eISSN 2255-0569

ORIGINAL

Variables associated with overweight and obesity in Spanish healthcare workers

Variables asociadas al sobrepeso y obesidad en trabajadores sanitarios españoles

Pedro Javier Tárraga Marcos[1], Ángel Arturo López-González[2,3,4], Emilio Martínez-Almoyna Rifá[2,3], Hernán Paublini Oliveira[2,3], Cristina Martorell Sánchez[2,3], Pedro Juan Tárraga López[5], José Ignacio Ramírez-Manent[2,4,6]

1. Sant Joan University Hospital. Alicante. Spain
2. ADEMA-Health group of University Institute of Health Sciences (IUNICS) of Balearic Islands. Spain
3. Faculty of Odontology. University School ADEMA-UIB. Spain
4. Health Service of the Balearic Islands. Spain.
5. Faculty of Medicine. Castilla la Mancha University. Spain
6. Faculty of Medicine. Balearic Islands University. Spain

Corresponding author
Pedro Juan Tárraga López
E-mail: pjtarraga@sescam.jccm.es

Received: 2 - XII - 2024
Accepted: 21 - XII - 2024

doi: 10.3306/AJHS.2025.40.03.9

Abstract

Introduction: Obesity is a multifactorial chronic disease that, due to the continuous increase in its prevalence worldwide and its high associated morbidity and mortality, is currently considered the pandemic of the 21st century. The objective of this study is to assess how various sociodemographic variables and health habits are associated with the prevalence of excess weight, as determined by five different scales, in a large cohort of healthcare workers.
Methodology: A dual study design —longitudinal-retrospective and cross-sectional— was conducted among healthcare workers divided into four categories (physicians, nurses, healthcare technicians, and auxiliary staff). The study evaluated the association of age, sex, professional category, smoking habits, physical activity, and adherence to the Mediterranean diet with obesity, as determined by five different scales: Body Mass Index (BMI), Waist-to-Height Ratio (WtHR), Body Adiposity Index (BAI), Clínica Universidad de Navarra Body Fat Estimator (CUN BAE), and the Visceral Fat Metabolic Score (METS-VF).
Results: All the variables analyzed in the study were associated with high values on the five overweight-obesity scales, with age showing the strongest association (as reflected in odds ratio values).
Conclusions: The healthcare worker profile at the highest risk of obesity, according to any of the five scales, is an older male, working as auxiliary nursing staff or porter, who smokes, is sedentary, and has low adherence to the Mediterranean diet.

Key words: Obesity, Mediterranean diet, physical activity, healthcare worker, smoking, CUN BAE.

Resumen

Introducción: La obesidad es una enfermedad crónica multifactorial que debido al incremento continuo de su prevalencia en todo el mundo y a su elevada morbimortalidad asociada es considerada en la actualidad como la pandemia del siglo XXI. El objetivo de este estudio es evaluar cómo las variables sociodemográficas y los hábitos de salud están asociados con la prevalencia de exceso de peso, determinada mediante cinco escalas diferentes, entre los trabajadores sanitarios de todas las regiones de España.
Metodología: Un estudio doble: longitudinal-retrospectivo y transversal en trabajadores sanitarios divididos en cuatro categorías (médicos, enfermeras, técnicos sanitarios y personal auxiliar) evaluó la asociación de la edad, el sexo, la categoría profesional, el tabaquismo, la actividad física y la adherencia a la dieta mediterránea con la presencia de obesidad determinada con cinco escalas diferentes: índice de masa corporal (IMC), índice cintura/altura (WtHR), índice de adiposidad corporal (BAI), Clínica Universitaria de Navarra Estimador de grasa corporal (CUN BAE) y puntuación metabólica para grasa visceral (METS-VF).
Resultados: Todas las variables analizadas en el estudio se asociaron con la presencia de valores altos de las cinco escalas de sobrepeso-obesidad, siendo la edad la que mostró una mayor asociación (reflejada en los valores de odds ratio).
Conclusiones: El perfil de trabajador sanitario con mayor riesgo de presentar obesidad con cualquiera de las cinco escalas sería un varón, de edad avanzada, auxiliar de enfermería o celador, fumador, sedentario y con baja adherencia a la dieta mediterránea.

Palabras clave: Obesidad, dieta mediterránea, actividad física, trabajador sanitario, consumo de tabaco, CUN BAE.

Cite as: Tárraga Marcos PJ, López-González ÁA, Martínez-Almoyna Rifá E, Paublini Oliveira H, Martorell Sánchez C, Tárraga López PJ, et al. Variables associated with overweight and obesity in Spanish healthcare workers. *Academic Journal of Health Sciences 2025*;40 (3): 9-19 doi: 10.3306/AJHS.2025.40.03.9

Introduction

Obesity is a chronic, multifactorial disease characterized by an abnormal or excessive accumulation of body fat that can harm health[1]. It is recognized as one of the most critical public health issues worldwide[2] due to its high prevalence[3] and severe consequences in terms of morbidity and mortality[4]. According to the World Health Organization (WHO), in 2022, 43% of adults aged 18 years and older were overweight, and 16% were obese[5]. These figures have continued to rise, highlighting the need for a comprehensive understanding of the epidemiological, pathophysiological, diagnostic, and complication-related aspects of obesity[6].

The prevalence of obesity has alarmingly increased in recent decades, affecting individuals of all ages, genders, and socioeconomic levels. This phenomenon has been termed the "global obesity pandemic"[7]. In regions such as North America and Europe, over 25% of the adult population is estimated to be obese[8]. In developing countries, epidemiological transitions have led to a rapid increase in obesity prevalence, coexisting with issues of undernutrition[9]. Moreover, childhood obesity has grown significantly, with nearly 39 million children under the age of 5 being overweight or obese in 2020. Childhood obesity constitutes a major risk factor for its persistence into adulthood, further contributing to the global healthcare burden[10].

Obesity results from a chronic imbalance between caloric intake and energy expenditure, regulated by a complex neurohormonal system involving the hypothalamus, adipose tissue, the gastrointestinal system, and endocrine signals[11]. Adipose tissue plays a central role in the pathophysiology of obesity[12], functioning not only as an energy storage depot but also as an active endocrine organ that secretes adipokines such as leptin[13], adiponectin[14], and resistin[15]. These molecules regulate metabolism, inflammation, and insulin sensitivity[16]. In obesity, adipose tissue expands and becomes dysfunctional, resulting in a state of chronic low-grade inflammation and insulin resistance[17].

Additionally, the distribution of body fat significantly impacts metabolic risk, with visceral fat being more harmful than subcutaneous fat. The accumulation of visceral fat is associated with metabolic dysfunction[18], lipotoxicity[19], and an increased production of inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6)[20].

Obesity is associated with a wide range of complications affecting nearly all body systems. Major complications include:
1. Metabolic: Insulin resistance, type 2 diabetes mellitus, dyslipidemia, and metabolic syndrome[21].
2. Cardiovascular: Hypertension, coronary artery disease, heart failure, and stroke[22].
3. Respiratory: Obstructive sleep apnea syndrome and restrictive lung disease[23].
4. Musculoskeletal: Osteoarthritis and chronic musculoskeletal pain, which can be disabling[24].
5. Oncological: Increased risk of cancers such as breast, colon, endometrial, and prostate cancer[25].
6. Psychological: Anxiety disorders, depression, and social stigmatization are common among individuals with obesity[26].

These complications underscore the importance of early identification and effective interventions for patients with obesity.

Diagnosing obesity extends beyond quantifying excess weight and includes evaluating body composition and fat distribution. Key diagnostic methods include:

1. Body Mass Index (BMI): The most widely used method for classifying obesity, calculated by dividing weight in kilograms by the square of height in meters (kg/m^2). While useful for initial classification, it does not differentiate between fat and lean mass or assess fat distribution[27].
2. Waist-to-Height Ratio (WHtR): This metric relates waist circumference to height, offering better evaluation of metabolic risk associated with abdominal fat[28].
3. Body Adiposity Index (BAI): Estimates body fat percentage based on the ratio of hip circumference to height. Although more specific than BMI, its use is limited due to the need for validation across diverse populations[29].
4. CUN-BAE (Clinica Universidad de Navarra Body Adiposity Estimator): A method using equations based on BMI, age, and sex, shown to be a reliable tool for estimating body fat in clinical settings[30].
5. METS-VF (Metabolic Syndrome Visceral Fat Index): Combines clinical and biochemical measures to estimate visceral fat volume and its impact on metabolic risk, particularly useful for identifying individuals at high cardiometabolic risk[31].

An integrative approach combining these metrics with advanced methods such as bioelectrical impedance analysis[32], dual-energy X-ray absorptiometry (DXA)[33], and magnetic resonance imaging (MRI)[34] enables a more accurate evaluation of obesity. This facilitates risk stratification, personalization of therapeutic interventions, and effective treatment monitoring.

Study Objective

The objective of this study is to analyze how different sociodemographic variables (age, sex, and socioeconomic status) and health behaviors (smoking, physical activity, and adherence to the Mediterranean diet) are associated with various scales used to evaluate overweight and obesity in a specific cohort of healthcare workers.

Methods

Study Design and Sample

This study utilized a mixed-methods approach, incorporating both a retrospective longitudinal study and a cross-sectional descriptive study. A total of 44,939 healthcare workers from various regions of Spain participated, including 14,305 men (31.8%) and 30,634 women (68.2%). The participants were selected from individuals undergoing mandatory annual medical check-ups provided by their employers during the study period. The longitudinal study covered the years 2010 to 2019.

Inclusion Criteria:

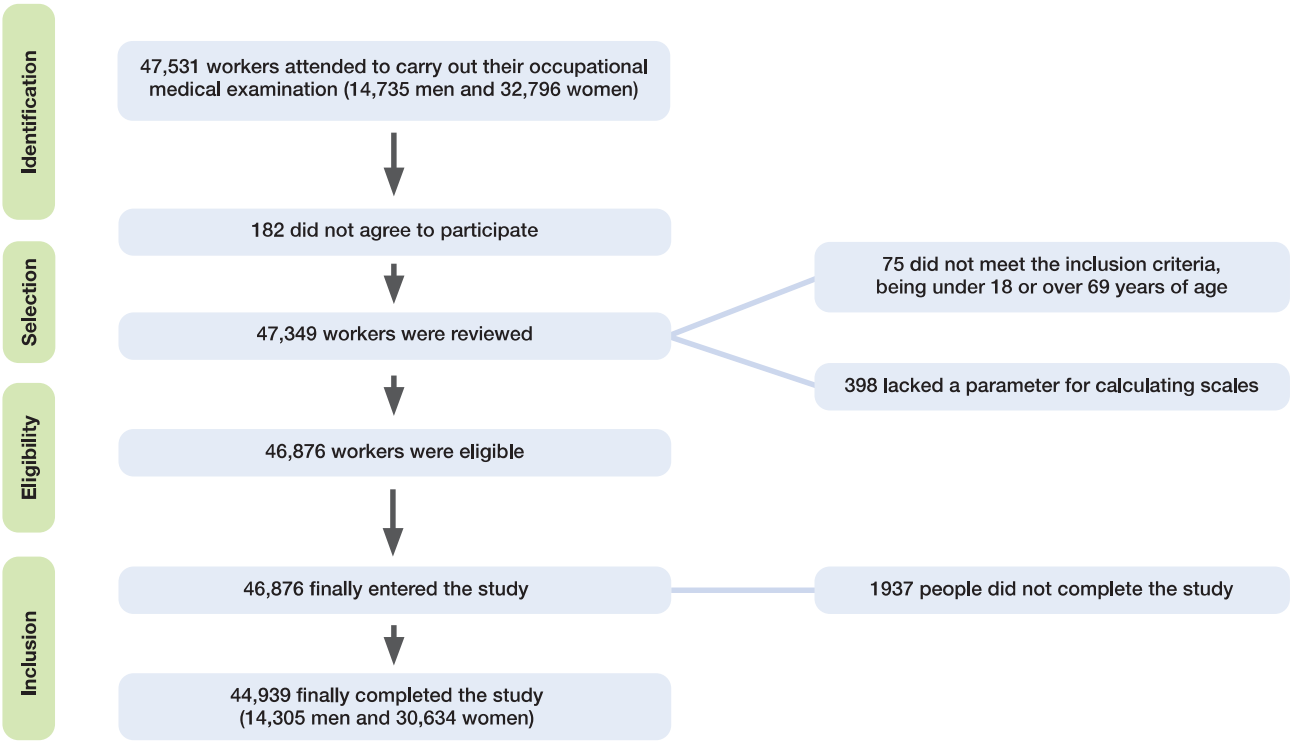
- Aged between 18 and 69 years.
- Employed by one of the participating companies.
- Provided informed consent to participate in the study.
- Authorized the use of their data for epidemiological purposes.

Exclusion Criteria:

- Aged under 18 or over 69 years.
- Not employed by a participating company.
- Did not provide informed consent to participate in the study.
- Did not authorize the use of their data for epidemiological purposes.

The flow chart of the study participants is presented in **figure 1**.

Figure 1: Presents the flowchart detailing the selection and inclusion process for study participants.



Data Collection Procedures

Data collection was conducted by occupational health teams from the collaborating companies using the following methods:

- Medical History: Sociodemographic information (age, sex, occupation) and health-related data such as smoking status, physical activity levels, adherence to the Mediterranean diet, and stress levels were recorded.
- Physical and Clinical Measurements: Data collected included height, weight, waist circumference, hip circumference, and blood pressure (systolic and diastolic).
- Laboratory Tests: Biochemical analyses included lipid profiles, liver function tests, and fasting blood glucose levels.

To minimize bias, all measurements adhered to standardized protocols:

- Height and Weight: Measured using a SECA 700 scale and SECA 220 stadiometer, with participants wearing only underwear.
- Circumferences: Waist circumference was measured using a SECA measuring tape placed between the

lowest rib and the iliac crest, while hip circumference was measured at the widest part of the buttocks, with participants standing upright and relaxed.
• Blood Pressure: Measured using an OMRON-M3 sphygmomanometer after 10 minutes of rest in a seated position, ensuring participants had not consumed food, beverages, or tobacco in the prior hour. Three measurements were taken at one-minute intervals, with the average recorded.

Blood samples were obtained via venipuncture after a 12-hour fast, refrigerated, and processed in reference laboratories within 72 hours. Laboratory analyses included:

• Triglycerides, total cholesterol, and glucose levels: Determined using enzymatic methods.
• HDL cholesterol: Measured by precipitation.
• LDL cholesterol: Calculated using the Friedewald formula, provided triglyceride levels were below 400 mg/dL.

Obesity scales
- BMI is calculated by dividing weight by height in meters squared. Obesity is considered to be over 30.
- Waist-to-height ratio (WtHR) is considered high from 0.5
- BAI was calculated using the equation ((hip circumference)/(height1.5))−18((\text{hip circumference}) / (\text{height}^{1.5})) - 18((hip circumference)/(height1.5))−18, as proposed by Bergman et al[35]. The resulting values were categorized as low, normal, high, or very high based on the criteria established by Gallagher et al[36]. for the White population.
- CUN BAE (Clínica Universidad de Navarra Body Adiposity Estimator)[37] The formula is:-44.988 + (0.503 x age) + (10.689 x gender) + (3.172 x BMI) - (0.026 x BMI^2) + (0.181 x BMI x gender) - (0.02 x BMI x age) - (0.005 x BMI^2x gender) + (0.00021 x BMI^2 x age). Where male sex equals 0 and female sex equals 1
- Metabolic score for visceral fat (METS-VF)[38] METS-VF = 4.466 + 0.011*(Ln(METS-IR))^3 + 3.239*(Ln(WtHR))^3 + 0.319*(Sex) + 0.594*(Ln(age)). Man = 1 woman = 0 METS-IR = Ln [(2*glycaemia) + Triglycerides]*BMI)/(Ln[HDLc]) High risk is considered as from 7,18.

Operational Definitions
• Professional Categories: Healthcare workers were classified into four groups: physicians, nurses, health technicians (e.g., laboratory, pathology, radiology), and nursing assistants/orderlies.
• Smoking: Defined as consuming at least one cigarette per day in the previous 30 days or having quit within the preceding year.
• Mediterranean Diet Adherence: Assessed using the PREDIMED questionnaire, with high adherence defined as a score of 9 or higher[39].
• Physical Activity: Measured using the International Physical Activity Questionnaire (IPAQ), evaluating frequency, duration, and intensity[40].

Statistical Analysis
Descriptive analysis of categorical variables was performed using frequencies and distributions. The Kolmogorov-Smirnov test assessed the normality of quantitative variables, followed by the calculation of means and standard deviations. Bivariate analysis included Student's t-test for comparing means and the chi-square test for proportions. Variables associated with obesity scales were analyzed using a binary logistic regression model, with model fit evaluated using the Hosmer-Lemeshow test. Stratified analysis was conducted to identify potential confounding factors, but no significant confounding was found. Concordance between scales was assessed using Cohen's kappa coefficient. Statistical analysis was performed using SPSS version 29.0, with a significance level of 0.05.

Ethical Considerations
The study complied with the ethical principles outlined in the Declaration of Helsinki and was approved by the Ethics and Research Committee of the Balearic Islands (CEI-IB) under code IB 4383/20. All participants provided signed informed consent, and their data were anonymized in accordance with Spain's Organic Law 3/2018 on Data Protection.

Results

The anthropometric, clinical, analytical, sociodemographic, and health-related data for the 44,939 workers included in the study are presented in **table I**. The participants' mean age was slightly over 41 years, with lower values consistently observed in the female group. The population's mean age predominantly ranged from 30 to 49 years.

Adherence to the Mediterranean diet was reported by 45.8% of men and 37.9% of women. Regular physical activity was practiced by 47.5% of men and 38.9% of women. Smoking prevalence was 16.1% in men and 15% in women.

Tables II and **III** present the mean values and prevalence of high values for the various scales assessing overweight and obesity, stratified by sociodemographic variables and health behaviors. The results indicate that both the mean values and the prevalence of high values on the overweight-obesity scales increase progressively with age and decrease as socioeconomic status declines. These values are higher among smokers, sedentary individuals, and those with low adherence to the Mediterranean diet. In contrast, all values are lower in women. The observed differences are consistently statistically significant ($p < 0.001$).

Table I: Characteristics of the population.

	Men n=14,305	Women n=30,634	
	Mean (SD)	Mean (SD)	p-value
Age (years)	41,1 (10,6)	40,4 (10,5)	<0.001
Height (cm)	176,0 (7,5)	162,6 (6,0)	<0.001
Weight (kg)	81,2 (14,5)	63,7 (13,3)	<0.001
Waist circumference (cm)	89,7 (12,6)	76,7 (11,8)	<0.001
Hip circumference (cm)	101,7 (8,8)	99,3 (10,7)	<0.001
Systolic blood pressure (mmHg)	128,2 (13,1)	116,1 (13,8)	<0.001
Diastolic blood pressure (mmHg)	79,9 (10,6)	74,8 (10,1)	<0.001
Total cholesterol (mg/dL)	191,8 (37,2)	187,8 (34,6)	<0.001
HDL-c (mg/dL)	48,9 (11,2)	59,3 (12,8)	<0.001
LDL-c (mg/dL)	165,2 (46,2)	144,8 (38,9)	<0.001
Triglycerides (mg/dL)	111,0 (73,2)	81,7 (47,0)	<0.001
Glucose (mg/dL)	93,6 (18,2)	88,9 (12,4)	<0.001
AST (U/l)	24,1 (17,2)	18,2 (8,0)	<0.001
ALT (U/l)	29,0 (36,7)	17,3 (13,7)	<0.001
GGT (U/l)	30,2 (28,8)	18,1 (18,1)	<0.001
	N (%)	N (%)	p-value
< 30 years	2400 (16.8)	5984 (19.5)	<0.001
30-39 years	4200 (29.4)	8304 (27.1)	
40-49 years	4512 (31.5)	10128 (33.0)	
50-59 years	2449 (17.1)	5150 (16.8)	
60-69 years	744 (5.2)	1120 (3.6)	
Physicians	5064 (35.4)	5024 (16.4)	<0.001
Nurses	4008 (28.0)	12752 (41.6)	
Health Technicians	1728 (12.1)	4128 (13.5)	
Nursing assistants or orderlies	3505 (24.5)	8782 (28.5)	
Non-smokers	12001 (83.9)	26094 (85.0)	<0.001
Smokers	2304 (16.1)	4592 (15.0)	
No physical activity	7512 (52.5)	18744 (61.1)	<0.001
Yes physical activity	6793 (47.5)	11942 (38.9)	
Non Mediterranean diet	7771 (54.2)	19213 (62.1)	<0.001
Yes Mediterranean diet	6534 (45.8)	11413 (37.9)	

HDL High density lipoprotein. LDL Low density lipoprotein. AST Aspartate Aminotransferase. ALT Alanine Aminotransferase. GGT Gamma-glutamyl transpeptidase. SD Standard deviation.

Table II: Mean values of obesity scales according sociodemographic variables and healthy habits by sex.

		BMI		WtHR		BAI		CUN BAE		METS-VF	
Men	n	Mean (SD)	p-value	Mean (SD)	p-value	Mean (SD)	p-value	Mean (SD)	p-value	Mean (SD)	p-value
< 30 years	2400	24.1 (4.1)	<0.001	0.46 (0.06)	<0.001	23.9 (4.3)	<0.001	19.7 (6.6)	<0.001	5.6 (0.8)	<0.001
30-39 years	4200	25.4 (4.0)		0.49 (0.06)		25.1 (3.7)		23.1 (5.6)		6.1 (0.6)	
40-49 years	4512	26.6 (3.9)		0.52 (0.06)		25.7 (3.4)		26.0 (5.3)		6.5 (0.6)	
50-59 years	2449	28.0 (4.1)		0.55 (0.08)		27.6 (4.6)		29.4 (5.4)		6.9 (0.6)	
60-69 years	744	28.3 (4.4)		0.56 (0.06)		27.7 (5.1)		30.3 (4.9)		7.1 (0.4)	
Physicians	5064	25.9 (3.7)	<0.001	0.50 (0.06)	<0.001	24.7 (5.2)	<0.001	23.6 (6.2)	<0.001	6.1 (0.7)	<0.001
Nurses	4008	25.7 (4.2)		0.50 (0.07)		25.3 (3.6)		24.6 (6.0)		6.2 (0.7)	
Health Technicians	1728	26.3 (4.9)		0.51 (0.09)		25.7 (3.9)		24.9 (7.6)		6.3 (0.9)	
Nursing assistants or orderlies	3505	27.2 (4.7)		0.53 (0.08)		26.5 (4.5)		26.6 (6.6)		6.6 (0.8)	
Non-smokers	12001	25.8 (4.3)	<0.001	0.50 (0.07)	<0.001	25.3 (4.2)	<0.001	24.6 (6.4)	<0.001	6.2 (0.8)	<0.001
Smokers	2304	26.2 (4.3)		0.51 (0.07)		25.7 (4.2)		25.0 (6.5)		6.4 (0.8)	
No physical activity	7512	27.3 (4.7)	<0.001	0.53 (0.08)	<0.001	26.6 (4.4)	<0.001	26.5 (6.9)	<0.001	6.6 (0.8)	<0.001
Yes physical activity	6793	25.0 (3.5)		0.49 (0.06)		24.7 (3.6)		23.1 (5.5)		6.1 (0.7)	
Non Mediterranean diet	7771	27.0 (4.6)	<0.001	0.52 (0.07)	<0.001	26.1 (4.4)	<0.001	26.0 (6.3)	<0.001	6.6 (0.8)	<0.001
Yes Mediterranean diet	6534	25.6 (3.7)		0.49 (0.07)		25.2 (3.8)		23.8 (5.8)		6.2 (0.8)	
Women	n	Mean (SD)	p-value	Mean (SD)	p-value	Mean (SD)	p-value	Mean (SD)	p-value	Mean (SD)	p-value
< 30 years	5984	22.3 (3.6)	<0.001	0.43 (0.05)	<0.001	27.9 (4.6)	<0.001	28.9 (5.7)	<0.001	4.7 (0.8)	<0.001
30-39 years	8304	23.2 (4.8)		0.45 (0.07)		28.9 (5.3)		31.6 (6.4)		5.2 (0.8)	
40-49 years	10128	24.8 (4.8)		0.48 (0.07)		30.8 (5.4)		35.2 (5.9)		5.8 (0.8)	
50-59 years	5150	25.9 (5.1)		0.51 (0.08)		32.2 (5.7)		38.1 (6.1)		6.2 (0.8)	
60-69 years	1120	26.1 (5.5)		0.53 (0.07)		32.3 (6.0)		39.3 (6.0)		6.4 (0.7)	
Physicians	5024	22.1 (3.2)	<0.001	0.44 (0.05)	<0.001	28.0 (4.3)	<0.001	30.3 (5.7)	<0.001	5.0 (0.9)	<0.001
Nurses	12752	23.4 (4.3)		0.46 (0.07)		29.2 (5.2)		32.3 (6.1)		5.3 (0.9)	
Health Technicians	4128	25.2 (5.2)		0.49 (0.08)		31.1 (5.7)		35.2 (7.2)		5.7 (0.9)	
Nursing assistants or orderlies	8782	25.9 (5.6)		0.51 (0.08)		31.9 (5.9)		36.7 (6.9)		6.0 (0.9)	
Non-smokers	26094	24.0 (4.7)	<0.001	0.47 (0.07)	<0.001	29.9 (5.4)	<0.001	33.5 (6.8)	<0.001	5.5 (0.9)	<0.001
Smokers	4592	24.4 (5.6)		0.48 (0.08)		30.5 (6.1)		34.3 (7.1)		5.7 (0.9)	
No physical activity	18744	24.8 (5.3)	<0.001	0.48 (0.08)	<0.001	30.9 (5.8)	<0.001	34.6 (7.3)	<0.001	5.7 (0.9)	<0.001
Yes physical activity	11942	23.0 (3.7)		0.45 (0.06)		28.7 (4.8)		32.2 (5.9)		5.3 (0.9)	
Non Mediterranean diet	19213	24.5 (5.3)	<0.001	0.48 (0.08)	<0.001	30.3 (5.7)	<0.001	34.1 (7.0)	<0.001	5.7 (0.8)	<0.001
Yes Mediterranean diet	11413	23.5 (3.8)		0.46 (0.07)		29.2 (5.9)		32.8 (6.0)		5.4 (0.8)	

BMI Body mass index. WtHR Waist to height ratio. BAI Body adiposity index. CUN BAE Clínica Universidad de Navarra-Body adiposity Estimator. METS-VF Metabolic score for visceral fat.SD Standard deviation.

Table III: Prevalence of high values of obesity scales according sociodemographic variables and healthy habits by sex.

Men	n	BMI obesity		WtHR high		BAI obesity		CUN BAE obesity		METS-VF high	
		%	p-value	%	p-value	%	p-value	%	p-value	%	p-value
< 30 years	2400	9.1	<0.001	20.9	<0.001	5.8	<0.001	16.8	<0.001	2.1	<0.001
30-39 years	4200	10.3		37.7		10.2		26.9		6.9	
40-49 years	4512	14.4		54.8		14.5		52.7		12.8	
50-59 years	2449	29.4		76.4		20.3		77.5		42.1	
60-69 years	744	32.3		83.9		22.5		82.8		48.4	
Physicians	5064	12.0	<0.001	41.9	<0.001	16.8	<0.001	32.9	<0.001	8.4	<0.001
Nurses	4008	13.7		45.0		9.9		46.4		13.3	
Health Technicians	1728	16.7		50.0		8.5		47.2		19.4	
Nursing assistants or orderlies	3505	22.6		63.7		12.3		56.2		27.4	
Non-smokers	12001	15.6	<0.001	48.9	<0.001	10.5	<0.001	37.5	<0.001	14.6	<0.001
Smokers	2304	15.8		49.4		14.2		46.6		16.4	
No physical activity	7512	21.7	<0.001	62.9	<0.001	22.1	<0.001	58.1	<0.001	23.3	<0.001
Yes physical activity	6793	9.2		34.3		7.3		30.8		8.1	
Non Mediterranean diet	7771	20.9	<0.001	60.0	<0.001	20.5	<0.001	52.8	<0.001	21.5	<0.001
Yes Mediterranean diet	6534	10.1		37.8		8.3		34.2		9.8	
Women	**n**	**%**	**p-value**	**%**	**p-value**	**%**	**p-value**	**%**	**p-value**	**%**	**p-value**
< 30 years	5984	4.5	<0.001	11.0	<0.001	1.9	<0.001	15.2	<0.001	0.5	<0.001
30-39 years	8304	6.9		19.1		4.6		26.0		1.3	
40-49 years	10128	13.1		31.8		5.1		44.2		2.2	
50-59 years	5150	18.3		51.0		7.1		63.7		9.3	
60-69 years	1120	18.6		55.7		7.9		74.3		12.9	
Physicians	5024	2.2	<0.001	11.5	<0.001	9.2	<0.001	19.4	<0.001	0.6	<0.001
Nurses	12752	7.5		19.1		4.2		29.9		1.6	
Health Technicians	4128	17.2		38.0		3.4		46.5		3.9	
Nursing assistants or orderlies	8782	17.9		47.0		6.9		56.5		6.4	
Non-smokers	26094	10.6	<0.001	27.5	<0.001	3.9	<0.001	37.4	<0.001	3.0	<0.001
Smokers	4592	12.2		33.4		5.1		41.5		3.8	
No physical activity	18744	13.8	<0.001	34.7	<0.001	10.3	<0.001	44.3	<0.001	4.5	<0.001
Yes physical activity	11942	6.2		18.4		3.2		28.1		0.9	
Non Mediterranean diet	19213	13.3	<0.001	33.0	<0.001	10.0	<0.001	41.9	<0.001	4.0	<0.001
Yes Mediterranean diet	11413	7.0		19.6		4.2		31.3		1.3	

BMI Body mass index. WtHR Waist to height ratio. BAI Body adiposity index. CUN BAE Clínica Universidad de Navarra-Body adiposity Estimator. METS-VF Metabolic score for visceral fat.

Table IV: Multinomial logistic regression.

	BMI obesity	WtHR high	BAI obesity	CUN BAE obesity	METS-VF high
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Women	1	1	1	1	1
Men	1.92 (1.80-2.04)	3.64 (3.47-3.82)	8.46 (7.90-9.03)	1.65 (1.57-1.73)	5.86 (5.01-6.73)
< 30 years	1	1	1	1	1
30-39 years	1.36 (1.20-1.52)	1.75 (1.56-1.95)	1.19 (1.14-1.25)	2.24 (1.97-2.51)	1.77 (1.55-1.99)
40-49 years	2.35 (2.08-2.62)	3.98 (3.55-4.41)	1.34 (1.21-1.47)	5.38 (4.75-6.02)	3.89 (3.69-4.20)
50-59 years	3.96 (3.47-4.46)	7.45 (6.64-8.27)	1.79 (1.60-1.99)	7.89 (7.01-8.77)	7.81 (6.91-8.72)
60-69 years	4.41 (3.81-5.02)	12.47 (11.01-13.93)	2.45 (2.05-2.86)	11.21 (10.01-12.42)	14.20 (12.99-15.42)
Physicians	1	1	1	1	1
Nurses	1.14 (1.10-1.18)	1.33 (1.24-1.43)	1.17 (1.13-1.21)	1.21 (1.13-1.29)	1.32 (1.17-1.48)
Health Technicians	1.68 (1.55-1.81)	2.15 (2.03-2.27)	1.64 (1.50-1.78)	1.78 (1.69-1.88)	1.91 (1.70-2.12)
Nursing assistants or orderlies	2.85 (2.60-3.11)	3.38 (3.16-3.60)	1.84 (1.68-2.00)	2.48 (2.33-2.63)	3.94 (3.50-4.39)
Non-smokers	1	1	1	1	1
Smokers	1.17 (1.12-1.22)	1.18 (1.13-1.24)	1.14 (1.10-1.18)	1.33 (1.21-1.45)	1.25 (1.19-1.32)
Yes physical activity	1	1	1	1	1
No physical activity	2.52 (2.36-2.69)	2.87 (2.74-3.01)	2.16 (2.02-2.31)	2.58 (2.47-2.69)	3.94 (3.57-4.31)
Yes Mediterranean diet	1	1	1	1	1
Non Mediterranean diet	1.90 (1.71-2.10)	2.02 (1.84-2.21)	1.72 (1.55-1.89)	1.98 (1.85-2.12)	2.87 (2.60-3.15)

BMI Body mass index. WtHR Waist to height ratio. BAI Body adiposity index. CUN BAE Clínica Universidad de Navarra-Body adiposity Estimator. METS-VF Metabolic score for visceral fat. OR Odss ratio.

Table IV presents the results of the multinomial logistic regression analysis, showing that all variables included in the model are associated with the presence of high values on the overweight-obesity scales. Among all variables, the strongest association (highest odds ratio values) is observed for age, followed by professional category and physical activity.

The Pearson correlation index is very high among all the scales assessing excess weight, whereas Cohen's kappa concordance coefficient values are low, except for the pairs BMI and BAI, WtHR and CUN-BAE, and BAI and METS-VF. Full data can be found in **table V**.

Table VI presents the results of the retrospective longitudinal study, showing the prevalence of high values on the overweight-obesity scales during the pre (2010) and post (2019) periods. The differences in prevalence between these periods increased with age and decreased with socioeconomic status. These

differences were more pronounced among smokers, individuals who do not engage in regular physical activity, and those with low adherence to the Mediterranean diet. In all cases, the prevalence differences were smaller among women. In all cases the differences observed show statistical significance (p<0.001).

Table V: Pearson and kappa Cohen coefficient.

Pearson	BMI	WtHR	BAI	CUN BAE	METS-VF
BMI	1	0.896	0.855	0.955	0.816
WtHR		1	0.820	0.904	0.937
BAI			1	0.835	0.774
CUN BAE				1	0.906
METS-VF					**1**
kappa Cohen	**BMI obesity**	**WtHR high**	**BAI obesity**	**CUN BAE high**	**METS-VF high**
BMI obesity	1	0.467	0.552	0.331	0.404
WtHR high		1	0.220	0.706	0.151
BAI obesity			1	0.150	0.553
CUN BAE high				1	0.100
METS-VF high					1

BMI Body mass index. WtHR Waist to height ratio. BAI Body adiposity index. CUN BAE Clínica Universidad de Navarra-Body adiposity Estimator. METS-VF Metabolic score for visceral fat.

Table VI: Differences in the prevalences of high values of overweight and obesity scales between the pre and post periods by sex.

		BMI obesity			WtHR high			BAI obesity			CUN BAE obesity			METS-VF high		
Men	n	% pre-post	difference %	p-value	% pre-post	difference %	p-value	% pre-post	difference %	p-value	% pre-post	difference %	p-value	% pre-post	difference %	p-value
<30 years	2400	8.6-9.1	5.3	<0.001	19.6-20.9	6.1	<0.001	5.4-5.8	7.3	<0.001	15.3-16.8	8.9	<0.001	1.9-2.1	7.3	<0.001
30-39 years	4200	9.4-10.3	8.7		34.7-37.7	7.9		9.2-10.2	9.9		23.5-26.9	12.8		6.2-6.9	9.9	
40-49 years	4512	12.4-14.4	13.8		48.3-54.8	11.8		12.5-14.5	13.5		44.6-52.7	15.3		11.2-12.8	12.4	
50-59 years	2449	24.4-29.4	17.1		65.5-76.4	14.3		16.7-20.3	17.8		62.6-77.5	19.2		35.9-42.1	14.8	
60-69 years	744	25.7-32.3	20.3		69.5-83.9	17.2		17.9-22.5	20.4		64.3-82.8	22.4		39.3-48.4	18.9	
Physicians	5064	11.2-12.0	6.7	<0.001	39.3-41.9	6.1		15.5-16.8	7.7	<0.001	29.7-32.9	9.8		7.7-8.4	7.9	
Nurses	4008	12.5-13.7	8.8		41.4-45.0	7.9		9.0-9.9	9.1		41.3-46.4	10.9		12.1-13.3	8.9	
Health Technicians	1728	14.7-16.7	11.8		43.1-50.0	13.8		7.5-8.5	11.8		39.5-47.2	16.3		17.1-19.4	11.8	
Nursing assistants or orderlies	3505	19.0-22.6	15.9		54.0-63.7	15.3		10.3-12.3	16.6		45.0-56.2	19.9		22.6-27.4	17.5	
Non-smokers	12001	14.1-15.6	9.9	<0.001	44.5-48.9	8.9	<0.001	9.5-10.5	9.7	<0.001	32.7-37.5	12.8	<0.001	13.1-14.6	10.1	<0.001
Smokers	2304	13.8-15.8	12.8		43.2-49.4	12.6		12.5-14.2	12.3		39.0-46.6	16.3		14.3-16.4	12.9	
No physical activity	7512	17.4-21.7	19.9	<0.001	50.1-62.9	20.3	<0.001	17.3-22.1	21.5	<0.001	44.4-58.1	23.5	<0.001	18.2-23.3	21.8	<0.001
Yes physical activity	6793	8.7-9.2	5.3		32.1-34.3	6.3		6.8-7.3	6.9		28.7-30.8	6.9		7.5-8.1	7.9	
Non Mediterranean diet	7771	17.0-20.9	18.6	<0.001	48.7-60.0	18.9	<0.001	16.4-20.5	20.0	<0.001	41.5-52.8	21.4	<0.001	17.1-21.5	20.5	<0.001
Yes Mediterranean diet	6534	18.8-10.1	6.7		35.0-37.8	7.4		7.7-8.3	7.5		31.6-34.2	7.6		9.0-9.8	8.6	
Men	n	% pre-post	difference %	p-value	% pre-post	difference %	p-value	% pre-post	difference %	p-value	% pre-post	difference %	p-value	% pre-post	difference %	p-value
<30 years	5984	4.4-4.5	2.8	<0.001	10.6-11.0	3.3	<0.001	1.8-1.9	3.9	<0.001	14.5-15.2	4.5	<0.001	0.5-0.5	5.7	<0.001
30-39 years	8304	6.5-6.9	6.1		17.9-19.1	6.4		4.3-4.6	6.3		24.2-26.0	6.8		1.2-1.3	8.2	
40-49 years	10128	11.9-13.1	8.9		28.8-31.8	9.5		4.6-5.1	9.9		39.8-44.2	9.9		2.0-2.2	10.3	
50-59 years	5150	15.6-18.3	14.8		44.2-51.0	13.4		6.1-7.1	13.4		55.0-63.7	13.6		7.8-9.3	15.9	
60-69 years	1120	15.5-18.6	16.9		46.3-55.7	16.9		6.4-7.9	18.9		61.2-74.3	17.6		10.4-12.9	19.7	
Physicians	5024	2.1-2.2	3.1	<0.001	11.1-11.5	3.6	<0.001	8.8-9.2	4.8	<0.001	18.4-19.4	4.9	<0.001	0.6-0.6	5.6	<0.001
Nurses	12752	7.1-7.5	5.2		18.3-19.1	4.4		3.9-4.2	6.1		27.8-29.9	6.9		1.5-1.6	7.9	
Health Technicians	4128	15.5-17.2	8.9		35.0-38.0	7.9		3.1-3.4	9.9		41.7-46.5	10.3		3.4-3.9	12.8	
Nursing assistants or orderlies	8782	15.3-17.9	14.3		41.2-47.0	12.3		5.8-6.9	15.3		48.1-56.5	14.8		5.4-6.4	15.8	
Non-smokers	26094	9.7-10.6	8.6	<0.001	25.3-27.5	7.9	<0.001	3.6-3.9	8.6	<0.001	33.8-37.4	9.6	<0.001	2.7-3.0	10.9	<0.001
Smokers	4592	10.9-12.2	10.8		30.3-33.4	9.3		4.6-5.1	10.5		36.8-41.5	11.3		3.3-3.8	13.1	
No physical activity	18744	11.3-13.8	18.3	<0.001	29.0-34.7	16.5	<0.001	8.7-10.3	15.8	<0.001	36.1-44.3	18.6	<0.001	3.6-4.5	20.4	<0.001
Yes physical activity	11942	5.9-6.2	5.4		17.4-18.4	5.3		3.0-3.2	6.2		26.4-28.1	6.1		0.8-0.9	7.9	
Non Mediterranean diet	19213	10.9-13.3	17.8	<0.001	28.0-33.0	15.3	<0.001	8.6-10.0	14.1	<0.001	34.7-41.9	17.5	<0.001	3.2-4.0	19.5	<0.001
Yes Mediterranean diet	11413	6.5-7.0	6.5		18.3-19.6	6.4		3.9-4.2	6.9		29.0-31.3	7.2		1.2-1.3	8.6	

BMI Body mass index. WtHR Waist to height ratio. BAI Body adiposity index. CUN BAE Clínica Universidad de Navarra-Body adiposity Estimator. METS-VF Metabolic score for visceral fat.

Discusion

In our study, we observed associations between sociodemographic factors (age, sex, socioeconomic status) and lifestyle factors (tobacco use, physical activity, and adherence to the Mediterranean diet) with the prevalence of overweight, assessed using indicators such as BMI, waist-to-height ratio, BAI, CUN-BAE, and METS-VF. These indicators provide a comprehensive perspective on the distribution and impact of excess weight in various contexts, including healthcare workers, who are exposed to occupational and personal factors that may influence their nutritional and metabolic status.

Age is one of the most consistently associated factors with overweight in our research. This finding aligns with previous studies that have shown a linear relationship, where increasing age is generally linked to higher levels of body fat up to a certain point, followed by stabilization or decline in advanced ages due to muscle loss and metabolic changes[41]. In the context of healthcare workers, this association may be influenced by the nature of their work, which often involves irregular shifts, variable physical demands, and high levels of stress[42]. Additionally, indicators such as METS-VF[43] and CUN-BAE[44], which provide more specific information on visceral adipose tissue and fat distribution, have proven particularly sensitive in detecting age-related changes. Several recent studies suggest that healthcare workers over 40 years of age are at higher risk of developing visceral obesity compared to their younger counterparts, which may increase their susceptibility to metabolic diseases[45,46].

Sex also plays a critical role in the prevalence and distribution of excess weight, as evidenced by the results obtained in this study. Various authors have demonstrated that women tend to present higher levels of general and subcutaneous adiposity compared to men, who are more prone to visceral fat accumulation, which is more closely associated with metabolic complications[47,48]. In the healthcare sector, women represent a significant proportion of the workforce and are exposed to factors that may exacerbate this tendency, such as long shifts and additional responsibilities outside of work. Recent research has shown that the CUN-BAE indicator may be particularly useful in assessing adiposity in women, as it incorporates sex- and age-specific factors in its calculations[49]. On the other hand, BMI and waist-to-height ratio, while widely used, may underestimate metabolic risk in men due to their inability to differentiate between lean and fat mass[50].

Socioeconomic status (SES) is a key social determinant in the development of overweight. In our research, this may be due to its influence on access to healthy foods, opportunities for physical activity, and perceived stress levels[51]. Among healthcare workers, the impact of SES could be mediated by professional categorization. For example, technical or auxiliary workers may be more exposed to factors that promote obesity, such as less flexible schedules and reduced access to workplace wellness programs[52].

According to our results, tobacco use is associated with high values on overweight and obesity scales. Some authors have traditionally considered tobacco as a protective factor against weight gain due to its appetite-suppressing effects[53]. However, this relationship is complex and depends on factors such as the duration and intensity of smoking, as well as the potential for weight gain after quitting[54]. Among healthcare workers, tobacco may interact with other lifestyle factors to influence overweight. For instance, a study conducted on nurses and doctors showed that smokers had lower BMI but higher levels of visceral fat, which could increase their risk of cardiovascular diseases[55].

Physical activity is one of the most important protective factors against overweight, as highlighted in our results. In the case of healthcare workers, physical activity may be limited by long working hours and associated fatigue. A study conducted in the Valencian Community on 647 healthcare workers that evaluated physical activity both at work and outside of it found lower activity levels among women. Additionally, higher professional categories were associated with higher levels of physical activity—two findings that align with our results[56].

Adherence to the Mediterranean diet, according to our findings, has been consistently associated with a lower risk of overweight and metabolic diseases. This dietary pattern, characterized by high consumption of fruits, vegetables, legumes, whole grains, fish, and olive oil, and low consumption of red meat and ultra-processed foods, appears to have a protective effect against visceral fat accumulation and chronic inflammation[57]. Among healthcare workers, adherence to the Mediterranean diet may be compromised by a lack of time to prepare healthy meals and the availability of unhealthy food options in hospital settings[58]. Recent studies have shown that higher adherence to this diet is associated with a lower prevalence of overweight according to indicators such as BAI[59] and CUN-BAE[60], underscoring the importance of promoting this dietary pattern in intervention programs targeting this population.

The strengths of this study include the large sample size (nearly 45,000 healthcare workers), making it one of the largest studies evaluating obesity in healthcare workers. Another strength is the use of numerous validated scales to assess overweight, addressing not only anthropometric profiles but also the estimation of body and visceral fat. Finally, we should highlight the inclusion of a wide range of variables, both sociodemographic and health-related, in the study.

One limitation of the study is the exclusion of unemployed individuals, retirees, those under 18, and those over 69 years of age. Although this exclusion reduces the generalizability of the results to the broader population, we believe that the large sample size partially mitigates this effect. Another limitation is the lack of information on potential confounding factors, such as the presence of comorbidities or the use of pharmacological treatments, due to the unavailability of these data.

Conclusion

Age, sex, professional category, tobacco use, physical activity, and adherence to the Mediterranean diet are all associated with the presence or absence of excess weight, assessed using different scales such as BMI, waist-to-height ratio, BAI, CUN-BAE, and METS-VF.

Conflict of Interest

The authors declared that there is no conflict of interest

References

1. Purnell JQ. What is Obesity?: Definition as a Disease, with Implications for Care. Gastroenterol Clin North Am. 2023 Jun;52(2):261-275. doi: 10.1016/j.gtc.2023.03.001. Epub 2023 Apr 7. PMID: 37197872.

2. Souza LMS, Chaves SCL, Santana JM, Pereira M. Public policy interventions for preventing and treating obesity: scoping review. Nutr Rev. 2023 Nov 10;81(12):1653-1664. doi: 10.1093/nutrit/nuad028. PMID: 37080562.

3. Chen K, Shen Z, Gu W, Lyu Z, Qi X, Mu Y, et al. Prevalence of obesity and associated complications in China: A cross-sectional, real-world study in 15.8 million adults. Diabetes Obes Metab. 2023 Nov;25(11):3390-3399. doi: 10.1111/dom.15238. Epub 2023 Aug 17. PMID: 37589256.

4. Cáceres-Távara ME, Espinoza-Solano CG, Nieto-Gutierrez W, Delgado-Delgado R. Methodological appraisal of the evidence about efficacy of metabolic surgery in adults with non-morbid obesity and hypertension: An overview of systematic reviews. Int J Surg. 2022 Aug;104:106716. doi: 10.1016/j.ijsu.2022.106716. Epub 2022 Jun 19. PMID: 35732261.

5. https://www.who.int/es/news-room/fact-sheets/detail/obesity-and-overweight

6. Fruh S, Williams S, Hayes K, Hauff C, Hudson GM, Sittig S, et al. A practical approach to obesity prevention: Healthy home habits. J Am Assoc Nurse Pract. 2021 Jan 27;33(11):1055-1065. doi: 10.1097/JXX.0000000000000556. PMID: 33534281; PMCID: PMC8313625.

7. Boutari C, Mantzoros CS. A 2022 update on the epidemiology of obesity and a call to action: as its twin COVID-19 pandemic appears to be receding, the obesity and dysmetabolism pandemic continues to rage on. Metabolism. 2022 Aug;133:155217. doi: 10.1016/j.metabol.2022.155217. Epub 2022 May 15. PMID: 35584732; PMCID: PMC9107388.

8. Vandevijvere S, De Pauw R, Djojosoeparto S, Gorasso V, Guariguata L, Løvhaug AL, et al. Upstream Determinants of Overweight and Obesity in Europe. Curr Obes Rep. 2023 Dec;12(4):417-428. doi: 10.1007/s13679-023-00524-1. Epub 2023 Aug 18. PMID: 37594616.

9. Yusuf S, Joseph P, Rangarajan S, Islam S, Mente A, Hystad P, et al. Modifiable risk factors, cardiovascular disease, and mortality in 155 722 individuals from 21 high-income, middle-income, and low-income countries (PURE): a prospective cohort study. Lancet. 2020 Mar 7;395(10226):795-808. doi: 10.1016/S0140-6736(19)32008-2. Epub 2019 Sep 3. Erratum in: Lancet. 2020 Mar 7;395(10226):784. doi: 10.1016/S0140-6736(19)32282-2. PMID: 31492503; PMCID: PMC8006904.

10. Thomas-Eapen N. Childhood Obesity. Prim Care. 2021 Sep;48(3):505-515. doi: 10.1016/j.pop.2021.04.002. Epub 2021 Jul 8. PMID: 34311854.

11. Lin X, Li H. Obesity: Epidemiology, Pathophysiology, and Therapeutics. Front Endocrinol (Lausanne). 2021 Sep 6;12:706978. doi: 10.3389/fendo.2021.706978. PMID: 34552557; PMCID: PMC8450866.

12. Koenen M, Hill MA, Cohen P, Sowers JR. Obesity, Adipose Tissue and Vascular Dysfunction. Circ Res. 2021 Apr 2;128(7):951-968. doi: 10.1161/CIRCRESAHA.121.318093. Epub 2021 Apr 1. PMID: 33793327; PMCID: PMC8026272.

13. Obradovic M, Sudar-Milovanovic E, Soskic S, Essack M, Arya S, Stewart AJ, Gojobori T, Isenovic ER. Leptin and Obesity: Role and Clinical Implication. Front Endocrinol (Lausanne). 2021 May 18;12:585887. doi: 10.3389/fendo.2021.585887. PMID: 34084149; PMCID: PMC8167040.

14. Zhao S, Kusminski CM, Scherer PE. Adiponectin, Leptin and Cardiovascular Disorders. Circ Res. 2021 Jan 8;128(1):136-149. doi: 10.1161/CIRCRESAHA.120.314458. Epub 2021 Jan 7. PMID: 33411633; PMCID: PMC7799441.

15. Zhang J, Lu E, Deng L, Zhu Y, Lu X, Li X, et al. Immunological roles for resistin and related adipokines in obesity-associated tumors. Int Immunopharmacol. 2024 Dec 5;142(Pt A):112911. doi: 10.1016/j.intimp.2024.112911. Epub 2024 Sep 3. PMID: 39232363.

16. Tong Y, Xu S, Huang L, Chen C. Obesity and insulin resistance: Pathophysiology and treatment. Drug Discov Today. 2022 Mar;27(3):822-830. doi: 10.1016/j.drudis.2021.11.001. Epub 2021 Nov 9. PMID: 34767960.

17. Kawai T, Autieri MV, Scalia R. Adipose tissue inflammation and metabolic dysfunction in obesity. Am J Physiol Cell Physiol. 2021 Mar 1;320(3):C375-C391. doi: 10.1152/ajpcell.00379.2020. Epub 2020 Dec 23. PMID: 33356944; PMCID: PMC8294624.

18. Waters DL, Aguirre L, Gurney B, Sinacore DR, Fowler K, Gregori G, et al. Effect of Aerobic or Resistance Exercise, or Both, on Intermuscular and Visceral Fat and Physical and Metabolic Function in Older Adults With Obesity While Dieting. J Gerontol A Biol Sci Med Sci. 2022 Jan 7;77(1):131-139. doi: 10.1093/gerona/glab111. PMID: 33839788; PMCID: PMC8751785.

19. Gugliucci A. Biomarkers of dysfunctional visceral fat. Adv Clin Chem. 2022;109:1-30. doi: 10.1016/bs.acc.2022.03.001. Epub 2022 Jul 13. PMID: 35953124.

20. Žužul K, Kunjko K, Milošević M, Jurakić Tončić R, Kelava T, Ljubojević Hadžavdić S. The Association Between the Severity of Psoriasis and Obesity Based on the Analysis of Visceral Fat Index and Serum Levels of Tumor Necrosis Factor-α, Interleukin-6, and Resistin. Acta Dermatovenerol Croat. 2022 Jul;30(1):8-17. PMID: 36153714.

21. Litwin M, Kułaga Z. Obesity, metabolic syndrome, and primary hypertension. Pediatr Nephrol. 2021 Apr;36(4):825-837. doi: 10.1007/s00467-020-04579-3. Epub 2020 May 9. PMID: 32388582; PMCID: PMC7910261.

22. Powell-Wiley TM, Poirier P, Burke LE, Després JP, Gordon-Larsen P, Lavie CJ, et al. Obesity and Cardiovascular Disease: A Scientific Statement From the American Heart Association. Circulation. 2021 May 25;143(21):e984-e1010. doi: 10.1161/CIR.0000000000000973. Epub 2021 Apr 22. PMID: 33882682; PMCID: PMC8493650.

23. Bonsignore MR. Obesity and Obstructive Sleep Apnea. Handb Exp Pharmacol. 2022;274:181-201. doi: 10.1007/164_2021_558. PMID: 34697666.

24. Nedunchezhiyan U, Varughese I, Sun AR, Wu X, Crawford R, Prasadam I. Obesity, Inflammation, and Immune System in Osteoarthritis. Front Immunol. 2022 Jul 4;13:907750. doi: 10.3389/fimmu.2022.907750. PMID: 35860250; PMCID: PMC9289681.

25. Lega IC, Lipscombe LL. Review: Diabetes, Obesity, and Cancer-Pathophysiology and Clinical Implications. Endocr Rev. 2020 Feb 1;41(1):bnz014. doi: 10.1210/endrev/bnz014. PMID: 31722374.

26. Steptoe A, Frank P. Obesity and psychological distress. Philos Trans R Soc Lond B Biol Sci. 2023 Oct 23;378(1888):20220225. doi: 10.1098/rstb.2022.0225. Epub 2023 Sep 4. PMID: 37661745; PMCID: PMC10475872.

27. Sweatt K, Garvey WT, Martins C. Strengths and Limitations of BMI in the Diagnosis of Obesity: What is the Path Forward? Curr Obes Rep. 2024 Sep;13(3):584-595. doi: 10.1007/s13679-024-00580-1. Epub 2024 Jul 3. Erratum in: Curr Obes Rep. 2024 Dec;13(4):831. doi: 10.1007/s13679-024-00584-x. PMID: 38958869; PMCID: PMC11306271.

28. Bajpai A. Waist-to-Height Ratio-Time for a New Obesity Metric? Indian J Pediatr. 2022 Jun;89(6):534-535. doi: 10.1007/s12098-022-04173-5. Epub 2022 Mar 12. PMID: 35277810.

29. Bennasar-Veny M, Lopez-Gonzalez AA, Tauler P, Cespedes ML, Vicente-Herrero T, Yañez A, et al. Body adiposity index and cardiovascular health risk factors in Caucasians: a comparison with the body mass index and others. PLoS One. 2013 May 29;8(5):e63999. doi: 10.1371/journal.pone.0063999. PMID: 23734182; PMCID: PMC3667028.

30. Chen X, Geng S, Shi Z, Ding J, Li H, Su D, et al. Association of the CUN-BAE body adiposity estimator and other obesity indicators with cardiometabolic multimorbidity: a cross-sectional study. Sci Rep. 2024 May 8;14(1):10557. doi: 10.1038/s41598-024-52164-7. PMID: 38719889; PMCID: PMC11078937.

31. Bello-Chavolla OY, Antonio-Villa NE, Vargas-Vázquez A, Viveros-Ruiz TL, Almeda-Valdes P, Gomez-Velasco D, et al. Metabolic Score for Visceral Fat (METS-VF), a novel estimator of intra-abdominal fat content and cardio-metabolic health. Clin Nutr. 2020 May;39(5):1613-1621. doi: 10.1016/j.clnu.2019.07.012. Epub 2019 Jul 30. PMID: 31400997.

32. Holmes CJ, Racette SB. The Utility of Body Composition Assessment in Nutrition and Clinical Practice: An Overview of Current Methodology. Nutrients. 2021 Jul 22;13(8):2493. doi: 10.3390/nu13082493. PMID: 34444653; PMCID: PMC8399582.

33. Chen M, Liu J, Ma Y, Li Y, Gao D, Chen L, et al. Association between Body Fat and Elevated Blood Pressure among Children and Adolescents Aged 7-17 Years: Using Dual-Energy X-ray Absorptiometry (DEXA) and Bioelectrical Impedance Analysis (BIA) from a Cross-Sectional Study in China. Int J Environ Res Public Health. 2021 Sep 2;18(17):9254. doi: 10.3390/ijerph18179254. PMID: 34501843; PMCID: PMC8431661.

34. Li G, Hu Y, Zhang W, Wang J, Ji W, Manza P, et al. Brain functional and structural magnetic resonance imaging of obesity and weight loss interventions. Mol Psychiatry. 2023 Apr;28(4):1466-1479. doi: 10.1038/s41380-023-02025-y. Epub 2023 Mar 14. PMID: 36918706; PMCID: PMC10208984.

35. Bergman RN, Stefanovski D, Buchanan TA, Sumner AE, Reynolds JC, Sebring NG, et al. A better index of body adiposity. Obesity (Silver Spring). 2011 May;19(5):1083-9. doi: 10.1038/oby.2011.38. Epub 2011 Mar 3. PMID: 21372804; PMCID: PMC3275633.

36. Gallagher D, Heymsfield SB, Heo M, Jebb SA, Murgatroyd PR, Sakamoto Y. Healthy percentage body fat ranges: an approach for developing guidelines based on body mass index. Am J Clin Nutr. 2000 Sep;72(3):694-701. doi: 10.1093/ajcn/72.3.694. PMID: 10966886.

37. López-González AA, Jover AM, Martínez CS, Artal PM, Bote SA, Jané BA, Ramírez-Manent JI. The CUN-BAE, Deurenberg Fat Mass, and visceral adiposity index as confident anthropometric indices for early detection of metabolic syndrome components in adults. Sci Rep. 2022 Sep 15;12(1):15486. doi: 10.1038/s41598-022-19343-w. PMID: 36109524; PMCID: PMC9477854.

38. Huang L, Liu H, Li L, Wang S, Sun G. Correlation between visceral fat metabolism score and erectile dysfunction: a cross-sectional study from NHANES 2001-2004. Front Endocrinol (Lausanne). 2023 Dec 5;14:1283545. doi: 10.3389/fendo.2023.1283545. PMID: 38125791; PMCID: PMC10732023.

39. Mestre Font M, Busquets-Cortés C, Ramírez-Manent JI, Tomás-Gil P, Paublini H, López-González ÁA. Influence of Sociodemographic Variables and Healthy Habits on the Values of Insulin Resistance Indicators in 386,924 Spanish Workers. Nutrients. 2023 Dec 16;15(24):5122. doi: 10.3390/nu15245122. PMID: 38140381; PMCID: PMC10746000.

40. Ramírez-Manent JI, Altisench Jané B, Tomás Salvà M, Arroyo Bote S, González San Miguel HM, López-González ÁA. Influence of Educational Level and Healthy Habits on the Prevalence of Diabesity in a Spanish Working Population. Nutrients. 2022 Oct 2;14(19):4101. doi: 10.3390/nu14194101. PMID: 36235753; PMCID: PMC9573222.

41. Liu C, Wong PY, Chung YL, Chow SK, Cheung WH, Law SW, et al. Deciphering the "obesity paradox" in the elderly: A systematic review and meta-analysis of sarcopenic obesity. Obes Rev. 2023 Feb;24(2):e13534. doi: 10.1111/obr.13534. Epub 2022 Nov 28. PMID: 36443946.

42. García Agudo S, González Casquero R, Vallejos D, Eugercios Escribano H, Roberto Martín JA, Gil Llinas M. Relevancia de los índices aterogénicos como predictores precoces de riesgo cardiovascular en el contexto laboral de los profesionales sanitarios. Academic Journal of Health Sciences 2024;39 (5): 15-22 doi: 10.3306/AJHS.2024.39.05.15

43. Huang TX, Zhang LL, Wang JW, Liu CT. Correlation between the metabolic score for visceral fat and chronic obstructive pulmonary disease among middle-aged and elderly American population. Eur Rev Med Pharmacol Sci. 2024 Aug;28(15):4046-4059. doi: 10.26355/eurrev_202408_36636. PMID: 39194200.

44. Davila-Batista V, Molina AJ, Fernández-Villa T, Romaguera D, Pérez-Gómez B, Vilorio-Marqués L, et al. The Relation of CUN-BAE Index with

Body Mass Index and Waist Circumference in Adults Aged 50 to 85 Years: The MCC-Spain Study. Nutrients. 2020 Apr 3;12(4):996. doi: 10.3390/nu12040996. PMID: 32260185; PMCID: PMC7231053.

45. Hao X, He H, Tao L, Wang P. Using hyperhomocysteinemia and body composition to predict the risk of non-alcoholic fatty liver disease in healthcare workers. Front Endocrinol (Lausanne). 2023 Jan 6;13:1063860. doi: 10.3389/fendo.2022.1063860. PMID: 36686421; PMCID: PMC9852987.

46. Carpio Arias TV, Mogrovejo Arias DC, Nicolalde Cifuentes TM, Tapia Veloz EC, De Zeeuw CI, Vinueza Veloz MF. Sleep quality does not mediate the negative effects of chronodisruption on body composition and metabolic syndrome in healthcare workers in Ecuador. Diabetes Metab Syndr. 2021 Jan-Feb;15(1):397-402. doi: 10.1016/j.dsx.2021.01.017. Epub 2021 Feb 3. PMID: 33571890.

47. Cooper AJ, Gupta SR, Moustafa AF, Chao AM. Sex/Gender Differences in Obesity Prevalence, Comorbidities, and Treatment. Curr Obes Rep. 2021 Dec;10(4):458-466. doi: 10.1007/s13679-021-00453-x. Epub 2021 Oct 2. PMID: 34599745.

48. Koceva A, Herman R, Janez A, Rakusa M, Jensterle M. Sex- and Gender-Related Differences in Obesity: From Pathophysiological Mechanisms to Clinical Implications. Int J Mol Sci. 2024 Jul 4;25(13):7342. doi: 10.3390/ijms25137342. PMID: 39000449; PMCID: PMC11242171.

49. Wang C, Huang X, He S, Kuang M, Xie G, Sheng G, et al. The Clínica Universidad de Navarra-Body Adiposity Estimator index is a reliable tool for screening metabolic dysfunction-associated steatotic liver disease: an analysis from a gender perspective. Lipids Health Dis. 2024 Sep 27;23(1):311. doi: 10.1186/s12944-024-02299-3. PMID: 39334354; PMCID: PMC11438085.

50. Luengo Pérez LM, Urbano Gálvez JM, Pérez Miranda M. Validación de índices antropométricos alternativos como marcadores del riesgo cardiovascular. Endocrinol Nutr. 2009 Nov;56(9):439-46. Spanish. doi: 10.1016/S1575-0922(09)72964-X. PMID: 20096207.

51. Anekwe CV, Jarrell AR, Townsend MJ, Gaudier GI, Hiserodt JM, Stanford FC. Socioeconomics of Obesity. Curr Obes Rep. 2020 Sep;9(3):272-279. doi: 10.1007/s13679-020-00398-7. PMID: 32627133; PMCID: PMC7484407.

52. Sooriyaarachchi P, Jayawardena R, Pavey T, King NA. Shift work and the risk for metabolic syndrome among healthcare workers: A systematic review and meta-analysis. Obes Rev. 2022 Oct;23(10):e13489. doi: 10.1111/obr.13489. Epub 2022 Jun 22. PMID: 35734805; PMCID: PMC9539605.

53. Escaffi MJ, Cuevas A, Vergara K, Alonso R. Tabaco y peso corporal. Revista Chilena de Enfermedades Respiratorias 2017; 33(3): 249-251. https://dx.doi.org/10.4067/s0717-73482017000300249

54. Hartmann-Boyce J, Theodoulou A, Farley A, Hajek P, Lycett D, Jones LL, et al. Interventions for preventing weight gain after smoking cessation. Cochrane Database Syst Rev. 2021 Oct 6;10(10):CD006219. doi: 10.1002/14651858.CD006219.pub4. PMID: 34611902; PMCID: PMC8493442.

55. Gómez-Aranda C, García-Pérez A, González-Aragón ÁE, Reyes-Jiménez O. Asociación entre estrés laboral y dependencia nicotínica en trabajadores de la salud. Rev Med Inst Mex Seguro Soc. 2021 Nov 1;59(6):510-516. Spanish. PMID: 34908425.

56. Marques-Sule E, Miró-Ferrer S, Muñoz-Gómez E, Bermejo-Fernández A, Juárez-Vela R, Gea-Caballero V, et al. Physical activity in health care professionals as a means of primary prevention of cardiovascular disease: A STROBE compliant cross-sectional study. Medicine (Baltimore). 2021 Jun 4;100(22):e26184. doi: 10.1097/MD.0000000000026184. PMID: 34087883; PMCID: PMC8183826.

57. Konieczna J, Ruiz-Canela M, Galmes-Panades AM, Abete I, Babio N, Fiol M, et al. An Energy-Reduced Mediterranean Diet, Physical Activity, and Body Composition: An Interim Subgroup Analysis of the PREDIMED-Plus Randomized Clinical Trial. JAMA Netw Open. 2023 Oct 2;6(10):e2337994. doi: 10.1001/jamanetworkopen.2023.37994. PMID: 37851444; PMCID: PMC10585413.

58. Di Lorenzo L, Vimercati L, Pipoli A, Manghisi NM, Lampignano L, Caputi A, et al. Interplay Between Adherence to the Mediterranean Diet and Lipid Profile: A Comparative Survey Between Day-Time Healthcare and Non-healthcare Female Workers. Front Public Health. 2021 Nov 4;9:649760. doi: 10.3389/fpubh.2021.649760. PMID: 34805058; PMCID: PMC8599123.

59. Lugones-Sanchez C, Recio-Rodriguez JI, Agudo-Conde C, Repiso-Gento I, G Adalia E, Ramirez-Manent JI, et al. Long-term Effectiveness of a Smartphone App Combined With a Smart Band on Weight Loss, Physical Activity, and Caloric Intake in a Population With Overweight and Obesity (Evident 3 Study): Randomized Controlled Trial. J Med Internet Res. 2022 Feb 1;24(2):e30416. doi: 10.2196/30416. PMID: 35103609; PMCID: PMC8848250.

60. Dominguez LJ, Sayón-Orea C, Gea A, Toledo E, Barbagallo M, Martínez-González MA. Increased Adiposity Appraised with CUN-BAE Is Highly Predictive of Incident Hypertension. The SUN Project. Nutrients. 2021 Sep 22;13(10):3309. doi: 10.3390/nu13103309. PMID: 34684310; PMCID: PMC8537177.