Original Article

Association of Depressive Symptoms and Physical Activity Profile with Cognitive Function in Individuals with Obesity Candidates for Bariatric Surgery

Ana Gabriela Terencio De Sousa[1], Tauan Dos Santos Santana[1], João Gabriel Penedo Cabral Atta[1], Eric Simas Bomfim[1,2], Lélia Lessa Teixeira Pinto[1], Lucas Antônio Jesus De Souza[1,3], Josias Melo Leite[1,2], João Henrique Cerqueira Barros[1,3], Luiz Alberto Bastos De Almeida[1,4], Clarcson Plácido Conceição Dos Santos[1,2,3]

[1]Research Group of Metabolic Diseases, Physical Exercise and Health Technologies, Bahiana School of Medicine and Public Health, [2]Stricto Sensu Postgraduate Program in Medicine and Human Health, Bahiana School of Medicine and Public Health, [3]Professional Master's Program in Health Technologies, Bahiana School of Medicine and Public Health, Salvador, [4]Department of Physical Education, Physical Activity Laboratory, Feira de Santana State University, Feira de Santana, Bahia, Brazil

Abstract

Introduction: Obesity is a major global health issue, associated with physical, psychological, and behavioral impacts. Sedentary lifestyles and depressive symptoms, common in individuals with obesity, may contribute to cognitive decline. **Objective:** To analyze the association between physical activity levels, the presence of depressive symptoms, and cognitive function performance in individuals with obesity. **Materials and Methods:** Cross-sectional study conducted with preoperative bariatric surgery patients at the "removed for anonymized review" in "removed for anonymized review". Assessments included the International Physical Activity Questionnaire, Center for Epidemiologic Studies Depression Scale, Mini–Mental State Examination, and a general clinical form. Data were collected via Research Electronic Data Capture and analyzed with R software (version 4.5). **Results:** The sample included 100 individuals (mean body mass index: 41.2 ± 5.2); 58% were physically active, 42% sedentary, and 26% had clinically significant depressive symptoms. Multiple linear regression indicated a mean cognitive function score of 28.52 in the reference group ($P < 0.001$), with no significant association with sedentary behavior ($\beta = +0.24$; $P = 0.469$) or absence of depressive symptoms ($\beta = -0.36$; $P = 0.398$). Higher education was associated with better cognitive performance, particularly among those with completed higher education ($\beta = +1.67$; $P < 0.001$) and incomplete higher education ($\beta = +1.25$; $P = 0.019$). The model was statistically significant (F: $P = 0.004$). **Conclusion:** Educational level was shown to be the main determinant of cognitive function in individuals with obesity, whereas depressive symptoms and sedentary behavior showed no significant association.

Keywords: Cognitive function, depressive symptoms, obesity, physical activity

Introduction

Obesity is a major public health challenge worldwide, with increasing prevalence across age groups and sociocultural contexts.[1,2] The World Health Organization estimates that approximately 890 million adults live with obesity, a condition associated with increased risk of cardiovascular, metabolic, and musculoskeletal diseases, along with negative effects on mental health and quality of life.[3]

Recent studies have also identified obesity as a risk factor for cognitive impairment, possibly mediated by chronic inflammatory processes, insulin resistance, vascular changes, and neuroendocrine dysfunctions,[4-6] particularly in domains such as memory, learning and executive functions.[7-9]

Access this article online

Quick Response Code:

Website: https://journals.lww.com/jobs

DOI: 10.4103/jbs.jbs_6_25

According to the Brazilian Association for the Study of Obesity and Metabolic Syndrome, 60% of individuals with obesity have a psychiatric disorder, most often depression and eating disorders.[10] This supports evidence showing high rates of depressive symptoms in this population, suggesting a bidirectional relationship between obesity and depression.[6,11,12]

Address for correspondence: Dr. Clarcson Plácido Conceição Dos Santos, Bahiana School of Medicine and Public Health, R. Silveira Martins, 100 - Cabula, Salvador, BA 41150-100, Bahia.
E-mail: clarcson@hotmail.com

Submitted: 26-Sep-2025 **Revised:** 17-Nov-2025
Accepted: 05-Dec-2025 **Published:** 31-Dec-2025

How to cite this article: Sousa AG, Santana TD, Atta JG, Bomfim ES, Pinto LL, Souza LA, *et al*. Association of depressive symptoms and physical activity profile with cognitive function in individuals with obesity candidates for bariatric surgery. J Bariatr Surg 0;0:0.

While excess weight may contribute to depression through stigma and physiological mechanisms, depression can, in turn, lead to behavioral and neurobiological changes that promote obesity.[6,13] The presence of depressive symptoms in this population is also associated with poorer quality of life and a higher risk of cognitive impairment.[9,12,14] Additionally, many individuals with obesity adopt unhealthy lifestyle habits, such as physical inactivity, which may further worsen their condition.[3]

Conversely, physical activity appears as a potentially protective factor against these outcomes.[15] Studies suggest that regular exercise improves executive function, memory, and attention, and also has an important role in the prevention and treatment of depressive symptoms.[16-18] Recent literature proposes that physical activity may mediate the relationship between depression and cognitive function by enhancing neuroplasticity, cerebral perfusion, and reducing inflammation.[19]

Therefore, given the prevalence of obesity and depressive symptoms in the population and the potential negative impacts of these conditions on cognitive function, understanding how physical activity may modulate this relationship is of critical importance. In this context, the present study aimed to analyze the association between physical activity profile and the presence of depressive symptoms with cognitive function performance in individuals with obesity.

Materials and Methods

This study is an excerpt from the initial project entitled "removed for anonymized review," approved by the Research Ethics Committee of the "removed for anonymized review," with CAAE number: "removed for anonymized review."

Study design and population

This observational cross-sectional study evaluated clinical patients at the "removed for anonymized review" in "removed for anonymized review." Participants were selected if they were ≥18 years old. Inclusion criteria required participants to be in the preoperative phase of bariatric surgery.

Procedures and measurement instruments

Data were collected at the "removed for anonymized review," where patients were invited to participate in the interview after signing the Informed Consent Form. Individuals who did not feel comfortable could opt not to participate. Volunteers completed instruments assessing sociodemographic characteristics, physical activity, depressive symptoms, and cognitive function. These instruments were administered online by trained evaluators using tablets or laptops, integrated with the Research Electronic Data Capture.

Clinical form and body composition

The clinical form was a structured instrument used to collect sociodemographic and socioeconomic information, treatment-related variables, and clinical and comorbidity diagnoses.

Body composition was assessed using the octopolar bioelectrical impedance analyzer InBody 720. For this study, the variables considered were weight, height, and body mass index (BMI).

Physical activity

Physical activity data were evaluated with the International Physical Activity Questionnaire, a globally validated instrument that assesses the weekly time spent in physical activities of varying intensities across different domains, as well as time spent in passive, seated activities.[20] Participants were asked about the frequency of activities during the week and the amount of time spent on each activity. In this study, physical activity levels were dichotomized into active and inactive, as the sample did not include substantial variation across different activity levels.[21]

Depressive symptoms

Depressive symptoms were assessed using the Center for Epidemiologic Studies Depression Scale (CES-D), a 20-item self-report instrument designed to screen for depression in population-based studies.[22] The items address mood, behavior, and perception, with responses ranging from "rarely" to "most of the time". The CES-D was selected for its ease of administration and availability of a validated Portuguese version.[23] In this study, participants were stratified into those without clinically significant symptoms and those with depressive symptoms, using a score ≥20 as the cutoff point for the presence of symptoms.[24]

Cognitive function

Cognitive function was evaluated using the Portuguese validated version of the Mini–Mental State Examination (MMSE).[25,26] The test consisted of 30 items assessing different cognitive domains. In this study, however, the cutoff was set as the mean score of the total sample, which was 23 points.[27]

Data analysis

Statistical analysis was conducted using R software, version 4.5.0 (R Foundation for Statistical Computing, Vienna, Austria). Descriptive analysis was first performed to characterize the sample according to sociodemographic, clinical, and behavioral variables, stratified by the presence or absence of depressive symptoms. Categorical variables were expressed as absolute and relative frequencies (*n*, %) and compared between groups using Fisher's exact test or Pearson's Chi-square test, as appropriate. Continuous variables were presented as mean and standard deviation and compared using Welch's *t*-test for independent samples.

Subsequently, cognitive function scores were compared between groups. Differences in scores were first analyzed according to depressive symptoms profile and then according to physical activity level (sedentary vs. active), using Wilcoxon's test for independent samples due to the non-normal distribution of the data.

To assess the association between depressive symptoms, physical activity level, and cognitive function, a simple

linear regression model was fitted, including both variables as predictors. The coefficient (β), standard error, *t*-statistic, and *P* value were reported.

In the next step, a multiple linear regression was conducted, including sociodemographic variables, health conditions, physical activity profile, and presence of depressive symptoms. Variable selection was based on both clinical relevance and previous literature findings. Statistical significance was set at $P < 0.05$. Coefficients β, standard errors, and *P* values were calculated for each predictor.

The quality of the linear and multiple regression model was each assessed using R^2 and adjusted R^2, residual standard error, and the *F*-test for the set of predictors. Finally, marginal effects were estimated to evaluate potential interactions between depressive symptoms and physical activity level on cognitive function, with results presented graphically along with their respective confidence intervals.

A *post hoc* power analysis was conducted to assess whether the study's sample size ($n = 100$) was sufficient to detect significant effects in the multiple regression model employed. For this calculation, the f^2 statistic derived from the observed coefficient of determination ($R^2 = 0.256$) was used, resulting in an effect size of $f^2 = 0.344$. Considering two main predictors in the model, a 5% significance level, and 97 residual degrees of freedom, the analysis indicated a statistical power of 0.9997. This value represents a power substantially higher than the conventional 0.80 threshold recommended in the literature to ensure an adequate probability of detecting true effects.

Results

The general characteristics of the sample are presented in Table 1. This study included 100 individuals with obesity, of whom 26% exhibited depressive symptoms. Sex distribution showed a higher prevalence of symptoms among women (30%) compared to men (5.6%; $P = 0.036$). No significant differences were observed between groups regarding mean age (37 years; $P = 0.96$), BMI ≈ 41 kg/m²; $P = 0.38$, or total body mass ($P = 0.16$).

Analysis of educational level showed a marginally significant trend ($P = 0.053$), suggesting a higher prevalence of depressive symptoms among individuals with lower education. Additionally, employment status was significantly associated with the presence of depressive symptoms ($P = 0.045$).

Regarding comorbidities, the proportion of individuals with depressive symptoms was higher among those without a diagnosis of systemic arterial hypertension (SAH) (33%), compared to those with hypertension (10%). Similarly, a higher frequency of depressive symptoms was observed among participants without nonalcoholic fatty liver disease (NAFLD) (37%), compared to those with the condition (16%). The differences between groups were statistically significant ($P = 0.017$ and $P = 0.016$, respectively).

In this sample, 58% of participants were physically active, and 42% were sedentary. No significant difference was observed between physical activity levels regarding the presence of depressive symptoms ($P = 0.61$).

Relationship between cognitive function with depressive symptoms, and physical activity level

Figures 1 and 2 show that neither depressive symptoms nor physical activity levels were significantly associated with cognitive function. Cognitive scores were similar between participants with and without depressive symptoms (Wilcoxon's test, $P = 0.92$), with comparable variability and outliers in both groups, suggesting no clear link between depression and cognitive performance. Similarly, while active individuals showed a slightly higher median score and fewer lower outliers compared to sedentary ones, this difference was not statistically significant (Wilcoxon's test, $P = 0.15$). The magnitude of the differences was estimated using Rosenthal's effect size r, interpreted as small ($r \approx 0.10$), medium ($r \approx 0.30$), or large ($r \geq 0.50$). The values obtained were $r = 0.0102$ in Figure 1 and $r = 0.143$ in Figure 2, both indicating a small effect. Overall, in this sample, cognitive function did not vary meaningfully based on depressive symptoms or physical activity level.

Effects of depressive symptoms and physical activity on cognitive function

A linear regression model was used to analyze the effects of depressive symptoms and physical activity on cognitive function in individuals with obesity [Table 2]. The model intercept was estimated at 28.36 points ($P < 0.001$), representing the mean cognitive function in the reference group, which includes participants with depressive symptoms who are physically active. Although statistically significant, the intercept has limited interpretative value, serving only as a starting point for the model.

Regarding depressive symptoms, the coefficient for the group without symptoms was −0.024 ($P = 0.952$), indicating

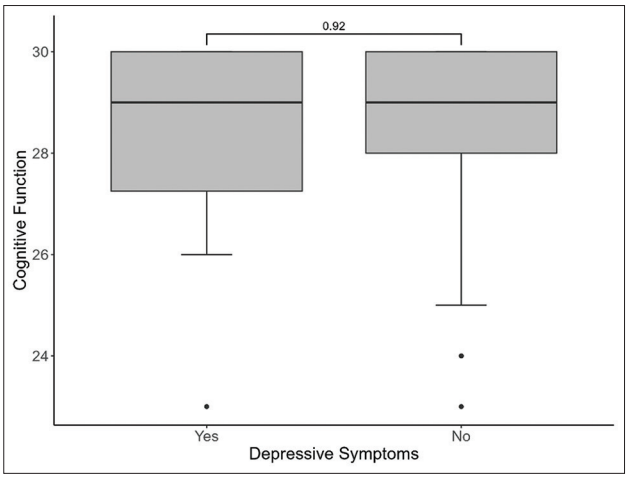

Figure 1: Comparison of cognitive function scores according to depressive symptom profile

Table 1: General characteristics of the sample according to depressive symptom profile

Variables	Total[a]	Depressive symptoms		95% CI	*P*[b]
		Yes (*n*=26)[a]	No (*n*=74)[a]		
Age (years)	37 (11)	37 (14)	37 (11)	35 to 40	0.96
Total body mass (kg)	113 (17)	109 (15)	115 (18)	110 to 119	0.16
BMI (kg/m^2)	41.2±5.2	42.0±5.5	40.9±5.1	40 to 42	0.38
Sex					
Female	82 (100)	25 (30)	57 (70)		0.036
Male	18 (100)	1 (5.6)	17 (94)		
Skin color/race					
Yellow	3 (100)	0	3 (100)		0.65
White	44 (100)	12 (27)	32 (73)		
Indigenous	2 (100)	1 (50)	1 (50)		
Brown	34 (100)	24 (71)	10 (29)		
Black	17 (100)	3 (18)	14 (82)		
Marital status					
Married	41 (100)	9 (22)	32 (78)		0.41
Separated/divorced	6 (100)	0	6 (100)		
Single	44 (100)	14 (32)	30 (68)		
Widowed	1 (100)	0	1 (100)		
Living with partner	8 (100)	3 (38)	5 (63)		
Educational level					
Middle school complete	24 (100)	9 (38)	15 (63)		0.053
High school complete	2 (100)	0	2 (100)		
Higher education complete	54 (100)	9 (17)	45 (83)		
Socioeconomic level					
A2	3 (100)	1 (33)	2 (67)		0.77
B1	7 (100)	1 (14)	6 (86)		
B2	10 (100)	2 (20)	8 (80)		
C	67 (100)	17 (25)	50 (75)		
D	13 (100)	5 (38)	8 (62)		
Employed					
No	14 (100)	7 (50)	7 (50)		0.045
Yes	86 (100)	19 (22)	67 (78)		
Asthma					
No	92 (100)	24 (26)	68 (74)		>0.99
Yes	8 (100)	2 (25)	6 (75)		
Diabetes mellitus					
No	86 (100)	23 (27)	63 (73)		>0.99
Yes	14 (100)	3 (21)	11 (79)		
Depression					
No	86 (100)	21 (24)	65 (76)		0.51
Yes	14 (100)	5 (36)	9 (64)		
SAH					
No	70 (100)	23 (33)	47 (67)		0.017
Yes	30 (100)	3 (10)	27 (90)		
NAFLD					
No	49 (100)	18 (37)	31 (63)		0.016
Yes	51 (100)	8 (16)	43 (84)		
Smoking status					
Former smoker	7 (100)	3 (43)	4 (57)		0.54
Nonsmoker	92 (100)	23 (25)	69 (75)		
Current smoker	1 (100)	0	1 (100)		
Physical activity					
Physically inactive	42 (100)	30 (71)	12 (29)		0.62
Physically active	58 (100)	44 (76)	14 (24)		

[a]*n* (%), mean±SD, [b]Fisher's exact test, Welch two-sample *t*-test, Pearson's Chi-squared test. CI: Confidence interval, BMI: Body mass index, SAH: Systemic arterial hypertension, NAFLD: Nonalcoholic fatty liver disease, SD: Standard deviation

that those without depressive symptoms had, on average, a slightly lower score (0.024 points) compared to the group with symptoms. Concerning physical activity level, the estimated coefficient for the sedentary group was +0.297 (P = 0.405), indicating that sedentary individuals had, on average, a 0.30-point higher score than physically active participants. Although the direction of the effect contradicts the theoretical hypothesis that higher physical activity benefits cognition, the results did not reach statistical significance.

Overall, the results of this model indicate that neither depressive symptoms nor physical activity level was significantly associated with cognitive function in individuals with obesity, with no relevant differences observed between the groups studied.

Regarding model quality, as shown in Table 3, the adjusted R^2 is negative, indicating that the model is less informative than the mean of the dependent variable. The F-test (P = 0.7018) shows that none of the predictors significantly explains the variability in cognitive function. There is no statistical evidence that depressive symptoms or physical activity level are associated with cognitive function scores in this sample.

Predictors associated with cognitive function

A multiple linear regression [Table 4] was performed to identify factors related to cognitive function in this sample. The model included variables related to sociodemographic aspects (age, sex, and educational level), health conditions (SAH and NAFLD), depressive symptoms, physical activity profile, and current employment. Among all the variables examined, only educational level showed a statistically significant relationship with cognitive outcomes. Individuals with a higher education degree had, on average, 1.67 points higher cognitive function scores compared to those who did not complete middle school (P < 0.10). Thus, the findings suggest that educational level may have a protective effect on cognition, even in at-risk populations such as individuals with obesity. Table 5 shows that the model explains 16% of the variation in cognitive function, which is modest but acceptable for human and behavioral data.

Interaction between the presence or absence of depressive symptoms and the physical activity level

Marginal effects analysis [Figure 3] was conducted using a linear regression model that included the interaction between depressive symptoms and physical activity level, aiming to assess their combined influence on cognitive performance.

When comparing groups, differences in cognitive scores between individuals with and without depressive symptoms were minimal among both sedentary and active participants, with substantial overlap in confidence intervals, indicating no statistically significant effect of depressive symptoms on cognition, regardless of activity level.

Regarding the comparison between sedentary and active participants, it was observed that sedentary individuals, with and without depressive symptoms, tended to have slightly higher cognitive scores than active participants, but these differences were subtle, and confidence intervals overlapped considerably, indicating a lack of statistically significant differences.

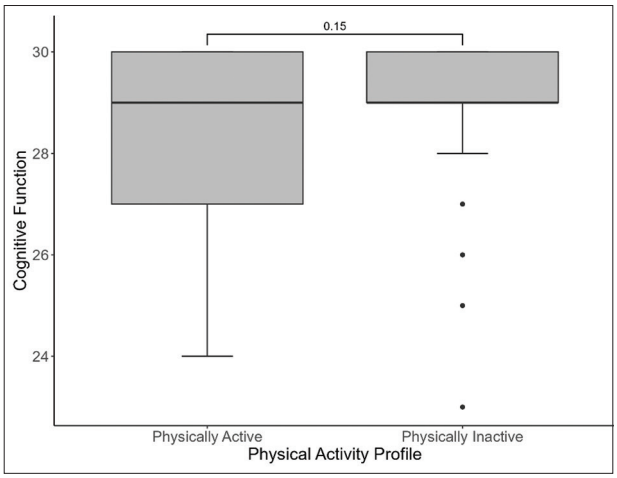

Figure 2: Comparison of cognitive function scores according to physical activity profile

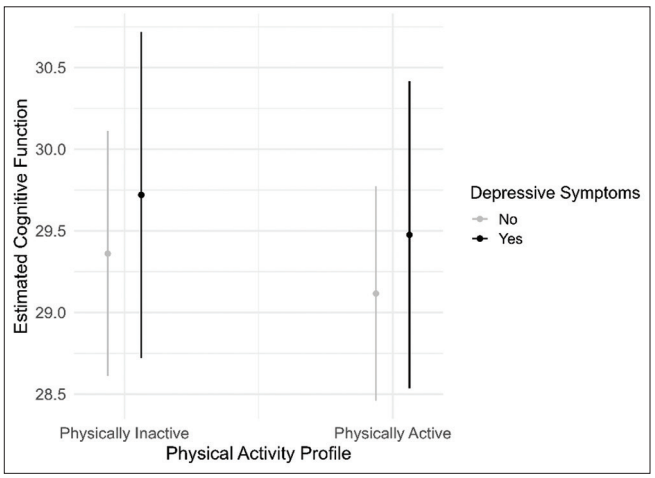

Figure 3: Marginal effects analysis of depressive symptoms and physical activity on cognitive function

Table 2: Linear regression analysis adjusted for physical activity and depressive symptoms

Variables	Coefficient (β)	SE	*t*	95% CI	*P*
Intercept	28.36	0.38	74.62	27.6 to 29.1	<0.001***
Depressive symptoms	−0.024	0.40	−0.06	−0.82 to 0.76	0.952
Physically active	+0.297	0.35	+0.84	−0.41 to 1.00	0.405

*** P < 0.001. SE: Standard error, CI: Confidence interval

Overall, the results of the marginal effects analysis did not reveal any significant individual or interactive effects of physical activity and depressive symptoms on cognitive performance in the studied sample.

Discussion

This study investigated the relationship between cognitive function, depressive symptoms, and physical activity level in individuals with obesity, also considering sociodemographic and clinical variables as potential predictors.

The lack of a significant association between depressive symptoms and cognitive performance differs from some of the literature, which often links such symptoms to poorer cognitive functioning, including declines in processing speed, attention, and memory.[9,28,29] Elevated levels of depressive symptoms are associated with a higher risk of cognitive decline.[29]

One possible explanation lies in the characteristics of the sample, which was composed primarily of young adults in the preoperative stage of bariatric surgery; this profile may reduce variability in cognitive function and attenuate the detection of subtle deficits. In addition, psychosocial factors such as social support, treatment motivation, and clinical stability may mitigate the impact of depression on cognition.[30]

Physiologically, obesity is a chronic pro-inflammatory state that can potentially damage the central nervous system due to neuroinflammation, which may impact memory formation and emotional regulation, thereby contributing to the development of neurological disorders, including depression.[6,8,31] However, studies have demonstrated the existence of the so-called "obesity paradox" in which excess weight, in certain contexts, appears to exert a protective effect on cognition.[8,14]

Langenberg *et al.* investigated the relationship between physical activity and cognitive performance in 71 patients with morbid obesity awaiting bariatric surgery.[7] The study identified that patients with higher depressive symptom scores showed poorer performance in short-term visuospatial memory, regardless of physical activity level.

Although physical activity has been associated with better cognitive performance and protection against decline,[16,32] the present study did not find a statistically significant association between sedentary behavior and being physically active with cognitive function. The use of binary categories (active vs. sedentary) may have limited the sensitivity of the analysis, since different intensities, frequencies, and types of physical activity exert distinct effects on cognition.[33]

Similar to our findings, Langenberg *et al*. also observed no association between daily physical activity and cognitive performance in severely obese patients awaiting bariatric surgery.[7] This may be explained by the fact that the activity level of these patients may not reach the threshold of intensity required to generate measurable cognitive benefits.

In the study by Pitrou *et al*.,[15] overweight older adults with high levels of physical activity were associated with a lower risk of cognitive decline, whereas no association was observed in individuals with low physical activity. Thus, vigorous physical activity may partially mediate the association between obesity and cognitive decline, while moderate or light activity did not show this mediating effect.[33]

In another study, poorer cognitive performance was indirectly associated with more severe depressive symptoms through lower levels of physical activity.[19] Conversely, in the study by Zhang *et al*.,[34] higher physical activity was observed to lead to fewer depressive symptoms, resulting in better cognitive function. This suggested that greater cognitive resources favored engagement in physical activity, which in turn contributed to the reduction of depressive symptoms.[18]

Table 3: Model quality of the linear regression analysis adjusted for physical activity and depressive symptoms

Metric	Value
Residual SE	1.749
R^2 (adjusted)	−0.013
F-statistic	0.3554 (*P*=0.7018)

SE: Standard error

Table 4: Multiple linear regression model: Factors associated with cognitive function in individuals with obesity

Variables	Coefficient (β)	SE	95% CI	*P*
Intercept	28.52	0.90	26.7 to 30.3	<0.001
No depressive symptoms	−0.36	0.42	−1.2 to 0.5	0.398
Sedentary (reference: Active)	+0.24	0.34	−0.4 to 0.9	0.469
Age (years)	−0.023	0.017	−0.1 to 0.0	0.164
Male sex (reference: Female)	−0.24	0.43	−1.1 to 0.6	0.582
Middle school incomplete (reference: Elementary school incomplete)	−0.78	1.71	−4.2 to 2.6	0.651
High school complete	+1.98	1.28	−0.6 to 4.5	0.124
Higher education complete	+1.67	0.42	0.8 to 2.5	<0.001
Higher education incomplete	+1.25	0.52	0.2 to 2.3	0.019
Hypertension (yes)	−0.35	0.38	−1.1 to 0.4	0.363
Nonalcoholic fatty liver disease (yes)	+0.50	0.35	−0.2 to 1.2	0.159
Currently employed (yes)	−0.35	0.52	−1.4 to 0.7	0.503

*P<0.05, **P<0.01, ***P<0.001. SE: Standard error, CI: Confidence interval

Table 5: Model quality of the multiple linear regression involving factors associated with cognitive function in individuals with obesity

Metric	Value
R^2	0.256
R^2 adjusted	0.164
Residual SE	1.589
F-statistic (model)	2.76
Model *P*	0.004

SE: Standard error

The most consistent finding was the positive and significant association between educational level and cognitive performance. This result is consistent with the "cognitive reserve" hypothesis,[35-37] according to which greater educational and intellectual engagement throughout life promotes increased resilience against cognitive decline and brain structural changes related to aging and disease.

In populations with obesity, this effect may be even more relevant, as the presence of multiple metabolic and cardiovascular risk factors could accelerate neurodegenerative processes.[4] Similar results were reported by Tsui *et al*.,[38] who observed that higher educational level mitigated the negative impact of systemic inflammatory markers on cognitive performance. In this context, education may act as a compensatory factor, preserving performance even in the presence of adverse conditions.

An important point to consider is the potential interaction between depressive symptoms, physical activity, and educational level. Although the isolated effects of depressive symptoms and physical activity were not significant, it is plausible that these factors are indirectly and bidirectionally related. Higher levels of physical activity are associated with reductions in depressive symptoms, which, in turn, support better cognitive function.[34] On the other hand, poorer cognitive functioning may predict lower levels of physical activity, contributing to higher depressive symptoms.[19] Therefore, the lack of statistical significance observed does not negate the clinical relevance of these interactions but suggests that more complex analyses are needed to elucidate these relationships.

None of the clinical conditions evaluated showed a significant association with cognitive function. This finding may reflect the fact that severe obesity already represents a sufficiently strong pro-inflammatory state to overshadow the isolated impact of other clinical conditions. Although population-based studies indicate that cardiovascular and metabolic diseases are related to cognitive decline,[15,39] investigations in more restricted groups, such as individuals with severe obesity, suggest that the isolated effect of these comorbidities may be attenuated when obesity itself constitutes a major systemic risk factor.

This study has some limitations that should be considered when interpreting the results. The small sample size limits the statistical power of the analysis, possibly preventing the detection of existing associations in the studied population. Although widely validated and easily accessible for rapid clinical administration, the MMSE scale to assess cognitive function is primarily used in older populations and may lack the sensitivity required to detect the subtle cognitive changes seen in younger adults with obesity, likely resulting in an underestimation of cognitive impairment in our sample.[40] In addition, the fact that data collection was limited to a private clinic increases internal validity and decreases external validity, given the characteristics of the population that seeks this type of service in this setting. These methodological considerations suggest caution in generalizing the findings and highlight the need for future studies with larger samples and more sensitive instruments for this population.

Conclusion

In this sample of individuals with obesity, educational level was the only factor significantly associated with cognitive function, highlighting the role of education as a protective factor for cognition. Depressive symptoms and physical activity do not appear to be associated with cognitive performance in this sample. These findings reinforce the need for further research with larger samples and diverse population profiles to clarify the mechanisms linking obesity, cognition, and psychosocial factors, as well as to identify intervention strategies that may mitigate the impact of obesity on cognitive health.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Ozima L. Chronic Obesity Is A Disease And A Global Epidemic. Jornal da USP (Campus Ribeirão Preto); 2024. Available from: https://jornal.usp.br/campus-ribeirao-preto/a-obesidade-cronica-e-uma-doenca-e-uma-epidemia-global/. [Last accessed on 2025 Aug 22].
2. Obesity Is A Chronic Disease, Not A Choice; 2024. Available from: https://cdd.org.br/noticias/obesidade-e-uma-doenca-cronica-nao-uma-escolha/. [Last accessed on 2025 Aug 22].
3. World Health Organization. Obesity and overweight. Geneva: WHO; 2025. Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight. [Last accessed on 2025 Aug 22].
4. Sellbom KS, Gunstad J. Cognitive function and decline in obesity. J Alzheimers Dis 2012;30 Suppl 2:S89-95.
5. Guillemot-Legris O, Muccioli GG. Obesity-induced neuroinflammation: Beyond the hypothalamus. Trends Neurosci 2017;40:237-53.
6. Wu C, Liu Y, Hong F, Korivi M. Isotemporal substitution of sedentary behavior with physical activity and its influence on depressive symptoms among adults with overweight/obesity in the United States: A cross-sectional study. Heliyon 2024;10:e36285.
7. Langenberg S, Schulze M, Bartsch M, Gruner-Labitzke K, Pek C, Köhler H, *et al*. Physical activity is unrelated to cognitive performance in pre-bariatric surgery patients. J Psychosom Res 2015;79:165-70.
8. Pardo-Moreno T, Mohamed-Mohamed H, Rivas-Dominguez A, Garcia-Morales V, Garcia-Lara RA, Suleiman-Martos S, *et al*. Poor cognitive agility conservation in obese aging people. Biomedicines 2023;11:138.
9. Cook RL, O'Dwyer NJ, Donges CE, Parker HM, Cheng HL, Steinbeck KS, *et al*. Relationship between obesity and cognitive

function in young women: The food, mood and mind study. J Obes 2017;2017:5923862.
10. Brazilian Society of Bariatric and Metabolic Surgery. 60% of Obese Patients Suffer from Psychiatric Disorders; 2022. Available from: https://sbcbm.org.br/noticias/60-dos-pacientes-com-obesidade-sofrem-de-disturbio-psiquiatrico/. [Last accessed on 2025 Aug 22].
11. Drew RJ, Morgan PJ, Collins CE, Callister R, Kay-Lambkin F, Kelly BJ, *et al*. Behavioral and cognitive outcomes of an online weight loss program for men with low mood: A randomized controlled trial. Ann Behav Med 2022;56:1026-41.
12. Mannan M, Mamun A, Doi S, Clavarino A. Is there a bi-directional relationship between depression and obesity among adult men and women? Systematic review and bias-adjusted meta analysis. Asian J Psychiatr 2016;21:51-66.
13. Luppino FS, de Wit LM, Bouvy PF, Stijnen T, Cuijpers P, Penninx BW, *et al*. Overweight, obesity, and depression: A systematic review and meta-analysis of longitudinal studies. Arch Gen Psychiatry 2010;67:220-9.
14. Lin WY. Associations of five obesity indicators with cognitive performance in 30,697 Taiwan biobank participants. BMC Geriatr 2022;22:839.
15. Pitrou I, Vasiliadis HM, Hudon C. Body mass index and cognitive decline among community-living older adults: The modifying effect of physical activity. Eur Rev Aging Phys Act 2022;19:3.
16. Erickson KI, Hillman C, Stillman CM, Ballard RM, Bloodgood B, Conroy DE, *et al*. Physical activity, cognition, and brain outcomes: A review of the 2018 physical activity guidelines. Med Sci Sports Exerc 2019;51:1242-51.
17. Stillman CM, Esteban-Cornejo I, Brown B, Bender CM, Erickson KI. Effects of exercise on brain and cognition across age groups and health states. Trends Neurosci 2020;43:533-43.
18. Csajbók Z, Sieber S, Cullati S, Cermakova P, Cheval B. Physical activity partly mediates the association between cognitive function and depressive symptoms. Transl Psychiatry 2022;12:414.
19. Wu Y, Kong X, Feng W, Xing F, Zhu S, Lv B, *et al*. A longitudinal study of the mediator role of physical activity in the bidirectional relationships of cognitive function and specific dimensions of depressive symptoms. J Affect Disord 2024;366:146-52.
20. Hallal PC, Victora CG. Reliability and validity of the International Physical Activity Questionnaire (IPAQ). Med Sci Sports Exerc 2004;36:556.
21. Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, *et al*. International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003;35:1381-95.
22. Radloff LS. The CES-D scale: A self-report depression scale for research in the general population. Appl Psychol Meas 1977;1:385-401.
23. Batistoni SS, Néri AL, Cupertino AP. Validity and reliability of the Brazilian version of the Center for Epidemiological Scale – Depression (CES-D) in elderly Brazilians. Psico-USF 2010;15:13-22.
24. Vilagut G, Forero CG, Barbaglia G, Alonso J. Screening for depression in the general population with the Center for Epidemiologic Studies Depression (CES-D): A systematic review with meta-analysis. PLoS One 2016;11:e0155431.
25. Folstein MF, Folstein SE, McHugh PR. "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 1975;12:189-98.
26. de Melo DM, Barbosa AJ. Use of the mini-mental state examination in research on the elderly in Brazil: A systematic review. Cien Saude Colet 2015;20:3865-76.
27. Kochhann R, Varela JS, Lisboa CS, Chaves ML. The mini mental state examination: Review of cutoff points adjusted for schooling in a large Southern Brazilian sample. Dement Neuropsychol 2010;4:35-41.
28. Vance DE, Marson DC, Triebel KL, Ball KK, Wadley VG, Cody SL. Physical activity and cognitive function in older adults: The mediating effect of depressive symptoms. J Neurosci Nurs 2016;48:E2-12.
29. Birch K, Ten Hope M, Malek-Ahmadi M, O'Connor K, Schofield S, Coon D, *et al*. Cognitive function as a mediator in the relationship between physical activity and depression status in older adults. J Aging Phys Act 2016;24:540-6.
30. Millan MJ, Agid Y, Brüne M, Bullmore ET, Carter CS, Clayton NS, *et al*. Cognitive dysfunction in psychiatric disorders: Characteristics, causes and the quest for improved therapy. Nat Rev Drug Discov 2012;11:141-68.
31. Tsai CL, Pan CY, Chen FC, Huang TH, Tsai MC, Chuang CY. Differences in neurocognitive performance and metabolic and inflammatory indices in male adults with obesity as a function of regular exercise. Exp Physiol 2019;104:1650-60.
32. Northey JM, Cherbuin N, Pumpa KL, Smee DJ, Rattray B. Exercise interventions for cognitive function in adults older than 50: A systematic review with meta-analysis. Br J Sports Med 2018;52:154-60.
33. Xu X, Xu Y, Shi R. Association between obesity, physical activity, and cognitive decline in Chinese middle and old-aged adults: A mediation analysis. BMC Geriatr 2024;24:54.
34. Zhang L, Zhang J, Chen Q, Cai X, Zu L, Liu L, *et al*. Unraveling the link between physical activity and cognitive function: The mediating impact of depressive symptoms. BMC Public Health 2025;25:1265.
35. Stern Y. Cognitive reserve in ageing and Alzheimer's disease. Lancet Neurol 2012;11:1006-12.
36. Cabeza R, Nyberg L, Park DC, editors. Cognitive Neuroscience of Aging: Linking Cognitive and Cerebral Aging. New York: Oxford University Press; 2004.
37. Opdebeeck C, Martyr A, Clare L. Cognitive reserve and cognitive function in healthy older people: A meta-analysis. Aging Neuropsychol Cogn 2016;23:40-60.
38. Tsui A, Richards M, Davis D. Systemic inflammation and modifiable risk factors for cognitive impairment in older persons: Findings from a British birth cohort. Aging Med (Milton) 2018;1:243-8.
39. Yaffe K, Weston AL, Blackwell T, Krueger KA. The metabolic syndrome and development of cognitive impairment among older women. Arch Neurol 2009;66:324-8.
40. Galioto R, Garcia S, Spitznagel MB, Strain G, Devlin M, Crosby RD, *et al*. The Mini-Mental State Exam (MMSE) is not sensitive to cognitive impairment in bariatric surgery candidates. Surg Obes Relat Dis 2014;10:553-7.