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Original Article

Addressing health disparities. Measuring body composition as a complementary predictor of cardiovascular risk

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ABSTRACT

Introduction. Obesity, increased waist circumference and elevated visceral fat are positively correlated with cardiovascular disease (CVD) risk, in contrast to Mediterranean Diet. Objective: To analyze the association between increased waist circumference (WC), visceral fat (VF), body mass index (BMI), age, sex, total cholesterol, total fat percentage, muscle mass and adherence to a Mediterranean Diet.
Methods. 566 office workers with increased WC (WHO criteria) were included in this multicentre, cross-sectional observational study, when they attended to their job-specific health checkup in Madrid (2023). BMI and body fat distribution (VF, total fat and muscle mass) was obtained using bioimpedance (TANITA™). Sex, age, waist circumference, total cholesterol and PREDIMED questionnaire (adherence to Mediterranean diet) were also collected.
Results. 95.3% of the employees were obese or overweight (BMI). 76.3% had increased TF or were in the obese range. 63% had medium or low adherence to the Mediterranean diet. 50.5% had normal visceral fat. 51.2% had normal cholesterol levels. High VF showed a statistically significant association (P<0.001) with BMI ≥30 (obesity).Being male was associated to greater obesity (P<0.001), high VF (P<0.001) and lower adherence to the Mediterranean diet (P<0.03).Being a woman was associated to high TF (P<0.001).A low adherence to the Mediterranean diet was associated to more VF (P<0.017).
Conclusions. Individual CVR prediction can be completed by clinicians using tools like bioimpedance that considers sex, VF, TF, in addition to BMI and WC.
Keywords: abdominal circumference, mediterranean diet, obesity, total fat, visceral fat.

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Introduction

Obesity is a public health problem with a major impact on quality of life and healthcare costs worldwide[1-4]. Spain is no exception, where its prevalence is increasing, also in the working population[1,5,6].

For their classification we use different indeces such as body mass index (BMI)[7,8], waist circumference (WC)[7,9,10,] or visceral fat (VF)[2]. High levels of any of these (BMI ≥ 30 kg/m2, WC ≥ 88 cm in women and 102 cm in men and/or VF ≥ 13) are associated with increased risk of developing insulin resistance, diabetes mellitus and cardiovascular disease (CVD)[2-3,6-8,11-14].

In fact, all three indices are part of cardiovascular risk modifiers (CVR). The European Guideline on Cardiovascular Prevention of 2021[15] aims to improve the prediction (discrimination and reclassification) of a patient's CVR by evaluating these risk modifiers.

However, while BMI and WC are widely used, the same is not true for total body fat percentage (TF) or VF. The relationship between the four indices is not straightforward[2,16]. Furthermore, subclinical atherosclerosis[2] development may be affected differently by VF accumulation than BMI or TF percentage.

Recent studies indicate that accurate knowledge of specific body fat distribution may be more useful than BMI alone in the management of obesity. Analyze body fat and where it is located, may improve the estimation of CVR and better predict insulin resistance and its complications at the individual level[1-2]. For all these reasons, some authors consider the inclusion of this assessment in daily clinical practice to be a priority[8,12].

Bioimpedance analysis (BIA)[17-19] can help make this a reality. This method estimates the percentage of FT and FV in a few seconds. It is a non-invasive, inexpensive, and accessible technique for both the patient and the healthcare professional.

Accurate and individual information about the patient's CVR, can lead to the prescription of appropriate treatment and to improve their cardiometabolic health.

Regardless of this, it is known that benefits can be obtained through a multidisciplinary approach that combines increased physical activity and a proper diet[20]. Specifically, the Mediterranean diet[21-24], which is included among the recommended dietary patterns, it has shown positive effects on most CVRFs (decreases in BMI, WC, lipids, blood pressure and endothelial inflammatory markers).

On the other hand, dyslipidaemia[15,25-26] has been shown to be associated with atherogenesis. Currently, in healthy individuals, the desirable total cholesterol level is below 200 mg/dl. Although for CVR management and therapeutic decisions we rely on low-density lipoprotein or LDL-cholesterol levels. However, the specific association of total cholesterol or its fractions, dietary cholesterol with obesity and cardiovascular disease outcomes remains under review[27]. Some studies have found a positive relationship: the higher the visceral fat, the higher the total cholesterol levels[28].

The main objective of this study was to analyze the relationship between increased WC and other obesity indices (VF or obesity according to BMI) in individuals of different age, sex, total cholesterol, total fat percentage (TF) or muscle mass (MM).

In addition, the adherence to the Mediterranean diet was quantified to measure its relationship with the different obesity indices.

Methods

Study design. Population. Sample

A multicenter, cross-sectional observational study was performed to measure body composition among active workers in a multinational company in the Spanish banking sector. The workers who agreed to participate in our study, were selected by convenience, through attendance to their job-specific health checkup at their company's own Occupational Risk Prevention Service in the Community of Madrid (Spain) between April and December 2023.

A total of 5206 employees participated in the health examination at that time. For a confidence level of 95 % and with a margin of error of 5 %, the representative sample had to include data from at least 358 employees.

Inclusion criteria were being older than 18 years and having elevated WC according to WHO criteria[29] (WC ≥ 88 cm in women and 102 cm in men). Pregnant or postpartum women (none) and 14 individuals were excluded because we did not have all the study outcomes collected. Finally, 566 employees were included in the study, 10.87% of the total, after signing the authorization consent form.

Ethical considerations

All procedures were performed in accordance with the ethical standards of the 2013 Declaration of Helsinki on clinical research[30].

Confidentiality was always respected in accordance with the Spanish law on personal data protection 3/2018[31]. In addition, the employee´s permission was obtained to extract data, anonymously and globally, to conduct epidemiological studies.

Data collection

The occupational nursing staff collected pre specified demographic and clinical measures. Data were collected with WinMEDTRA software and exported to an anonymous Excel spreadsheet.

Variables and measurements

- Demographics. *Age*: in years. *Sex*: male or female.
- Clinical measures.

  WC (waist circumference)[29]: in centimeters (cm). A GulicK™ II tape measure model 67020 was used. The measurement was made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest.

  Height: in cm. A Seca™ measuring rod was used. Feet together, back straight, heels resting on the measuring rod. The head was in a position that allowed the lower margin of the orbit and the auricular fissure above the swallow to be in the same horizontal plane.

  Weight: in kilograms (kg). The individual was weighed using a Tanita BC 601[32] scale. The worker remained lightly clothed but took off his shoes and removed superfluous weight (pockets, belt, etc.). The individual's characteristics in terms of age, sex, height, and level of physical activity were entered to obtain personalized results. *BMI:* Was calculated automatically by the Tanita BC 601[32] scale based on the kg/m2 formula. Its categories according to the WHO are:

  - Normal: BMI between 18.50 and 24.9
  - Overweight: BMI between 25 and 29.9
  - Obesity: BMI ≥ 30

Body composition: the Tanita BC 601[32] scale took segmental readings of legs, arms, and trunk based on age, sex. Through bioimpedance it reported the following results that were read according to the manufacturer's indications:

a. Percentage of total fat (TF): see Figure 1.

b. Visceral Fat Index (VF): fat in the abdominal cavity. The following categories were considered according to the manufacturer:

- 0 to 12 healthy fat level.
- From 13 to 59 excessive fat level

c. Muscle mass (MM): Counts the amount of muscle in the body (kg).

Total cholesterol levels: blood samples were obtained by peripheral venipuncture after a 10-hour fasting period and were sent to the reference laboratory. They were processed within 48-72 hours.

Total cholesterol levels were determined by automated enzymatic methods and expressed in mg/dl:

- Normal: <200 mg/dl
- Elevated: ≥ 200 mg/dl

Dietary assessment: Adherence to the Mediterranean diet was assessed with the validated PREDIMED[33-34] questionnaire. It consists of 14 direct questions on the frequency and quantity of food consumption: olive oil, fruit, vegetables, pulses, fish, nuts, wine, white meat, red meat, processed meats, and industrial bakery products. Four categories were considered: high adherence 12 -14 points, medium[8 -11], low[5-7] and very low[5].

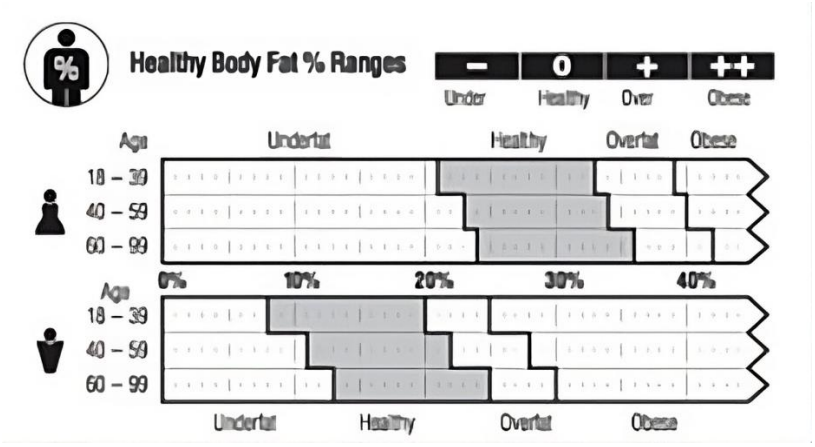

Figure 1. Percentage of total body fat (TF). Tanita Results.

Statistical analysis

Analyses were performed at the individual level. SPSS software version was used.

Quantitative variables were described using the mean and standard deviation (SD).

Qualitative variables were described using absolute frequency and relative frequency by percentages.

Chi-square tests were used to analyze relationships between prevalence of variables.

Results

566 workers were included: 43.9 % (246) were female and 56.1 % (320) male. Most people were 46-55 years old, representing 46.2 % (Table 1). The mean age was 47.84 ± 1.62 years (SD).

Table 1. Sample distribution according to age groups

Age (years)	Absolute Frequency (n)	Relative Frequency (%)
25-35	50	8.8
36-45	186	32.9
46-55	262	46.3
56-65	68	12
Total	566	100

According to their BMI, 95.4 % of individuals with increased WC were either obese (53.89 %) or overweight (41.52 %). Exceptionally, 26 workers (4.59 %) were classified as normal weight.

A total of 76.3 % of the sample had high percentage of TF or were in the obese range.

50.5 % had normal VF (286 employees) and 51.2 % had total cholesterol levels less than 200 mg/dl. A value was statistically significant if $p < 0.05$. Elevated GV and obesity established by BMI were statistically significantly related to $p < 0.001$ (Table 2).

Table 2. Sample distribution according to Visceral Fat Index (VF)

	Visceral fat		Total
BMI	Excess (n)	Normal (n)	
Normal weight	0	26	26
Overweight	219	86	305
Obese	61	174	235
Total	280	286	566

In terms of adherence to the Mediterranean diet, 63 % scored low or medium adherence. By sex, being male was associated with greater obesity (p <0.001), higher VF (p <0.001, Table 3) and lower adherence to the Mediterranean diet (p <0.03) tan being women.

Table 3. Visceral Fat Index (VF) according to sex

	Visceral Fat		Total
Sex	Excess (n)	Normal (n)	
Women	24	222	246
Men	256	64	320
Total	280	286	566

Female sex was statistically significantly (p < 0.001) related to having higher TF (Figure 2). Increased VF was associated with lower adherence to the Mediterranean diet (p < 0.017).

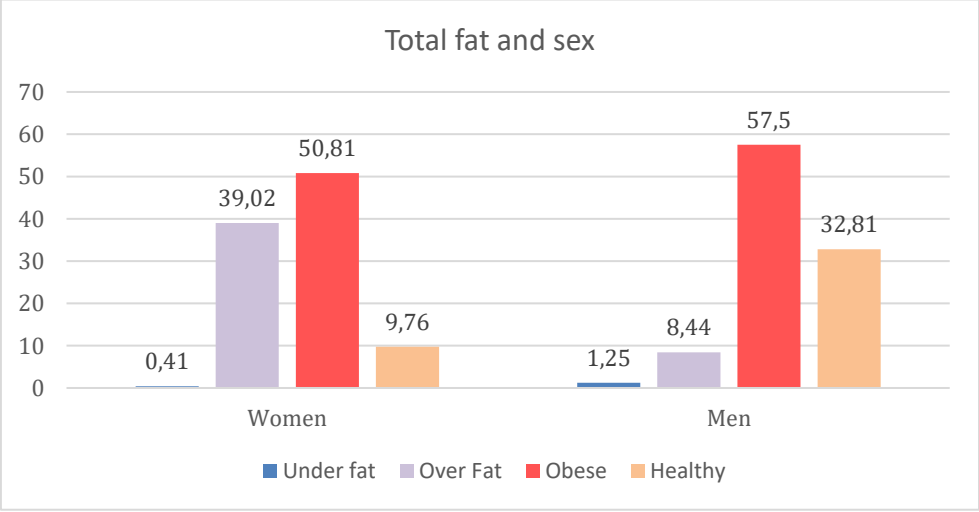

Figure 2. Percentage of total fat (TF) and sex

Discussion

Of the 5206 individuals who participated in their occupational health checkup, 580 employees, 11.14 %, had abdominal obesity based on waist circumference. 566 were included in the study, 10.87 %. The remaining 14 individuals, 0.27 %, were excluded because they did not have all the study outcomes collected.

As this is a specific population, active office workers with criteria for abdominal obesity, we consider the sample size of this study to be adequate. It exceeds some of the studies consulted, such as that published by Jabłonowska-Lietz et al.[13], whose sample size was 106 obese individuals, or that of Strauss et al.[10] which was 46 German office workers.

However, it is smaller than other studies, conducted in the Spanish working population. A 2006 study[5] analyzed the prevalence of CVRF in the Spanish working population in a sample of 216,914 workers. López-González et al.[6] examined the coexistence of obesity and diabetes in 420,000 workers in their 2022 study. However, these authors included workers from all sectors, and they did not select the sample based on body composition or BMI.

The prevalence of obesity in the Spanish working population varies according to the study consulted and the index used to measure it[1,4-6]. Sanchez-Chaparro´s[5] study found that 14.9% of workers had abdominal obesity, with more men (15.5%) than women (13.3%). In Goday-Arnó's research[1] the obesity rate was 14.5 % (17 % in men, 7.7 % in women). It was higher in primary sector workers than in tertiary sector workers (16.4 % versus 10.9 %). In the study by López-González et al.[6], using BMI, obesity also affected more men (19.6 %) than women (16.4 %). However, if the Deuremberg fat mass index was applied, the opposite was true: 68.5 % of Spanish female workers met the criteria for obesity compared to 48.2 % of male workers.

The prevalence results obtained in this research are lower: 11.14 % of the active workers who underwent occupational health screening showed abdominal obesity according to WC. The figures do agree with those published specifically in the tertiary/non-manual[1] working population, which are lower than those reported by workers in the primary or manual sector.

Regarding age, our results agree with previous findings: waist circumference tends to increase over the years[5].More than the half of the workers studied, 58.3 % were over 45 years old.

Likewise, the gender differences observed in this study is in line with previous studies[6]: there were more men, and they also had a higher percentage of individuals with BMI ≥ 30 and a higher VF index, while women had a higher percentage of high TF.

According to BMI, 26 workers, 4.5 %, were classified as normal weight. These results are consistent with the findings observed in other investigations[7], where 3 % of individuals with normal weight were diagnosed of abdominal obesity.

In all normal weight workers, bioimpedance analysis showed a healthy VF index despite increased WC. This percentage decreased as the BMI increased. In the case of overweight, 74.04 % of workers had VF in healthy range, as well as 28.3 % of obese.

76.3 % had elevated TF or in the obese range while only 49.5 % had VF in the unhealthy range. In addition, having excess VF was statistically significantly related to obesity according to BMI. The accumulation of adipose tissue in the upper body[3-13] (abdominal region) is associated with the development of obesity-related comorbidities and even all-cause mortality. We therefore consider this difference in percentages relevant to clinical practice.

Regarding adherence to the Mediterranean diet, the conclusions of this study are like those published by George et al[23]. Their nutritional intervention, based on the Mediterranean diet, found significant improvements in participants' VF. In our study, workers with a lower adherence to the Mediterranean diet showed higher VF.

More than half of the workers had total cholesterol levels in the desirable range, 51.2 %. In contrast to what was published by Lupattelli et al[28], no statistically significant differences were observed in our study between total cholesterol levels and the different obesity indices.

Limitations of the study

Some of the limitations of this study relate to the efficacy of body composition analysis at the population level. A validated cut-off value for the bioimpedance VF index associated with cardiometabolic risk in the European population is still to be determined[8]. Further research is needed. In this analysis only total cholesterol levels were considered whereas cholesterol fractions were not.

Conclusions

- Increased waist circumference affects mainly the middle-aged population (46-55 years), more men than women.
- Increased waist circumference is related to obesity and overweight, high total fat and low or medium adherence to the Mediterranean diet.
- High visceral fat level is correlated to obesity according to BMI, and low adherence to the Mediterranean diet.
- According to sex, men had a higher level of obesity, higher visceral fat and lower adherence to the Mediterranean diet, while women had higher total fat.

Beyond BMI and WC, we consider it necessary to personalize the estimation of individual cardiovascular risk according to gender, body composition and fat location (percentage of total fat and/or visceral fat), to reduce the limitations of these indexes or the classic CVRFs. Occupational Risk Prevention Services can make a difference because they have an easy access to working population.

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