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Association between central obesity and symptoms of autonomic dysfunction: a cross-sectional study

Asociación entre la obesidad central y los síntomas de disfunción autonómica: un estudio transversal

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ABSTRACT

Introduction: Central obesity is associated with diverse complications, including autonomic symptoms; however, there are several diagnostic criteria for defining central obesity. This study aimed to examine the association between central obesity, using two different definitions, and the presence of autonomic dysfunction symptoms in adults.

Methods: Secondary data analysis using information from an observational, cross-sectional study conducted in the North of Peru, between 2016 and 2017. Autonomic symptoms were assessed using the Survey of Autonomic Symptoms, whereas central obesity was defined based on waist circumference, using two different criteria (International Diabetes Federation [IDF] and the Adult Treatment Panel III [ATP III]). Crude and adjusted (for age, sex, education level, and socioeconomic status) Poisson regression models were created to evaluate the association of interest. Prevalence ratios (PR) and 95% confidence intervals (95% CI) were reported.

Results: A total of 1,609 participants were analyzed, with a mean age of 48.2 years (SD: 10.6) and 810 (50.3%) were women. The prevalence of central obesity was 79.4% (95% CI: 77.3%–81.3%) according to IDF criterion, and 45.5% (95% CI: 43.1%–48.0%) based on ATP III criterion. In multivariable model, central obesity as defined by IDF was significantly associated with urinary leakage (PR = 2.12; 95% CI: 1.22–3.69). A significant but weaker association was observed when applying ATP III criteria (PR = 1.47; 95% CI: 1.10–1.97).

Conclusions: Central obesity, as defined by both IDF and ATP III criteria, was significantly associated with autonomic dysfunction symptoms, particularly urinary leakage.

Keywords: Abdominal obesity; dysautonomia; autonomic nervous system

RESUMEN

Introducción: La obesidad central se asocia con diversas complicaciones, incluyendo síntomas autonómicos; sin embargo, existen varios criterios diagnósticos para definir obesidad abdominal. Este estudio tuvo como objetivo examinar la asociación entre la obesidad central, utilizando dos definiciones diferentes, y la presencia de síntomas de disfunción autonómica en adultos.

Metodología: Análisis de datos secundarios a partir de información de un estudio observacional transversal realizado en el norte del Perú entre 2016 y 2017. Los síntomas autonómicos se evaluaron mediante la Encuesta de Síntomas Autonómicos, mientras que la obesidad central se definió según la circunferencia de la cintura, utilizando dos criterios diferentes (Federación Internacional de Diabetes [IDF] y el Panel de Tratamiento de Adultos III [ATP III]). Se crearon modelos de regresión de Poisson crudos y ajustados (por edad, sexo, nivel educativo y nivel socioeconómico) para evaluar la asociación de interés. Se reportaron razones de prevalencia (RP) e intervalos de confianza del 95% (IC 95%).

Resultados: Se analizaron 1609 participantes, con una edad media de 48,2 años (DE: 10,6), de los cuales 810 (50,3%) eran mujeres. La prevalencia de obesidad central fue del 79,4% (IC del 95%: 77,3%-81,3%) según los criterios de la IDF y del 45,5% (IC del 95%: 43,1%-48,0%) según los criterios del ATP III. En un modelo multivariable, la obesidad central, definida por la IDF, se asoció significativamente con la pérdida urinaria (RP = 2,12; IC del 95%: 1,22-3,69). Se observó una asociación significativa, aunque más débil, al aplicar los criterios del ATP III (RP = 1,47; IC del 95%: 1,10-1,97).

Conclusión: La obesidad central, definida tanto por los criterios de la IDF como por los del ATP III, se asoció significativamente con síntomas de disfunción autonómica, en particular con la pérdida urinaria.

Palabras clave: Obesidad abdominal; disautonomía; sistema nervioso autónomo

KEY MESSAGES

- The prevalence of central obesity by the IDF was 79.4%, whereas it was 45.5% by the ATP-III definition.
- Obesity was more frequent in females, mid-aged subjects, those with low education, unemployed, low physical activity levels, hypertension and type 2 diabetes.
- Central obesity was associated with a greater prevalence of dizziness, pale skin, colder feet compared to the rest of the body, nausea, vomiting, abdominal distension after a small meal, persistent diarrhea, persistent constipation, and urinary leakage.

INTRODUCTION

Autonomic dysfunction is a malfunctioning of the autonomic nervous system, leading to a diverse group of clinical manifestations[1,2]: orthostatic symptoms (e.g., dizziness), non-orthostatic symptoms (e.g., excessive sweating), and diffuse symptoms (e.g., fatigue)[3]. Nevertheless, this condition remains unrecognized due to the symptom's heterogeneity[2].

Although several tests are available to detect dysautonomia, many are costly or require specialized equipment[3]. The use of questionnaires or scales may be an economic alternative for identifying dysautonomia symptoms. The Survey of Autonomic Symptoms (SAS), validated in English[4], is brief and has demonstrated high performance when compared to other tools[3], and has been used in Spanish in a previous manuscript[5]. The presence of autonomic symptoms is strongly linked to cardiovascular and neurodegenerative disorders, including Parkinson's disease[1], and metabolic syndrome and obesity[6].

Obesity affected 968 million individuals globally in 2020, with projections indicating that 1.9 billion individuals will be affected by 2035[7]. Obesity is associated with different complications, but waist circumference is a more effective measure of cardiovascular risk[8]. There are several diagnostic criteria for defining abdominal obesity: the Adult Treatment Panel III (ATP III) defines central obesity with different cutoffs[9] than those reported by the International Diabetes Federation (IDF) whose cutoff values depending on ethnicity[10].

Excess adipose tissue may contribute to autonomic dysfunction through alterations in both the cardiovascular and endocrine systems[6,11]. For example, two systematic reviews reported the association between obesity and urinary symptoms (i.e., incontinence) among children, adults and elderly subject[12,13]. Similarly, a different review reported an association between obesity and cardiac autonomic symptoms (i.e., hear rate variability) among children and adolescents[14]. The accumulation of adipose tissue prompts the body to increase cardiac output to meet the metabolic demands of the excess tissue. This adiposity facilitates vascular remodeling, resulting in heightened vascular resistance, leading to the development of arterial hypertension[6]. These changes can impair the delivery of oxygen and nutrients to the nerves precipitating dysfunction within the ANS. Moreover, obesity is strongly linked to insulin resistance and hyperglycemic

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states[2], both of which can cause damage to the autonomic system through oxidative stress and the accumulation of advanced glycation end products[15].

Given that more than a quarter of the adult population in Peru is affected by obesity[16], it is crucial to expand research on related pathologies, including autonomic dysfunction. Therefore, the present study aimed to investigate the association between central obesity, defined according to two different criteria, and the presence of autonomic dysfunction symptoms, especially those related to gastrointestinal, urinary, sexual disturbances, and vasomotor and sudomotor function.

METHODS

Study design

A secondary data analysis was performed utilizing data from a population-based observational study. The general objective of the original study was to assess the diagnostic accuracy of various strategies for detecting type 2 diabetes in the general population, and it was conducted between 2016 and 2017[17].

Study setting and population

Data collection was conducted in Tumbes, a semi-urban region in northern Peru with 225,000 inhabitants. Participants were randomly selected from the study area, using information of the most updated census of the region, conducted in 2014. The inclusion criteria of the original study were adults aged 30 to 69 years, full-time residents in the study area (≥6 months), and able to understand study procedures. Women who were pregnant at the moment of the study, or those bedridden or with physical disabilities preventing anthropometric measurements were excluded from the study[17].

For the current analysis, participants with complete data (full responses on the SAS and those with waist circumference measurements) were included in the analysis.

Definition of outcomes and covariates

The outcome variable was the presence of autonomic symptoms, according to results of the SAS. This scale assesses the presence and severity of autonomic dysfunction symptoms (gastrointestinal, urinary, sexual disturbances, and vasomotor and sudomotor function)[4], and comprises 11 items for women and 12 for men. Each item is assessed independently with a binary response option of "yes" (1) or "no" (0). Severity is measured using a Likert scale ranging from 1 (least severe) to 5 (most severe). For analysis purposes, each symptom and the total sum of symptoms were assessed independently.

The exposure of interest was central obesity, assessed through waist circumference (in cm). We utilized the criteria established by IDF and ATP III. Central obesity by IDF was defined as waist circumference ≥90 cm in men and ≥80 cm in women[10]. In contrast, the ATP III defines used other cutoffs: ≥102 cm in men and ≥88 cm in women[9].

The covariates included in this study were: sex (male or female), age (<40, 40–49, 50–59, and 60+ years), education level (primary, secondary, or higher education), socioeconomic status (based on a wealth index, a composite measure of a household's cumulative living standard, and then split into tertiles: low, middle, and high), current employment status (yes or no), daily tobacco use (consumption of at least one cigarette per day), alcohol consumption (intake of 6 or more bottles of beer or the equivalent in the past month, categorized as ≤1 time or >1 time per month), physical activity levels (assessed using the International Physical Activity Questionnaire [IPAQ] and classified as moderate/high versus low) and consumption of at least one vegetable or fruit per day (yes or no). For descriptive purposes, hypertension, self-reported diagnosis or treatment, or if systolic blood pressure was ≥140 mmHg or ≥90 mmHg for diastolic blood pressure, and type 2 diabetes, defined as fasting glucose ≥126 mg/dL, postprandial glucose ≥200 mg/dL, or a prior diagnosis or self-reported specific treatment[18], were also described.

Data Collection

Participants were selected using a sex-stratified sampling method[17]. Fieldworkers visited participants' households to assess their eligibility. Eligible individuals were invited to participate, provided written informed consent, and scheduled for an appointment at the local health center. On the scheduled day, fasting status (8 to 12 hours) was verified, and once confirmed, a venous blood sample (7.5 mL) was collected. According to international guidelines, an oral glucose tolerance test was started by the oral administration of 75g of anhydrous glucose in 300 mL of water. As a postprandial blood sample was required two hours later, the participants completed the questionnaire and underwent anthropometric measurements during this waiting period. Blood testing was carried out by a certified Peruvian laboratory located in Lima. Laboratory staff were blinded to results of questionnaires and measurements. Glucose was measured in serum using a Cobas Modular Platform auto-mated analyzer and reagents supplied by Roche Diagnostics Data collection was conducted using tablets operated by trained personnel and equipped with an application built with Open Data Kit. The questionnaire comprised different sections including demographics, lifestyle behaviors, as well as risk factors. After the application of the questions, anthropometric measurements were taken using a stadiometer for standing height and a bioimpedance device for weight and body composition. Waist circumference was measured three times using a standardized and validated technique as recommended by the WHO[19], with a measuring tape at the midpoint between the costal margin and the iliac crest. Blood pressure and heart rate were also measured in triplicate using a validated OMRON HEM-780 monitor.

Statistical analysis

For this analysis, with a sample of 1600 subjects and assuming a prevalence of autonomic symptoms in non-obese people of 11.4 % and among obese people of 22.2 %, a ratio between sample sizes of 1 to 2 and a level 95 % confidence, there was a power over 90% to detect these differences.

Statistical analysis was performed using STATA 16.0 for Windows, and we followed the STROBE guideline for cross-sectional studies to report results. Descriptive statistics were presented using means and standard deviations (SD) for continuous variables, and absolute and relative frequencies for categorical variables. Normality of numerical variables were evaluated using the Shapiro-Wilk test. For variables of interest, prevalence and their corresponding 95% confidence intervals (95%CI) were reported.

To examine the associations of interest, crude and adjusted Poisson regression models were built. Confounders were selected a priori based on their role in the association of interest: age, sex, education level, and socioeconomic status were included in adjusted models. These variables were included directly in the final model without using stepwise approaches. Prevalence ratios (PR) and their respective 95%CI were reported.

Finally, linear regression models were utilized to assess the relationship between central obesity and the total score on the SAS utilizing a similar approach as the Poisson regression models. Both crude and adjusted (by age, sex, education level, and socioeconomic status) models were developed, and coefficients (β) with 95%CI were reported.

Ethical statement

The original protocol and informed consent were approved by the Ethics Committees of the London School of Hygiene and Tropical Medicine, UK, and Universidad Peruana Cayetano Heredia, Peru. The current study was reviewed and approved by the Ethics Committee of Universidad Científica del Sur (code: PRE-15-2023-00884).

RESULTS

Study population

In the original study, a total of 2,114 individuals were invited to the study, 486 (22.9%) declined the invitation, 16 (0.8%) were excluded due to pregnancy, and three participants did not complete blood samples. As a result, a total of 1,609 participants were included in the analysis as none was excluded for having incomplete data, mean age of 48.2 (±10.6) years, and 810 (50.3%) women.

Prevalence of central obesity and associated factors

The prevalence of central obesity by IDF was 79.4% (95%CI: 77.3%–81.3%), whereas it was 45.5% (95%CI: 43.1%–48.0%) by ATP III definition. Obesity, using both definitions, was more frequent among females, mid-aged subjects, those with low education, those unemployed, those without tobacco and alcohol consumption, those with low physical activity levels, those consuming vegetable or fruits, those with hypertension and those with type 2 diabetes (see details in Table 1).

Association between central obesity and the presence of autonomic symptoms

The most prevalent autonomic symptom was dizziness (30.2%) whereas the least common was reduced body sweating (1.4%). In crude model, central obesity, by IDF of ATP III, was associated with greater prevalence of dizziness, pale skin, colder feet compared to the rest of the body, nausea, vomiting, abdominal distension after a small meal, persistent diarrhea, persistent constipation, and urinary leakage. However, in multivariable model, obesity by IDF was associated with urinary leakage (PR=2.12; 95%CI: 1.22–3.69, Table 2).

Table 1. Characteristics of the study population by central obesity criteria

Characteristics	IDF			ATP III		
	No obesity N = 332	Obesity N = 1277	p-value	No obesity N = 876	Obesity N = 733	p-value
Sex						
Male	260 (32.5%)	539 (67.5%)	<0.001	629 (78.7%)	170 (21.3%)	<0.001
Female	72 (8.9%)	738 (91.1%)		247 (30.5%)	563 (69.5%)	
Age						
<40 years	122 (27.7%)	319 (72.3%)	<0.001	275 (62.4%)	166 (37.6%)	<0.001
40 – 49 years	91 (19.0%)	389 (81.0%)		239 (49.8%)	241 (50.2%)	
50 – 59 years	69 (16.9%)	340 (83.1%)		205 (50.1%)	204 (49.9%)	
60 + years	50 (17.9%)	229 (82.1%)		157 (56.3%)	122 (43.7%)	
Education						
Primary	91 (17.5%)	428 (82.5%)	0.03	247 (47.6%)	272 (52.4%)	<0.001
Secondary	176 (23.5%)	573 (76.5%)		445 (59.4%)	304 (40.6%)	
Higher education	65 (19.1%)	276 (80.9%)		184 (54.0%)	157 (46.0%)	
Socioeconomic status						
Low	124 (23.0%)	416 (77.0%)	0.15	299 (55.4%)	241 (44.6%)	0.25
Medium	114 (20.7%)	436 (79.3%)		284 (51.6%)	266 (48.4%)	
High	94 (18.1%)	425 (81.9%)		293 (56.5%)	226 (43.5%)	
Employment status						
No	49 (9.5%)	469 (90.5%)	<0.001	174 (33.6%)	344 (66.4%)	<0.001
Yes	283 (25.9%)	808 (74.1%)		702 (64.3%)	389 (35.7%)	
Daily tobacco consumption						
No	300 (19.8%)	1217 (80.2%)	0.001	799 (52.7%)	718 (47.3%)	<0.001
Yes	32 (34.8%)	60 (65.2%)		77 (83.7%)	15 (16.3%)	
Alcohol consumption						
≤1 time/month	279 (19.2%)	1177 (80.8%)	<0.001	755 (51.9%)	701 (48.2%)	<0.001
+ 1 time/month	53 (34.6%)	100 (65.4%)		121 (79.1%)	32 (20.9%)	
Physical activity						
Moderate/high	259 (25.8%)	745 (74.2%)	<0.001	621 (61.9%)	383 (38.1%)	<0.001
Low	73 (12.1%)	532 (87.9%)		255 (42.2%)	350 (57.8%)	
At least one vegetable or fruit/day						
No	177 (23.1%)	591 (76.9%)	0.02	440 (57.3%)	328 (42.7%)	0.03
Yes	155 (18.4%)	686 (81.6%)		436 (51.8%)	405 (48.2%)	
Hypertension						
No	281 (23.6%)	911 (76.4%)	<0.001	687 (57.6%)	505 (42.4%)	<0.001
Yes	51 (12.2%)	366 (87.8%)		189 (45.3%)	228 (54.7%)	
Type 2 diabetes						
No	312 (21.8%)	119 (78.2%)	0.001	803 (56.1%)	628 (43.9%)	<0.001
Yes	20 (11.4%)	156 (88.6%)		72 (40.9%)	104 (59.1%)	

Proportions were estimated and shown in rows. P-values were calculated using the Chi-squared test.

Table 2. Association between central obesity according to the IDF definition and the presence of autonomic dysfunction symptoms

Autonomic dysfunction symptoms	% of autonomic symptoms		Crude model PR (95%CI)	Adjusted model* PR (95%CI)
	No obesity N = 332	Obesity N = 1277		
Dizziness	22.0%	32.3%	**1.47 (1.18; 1.83)**	1.32 (0.90;1.42)
Dry mouth and eyes	22.3%	27.6%	1.24 (0.99; 1.54)	1.02 (0.81; 1.28)
Pale skin	2.4%	5.8%	**2.40 (1.17; 4.94)**	1.67 (0.79; 3.48)
Feet colder than the rest of the body	9.9%	15.5%	**1.56 (1.10; 2.21)**	0.99 (0.69; 1.43)
Reduce sweating in feet	1.2%	2.1%	1.75 (0.62; 4.98)	1.11 (0.37; 3.30)
Reduce sweating in the body	0.6%	1.6%	2.59 (0.61; 11.07)	1.37 (0.26; 7.11)
Increase sweating in hands	6.0%	5.3%	0.88 (0.54; 1.43)	0.87 (0.51; 1.47)
Nausea, vomiting or abdominal after a small meal	5.4%	9.6%	**1.76 (1.09; 2.85)**	1.21 (0.72; 2.03)
Persistent diarrhea	4.8%	9.3%	**1.93 (1.16; 3.21)**	1.51 (0.89; 2.55)
Persistent constipation	16.6%	23.3%	**1.40 (1.08; 1.82)**	0.93 (0.71; 1.21)
Urinary leakage	3.9%	16.4%	**4.18 (2.42; 7.22)**	**2.12 (1.22; 3.69)**
Difficulty achieving an erection (only males)	7.7%	7.8%	1.01 (0.61; 1.69)	0.76 (0.46; 1.27)

PR = Prevalence ratio; 95%CI: 95% confidence intervals. Bolded values are statistically significant. *Adjusted for sex, age, education level, and socioeconomic status.

When using the ATP III definition, central obesity was associated with greater prevalence of urinary leakage in adjusted model (PR=1.47; 95%CI: 1.10–1.97, Table 3).

Association between central obesity and the autonomic symptoms scale

When using ATP III, but not IDF definition, a significant association between central obesity and severity of symptoms was observed in the crude model (Table 4). However, in multivariable model, no significant association was found between any definition of central obesity and the SAS total score.

Table 3. Association between central obesity according to the ATP III definition and the presence of autonomic dysfunction symptoms

Autonomic dysfunction symptoms	% of autonomic symptoms		Crude model PR (95%CI)	Adjusted model* PR (95%CI)
	No obesity N = 876	Obesity N = 733		
Dizziness	24.4 %	37.1 %	**1.52 (1.31; 1.76)**	1.12 (0.95; 1.32)
Dry mouth and eyes	24.5 %	28.8 %	**1.17 (1.00; 1.38)**	0.91 (0.75; 1.09)
Pale skin	4.0 %	6.4 %	**1.60 (1.05; 2.46)**	1.02 (0.63; 1.65)
Feet colder than the rest of the body	10.6 %	18.8 %	**1.77 (1.39; 2.26)**	1.06 (0.81; 1.38)
Reduce sweating in feet	1.8 %	2.1 %	1.12 (0.56; 2.25)	0.62 (0.29; 1.32)
Reduce sweating in the body	1.1 %	1.6 %	1.43 (0.62; 3.30)	0.64 (0.25; 1.64)
Increase sweating in hands	5.3 %	5.7 %	1.09 (0.73; 1.64)	0.95 (0.59; 1.51)
Nausea, vomiting or abdominal after a small meal	6.4 %	11.5 %	**1.79 (1.30; 2.48)**	1.12 (0.80; 1.56)
Persistent diarrhea	6.6 %	10.5 %	**1.59 (1.14; 2.20)**	1.21 (0.84; 1.73)
Persistent constipation	18.8 %	25.5 %	**1.35 (1.13; 1.63)**	0.80 (0.66; 0.97)
Urinary leakage	7.3 %	21.6 %	**2.95 (2.24; 3.88)**	**1.47 (1.10; 1.97)**
Difficulty achieving an erection (only in males)	7.2 %	10.0 %	1.40 (0.82; 2.38)	1.13 (0.67; 1.89)

PR = Prevalence ratio; 95%CI: 95% confidence intervals. Bolded values are statistically significant. *Adjusted for sex, age, education level, and socioeconomic status.

Table 4. Association between central obesity and total scale score and severity

	Crude model Coefficient (95%CI)	Adjusted model* Coefficient (95%CI)
SAS: total score		
Central obesity (IDF)	0.51 (0.34; 0.68)	0.12 (-0.05; 0.29)
Central obesity (ATP III)	0.56 (0.40; 0.72)	0.04 (-0.13; 0.22)
SAS: severity		
Central obesity (IDF)	1.49 (0.93; 2.04)	0.15 (-0.40; 0.69)
Central obesity (ATP III)	**1.85 (1.32; 2.40)**	0.12 (-0.45; 0.69)

SAS = Survey of autonomic symptoms. Bolded values are statistically significant. *Adjusted for sex, age, education level, and socioeconomic status.

DISCUSSION

According to our results, in multivariable model adjusting for age, sex, education level, and socioeconomic status, an association between central obesity, using two different definitions, and autonomic dysfunction, particularly urinary leakage, has been observed. Additionally, the most common autonomic dysfunction symptoms were dizziness, dry mouth and eyes, and persistent constipation. Finally, based on the IDF definition, nearly 80% of the population exhibited abdominal obesity, whereas the ATP III criteria identified central obesity in about 50% of participants.

Abdominal obesity, by the ATP III and IDF criteria, is associated with urinary leakage, as previously documented. Two different systematic reviews have reported results regarding the association between obesity and urinary symptoms. In the first one[13], 16 reports were meta-analyzed to show that obesity was associated with urgent urinary incontinence but not with stress urinary incontinence among middle-aged and older women. In the second one[12], 11 manuscripts were included in the review, and found association between obesity and enuresis, daytime urinary incontinence and overactive bladders among children and adolescents. In addition, a prospective study involving 840 women reported that general obesity (BMI ≥30 kg/m^2) was an independent risk factor for both overactive bladder and detrusor overactivity[20]. Furthermore, an analysis of data from 920 men and women enrolled in the Lower Urinary Tract Dysfunction Symptom Research Network Cohort Study[21] reported that greater abdominal circumference was positively correlated with an increased risk of urinary incontinence in both sexes, while overactive bladder was observed exclusively in women. Excess visceral adiposity may increase intra-abdominal pressure, imposing direct mechanical strain on the bladder, stretching the pelvic floor, or altering detrusor muscle function, contributing to pelvic organ prolapse, overactive bladder, or urethral hypermobility in women[20,21]. In men, obesity has been implicated in systemic hyperinsulinemia, which may promote prostatic hypertrophy, resulting in urinary discomfort[22].

Although the adjusted model did not reveal a significant association between central obesity and gastrointestinal symptoms, a correlation was observed in the crude model. In a cross-sectional study of 3,866 Saudi participants, obesity was found to be associated with symptoms such as heartburn, nausea, and diarrhea[23], explained by impaired gastric motility, delayed gastric emptying, and increased gastric volume, which have been implicated in the pathogenesis of functional dyspepsia[24]. Furthermore, obesity has been associated with bile acid malabsorption, accelerated intestinal transit, and gut microbiota dysbiosis[25], which may contribute to diarrhea. However, impaired gastric motility has also been suggested as a potential mechanism underlying obesity-related constipation[25].

Whereas we found no significant association between central obesity and sudomotor system symptoms, prior research has documented sudomotor dysfunction in individuals with obesity, particularly reduced sweat production[26]. Although the present research did not consider cardiovascular symptoms, literature has reported that association[27]. Thus, a study enrolling 1,409 subjects reported an inverse association between waist-to-hip ratio, an obesity marker, and heart rate variability, suggesting autonomic dysregulation of cardiac function[28].

Obesity initially affects blood pressure and heart rate regulation, leading to symptoms such as orthostatic hypotension, postural tachycardia, and exercise intolerance. Over time, these cardiovascular disturbances may extend to involve additional systems[29]. The hyper-insulinemic state associated with obesity activates proinflammatory pathways, promoting reactive oxygen species and inflammatory mediators. These mechanisms result in neuronal damage within the autonomic nervous system, initially impacting the parasympathetic branch and later extending to the sympathetic branch[15,21]. Besides, the adipose tissue distribution in central obesity results in an increase in intra-abdominal pressure, which contributes to a rise in bladder pressure through mechanical forces[21].

The current study also revealed a significant variation in the prevalence of central obesity based on the definition applied, highlighting the importance of establishing appropriate parameters and cut-off points specific to Peruvian population. This can have a huge impact on the clinical management of obesity in our context. In Peru, several obesity intervention strategies have been implemented[30], but the efficacy of such protocols have not been completely evaluated. Moreover, unlike other international guidelines, these strategies do not encompass the detection and management of obesity-related complications and comorbidities. A pertinent example is the Spanish Guidelines for the Integrated and Multidisciplinary Management of Obesity in Adults (GIRO, for its Spanish acronym), which underscore the critical need for early intervention in individuals with central obesity to prevent cardiovascular and metabolic complications[31].

This study has certain limitations. As a cross-sectional study, only association and not causality can be established. Moreover, reverse causality can be present as some symptoms may predispose to obesity. Then, the reliance on questionnaires rather than diagnostic tools for autonomic dysfunction may lead to an underestimation of the presence of dysautonomia. Thus,

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an under-estimation of the prevalence of autonomic symptoms, due to misclassification, may be present. Furthermore, the questionnaire does not assess cardiovascular abnormalities, which represent the most common form of neuropathy associated with obesity. Similarly, obesity was evaluated using a traditional anthropometric measure (i.e., waist circumference), which remain widely applied but are less precise than more modern approaches such as body fat percentage, bio-impedance analysis, dual-energy X-ray absorptiometry (DEXA), etc. These latter methods could provide greater accuracy and should be considered in future research. Representativeness can be also a concern as more than 20% of eligible individuals rejected participation. Finally, only some confounders were used in the multivariable model as many of the other potential confounders are in the causal pathway of obesity.

The study, however, benefits from the use of a representative sample from a semi-urban region, allowing the extrapolation of findings to similar populations. The application of two definitions of central obesity provides a broader perspective on excess weight, enabling a comprehensive understanding of its prevalence and its association with autonomic dysfunction.

CONCLUSIONS

Consistent with literature, our study confirms the association between central obesity, using two different definition and urinary leakage. These results emphasize the need for research using more advanced and precise diagnostic techniques for dysautonomia. From the clinical perspective, there is a need to implement strategies to prevent central obesity.

AUTHORS' CONTRIBUTIONS

All authors participated in the writing and approved the final version of this manuscript.

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CONFLICTS OF INTEREST

The authors state that there are no conflicts of interest when writing the manuscript.

DATA AVAILABILITY

Data from this study are available upon request from the corresponding author.

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