RESEARCH ARTICLE

Anthropometric indicators for obesity and its relationship with depressive symptoms: analysis of a Peruvian national survey [version 1; peer review: awaiting peer review]

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Abstract

Background: The association between obesity and depression has been frequently reported. However, it still remains unclear which anthropometric indicators for obesity could be the best measure to explain its linkage with depressive symptoms.

Methods: This is a cross-sectional analytical study. Secondary data was analyzed using information from the Demographic and Health Survey of Peru (ENDES in Spanish). Data from the years 2018 to 2021 were reviewed. The outcome of interest was the presence of depressive symptoms, assessed with the Patient Health Questionnaire-9 (PHQ-9). The exposure variable was the presence of obesity, which was evaluated by body mass index (BMI) and abdominal circumference. Crude and adjusted odds ratios (cOR and aOR) were calculated using logistic regression. Both prevalence and association measures were presented with 95% confidence intervals (95% CI).

Results: A total of 141,134 subjects were included in the study. Depression was present in 2.51% (95% CI 2.38–2.65). Obesity according to BMI was present in 25.42% (95% CI 24.97–25.88), while abdominal obesity was shown in 41.67% (95% CI 41.19–42.15). In the multivariate analysis, a statistically significant association was found in regard to symptoms of depression in patients with abdominal obesity (aOR: 1.13; 95% CI 1.03–1.24), while no association was found with obesity according to BMI.

Conclusions: Abdominal circumference could be a better anthropometric measure than BMI to evaluate the association between obesity and depressive symptoms in the Peruvian

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population.

Keywords
obesity, depression, association, body mass index, abdominal circumference

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Introduction

Depressive disorder is one of the main causes of disease burden worldwide.[1] Depression is estimated to affect around 350 million people globally.[2] Furthermore, this is projected to be the largest contributor to the disease burden by 2030, according to the World Health Organization (WHO).[3]

In addition to this, the relationship between obesity and depression has been frequently studied in the scientific literature, although how this relationship works is still not fully understood. Some previous studies suggest this mental issue is more common among people with obesity, particularly women, but in contrast, there is some evidence linking obesity with lower levels of depressive symptoms.[4,5]

Many studies looking for the correlation between both characteristics have used the body mass index (BMI) as a prognostic index of fat accumulation; however, it is known that it has some limitations for indicating how it is distributed throughout the body.[6] Therefore, some researchers consider other indicators of obesity, particularly abdominal circumference (AC), to be better indicators of many diseases, including depression.[7]

Even though the relationship between central obesity and depressive symptoms has been reported,[7] the evidence among adults is still scarce. For this reason, examining this anthropometric marker and its role in predicting or indicating depressive symptoms, compared to BMI, could help to clarify the association mechanism between obesity and symptoms of depression in adults.

Consequently, we aimed to explore which obesity anthropometric indicator is more useful for the association between obesity and depression in the Peruvian population.

Methods

Study design

We undertook a cross-sectional analytical study. Secondary data were taken from the Demographic and Health Survey of Peru (ENDES, in Spanish), anually executed by Instituto Nacional de Estadística e Informática-Peru (freely available in: https://iinei.inei.gob.pe/microdatos/) covering the years 2018 to 2021, and analyzed. The STROBE guidelines (Strengthening the Reporting of Observational Studies in Epidemiology) were followed for the present study.[8]

Population and sample

The ENDES is a nationally representative survey with a two-stage sampling design (Instituto Nacional de Estadística e Informática, 2015). The sample was characterized by being probabilistic of a balanced, stratified, and independent type, at the departmental level and in urban and rural areas. For our research, only the data of the respondents of both sexes and that had the main variables of interest were analyzed.

Variable definition

The outcome of interest was the presence of depressive symptoms, which was assessed with the Patient Health Questionnaire-9 (PHQ-9) in the Peruvian survey. The questionnaire consists of nine items formulated to assess and monitor the severity of depression for patients in primary care and other environments. It was designed to be self-administered, and collects information on depressive symptoms over the course of the previous 2 weeks. Each item has a score ranging from 0 to 3, with a total maximum of 27 points.[9,10] Individuals with a score of 15 or more are considered to have depression.[10] The PHQ-9 was previously validated in the Peruvian population[11] and its psychometric properties have been recognized as adequate for different population groups.[12]

The exposure variable was the presence of obesity, which was assessed by BMI and AC. Anthropometric measurements (weight, height) of all participants were evaluated by trained personnel following standardized techniques based on the WHO and the Instituto Nacional de Salud from Peru.[13] Obesity according to BMI was defined with a cut-off point of BMI $\geq$ 30 kg/m^2, while abdominal obesity was defined if there was AC $\geq$ 104 cm in men and $\geq$ 88 cm in women, measurements recommended by the Adult Treatment Panel III (CA-ATP-III).

The factors evaluated were gender (man vs. woman); categorized age (15-34, 35-60, 61-69, and $\geq$70 years); educational level (primary, secondary and higher); the wealth index (poor, medium, rich and richest), the natural region (Metropolitan Lima, rest of the coast, Andean and jungle), daily tobacco use (yes vs no), physical disability (yes vs no), the self-reported alcohol consumption in the previous 12 months (yes vs no), history of hypertension (yes vs no) and Diabetes Mellitus type 2 (DM2) (yes vs no).

Statistical analysis

We used STATA 17 software for analysis and the prevalence of depressive and obesity symptoms was estimated. Bivariate analysis through a Chi-square test was used to analyze each possible factor associated with depression. Finally, the crude and adjusted odds ratio (cOR and aOR respectively) were calculated using logistic regression. Each marker was independently adjusted for sex, categorized age, natural region, educational level, wealth index, daily smoking, alcohol consumption, physical disability, history of hypertension, and history of DM2.

All analyses were performed considering complex samples. It was considered statistically significant if the p value was <0.05. Both prevalence and association measures were presented with 95% confidence intervals.

Ethical considerations

This study was developed with an analysis of survey data sets that are openly published and available online (at http://iinei.inei.gob.pe/microdatos/). In the ENDES survey, run by trained interviewers, informed consent was obtained from all participants. Additionally, in order to ensure data privacy, the responses were anonymized through coding.

Results

A total of 141,134 subjects were included in the study. The female sex represented 48.40%; 8.07% were 70 years of age or older. The prevalence of hypertension and DM2 was 9.85% and 4.18%, respectively. See Table 1.

Table 1. Descriptive characteristics of the general population in the ENDES survey (2018-2021).

Characteristics	n (% weighted)
Gender	
Woman	68 303 (48.40)
Man	72 831 (51.60)
Categorized age	
15 to 35 years old	60 022 (42.53)
35 to 60 years old	56 893 (40.31)
60 to 69 years old	12 832 (9.09)
70 years old or more	11 387 (8.07)
Region	
Metropolitan Lima	52 459 (37.17)
Rest of coast	36 286 (25.71)
Andean	34 898 (24.73)
Jungle	17 488 (12.39)
Education level	
No level	252 (0.20)
Primary	24 715 (19.95)
Secondary	57 582 (46.49)
Higher	41 317 (33.36)
Wealth index	
The poorest	26 266 (18.61)
Poor	29 176 (20.67)
Medium	29 463 (20.88)
Rich	28 435 (40.15)
Richer	27 793 (19.69)
Smoke daily	
No	139 116 (98.57)
Yes	2 018 (1.43)

Table 1. *Continued*

Characteristics	n (% weighted)
Alcohol consumption in last 12 months	
No	125 502 (88.96)
Yes	15 573 (11.04)
Physical disability	
No	137 586 (97.49)
Yes	3 548 (2.51)
History of hypertension	
No	127 142 (90.15)
Yes	13 890 (9.85)
History of DM2	
No	135 155 (95.82)
Yes	5 899 (4.18)

Depression was present in 3,544 individuals (2.51%; 95% CI 2.38–2.65). Obesity according to BMI occurred in 29,923 subjects (25.42%; 95% CI 24.97–25.88), while abdominal obesity was seen in 52,839 people (41.67%; 95% CI 41.19–42.15). See Table 2.

Table 2. Bivariate characteristics of the factors associated with symptoms of depression in patients with obesity.

Characteristics	Depressive symptoms		
	No	Yes	p*
	n (%)	n (%)	
Gender			
Woman	67 300 (98.53)	1 003 (1.47)	**<0.001**
Man	70 290 (96.51)	2 541 (3.49)	
Categorized age			
15 to 35 years old	59 047 (98.38)	975 (1.62)	**<0.001**
35 to 60 years old	55 484 (97.52)	1 409 (2.48)	
60 to 69 years old	12 356 (96.29)	477 (3.71)	
70 years old or more	10 704 (94.00)	683 (6.00)	
Region			
Metropolitan Lima	51 386 (97.95)	1 073 (2.05)	**<0.001**
Rest of coast	35 465 (97.73)	824 (2.27)	
Andean	33 594 (96.26)	1 304 (3.74)	
Jungle	17 146 (98.05)	342 (1.95)	
Education level			
No level	231 (91.82)	21 (8.18)	**<0.001**
Primary	23 711 (95.94)	1 004 (4.06)	
Secondary	56 363 (97.88)	1 219 (2.12)	
Higher	40 663 (98.42)	655 (1.58)	
Wealth index			
The poorest	25 365 (96.57)	901 (3.43)	**<0.001**
Poor	28 410 (97.38)	765 (2.62)	
Medium	28 685 (97.36)	778 (2.64)	
Rich	27 828 (97.87)	607 (2.13)	
Richer	27 302 (98.23)	492 (1.77)	

Table 2. *Continued*

Characteristics	Depressive symptoms		
	No	Yes	p*
	n (%)	n (%)	
Smoke daily			
No	135 626 (97.49)	3 490 (2.51)	0.812
Yes	1 964 (97.35)	54 (2.65)	
Alcohol consumption in last 12 months			
No	122 266 (97.42)	3 236 (2.58)	**0.003**
Yes	15 266 (98.03)	307 (1.97)	
Physical disability			
No	134 370 (97.66)	3 216 (2.34)	**<0.001**
Yes	3 220 (90.76)	328 (9.24)	
History of hypertension			
No	124 347 (97.80)	2 796 (2.20)	**<0.001**
Yes	13 155 (94.71)	735 (5.29)	
History of DM2			
No	131 957 (97.63)	3 198 (2.37)	**<0.001**
Yes	5 564 (94.32)	335 (5.68)	
Obesity according to BMI			
No	85 635 (97.54)	2 158 (2.46)	**0.024**
Yes	29 070 (97.15)	853 (2.85)	
Obesity according to AC-ATP III			
No	72 484 (98.01)	1 475 (1.99)	**<0.001**
Yes	51 132 (96.77)	1 707 (3.23)	

*Analysis performed with the chi square of independence.

The analysis in Table 2, shows a statistically significant association between depressive symptoms and most of the sociodemographic, health-related and habits variables, except in the case of daily smoking (p=0.812).

In the multivariable analysis, a statistically significant association was found to connect signs of depression in patients with abdominal obesity (aOR: 1.13; 95% CI 1.03–1.24), while no association was found with obesity according to BMI. See Table 3.

Table 3. Simple and adjusted multivariable regression analysis of the factors associated with symptoms of depression in patients with obesity.

Characteristic	Crude analysis			Adjusted analysis*		
	cOR	95% CI	P	aOR	95% CI	P
Obesity according to BMI						
No	Ref.			Ref.		
Yes	1.16	1.03–1.26	**<0.001**	1.05	0.96–1.15	0.249
Abdominal obesity						
No	Ref.			Ref.		
Yes	1.64	1.53–1.76	**<0.001**	1.13	1.03–1.24	**0.006**

OR: Odds ratio. 95% CI: Confidence interval at 95%.
*Each marker has been adjusted independently by sex, categorized age, natural region, educational level, wealth index, daily smoking, alcohol consumption in the last 12 months, physical disability, history of hypertension, and history of DM2.
**Significant p-value <0.05.

Discussion

Comparison with other studies

In the present study, no significant correlation was found between obesity measured by BMI and depressive symptoms. BMI is a regular and easy tool for the assessment of excess adiposity, but it has restrictions, that include the inability to distinguish between adipose tissue distribution and lean body mass[14] and also, there are significant differences in the performance of BMI between ethnic groups.[15,16] These limitations may be greater in men due to their greater muscle mass compared to women. This may explain the fact that several studies have reported that BMI is an important predictor of depressive symptoms in women but no in men,[17,18] although when the studies are carried out prospectively, the BMI is related to depression.[19] According to our findings, Guedes *et al.*[20] suggested that particularly, the body fat percentage and not BMI was related to a greater severity of depressive symptoms.

However, other studies that only included BMI as an anthropometric variable reported an association between BMI and depressive symptoms, such as the study by De Godín *et al.,*[21] which documented that a high BMI is considered a risk factor for manifestation of depressive symptoms among older adult subjects in France, compared to normal BMI. Furthermore, Sachs-Ericsson *et al.*[22] reported that BMI was a predictor of depression in old age, and that its effect was stronger in African-Americans than in the white population, regardless of sex. However, differences have also been found in relation to sex, since Anderson *et al.*[23] carried out a prospective longitudinal study to evaluate the association between depression and weight variation in a study carried out from the early years to adulthood, and found out that depression was associated with elevated BMI in women but not in men. Similarly, the systematic review by Luppino *et al.*[19] showed that obesity defined by BMI was related to a major risk of depression in American subjects compared to Europeans, and being overweight was associated with a higher risk of depression in adult populations but not in young ones. Another aspect to consider is that the association between BMI and depression varies depending on the different subtypes of depression, as reported in a recent meta-analysis.[5] The differences found between the different studies can be explained by the methodological variation, including population, follow-up, cut-off point in diagnostic tools, and criteria for obesity and depression.

The evidence seems to indicate that some anthropometric markers have a better explanatory value in regard the association between obesity and depression. An example of this is the study by Zhao *et al.*, which found that abdominal obesity among obese and overweight people was strongly associated with an increase in depressive symptoms.[24] Likewise, other works such as that of Hadi *et al.,*[25] in which different anthropometric indicators of obesity were studied, concluded that those related to abdominal adiposity have a better association with depression, compared to BMI. On the other hand, Lee *et al.* reported that depressed mood in overweight premenopausal women is associated with visceral fat, but not subcutaneous fat.[26] The follow-up study by Herva *et al.*[27] argued that in both men and women, abdominal obesity may be closely associated with depression.

A Swiss cohort study by Lasserre *et al.*[28] reported that depressive disorder was an important risk factor for obesity as AC increased in both sexes. Ma and Xiao[29] reported that higher waist circumference was associated with depression, regardless of BMI. While Williams *et al.*[30] found out that women with antecedents of depressive issues tended to have higher BMI, weight, waist circumference, and body fat than those without antecedents of mental issues.

Interpretation of results

Abdominal adipose tissue induces the activation of the immune system, the release of regulatory molecules and citokines that, in turn, unchain inflammatory signaling pathways.[31,32] Symptoms of depression can be aggravated by systemic inflammation, so it is relevant to focus on central adiposity when discussing the association between obesity and depression.[33] In addition, some mechanisms have been suggested for the linkage between obesity and depression, which includes the hypothalamic-pituitary-adrenocortical axis dysregulation resulting from reduced glucocorticoid receptors and excessive cortisol secretion.[34]

Study limitations

Among the limitations of this study, it is important to mention two. First, due to the cross-sectional nature of this work, we were unable to determine the direction of causality between anthropometric measures and depressive symptoms. Secondly, it is not possible to talk about the diagnosis of depression itself, since what was assessed was the presence of depressive symptoms. Likewise, subtypes of depression could not be established.

Despite the limitations, this study has the strength of having benefited from a nationally representative sample, as well as from the methodology used to obtain it. Finally, we emphasize that the present study gives us a first impression about the importance of appropriately selecting the anthropometric marker of obesity used to assess its association with depressive symptoms among the Peruvian population.

Conclusions

AC could be a better anthropometric marker, compared to BMI, for assessing the relationship between abdominal obesity and depression in the Peruvian population. The steadily rises in worldwide prevalence of overweight and obesity points out that mental health issues should be examined and surveilled in obese subjects, especially those with central obesity.

Authors' contributions

Víctor Juan Vera-Ponce, Jenny Raquel Torres-Malca, Jamee Guerra Valencia, Rubén Espinoza Rojas, Fiorella E. Zuzunaga-Montoya, Gianella Zulema Zeñas-Trujillo, Liliana Cruz-Ausejo and Jhony A. De La Cruz-Vargas participated in conceptualization, data curation, formal analysis, investigation, methodology, supervision, validation and visualization, as well as the writing of the original draft and the manuscript review & editing.

Data availability

No primary data are associated with this article.

The secondary data used for this research, taken from the Demographic and Health Survey of Peru (ENDES), are freely available from the Peruvian National Institute of Statistics and Information (INEI). In addition, dataset and codes are available at: https://data.mendeley.com/datasets/4rjb88t4mc, and INEI link at: https://iinei.inei.gob.pe/microdatos/.

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