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Original Research Article

Association of the level of cognition and obesity among middle-aged adults in Sri Lanka

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ABSTRACT

Background: Cognition is the collection of an intellectual process, such as perception, thinking, and reasoning for goal-directed behaviours. The obesity-associated cognitive functions (CFs) was varied due to inconsistency of the findings and it is also context bounded. The objective was to assess the association between cognitive function and obesity among middle-aged adults in Sri Lanka.
Methods: A descriptive study was conducted among middle-aged adults aged between 50-60 years in Colombo District, Sri Lanka. While Generalized obesity was estimated by the WHO cutoff of body mass index (BMI) while the central obesity was determined using and waist hip ratio (WHR). CFs was assessed using a validated Montreal cognitive assessment (MoCA) and the Mini-mental state examination (MMSE) tools.
Results: The study sample consisted of 83 subjects of each obese and normal weight categories, while 50% were females. Middle-aged adults with obesity showed significantly lower CF scores in both MoCA and MMSE compared to the normal-weight adults ($p<0.01$). In addition, lower MMSE scores were significantly associated with high WHR values ($p<0.05$). The level of education of adults was a significant predictor of cognitive functions among middle-aged adults ($p<0.05$).
Conclusions: Therefore, the results further confirmed that obesity-associated cognitive impairment among middle-aged adults and further research is warranted to clarify the cause and effect relationship between obesity and body composition.

Keywords: Cognition, Obesity, Middle-aged adults

INTRODUCTION

Obesity is a multifactorial health problem affecting both developed and developing countries worldwide.[1] In the year 2014, there had been around two billion overweight and more than half a million adults with overweight or obesity in the world.[2] According to the Sustainable Development Goal (SDG), the prevalence of Sri Lankan adults with obesity was 6.2% in 2017, and this number was comparatively higher than the regional countries and had been increasing over recent decades.[3] Besides, obesity leads to many public health problems and increases the economic burden of health care.[4]

Cognition represents the behaviour characteristics of the individuals as a whole and consistent with different abilities which are specific to the individuals. However, other factors, such as lifestyle and motor skills, may influence cognition.[5] The prefrontal cortex (PFC), which is involved in the control of cognition and its associated behaviour, has the longest maturation period in the brain.[6]

Obesity and excessive fat intake lead to systemic inflammation and free fatty acids level in the body.[7] Circulating cytokines, extra fatty acids and immune cells get through the brain at the level of the hypothalamus for exacerbating the local inflammation, which leads to poor cognitive functions (CFs).[8] Moreover, CF is predominantly lower amongst obese adults, irrespective of their comorbid medical conditions.[9,10] Further, studies reported that adults with higher BMI had shown a lower level of cognition.[9,11] Individuals with obesity had experienced, more unsatisfactory memory performance in learning, lower physical performances, delayed recall and recognition when compared to normal middle-aged adults.[12,13] Verbal memory and decision making are the core components of cognition, and these aspects were significantly lower in adults with obesity when compared to its normal-weight subjects.[14] In addition, performances in psychomotor and speed tests too were significantly lower in adults with obesity in several studies.[9,15] Furthermore, several studies revealed that poor cognitive function scores had been reported among adults with obesity across the life span.[11,12] However, the paucity of published data available in the South Asian region with the obesity and CFs, this study was designed to determine the association between obesity and CFs among middle-aged adults in Colombo District, Sri Lanka.

METHODS

Study type, place and period of study

The study was conducted as a cross-sectional study, between a similar number of adults with obesity and adults with normal weight. Data was collected in selected Medical Office of Health (Homagama) in Colombo district during the period of June – December 2018.

Section criteria of the participants

The participants were recruited for the study by using simple random sampling method and 2018 updated electorate register was taken as a sampling frame. The sample size was calculated using the equation of $n = z^2 p (1-p) / d^2$. where n = Sample size, z = 1.96; Critical value of specified confidence, at 95% confidence interval, p= Probable estimate of the proportion of the prevalence percentage of Middle-aged adults (50 – 59 years) with obesity was 6.2% in 2017 in Sri Lanka[3], d = 5% of the accepted amount of the absolute error. The minimum sample size of the study was 83. Therefore, a total of 83 Middle-aged adults (50 – 59 years) with obesity (BMI above 27.5 Kg/m^2) were included in this study. In the meantime, a similar number of adults (n=83) with normal weight (BMI range between 18.5 to 22.9 Kg/m^2) were recruited from the same community for the comparison group.

WHO Asian cutoff values of BMI was used for assessing generalized obesity.[16] Normal weight was considered as the BMI range between 18.5 to 22.9 Kg/m^2 and obese was considered as the BMI above 27.5 Kg/m^2 while the Central obesity of the study sample (normal-weight vs obese) was estimated by WHO cutoff values of Waist to hip ratio (WHR) of both male and female.[16-17] While normal WHR for males <0.90 and females <0.80, WHR values ≥0.90 for males and ≥0.80 for females were considered as high respectively.[17] The height was taken to the nearest 0.1 cm, as the maximum distance to the uppermost position on the head from heels, with the individual keep standing barefoot while maintaining full inspiration by using the SECA stadiometer (SECA model 240). Body weight was measured to the nearest 0.1 kg by using the SECA digital weighing scale while the participants were wearing indoor light clothing. Weighing scales were calibrated at each 25th measurement. The BMI was calculated as weight in kilograms divided by height squared in meters (kg/m^2).

Procedure

Montreal cognitive assessment test (MoCA)

MoCA has been developed to determine individuals with impaired cognitive functions, and that has shown a positive correlation with MMSE in many studies.[18,19] MoCA consists of the eight cognitive domains: visuospatial skills, executive functions, recovery of short-term memory and attention, concentration, working memory, language and orientation. The maximum score of MoCA is 30 and an individuals' score over 26 is considered normal while less than 26 is assumed as having Mild cognitive impairment (MCI). The MoCA was culturally adapted and validated to Sri Lankan context in 2011. [20]

Table 1: Dementia staging and the clinical dementia rating scale.

Cognition level	MMSE	MoCA
Normal	27-30	26-30
MCI	24-26	18-25
Mild dementia	18-23	11-17
Moderate dementia	10-17	6-10
Severe dementia	Below 10	Below 6

Mini-mental status examination (MMSE)

The MMSE is the best known and most widely used measure of cognition in clinical practice worldwide. MMSE assesses cognitive function from the domains of orientation, memory, attention and calculation, language and visual construction. The score range between 0 and 30 points and cutoff of 23/24 has typically been used to show significant cognitive impairment.[21] However, studies

conducted in symptomatic populations with similar educational and socioeconomic backgrounds that the cutoff values of MMSE have been waived off up to 26/27.[22,23] According to the dementia and driving safety, a clinical guideline for the categorization of the level of cognition was developed and tabulated below for both MoCA and MMSE (Table 1).[24]

Ethical approval

The ethical approval for the study was granted by Ethics Review Committee, Faculty of Medicine, General Sir John Kotelawala Defence University, Sri Lanka. Written Informed consent was obtained from the middle-aged adults in the MOH division after providing information through an information sheet. Subjects were recruited after obtaining the written informed consent. Privacy and confidentiality of the participants were maintained. All data obtained were securely stored and were accessible only to the investigator and supervisors.

Statistical analysis

Data were analyzed using the statistical package for social sciences (SPSS) (version 20). Descriptive statistics were reported as mean and Standard Deviation (SD) for continuous variables and frequencies and percentages for categorical variables. Independent sample "'t' test was used to significance of mean differences of anthropometric parameters between adults with obesity and adults with an average weight in the control group. Independent sample "'t' test was performed with a group (normal and obesity) as independent variables and mean scores of cognitive function domains as dependent variables. A multivariate logistic regression method was performed to determine the factors associated with MoCA and MMSE among middle-aged adults with obesity. The level of significance was considered at a p-value less than 0.05.

RESULTS

General characteristics of the study sample

A total of 166 adults with a mean age of 54.59 years (SD±3.1) have participated in the study. Female participants had slightly higher BMI values (26.9±5.0) compared to male participants (24.2±4.0). However, males showed a higher Waist to hip ratio (0.96±0.1) than females (0.93±0.1). A significantly higher mean BMI and WHR values were observed in the obese group when compared to the normal weight group (Table 2).

Performance of cognitive function tasks among the groups with WHR and groups with normal weight and obese

Independent sample' 't' test was performed with a group (normal and obesity) as independent variables and mean scores of cognitive function domains as dependent variables. Obese subjects had significantly lower mean scores in MoCA and MMSE compared to normal subjects (Table 3).

Table 2: Basic anthropometric parameters of the study sample.

Variable	Normal weight (n=83)	Obese (n= 83)	P value
	Mean (SD)	Mean (SD)	
Weight (Kg)	54.7 (7.3)	80.5 (8.4)	0.006
Height (cm)	159.5 (8.6)	155.8 (9.3)	0.008
BMI (Kg/m^2)	21.4 (1.6)	29.6 (2.8)	0.001
WC (cm)	83.9 (7.6)	100.7 (6.7)	0.001
HC (cm)	89.1 (5.7)	100.2 (5.3)	0.001
WHR	0.90 (0.1)	0.94 (0.1)	0.002

The middle adults in the sample were categorized into normal and high WHR categories based on cutoff values of both males and females. For male, WHR≤0.90 indicates normal WHR, while WHR>0.90 indicates a high WHR category. For female, WHR≤0.85 indicates normal WHR, while WHR>0.85 indicates a high WHR category.17 A significantly lower mean MMSE score was observed in the group with high WHR compared to the group with normal WHR ($p<0.05$) while MoCA was not significant among WHR groups (Table 3).

Factors associated with cognitive function tasks

The factors associated with cognitive functions (MoCA / MMSE) among middle-aged adults were analyzed by a multivariate logistic regression method. Table 4 shows that obese people were more likely to have low cognitive function tasks. The age, gender, occupation and monthly income of the participants were not significantly associated with cognitive functions (Table 4).

Table 3: Comparison of cognitive function tasks among in WHR groups and normal and obese groups.

Cognitive Function	Normal Weight	Obesity		Normal WHR (n=28)	High WHR (n=138)	
Tasks	**Mean (SD)**	**Mean (SD)**	**P value**	**Mean (SD)**	**Mean (SD)**	**P value**
MoCA	131.4 (10.8)	127.3 (11.1)	0.001	22.5 (4.0)	22.1 (3.0)	0.604
MMSE	124.6 (11.2)	122.1 (15.6)	0.002	27.1 (1.8)	26.1 (2.3)	0.050

Table 4: Factors associated with cognitive function tasks.

Variables	Categories	MMSE			MOCA		
		OR	95% CI	P value	OR	95% CI	P value
Age (years)	50-54	1			1		
	55-59	0.890	0.467 – 1.695	0.722	1.394	0.555 – 3.506	0.480
Gender	Male	1			1		
	Female	0.759	0.328 – 1.755	0.519	0.641	0.183 – 2.243	0.486
Occupation	Unemployed	1			1		
	Employed	1.031	0.405 - 2.625	0.949	0.902	0.181 – 4.488	0.900
Education status	Upto O/L	1			1		
	More than O/L	2.125	1.032 – 4.377	0.041	1.806	0.680 – 4.793	0.2355
Monthly income (SLR)	≤40,000	1			1		
	>40,000	1.051	0.459 - 2.405	0.906	1.783	0.600 – 5.288	0.299
BMI	Normal	1			1		
	Obese	0.499	0.255 - 0.978	0.043	0.146	0.046 – 0.467	0.001

DISCUSSION

Considering the central WHR values of the majority of middle-aged adults in this sample, they were categorized into average weight and obese based on WHO BMI Asian cutoff values. Therefore, 83 subjects were recruited to each group after screening their BMI values. When considered the central obesity WHR values, the majority of the subjects (77%) belonged to a high WHR category. Further, there was a significant positive correlation between BMI and WHR ($p<0.001$). Similar to the present study, Mehdad et al., reported that there was a significant association among BMI, WHR, fat mass and BF%.[25]

The present study revealed that a significantly lower mean composite score in MoCA and MMSE in individuals with obesity when compared to the subjects with normal weight. Recent studies revealed that there was growing evidence showing the relationship between obesity and impaired performance on global cognitive function, memory, and language.[9-11] Furthermore, many studies confirmed that obesity was associated with altered neuropsychological outcomes across the life span.[25-30] Similar study conducted by Ahmadi et al found that significantly lower MMSE score among middle-aged adults with obesity when compared to normal-weight subjects in Tabriz, Iran.[31]

The present study revealed that significantly lower MMSE values among the group with high WHR when compared to the group with normal WHR. Similarly, high BMI, WC and WHR were associated with lower performance on global cognitive function, memory and language.[32] Nevertheless, adults with high WHR have performed decreases in the block design test which was used for assessing the reasoning domain when compared to the middle-aged adults with normal WHR.[33]

However, there is no evidence to prove that obesity has contributed to a decline in CF, even among obese individuals who had displayed evidence of metabolic syndrome and/or elevated systemic inflammation.[34] Moreover, a cross-sectional study on the effect of BMI on intelligence tasks among middle-aged adults had revealed that there were no associations between BMI and CFs tasks.[35]

In the present study, the blocking concept is used to control the extraneous variable, which affects the consequences of the comparative study. While age, monthly income, gender was not involved in determining an associative factor for cognition, BMI was a predictive variable for CFs. Dore and colleagues revealed that only WHR was inversely related to the various CFs tasks with the control of age, education, gender, and the number of prior exams.[36] Recent studies have revealed that females had significantly higher cognitive impairments (MMSE) when compared to males; however, the present study revealed that gender has no predominant predictive ability.[37,38]

Obesity contributes to the comorbidity of hypertension, diabetes, stroke, cancer etc. and also recently confirmed that higher body composition was independently correlated with poor performances on cognitive functions and diagnosed dementia among middle and older adulthood.[11,39] Recent research revealed that brain-derived neurotropic factor and leptin – biomarkers have been associated with cognitive function in human studies.[40] Thus, these studies further attire the findings of the present study.

Therefore, remedial actions need to be taken to overcome adulthood obesity and prevent drawbacks of the neurophysiological development in the brain during this period. A referral system should be established for counselling and follow up of those adults who were found to have poor CFs contributing to obesity. Furthermore, a longitudinal study is recommended with an intervention component and would shed further light on the contribution of obesity-related cognitive decline.

This study has several limitations. The cross-sectional design of the study only allowed for the descriptive association of cognitive functions and its associated factors among obese and normal middle-age adults, but a causal conclusion could not be drawn. Therefore, a longitudinal study would be more effective in that respect. Furthermore, this study recruited obese and normal-weight middle-aged adults. However, recruiting the participants with all range of BMI categories as; obese, overweight, normal weight and underweight will be provided with a more reliable conclusion. The participants of the present study were recruited from a selected MOH division in Colombo District; thus; it was not possible to represent the cognitive impairment of obese middle-aged adults in the country. Therefore, we recommend that multi-centre research should be conducted in the future.

CONCLUSION

Results of the current study have further confirmed the association of poor cognitive function tasks in middle-aged adults with obesity when compared to people with normal weight. The education status was a significant predictor of the level of cognition. Future research should seek to clarify the causality and the cause-effect relationship between other cognitive function tasks and body compositions.

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