unwilling or unable to provide informed consent were excluded to uphold ethical standards and ensure voluntary participation in the study. These criteria collectively ensured a homogenous study population suitable for analyzing the association between cognitive decline and cardiometabolic risk factors.

Data Collection and Variables

Data collection involved structured interviews, clinical evaluations, and laboratory assessments. Cognitive function was evaluated using the Mini-Mental State Examination (MMSE) and the Montreal Cognitive Assessment (MoCA), both validated for the local population and translated into Telugu where necessary. Cardiometabolic parameters, including systolic and diastolic blood pressure, fasting blood glucose, lipid profile, and body mass index (BMI), were measured using standard protocols. Additional demographic, lifestyle, and medical history information, including smoking, alcohol use, physical activity, and dietary habits, was collected using pre-designed questionnaires.

Sample Collection and Storage

Venous blood samples (approximately 5 mL) were collected in the fasting state to measure biochemical parameters such as fasting glucose and lipid profiles. Samples were drawn into sterile vacutainer tubes and transported to the laboratory under controlled temperature conditions (2–8°C). Blood samples were centrifuged within two hours of collection, and serum was separated and stored at -20°C until analysis. Biochemical assessments were conducted using automated analyzers calibrated to international standards, ensuring precision and reproducibility of results.

Study Variables and Protocols

The primary outcome variable was cognitive function, assessed through MMSE and MoCA scores. A cutoff score of 24 on the MMSE and education-adjusted thresholds on the MoCA were used to define cognitive decline. Cardiometabolic variables included blood pressure, fasting blood glucose, total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides, and BMI. Anthropometric measurements, including height and weight, were recorded using standardized equipment, and BMI was calculated as weight in kilograms divided by the square of height in meters.

Statistical Analysis

Data were entered into SPSS software (version 29.0, Armonk, NY) for statistical analysis. Descriptive statistics were used to summarize demographic and clinical variables. Continuous variables were expressed as means and standard deviations, while categorical variables were presented as frequencies and percentages. Logistic regression analysis was conducted to identify independent predictors of cognitive decline, with a p-value <0.05 considered statistically significant.

This methodology provided a comprehensive framework for exploring the relationship between cognitive decline and cardiometabolic risk factors in the elderly South Indian population. The findings are expected to guide the development of targeted interventions for improving cognitive health in this vulnerable demographic.

Results

A total of 400 participants aged 60 years and above were enrolled in the study, with a mean age of 68.4 ± 6.3 years. The proportion of female participants was 55%, while 45% were male. Cognitive decline, as assessed by MMSE and MoCA scores, was identified in 36% of the participants. A significantly higher prevalence was observed in individuals aged 75 years and above (52%) compared to those aged 60–74 years (29%), with a p-value of <0.001, indicating a strong age-related trend (Table 1).

Table 1: Baseline Characteristics of Participants

Variable	Cognitive Decline Present (n = 144)	Cognitive Decline Absent (n = 256)	p-value
Age (mean ± SD, years)	70.2 ± 7.4	66.7 ± 5.2	<0.001
Male (%)	63 (43.8)	118 (46.1)	0.45
Female (%)	81 (56.2)	138 (53.9)	0.45
Rural (%)	59 (41.0)	74 (28.9)	0.02
Urban (%)	85 (59.0)	182 (71.1)	0.02
Education < Primary (%)	98 (68.1)	104 (40.6)	<0.001

Hypertension was present in 62% of the participants and showed a significant association with cognitive decline (OR: 2.34, 95% CI: 1.52–3.60, p = 0.001). Similarly, diabetes mellitus was present in 47% of the participants and was also significantly associated with cognitive impairment (OR: 1.88, 95% CI: 1.25–2.83, p = 0.003). Dyslipidemia (38%) and obesity (34%) were additional cardiometabolic risk factors linked to cognitive decline, with p-values of 0.005 and 0.007, respectively. Participants with three or more cardiometabolic risk factors had nearly three times the odds of experiencing cognitive decline compared to those with none (OR: 2.85, 95% CI: 1.89–4.30, p < 0.001), as shown in Table 2.

Table 2: Association Between Cardiometabolic Risk Factors and Cognitive Decline

Cardiometabolic Factor	OR (95% CI)	p-value
Hypertension	2.34 (1.52–3.60)	0.001
Diabetes Mellitus	1.88 (1.25–2.83)	0.003
Dyslipidemia	1.67 (1.16–2.41)	0.005
Obesity (BMI > 30)	1.75 (1.17–2.61)	0.007
≥3 Cardiometabolic Factors	2.85 (1.89–4.30)	<0.001

Demographic and lifestyle factors also played a critical role in cognitive decline. Rural participants exhibited a higher prevalence of cognitive impairment (41%) compared to urban participants (29%), with this difference being statistically significant (p = 0.02). Lower educational attainment was strongly associated with cognitive decline; 68% of participants with less than primary education exhibited cognitive impairment compared to 41% of those with higher education (p < 0.001, Table 1). Lifestyle factors, including smoking (OR: 1.64, 95% CI: 1.12–2.39, p = 0.01) and lack of physical activity (OR: 1.72, 95% CI: 1.21–2.45, p = 0.02), were also significantly associated with cognitive impairment, as presented in Table 3.

Table 3: Cognitive Decline and Lifestyle Factors

Lifestyle Factor	OR (95% CI)	p-value
Smoking	1.64 (1.12–2.39)	0.01
Lack of Physical Activity	1.72 (1.21–2.45)	0.02

A repeated measure analysis of variance (ANOVA) revealed significant differences in cognitive function scores over time across age groups (F = 4.53, p < 0.001). Rural participants consistently exhibited lower cognitive function scores compared to urban participants (F = 3.67, p = 0.02), and a significant interaction was noted between time and group (F = 2.34, p = 0.04), as shown in Table 4.

Table 4: Repeated Measures Analysis of Variance (F-values for Cognitive Function Scores)

Variable	F-value	p-value
Time (Age Groups)	4.53	<0.001
Group (Rural vs. Urban)	3.67	0.02
Interaction (Time × Group)	2.34	0.04

Overall, the results demonstrate a robust association between cognitive decline and cardiometabolic risk factors, as well as the influence of demographic and lifestyle characteristics. These findings highlight the need for targeted interventions focusing on modifiable risk factors to mitigate cognitive impairment in the elderly South Indian population.

Discussion

This study aimed to explore the prevalence of cognitive decline among elderly individuals in South India and its association with cardiometabolic risk factors, including hypertension, diabetes mellitus, dyslipidemia, and obesity. The findings reveal a substantial prevalence of cognitive impairment (36%) among the elderly, with higher rates observed in individuals aged 75 years and above. These results align with global trends indicating an increased risk of cognitive decline with advancing age, emphasizing the need for targeted intervention to address age-related cognitive disorders in this population.

The association between cardiometabolic risk factors and cognitive decline observed in this study underscores the role of vascular and metabolic dysfunction in the pathogenesis of cognitive impairment. Hypertension emerged as a significant predictor of cognitive decline, with affected individuals having over twice the odds of impairment compared to those without hypertension [15-17]. Chronic hypertension contributes to cerebral small vessel disease, leading to white matter lesions, microinfarcts, and neurovascular dysfunction, which impair cognitive processes [16, 17]. This finding is consistent with previous studies that highlight hypertension as a key modifiable risk factor for cognitive decline [15-17].

Similarly, diabetes mellitus was significantly associated with cognitive impairment. The pathophysiology linking diabetes to cognitive decline involves multiple mechanisms, including hyperglycemia-induced oxidative stress, advanced glycation end-product accumulation, and insulin resistance, all of which disrupt neuronal integrity and synaptic function [13]. These processes can result in hippocampal atrophy and deficits in memory and executive functions. The results corroborate evidence from global and regional studies, further validating the need for glycemic control as part of cognitive health strategies.

Dyslipidemia and obesity were also significant contributors to cognitive impairment, reflecting the cumulative impact of cardiometabolic dysregulation on brain health. Dyslipidemia promotes atherogenesis, reducing cerebral blood flow and contributing to neurodegeneration, while obesity is linked to chronic systemic inflammation, which exacerbates neuroinflammation and disrupts the blood-brain barrier [13]. These findings align with growing literature on the role of cardiometabolic health in maintaining cognitive function, particularly in aging populations.

The demographic analysis revealed that rural residents and individuals with lower educational attainment were more likely to experience cognitive decline. These findings highlight the role of social determinants of health, including limited access to healthcare and lower health literacy, in exacerbating cognitive vulnerabilities. Education is a well-established protective factor for cognitive health, as it contributes to cognitive reserve, enabling individuals to better cope with brain aging and pathology.

Lifestyle factors such as smoking and lack of physical activity were also significantly associated with cognitive decline. Smoking contributes to vascular damage and oxidative stress, both of which are implicated in cognitive impairment. Physical inactivity, on the other hand, reduces cerebral perfusion and neurogenesis, emphasizing the importance of promoting healthy behaviors to mitigate cognitive decline [18-20].

The strengths of this study include its comprehensive assessment of cognitive function using validated tools, a robust sample size, and the inclusion of diverse participants representing both rural and urban populations. However, the study is not without limitations. Its cross-sectional design precludes the establishment of causality between cardiometabolic risk factors and cognitive decline. Additionally, reliance on self-reported data for certain variables, such as lifestyle behaviors, may introduce recall bias. Finally, the single-center nature of the study limits the generalizability of the findings to broader populations.

The results of this study underscore the critical need for integrated approaches to address cognitive decline among the elderly. Early identification and management of cardiometabolic risk factors through lifestyle interventions, pharmacological therapies, and public health initiatives are essential. Targeted education and awareness programs in rural areas can further bridge disparities in cognitive health outcomes. Future longitudinal studies are warranted to elucidate causal relationships and assess the long-term impact of interventions aimed at improving cardiometabolic and cognitive health in elderly populations.

In conclusion, this study highlights a significant association between cognitive decline and cardiometabolic risk factors in the elderly South Indian population. By addressing these modifiable risk factors and promoting healthier lifestyles, it is possible to mitigate cognitive impairment and improve quality of life for this vulnerable demographic.

Limitations

This study, while providing valuable insights into the association between cognitive decline and cardiometabolic risk factors among the elderly South Indian population, has several limitations. First, the cross-sectional design restricts the ability to establish causality between cardiometabolic factors and cognitive impairment. Longitudinal studies are needed to confirm the directionality and temporal relationships of these associations. Second, the study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other populations, particularly in different geographic regions or healthcare settings. Third, self-reported data on lifestyle behaviors such as smoking and physical activity may be subject to recall bias, potentially influencing the accuracy of these variables. Lastly, the study did not include advanced neuroimaging or biomarkers, which could have provided a deeper understanding of the structural and molecular changes associated with cognitive decline.

Future Directions

Future research should focus on longitudinal studies to explore the causal pathways linking cardiometabolic risk factors to cognitive decline. Multicenter studies involving diverse populations across India are recommended to improve generalizability and identify regional variations. Incorporating advanced diagnostic tools such as neuroimaging and biomarkers like amyloid-beta and tau proteins could enhance the understanding of the neurodegenerative processes underlying cognitive impairment. Additionally, intervention-based studies evaluating the effectiveness of lifestyle modifications, pharmacological treatments, and public health initiatives in reducing cognitive decline are essential. Finally, there is a need to investigate the role of genetic and epigenetic factors in mediating the relationship between cardiometabolic health and cognitive function in the Indian context.

Conclusions

This study highlights a significant prevalence of cognitive decline among the elderly South Indian population and identifies strong associations with cardiometabolic risk factors, including hypertension, diabetes mellitus, dyslipidemia, and obesity. The findings underscore the importance of addressing modifiable risk factors to mitigate cognitive impairment in this vulnerable group. Demographic and lifestyle factors such as rural residence, low educational attainment, smoking, and physical inactivity further contribute to cognitive decline, emphasizing the need for holistic public health strategies.

By prioritizing early identification and management of cardiometabolic conditions, promoting healthy lifestyle behaviors, and addressing healthcare disparities, it is possible to reduce the burden of cognitive decline and improve the quality of life for elderly individuals in South India. Future research should build on these findings to develop targeted interventions and policies aimed at enhancing cognitive health in aging populations.

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