Is Waist-Circumference Related to Anxiety Levels in Peri and Postmenopausal Women?

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RESUMEN

Introducción: la depresión, la ansiedad, y el estado menopáusico parecen desempeñar un papel importante en la etiología de la obesidad, el sobrepeso y el aumento del perímetro de la cintura; variables que son importantes predictores del riesgo cardiometabólico. Dada esta asociación, nuestro objetivo es evaluar la relación entre el perímetro de cintura y los puntajes de ansiedad en un grupo de mujeres peri y posmenopáusicas. **Método:** evaluamos a 329 participantes con una edad media de 52.4 años; 20.06% perimenopáusicas y 79.9% posmenopáusicas. Realizamos una evaluación tanto del estado reproductivo, con la clasificación del Taller de Etapas del Envejecimiento Reproductivo, como de la ansiedad, con el Inventario de Ansiedad Estado-Rasgo y medidas antropométricas. El análisis estadístico involucró análisis descriptivos usando chi-cuadrada y t-test. Las correlaciones bivariadas exploraron variables relacionadas con el perímetro de cintura, y finalmente un modelo logístico examinó la asociación entre el perímetro de la cintura y la ansiedad. **Resultados:** observamos una correlación significativa entre el perímetro de cintura y la ansiedad de estado y ansiedad de rasgo. No observamos una correlación entre la ansiedad y el estado menopáusico, la terapia de reemplazo hormonal y la edad. Por cada punto de aumento en la puntuación de ansiedad de estado en la evaluación STAI, el riesgo de tener una cintura > 88 cm aumentó en un 4%. **Discusión y Conclusiones:** los hallazgos sugieren que niveles altos de ansiedad durante la transición menopáusica están relacionados con un mayor perímetro de cintura. Estudios prospectivos con una muestra más grande podrían aclarar la naturaleza de esta asociación.

Palabras clave: ansiedad, menopausia, obesidad, perimenopausia.

ABSTRACT

Introduction: depression, anxiety, and the menopausal status seem to play an important role on the etiology of obesity, overweight and increased waist circumference; variables which could be important predictors of cardiometabolic risk. Given this association, it is our aim to evaluate the relationship between waist circumference and anxiety scores in a group of peri and postmenopausal women. **Method:** we evaluated 329 participants with a mean age of 52.4 years; 20.06% perimenopausal and 79.9% postmenopausal. We performed an evaluation of both reproductive status, using the classification of the Stages of Reproductive Aging Workshop, and anxiety, using the State and Trait Anxiety Inventory as well as anthropometric measures. Statistical analysis involved descriptive analysis using chi-square and t-test. Bivariate correlations explored variables related to waist circumference; and finally, a logistic model examined the association between waist circumference and anxiety. **Results:** we observed a significant correlation between waist circumference and state anxiety and trait anxiety. We did not observe a correlation between anxiety and menopausal status, hormone replacement therapy and age. For every one-point increase in the anxiety-state score in the STAI evaluation, the risk of having a waist > 88 cm, increased by 4%. **Discussion and Conclusions:** findings suggest that high levels of anxiety during menopausal transition are related to a greater circumference of the waist. Prospective studies with a larger sample could clarify the nature of this association.

Keywords: anxiety, menopause, obesity, perimenopause.

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INTRODUCTION

Obesity is a public health problem, with its prevalence on the rise in recent years (Mohn, 2015). According to the World Health Organization (WHO), in 2022 more than 2.5 billion adults were classified as overweight, and among them, over 890 million were identified as obese (WHO, 2024). Apart from the health implications and heightened mortality associated with obesity (Flegal et al., 2013), waist circumference has emerged as a predictor of cardiometabolic outcomes independently of body mass index (BMI; Browning et al., 2010; Liu et al., 2014). To determine metabolic syndromes in postmenopausal women in Latin America, the optimal waist circumference cut-off is identified as 88 cm (Blümel et al., 2012). Also, the risk for cardiometabolic outcomes in women increases during postmenopausal age (Marlatt et al., 2022), hence the assessment of anthropometric measures becomes crucial in this group. Some of the factors that have been linked to obesity in postmenopausal women are sedentary lifestyle, psychiatric symptoms (depression and anxiety), medical conditions (diabetes and arterial hypertension), socio-demographic aspects (such as having a stable partner, or many individuals residing in a household), reproductive variables (including contraceptive use) and vasomotor symptoms (Blümel et al., 2015), as well hormonal changes during the transition to menopause, all of these contribute significantly to weight gain (Greendale et al., 2019).

Regarding psychiatric disorders, there is an observed connection between obesity and a lifetime diagnosis of anxiety and depression (Avila et al., 2015). Nevertheless, evidence suggests that the association between anxiety disorders and obesity is stronger than that between mood disorders and obesity (Scott et al., 2008). This correlation may be influenced by unhealthy behaviors such as smoking, physical inactivity, binge drinking and heavy drinking (Strine et al., 2008).

A meta-analysis that included 16 studies, most of them with a cross-sectional design, provides evidence for the link between obesity and anxiety disorders in both women and men (Gariepy et al., 2010), however, the results are insufficient to establish a clear causal relationship between these two variables and discrepancies arise when different anthropometric measure assessments are conducted. For instance, in a group of patients diagnosed with metabolic syndrome, no correlation was found between waist circumference and anxiety and depressive disorders, but a correlation was observed with the body fat percentage (Guedes et al., 2013).

In patients with type 2 diabetes, depression has been associated with abdominal obesity and cardiovascular disease, but anxiety has not shown any similar associations (Labad et al., 2010). Sex differences have also been noted, with waist-hip ratio demonstrating an independent association with anxiety among males (Rivenes et al., 2009), while depression was associated with both males and females.

In summary, the etiology of obesity involves the intricate interplay of multiple factors, with anxiety and reproductive variables, such as menopausal status, playing a significant role in its occurrence. Moreover, beyond overall body weight, waist circumference alone could serve as a substantial risk factor to cardiovascular disease. In light of these considerations, our objective is to evaluate the relationship between waist circumference and anxiety scores in a group of peri and postmenopausal women. Additionally, we are interested in exploring the relevance of waist-hip ratio in the assessment of this group of women.

METHOD

Participants

Patients attending a women's specialized hospital from 2016-2018 were invited to participate in the present study. All of them were between 40 and 65 years old, either in the perimenopause or postmenopause stage according to the classification of the Stages of Reproductive Aging Workshop (STRAW) criteria (stages -2 to +2). All of them had both ovaries, but not all had an intact uterus. Exclusion criteria included patients already enrolled in a structured weight-loss program, patients with chronic or uncontrolled medical illness, substance abuse according to the DSM-IV criteria, consumption of drugs that reduce or increase weight, anxiolytics or antidepressants use as well as other drugs with sedative effects. All participants signed an informed consent approved by the institutional ethics committee.

The participants' assessment included a complete clinical evaluation, socio-demographic variables registration, anthropometric measurements and anxiety rating.

Sociodemographic Variables

A form was created to register the sociodemographic characteristics of the patients. Marital status was recorded as follows: single, married or living with a partner, separated or divorced, and widowed. Educational level was recorded in study years and after that grouped in three categories that correspond to

the educational system, that is elementary level (zero to six study years), middle and high school (seven to 12 study years), and graduate or postgraduate (equal or more than 13 study years). Socio-economic level was measured with a special questionnaire developed by the Mexican Association of Market Research and Public Opinion (AMAI, 2016). This questionnaire contains 10 items, rating seven socioeconomic levels: very low, low, middle-low, middle-middle, middle-high, high, and very high. We simplified the categories grouping the middle level together resulting in: very low, low, medium, and high.

Clinical Evaluation

A complete medical history was performed stressing the information about their menstrual cycles in order to classify them into perimenopause or postmenopause groups according to the STRAW criteria. Perimenopause was considered when the patient had persistent menstrual irregularities with variable cycle length (more than seven days different from normal) or more than 2 skipped cycles and/or an interval of amenorrhea ≥ 60 days within the past 12 months. Postmenopause was considered when no menstrual period or menstrual bleeding was present within the last 12 months and this was not due to a condition such as being pregnant, undergoing chemotherapy or some other treatment that could affect menstruation. Family and past medical history was also investigated. Information regarding the use of medication, specifically hormonal and psychiatric drugs, was registered. Hormone replacement therapy (HRT) was recorded by the gynecologist including dosage and formulation. Information about physical activity was collected through self-reports.

Anthropometric Measures

Body weight was assessed in all patients with a scale TANITA BWB 800 ®, with minimal clothing and barefoot, at a time between 8 and 11 a.m. Body size was evaluated with a stadiometer, barefoot and with heels, hip and shoulder blade attached to the vertical surface. The waist measurement was performed with level type applying it to the narrowest area of the abdomen and hip measurements were performed on the higher perimeter of the buttocks. Both measurements were made on a horizontal plane.

The BMI was determined using the formula: weight/height^2, and according to this measurement we classified the women into the following categories: underweight, normal weight, overweight, obese I, obese II, and obese III, according to WHO criteria. The waist-hip ratio was calculated by dividing the waist measurement by the hip measurement, and was used to classify patients according to the distribution of fat into gynecoid (< .79) and Android (≥ .8).

Anxiety Evaluation

All participants completed the State and Trait Anxiety Inventory (STAI; Spielberger et al., 1970). These are two distinct self-report instruments that assess the temporary condition of state anxiety (A-State) and the longstanding quality of trait anxiety (A-Trait) respectively. The State questionnaire comprises 20 items with response options based on a 4-point Likert scale, evaluating how individuals have felt in the past two weeks; it serves as an indicator of a transient state, encompassing feelings of tension, nervousness, unexplained fear, irritability or restlessness, along with sensations of racing or pounding heart. The Trait questionnaire also consists of 20 items on a Likert scale and inquires about how individuals typically feel. Trait anxiety reflects a relatively stable characteristic associated with a general increase in negative emotions. The Spanish version of the STAI was validated for its use in the Spanish-speaking population (Arias-Galicia, 1990).

Statistical Analysis

Statistical analysis was performed using the program R version 3.2.2. Descriptive analysis were performed, using chi-square and t test. Waist circumference was compared according to menopausal status (perimenopausal vs postmenopausal) and the use of HRT (yes or no) using the t test. Bivariate correlations were assessed in order to explore variables related to waist circumference.

A dichotomous variable was constructed called "largewaist" where "0" corresponds to women with a waist circumference equal or lower than 88 centimeters, and "1" to women with a waist circumference greater than 88 centimeters. We adjusted a logistic model:

$$\log\left(\frac{p}{1-p}\right) = b_0 + b_1 * \text{A} - \text{State} + b_2 * \text{Weight} + b_3 * \text{Height}$$

Where:
p = is the Bernoulli distribution parameter of the "largewaist" variable.
A-State = total score of state anxiety subscale of the STAI.

We used the stepwise method to build the model in both directions: backward and forward. The Akaike information criterion (AIC) was used to the

model selection (Akaike, 1998). The Hosmer Lemenshow test was used to evaluate the goodness of fit of the model. Significance level was set at 0.01.

RESULTS

A total of 433 patients were invited to participate in the study. 61 refused to participate, therefore 372 patients were evaluated in a first interview; 15 were not included because they did not meet the inclusion criteria. Of the remaining patients, only 329 completed all the evaluations and were included in the final analysis. Mean age of the sample was 52.44 (*standard deviation* = 7.13) years; 20.06% of the participants were perimenopausal and 79.9% postmenopausal. The clinical and sociodemographic characteristics of the participants are shown in Table 1. It is worth noting that more than 90% of the participants reported physical activity for only one hour per week. Distribution of the sample according to HRT was similar between women using HRT and women who did not. Anthropometric measures and anxiety scores by menopausal status are shown in Table 2. Differences in anthropometric measures between perimenopausal and postmenopausal women were observed in weight (70.29

Table 1
Sociodemographic and clinical characteristics of patients, according to hormone therapy use

	Without hormone therapy		With hormone therapy				
	n =166	%	n = 163	%	x^2	*fd*	*p*
Age							
40-45 years	35	21.08	18	11.04	139.29	4	< .000*
46-50 years	70	42.16	11	6.74			
51-55 years	53	31.92	29	17.79			
56-60 years	7	4.21	64	39.26			
≥61 years	1	0.60	41	25.15			
Marital status							
Single	24	14.45	22	13.49	2.68	3	.443
Married or living with a partner	101	60.84	88	53.98			
Separated or divorced	34	20.48	42	25.76			
Widow	7	4.21	11	6.74			
Socioeconomic level							
Very low	27	16.26	29	17.79	0.67	3	.880
Low	57	34.33	50	30.67			
Medium	77	46.38	80	49.07			
High	5	3.01	4	2.45			
Education level							
0-6 years	67	40.36	60	36.80	1.31	2	.519
7-12 years	91	54.81	98	60.12			
≥13 years	8	4.81	5	3.06			
Physical activity							
0-1 hours per week	154	92.77	162	99.38	9.84	2	.007*
2-4 hours per week	7	4.21	0	0			
≥5 hours per week	5	3.01	1	0.61			
Menopausal status							
Perimenopause	46	27.71	20	12.26	12.22	1	< .000*
Postmenopause	120	72.28	143	87.73			

Table 2
Anthropometric measures and anxiety scores by menopausal status

	Perimenopause	Postmenopause			
Anthropometric measures	mean (sd)	mean (sd)	*t*	*fd*	*p*
Weight	70.29 (13.24)	66.79 (11.48)	2.12	325	.035*
BMI	29.22 (5.50)	28.59 (4.60)	.93	325	.352
Waist	87.24 (9.84)	86.27 (9.13)	.74	325	.455
Hip	106.81 (10.99)	104.59 (9.46)	1.63	325	.104
WHR	.81 (0.10)	.83 (0.04)	-2.06	325	.040*
STAI scores					
A-State	25.59 (9.50)	23.98 (11.10)	1.18	113.87	.238
A-Trait	21.06 (10.23)	19.74 (12.11)	.90	115.22	.370
PSS	21.52 (9.76)	20.21 (9.45)	.99	327	.321

Notes: BMI = body mass index; WHR = waist to hip ratio; A-State = state anxiety scores; A-Trait = trait anxiety scores; PSS = perceived stress scale; *fd* = degrees of freedom.

vs 66.79 kg; $T = 2.12$, $fd = 325$, $p = .035$) and waist-hip (0.81 vs 0.83; $t = -2.06$, $fd = 325$, $p = .04$). No differences were observed regarding waist circumference, body mass index and hip measures (Tables 1 y and 2).

Hormonal use differences were observed only in body weight, heavier women without hormone therapy (68.82 vs 66.08 kg; $t = 2.08$, $fd = 325$, $p = .03$). There were no differences in waist circumference measurements between women using and not using HRT ($t = 0.05$, $fd = 325$, $p = .95$). No significant correlation of waist circumference was observed with menopausal status, HRT, and age (Table 3).

Variables that correlated significantly with waist circumference were state anxiety (Pearson correlation = .195, $p < .001$) and trait anxiety (Pearson correlation = .184, $p = .001$).

Regarding the logistic regression analysis, we performed different models including all of the variables that could influence the waist circumference. The initial proposed model included the weight, height, state-anxiety, trait-anxiety, hormone therapy and menopausal status variables. We did not include physical activity because the proportion of women who exercised two or more hours was too small. We used the stepwise method in both directions for the construction of the model. We observed that four variables were significant for waist circumference: weight, height, state-anxiety and hormone therapy. Due to the diverse hormone therapy formulations used by our patients, we decided to eliminate this variable from the final model presented in Table 4. When we compared the model including the hormonal therapy variable and the model without it, we observed no significant differences, therefore, state-anxiety explained the waist circumference in either presence or absence of hormonal therapy. Additionally, hormonal therapy seems not to impact the waist circumference, but it is related to anxiety (Table 4).

We used the Akaike Information Criterion in order to choose the most appropriate model, since it considers both how well a model fits the data and the number of parameters used It provides a balance

Table 3
Predictors of waist-circumference

	Estimate	Std. error	z value	Pr (>|z|)
Intercept	2.30383	3.89372	.592	.55407
A-State	.04154	.01603	2.592	.00954**
Weight	.21076	.02474	8.518	< 2e-16***
Height	-11.99935	2.92076	-4.108	3.99e-05***

Notes: 0 '***' .001 '**' .01 '*' .05 '.' .1 ' ' 1
Independent variable: "largewaist".

Table 4
Correlation between numerical variables

		Age	Weight	BMI	Waist	WHR	A-State	A-Trait	PSS
Age	*r*	1	-.120*	-.026	-.024	.034	-.177**	-.059	-.113*
	p		.030	.641	.666	.538	.001	.285	.041
Weight	*r*		1	.874**	.797**	-.108	.086	.051	.001
	p			< .000	< .000	.051	.121	.355	.989
BMI	*r*			1	.833**	-.040	.125*	.054	-.016
	p				< .000	.476	.024	.329	.780
Waist	*r*				1	.303**	.195**	.148**	.003
	p					< .000	< .000	.008	.957
WHR	*r*					1	.055	.181**	-.053
	p						.325	.001	.346
A-State	*r*						1	.496**	.453**
	p							< .000	< .000
A-Trait	*r*							1	.423**
	p								< .000
PSS	*r*								1
	p								

Notes: * = correlation is significant at the 0.05 level (2-tailed); ** = correlation is significant at the 0.01 level (2-tailed); BMI = body mass index; WHR = waist to hip ratio; A-State = state anxiety scores; A-Trait = trait anxiety scores; PSS = perceived stress scale; p = p value; r = Pearson correlation coefficient.

between goodness of fit and simplicity. The best fitted model included the variables A-State, weight and height; in this model, the three coefficients of the variables were statistically significant. We observed that for every one-point increase in the A-state score, the risk of having a waist > 88 cm increased by 4% (Table 5).

Table 5
Correlation between "largewaist", hormone therapy and sociodemographic variables

		Largewai st	Socioeconomic level	Marital status	Education level	Menopausal status	Hormone therapy
Largewaist	*rho*	1	-.037	.038	-.024	-.059	.070
	p		.509	.490	.666	.284	.203
Socioeconomic level	*rho*		1	-.207**	-.014	.035	.006
	p			< .000	.797	.528	.909
Marital status	*rho*			1	-.024	.050	.064
	p				.660	.369	.247
Education level	*rho*				1	.009	.023
	p					.868	.674
Menopausal status	*rho*					1	.193**
	p						< .000
Hormone therapy	*rho*						1
	p						

Notes: * correlation is significant at the .05 level (2-tailed); ** correlation is significant at the .01 level (2-tailed); *rho* = Spearman rank-order correlation; *p* = *P* value.

DISCUSSION AND CONCLUSIONS

While obesity is a multifactorial public health problem, most of the involved factors, such as diet, physical activity and psychiatric symptoms, are modifiable. The menopause transition has been linked to weight gain and body fat distribution changes. It has been observed that in women moving toward menopause, a sedentary lifestyle increases the severity of menopausal, depressive and anxiety symptoms, as well as insomnia (Santoro, 2021). In the present study we observed a great proportion of sedentary women, only 1.8% of the evaluated women had physical activities for 5 or more hours per week, and almost all reported to do physical exercise between 0 to 1 hours per week. However, the proportion of sedentary women among perimenopausal and postmenopausal women was similar in the evaluated participants, indicating that differences in anthropometric measures between groups were not derived from sedentary life-style.

When we compared the anthropometric measures according to menopausal status, perimenopausal women had a significantly greater body weight, but a smaller waist-hip ratio compared to postmenopausal women. According to this, we may assume that menopausal status may modify the body composition, probably mediated by an estrogen deficiency that leads to increased abdominal fat accumulation. (Clegg, 2012; Ko & Kim, 2020; Shea et al., 2015). This conjecture, however, continues to be controversial and must be clarified with new clinical studies (Van Pelt et al., 2015).

Moreover, it seems that the waist circumference increase in women is not correlated with BMI as it is observed in men--that is to say, there is an independent increase in waist circumference (Freedman & Ford, 2015). The observation above becomes important when we consider the relationship observed between waist circumference, cardiovascular risk (Kannel et al., 1991) and metabolic syndrome (Nicklas et al., 2003). Additionally, trait anxiety has been associated with biomarkers for hypertension, and thus linked with an increase in cardiovascular risk (Lemche et al., 2016). It is important to mention that trait anxiety reflects a characteristic that an individual carries throughout their life, which may have different implications compared to state anxiety, which only reflects what occurs at the moment of assessment.

Furthermore, psychiatric disorders, particularly anxiety and depression, could influence the body weight and waist circumference in women. Depressive symptoms have been related to increased waist circumference and BMI in women between 18 and 75 years (Moreira et al., 2007); similar results have been observed in postmenopausal women (Katz et al., 2000). Not all authors agree with this observation: in a large sample of 10,026 women, BMI and waist circumference were not related to depression in neither men nor women ("Turley et al., 2006). Another study in the aging Chinese population also failed to demonstrate an association between depressive scores and anthropometric measures (Ho et al., 2008). The severity of the anxiety or depressive symptoms, more than the disorder diagnosis itself, have also been associated with abdominal obesity, as observed in some studies (Fulton et al., 2022; Hiles et al., 2016).

We observed in our sample that anxiety was related to waist circumference, therefore increasing the risk for a waist circumference higher than 88 centimeters, which is the suggested waist measurement for cardiovascular risk. Anxiety was not correlated to body weight or any other anthropometric variable. A plausible explanation of this finding includes the metabolic changes that have been related to depression, such as hypercortisolemia, insulin and leptin resistance, and metabolic inflammatory signals (Milaneschi et al., 2019); it was also observed that people suffering from stress are more prone to consume palatable foods (Dallman, 2010; Epel et al., 2004). Anxiety by itself explains the perimenopausal distress experienced by women, since the anxiety sensitivity is more important than the trait anxiety in women older than 40 years (Muslić & Jokić-Begić, 2016).

Hormone therapy has been related to both increased weight and cardiovascular risk. We found an association between waist circumference and hormonal use; although this effect appears to be dependent on the chemical compound used in the hormonal therapy, our sample, however, included diverse formulations for patients. In general, different studies agree with the fact that hormonal replacement therapy did not increase the body weight in perimenopausal and postmenopausal women (Junge et al., 2009; Khoo et al., 1998; Opoku et al., 2023). Our results suggest that the evaluation of anthropometric measures is essential in women transitioning to menopause who will use hormonal therapy, considering their associated risks. Oral estrogen administration has been associated with an increased risk of venous thromboembolism as well as norpregnane derivatives (Lobo, 2011). Additionally, estrogen plus progestin increase the risk of an ischemic stroke (Wassertheil-Smoller et al., 2003). Even though it is

still controversial, some kinds of cancer have also been related to specific formulations of hormonal compounds, such as some types of breast cancer (Li et al., 2008), ovarian cancer (Liu et al., 2019) and endometrial cancer (Sjögren et al., 2016).

Limitations of the present study include the lack of assessment of vasomotor symptoms. Some authors have proposed that the BMI is associated with the presence of vasomotor symptoms, particularly hot flashes (Freeman et al., 2005; Gold et al., 2006). Additionally, vasomotor symptoms seem to be a factor that increases the risk of suffering anxiety and depressive symptoms during the menopausal transition (Cohen et al., 2006). Furthermore, we did not differentiate between women in the early postmenopause and late postmenopause; waist circumference and as anxiety levels may differ between these groups. Lastly, the hormone therapy formulations in our sample were diverse and we only grouped in using or not using hormone compounds. In sum, prospective studies with a large sample to evaluate the relationship between waist-circumference and anxiety are needed in order to make this relationship clearer; it could be important to be alert about cardiovascular risk in women at this stage of life.

In conclusion, our findings suggest that high levels of anxiety during menopausal transition are related to a greater waist circumference. Prospective studies with a larger sample could clarify the nature this association, which in turn becomes important due to its implications on cardiovascular risk.

ETHICAL CONSIDERATIONS

The study was approved by the Ethics Committee of the National Institute of Perinatology.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHOR CONTRIBUTIONS

Mónica Flores-Ramos and Roberto Silvestri-Tomassoni designed the study, the main conceptual ideas and proof outline. Rodrigo Guiza-Zayas and Martín Armando Burrola-Suárez performed the measurements and field work. Leticia Gracia-Medrano performed the calculations, statistical and analytic calculations. Mónica Flores-Ramos and Roberto Silvestri-Tomassoni contributed to the interpretation of the results. All the authors read, analyzed and approved the final manuscript.

REFERENCES

Akaike, H. (1998). Information Theory and an Extension of the Maximum Likelihood Principle. In E. Parzen, K. Tanabe, & G. Kitagawa (Eds.). *Selected Papers of Hirotugu Akaike* (pp. 199-213). New York, NY: Springer Series in Statistics. https://doi.org/10.1007/978-1-4612-1694-0_15

Arias-Galicia, L. F. (1990). Investigaciones sobre el IDARE en cuatro países latinoamericanos: Argentina, Ecuador, México y Perú. *Revista Intercontinental de Psicología y Educación*, *3*(1-2), 49-85.

Asociación Mexicana de Agencias de Inteligencia de Mercado y Opinión, A.C. [AMAI]. (2016). *Niveles socioeconómicos 2016*. Retrieved from https://www.amai.org/NSE/index.php?queVeo=2016

Avila, C., Holloway, A. C., Hahn, M. K., Morrison, K. M., Restivo, M., Anglin, R., & Taylor, V. H. (2015). An Overview of Links Between Obesity and Mental Health. *Current Obesity Reports*, *4*(3), 303-310. https://doi.org/10.1007/s13679-015-0164-9

Blümel, J. E., Chedraui, P., Aedo, S., Fica, J., Mezones-Holguín, E., Barón, G., Bencosme, A., Benítez, Z., Bravo, L. M., Calle, A., Flores, D., Espinoza, M. T., Gómez, G., Hernández-Bueno, J. A., Laribezcoa, F., Martino, M., Lima, S., Monterrosa, A., Mostajo, D., ... Zúñiga, M. C. (2015). Obesity and its relation to depressive symptoms and sedentary lifestyle in middle-aged women. *Maturitas*, *80*(1), 100-105. https://doi.org/10.1016/j.maturitas.2014.10.007

Blümel, J. E., Legorreta, D., Chedraui, P., Ayala, F., Bencosme, A., Danckers, L., Lange, D., Espinoza, M. T., Gomez, G., Grandia, E., Izaguirre, H., Manriquez, V., Martino, M., Navarro, D., Ojeda, E., Onatra, W., Pozzo, E., Prada, M., Royer, M., ... Zuñiga, C. (2012). Optimal waist circumference cutoff value for defining the metabolic syndrome in postmenopausal Latin American women. *Menopause*, *19*(4), 433-437. https://doi.org/10.1097/gme.0b013e318231fc79

Browning, L. M., Hsieh, S. D., & Ashwell, M. (2010). A systematic review of waist-to-height ratio as a screening tool for the prediction of cardiovascular disease and diabetes: 0·5 could be a suitable global boundary value. *Nutrition Research Reviews*, *23*(2), 247-269. https://doi.org/10.1017/S0954422410000144

Clegg, D. J. (2012). Minireview: The Year in Review of Estrogen Regulation of Metabolism. *Molecular Endocrinology*, *26*(12), 1957-1960. https://doi.org/10.1210/me.2012-1284

Cohen, L. S., Soares, C. N., Vitonis, A. F., Otto, M. W., & Harlow, B. L. (2006). Risk for New Onset of Depression During the Menopausal Transition: The Harvard Study of Moods and Cycles. *Archives of General Psychiatry*, *63*(4), 385-390. https://doi.org/10.1001/archpsyc.63.4.385

Dallman, M. F. (2010). Stress-induced obesity and the emotional nervous system. *Trends in Endocrinology and Metabolism*, *21*(3), 159-165. https://doi.org/10.1016/j.tem.2009.10.004

Epel, E., Jimenez, S., Brownell, K., Stroud, L., Stoney, C., & Niaura, R. (2004). Are Stress Eaters at Risk for the Metabolic Syndrome? *Annals of the New York Academy of Sciences*, *1032*(1), 208-210. https://doi.org/10.1196/annals.1314.022

Flegal, K. M., Kit, B. K., Orpana, H., & Graubard, B. I. (2013). Association of All-Cause Mortality with Overweight and Obesity Using Standard Body Mass Index Categories: A Systematic Review and Meta-analysis. *JAMA*, *309*(1), 71-82. https://doi.org/10.1001/jama.2012.113905

Freedman, D. S., & Ford, E. S. (2015). Are the recent secular increases in the waist circumference of adults independent of changes in BMI? *The American Journal of Clinical Nutrition*, *101*(3), 425-431. https://doi.org/10.3945/ajcn.114.094672

Freeman, E. W., Sammel, M. D., Lin, H., Gracia, C. R., Kapoor, S., & Ferdousi, T. (2005). The role of anxiety and hormonal changes in menopausal hot flashes. *Menopause*, *12*(3), 258-266. https://doi.org/10.1097/01.gme.0000142440.49698.b7

Fulton, S., Décarie-Spain, L., Fioramonti, X., Guiard, B., & Nakajima, S. (2022). The menace of obesity to depression and anxiety prevalence. *Trends in Endocrinology and Metabolism*, *33*(1), 18-35. https://doi.org/10.1016/j.tem.2021.10.005

Gariepy, G., Nitka, D., & Schmitz, N. (2010). The association between obesity and anxiety disorders in the population: a systematic review and meta-analysis. *International Journal of Obesity*, *34*(3), 407-419. https://doi.org/10.1038/ijo.2009.252

Gold, E. B., Colvin, A., Avis, N., Bromberger, J., Greendale, G. A., Powell, L., Sternfeld, B., & Matthews, K. (2006). Longitudinal Analysis of the Association between Vasomotor Symptoms and Race/Ethnicity across the Menopausal Transition: Study of Women's Health across the Nation. *American Journal of Public Health*, *96*(7), 1226-1235. https://doi.org/10.2105/AJPH.2005.066936

Greendale, G. A., Sternfeld, B., Huang, M., Han, W., Karvonen-Gutierrez, C., Ruppert, K., Cauley, J. A., Finkelstein, J. S., Jiang, S.-F., & Karlamangla, A. S. (2019). Changes in body composition and weight during the menopause transition. *JCI Insight*, *4*(5), e124865.https://doi.org/10.1172/jci.insight.124865

Guedes, E. P., Madeira, E., Mafort, T. T., Madeira, M., Moreira, R. O., Mendonça, L. M., Godoy-Matos, A. F., Lopes, A. J., & Farias, M. L. F. (2013). Body composition and depressive/anxiety symptoms in overweight and obese individuals with metabolic syndrome. *Diabetology & Metabolic Syndrome*, *5*(1). https://doi.org/10.1186/1758-5996-5-82

Hiles, S. A., Révész, D., Lamers, F., Giltay, E., & Penninx, B. W. J. H. (2016). Bidirectional Prospective Associations of Metabolic Syndrome Components with Depression, Anxiety, and Antidepressant Use. *Depression and Anxiety*, *33*(8), 754-764. https://doi.org/10.1002/da.22512

Ho, R. C. M., Niti, M., Kua, E. H., & Ng, T.-P. (2008). Body mass index, waist circumference, waist-hip ratio and depressive symptoms in Chinese elderly: a population-based study. *International Journal of Geriatric Psychiatry*, *23*(4), 401-408. https://doi.org/10.1002/gps.1893

Junge, W., El-Samalouti, V., Gerlinger, C., & Schaefers, M. (2009). Effects of menopausal hormone therapy on hemostatic parameters, blood pressure, and body weight: Open-label comparison of randomized treatment with estradiol plus drospirenone versus estradiol plus norethisterone acetate. *European Journal of Obstetrics, Gynecology, and Reproductive Biology*, *147*(2), 195-200. https://doi.org/10.1016/j.ejogrb.2009.09.004

Kannel, W. B., Cupples, L. A., Ramaswami, R., Stokes, J., Kreger, B. E., & Higgins, M. (1991). Regional obesity and risk of cardiovascular disease; the Framingham Study. *Journal of Clinical Epidemiology*, *44*(2), 183-190. https://doi.org/10.1016/0895-4356 (91) 90265-b

Katz, J. R., Taylor, N. F., Goodrick, S., Perry, L., Yudkin, J. S., & Coppack, S. W. (2000). Central obesity, depression and the hypothalamo-pituitary-adrenal axis in men and postmenopausal women. *International Journal of Obesity*, *24*(2), 246-251. https://doi.org/10.1038/sj.ijo.0801122

Khoo, S. K., Coglan, M. J., Wright, G. R., DeVoss, K. N., & Battistutta, D. (1998). Hormone therapy in women in the menopause transition. Randomised, double-blind, placebo-controlled trial of effects on body weight, blood pressure, lipoprotein levels, antithrombin III activity, and the endometrium. *The Medical Journal of Australia*, *168*(5), 216-220. https://www.ncbi.nlm.nih.gov/pubmed/9539899

Ko, S.-H., & Kim, H.-S. (2020). Menopause-Associated Lipid Metabolic Disorders and Foods Beneficial for Postmenopausal Women. *Nutrients*, *12*(1), 202. https://doi.org/10.3390/nu12010202

Labad, J., Price, J. F., Strachan, M. W. J., Fowkes, F. G. R., Ding, J., Deary, I. J., Lee, A. J., Frier, B. M., Seckl, J. R., Walker, B. R., & Reynolds, R. M. (2010). Symptoms of depression but not anxiety are associated with central obesity and cardiovascular disease in people with type 2 diabetes: the Edinburgh Type 2 Diabetes Study. *Diabetologia*, *53*(3), 467-471. https://doi.org/10.1007/s00125-009-1628-9

Lemche, A. V., Chaban, O. S., & Lemche, E. (2016). Trait anxiety but not state anxiety level associates with biomarkers for hypertension in the metabolic syndrome. *Psychophysiology*, *53*(6), 914-920. https://doi.org/10.1111/psyp.12623

Li, C. I., Malone, K. E., Porter, P. L., Lawton, T. J., Voigt, L. F., Cushing-Haugen, K. L., Lin, M. G., Yuan, X., & Daling, J. R. (2008). Relationship between Menopausal Hormone Therapy and Risk of Ductal, Lobular, and Ductal-Lobular Breast Carcinomas. *Cancer Epidemiology, Biomarkers & Prevention*, *17*(1), 43-50. https://doi.org/10.1158/1055-9965.EPI-07-0558

Liu, P., Ma, F., Lou, H., & Zhu, Y. (2014). Utility of obesity indices in screening Chinese postmenopausal women for metabolic syndrome. *Menopause*, *21*(5), 509-514. https://doi.org/10.1097/GME.0b013e3182a170be

Liu, Y., Ma, L., Yang, X., Bie, J., Li, D., Sun, C., Zhang, J., Meng, Y., & Lin, J. (2019). Menopausal Hormone Replacement Therapy and the Risk of Ovarian Cancer: A Meta-Analysis. *Frontiers in Endocrinology*, *10*. https://doi.org/10.3389/fendo.2019.00801

Lobo, R. A. (2011). Risk of venous thromboembolism by route of administration of estrogen. *Menopause*, *18*(5), 469-470. https://doi.org/10.1097/gme.0b013e318211745b

Marlatt, K. L., Pitynski-Miller, D. R., Gavin, K. M., Moreau, K. L., Melanson, E. L., Santoro, N., & Kohrt, W. M. (2022). Body composition and cardiometabolic health across the menopause transition. *Obesity*, *30*(1), 14-27. https://doi.org/10.1002/oby.23289

Milaneschi, Y., Simmons, W. K., van Rossum, E. F. C., & Penninx, B. W. (2019). Depression and obesity: evidence of shared biological mechanisms. *Molecular Psychiatry*, *24*(1), 18-33. https://doi.org/10.1038/s41380-018-0017-5

Mohn, E. S. (2015). Obesity: Prevention and Treatment. Obesity: Epidemiology, Pathophysiology, and Prevention. Second Edition. *American Journal of Epidemiology*, *181*(12), 1018-1019. https://doi.org/10.1093/aje/kwv088

Moreira, R. O., Marca, K. F., Appolinario, J. C., & Coutinho, W. F. (2007). Increased waist circumference is associated with an increased prevalence of mood disorders and depressive symptoms in obese women. *Eating and Weight Disorders*, *12*(1), 35-40. https://doi.org/10.1007/BF03327770

Muslić, L., & Jokić-Begić, N. (2016). The experience of perimenopausal distress: examining the role of anxiety and anxiety sensitivity.

Journal of Psychosomatic Obstetrics and Gynecology, *37*(1), 26-33. https://doi.org/10.3109/0167482X.2015.1127348

Nicklas, B. J., Penninx, B. W. J. H., Ryan, A. S., Berman, D. M., Lynch, N. A., & Dennis, K. E. (2003). Visceral Adipose Tissue Cutoffs Associated With Metabolic Risk Factors for Coronary Heart Disease in Women. *Diabetes Care*, *26*(5), 1413-1420. https://doi.org/10.2337/diacare.26.5.1413

Opoku, A. A., Abushama, M., & Konje, J. C. (2023). Obesity and menopause. Best Practice & Research. *Clinical Obstetrics & Gynaecology*, *88*, 102348. https://doi.org/10.1016/j.bpobgyn.2023.102348

Rivenes, A. C., Harvey, S. B., & Mykletun, A. (2009). The relationship between abdominal fat, obesity, and common mental disorders: Results from the HUNT Study. *Journal of Psychosomatic Research*, *66*(4), 269-275. https://doi.org/10.1016/j.jpsychores.2008.07.012

Santoro, N., Roeca, C., Peters, B.A., Neal-Perry, G. (2021). The Menopause transition: signs, symptoms and management options. *The Journal of Clinical Endocrinology and Metabolism*, *106*(1), 1-15. doi: 10.1210/clinem/dgaa764

Scott, K. M., McGee, M. A., Wells, J. E., & Oakley, M. A. (2008). Obesity and mental disorders in the adult general population. *Journal of Psychosomatic Research*, *64*(1), 97-105. https://doi.org/10.1016/j.jpsychores.2007.09.006

Shea, K. L., Gavin, K. M., Melanson, E. L., Gibbons, E., Stavros, A., Wolfe, P., Kittelson, J. M., Vondracek, S. F., Schwartz, R. S., Wierman, M. E., & Kohrt, W. M. (2015). Body composition and bone mineral density after ovarian hormone suppression with or without estradiol treatment. *Menopause*, *22*(10), 1045-1052. https://doi.org/10.1097/GME.0000000000000430

Sjögren, L. L., Mørch, L. S., & Løkkegaard, E. (2016). Hormone replacement therapy and the risk of endometrial cancer: A systematic review. *Maturitas*, *91*, 25-35. https://doi.org/10.1016/j.maturitas.2016.05.013

Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1970). *STAI manual for the State-Trait Anxiety Inventory ("self-evaluation questionnaire")*. Consulting Psychologists Press.

Strine, T. W., Mokdad, A. H., Dube, S. R., Balluz, L. S., Gonzalez, O., Berry, J. T., Manderscheid, R., & Kroenke, K. (2008). The association of depression and anxiety with obesity and unhealthy behaviors among community-dwelling US adults. *General Hospital Psychiatry*, *30*(2), 127-137. https://doi.org/10.1016/j.genhosppsych.2007.12.008

Turley, M., Tobias, M., & Paul, S. (2006). Non-fatal disease burden associated with excess body mass index and waist circumference in New Zealand adults. *Australian and New Zealand Journal of Public Health*, *30*(3), 231-237. https://doi.org/10.1111/j.1467-842x.2006.tb00863.x

Van Pelt, R. E., Gavin, K. M., & Kohrt, W. M. (2015). Regulation of Body Composition and Bioenergetics by Estrogens. *Endocrinology and Metabolism Clinics of North America*, *44*(3), 663-676. https://doi.org/10.1016/j.ecl.2015.05.011

Wassertheil-Smoller, S., Hendrix, S. L., Limacher, M., Heiss, G., Kooperberg, C., Baird, A., Kotchen, T., Curb, J. D., Black, H., Rossouw, J. E., Aragaki, A., Safford, M., Stein, E., Laowattana, S., Mysiw, W. J., & WHI Investigators. (2003). Effect of Estrogen plus Progestin on Stroke in Postmenopausal Women: The Women's Health Initiative: A Randomized Trial. *JAMA*, *289*(20), 2673-2684. https://doi.org/10.1001/jama.289.20.2673

World Health Organization [WHO]. (2024). *Obesity and overweight*. Retrieved from https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight