Determination of Cardiovascular Risk in 56,262 Spanish Construction Workers

Cardiovascular Risk in Construction Workers

Ángel Arturo López-González, PhD, Pere Riutord Sbert, PhD, Sebastiana Arroyo Bote, PhD, Hilda González San Miguel, PhD, Carmen Vidal Real, PhD, and José Ignacio Ramirez-Manent, PhD

Objective: To evaluate different cardiovascular risk scales in construction workers. **Methods:** A descriptive, cross-sectional study was carried out in 56,262 Spanish construction workers. Scales of obesity and fatty liver, metabolic syndrome, atherogenic indices, and cardiovascular risk scales, among others, were assessed. **Results:** In women, 19.6% were obese, 18.2% hypertensive, 12.6% had metabolic syndrome, 12% were at high risk of non-alcoholic fatty liver disease, and 4.3% were at moderate or high risk on the SCORE scale. In men, 20.1% were obese, 30.1% hypertensive, 17.5% had metabolic syndrome, and 27.6% had high or moderate risk on the SCORE scale. **Conclusions:** Knowing the cardiovascular risk of a large number of construction workers by means of a large number of scales may be of great interest to occupational health professionals, as it may enable them to establish prevention strategies.

Keywords: abdominal obesity, cardiovascular disease, fatty liver, hypertension, metabolic syndrome

According to the data from the human resources company Randstad,[1] Spain employed 1,276,400 construction workers in 2019, which represents 6.4% of the total number of people employed. These data indicate the importance of this sector in the national economy. Most of these workers are men, although women represent around 9% of the total, according to EPA data, from the last quarter of 2018.[2]

From the Department of ADEMA University School Palma, Balearic Islands, Spain (Dr López-González, Dr Sbert, Dr Arroyo, Dr Miguel, Dr Real); Balearic Islands Health Service (Dr Ramirez-Manent); University of the Balearic Islands, Balearic Islands, Spain (Dr Ramirez-Manent).

Ángel Arturo López-González, PhD, Vice-President of Royal Academy of Medicine of the Balearic Islands, Occupational Health Physician, Titular professor of ADEMA University School. 0000-0002-7439-8117.

Pere Riutord Sbert, PhD, Academic Numeric of Royal Academy of Medicine of the Balearic Islands, Titular professor of ADEMA University School. 0000-0003-2135-9699.

Sebastiana Arroyo Bote, PhD, Titular professor of ADEMA University School. 0000-0002-5549-7697.

Hilda González San Miguel, PhD, Titular professor of ADEMA University School. 0000-0002-7759-2206.

Carmen Vidal Real, PhD, Titular professor of ADEMA University School.

José Ignacio Ramirez-Manent, PhD, Associate professor faculty of Medicine of the Balearic Islands, Primary Care Physician. 0000-0001-6887-4562.

Authors' Contributions: Conceptualization: AALG, PRS, Data collection and analysis: SAB, HGSM, Methodology: JIRM, CVR, Draft: JIRM, AALG, Revision PRS, HGSM, SAB.

The article has not had any source of funding

The authors report no conflicts of interest.

Clinical Significance: The assessment of cardiovascular risk with such a large number of scales and in such a large sample is of great interest to occupational health professionals and can serve as a reference for subsequent studies, either in this little-studied group or in other occupational groups.

Address correspondence to: Ángel Arturo López-González, PhD, ADEMA University School, Gremi Passamaners 11 2° 07009 Palma, Balearic Islands, Spain (angarturo@gmail.com).

DOI: 10.1097/JOM.0000000000002402

In Spain, cardiovascular diseases are the most important cause of morbidity and mortality and represent a major public health problem that requires the establishment of strategies focused on reducing its incidence. Interventions targeting the so-called modifiable risk factors are considered a primary prevention strategy with a large body of scientific, epidemiological, and clinical evidence supporting their effectiveness.[3]

There is a multifactorial epidemiological pattern in these diseases that we find in most cases, among which we would highlight tobacco use, arterial hypertension, hypercholesterolemia, diabetes, and obesity. It is also possible to find other possible risk factors such as socioeconomic, environmental, and occupational conditions.[4]

Traditionally, it has been considered that this group of workers, belonging to the most disadvantaged social classes, have inadequate lifestyles which, in principle, should be reflected in high levels of cardiovascular risk.[5]

The objective of this study was to determine the level of cardiovascular risk in a large group of construction workers of both sexes, assessing the influence of sociodemographic variables such as age, gender, and tobacco consumption.

METHODS

A descriptive, cross-sectional study was performed in 57,386 Spanish construction workers between January 2019 and December 2019. A 1124 of them were excluded (167 for not agreeing to participate, 230 for a history of previous cardiovascular event, and 727 for lacking any of the parameters necessary to calculate the different cardiovascular risk scales), leaving 56,262 workers. A 2595 were women (mean age 41.1 years) and 53,667 were men (mean age 41.6 years). See flow chart in Figure 1.

The workers were selected from among those who attended periodic occupational medical check-ups.

Inclusion Criteria

- Age between 18 and 67 years.
- Give consent to participate in the study and the use of the data for epidemiological purposes.
- Not having suffered previous cardiovascular events.

Anthropometric, clinical, and analytical determinations were carried out by the healthcare professionals of the different occupational health units that participated in the study, after standardizing the measurement techniques.

The following parameters were included in the assessment:

- Weight (in kg) and height (in cm) are determined with a SECA model 700 scale and a SECA 220 measuring rod.
- Abdominal waist circumference (in cm) is measured with a SECA model 200 tape measure. For the waist-to-height ratio, the cutoff point is set at 0.50.[6]
- Blood pressure is measured in the decubitus supine position with a calibrated OMRON M3 automatic sphygmomanometer and

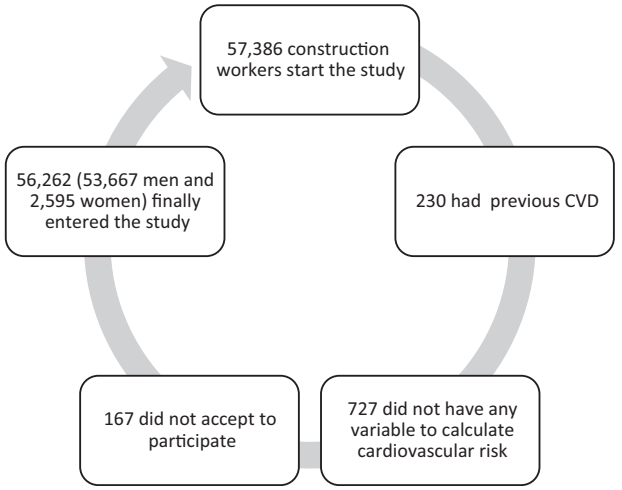

FIGURE 1. Participant flow chart.

after a 10-minute rest period. Three determinations are made at 1 minute intervals, obtaining the mean of the three hypertension is considered when the values are equal/higher than 140 mmHg systolic or 90 mmHg diastolic blood pressure or if the worker is receiving antihypertensive treatment.[7]

- Blood glucose, total cholesterol, and triglycerides are determined by peripheral venipuncture after fasting for at least 12 hours. Glycemia, total cholesterol, and triglycerides are determined by automated enzymatic methods. High-density lipoprotein (HDL) is determined by precipitation with dextran sulfate Cl2Mg and low-density lipoprotein (LDL) is calculated using the Friedewald formula (provided that triglycerides are less than 400 mg/dL). All the above values are expressed in mg/dL.

Friedewald formula: LDL-c = total cholesterol − HDL-c − triglycerides/5

The following are considered altered values: 200 mg/dL for cholesterol, 130 mg/dL for LDL, and 150 mg/dL for triglycerides or if they are under treatment for any of these analytical alterations.[8]

Blood glucose values are classified according to the criteria of the American Diabetes Association[9] and are considered to be diabetes at 126 mg/dL or if they are receiving hypoglycemic treatment.

Body mass index (BMI) is calculated by dividing weight by height in meters squared. Obesity is considered to be 30 kg/m^2 or more.

We use different scales to estimate the percentage of body fat:

- CUN BAE[10] (Clínica Universitaria de Navarra Body Adiposity Estimator)
  $-44{,}988 + (0.503 \times \text{age}) + (10.689 \times \text{gender}) + (3.172 \times \text{BM-}$
  $(3.172 \times \text{BMI}) - (0.026 \times \text{BMI}^2) + (0.181 \times \text{BMI} \times \text{gender}) -$
  $\text{BMI} \times \text{gender}) - (0.02 \times \text{BMI} \times \text{age}) - (0.005 \times \text{BMI}^2 \times \text{gend-}$
  $\times \text{BMI}^2 \times \text{gender}) + (0.00021 \times \text{BMI}^2 \times \text{age})$
  Male = 0 Female = 1
- ECORE-BF[11] (Equation COrdoba Estimator Body Fat)
  $-97.102 + 0.123$ (age) $+ 11.9$ (gender) $+ 35.959$ (LnBMI)
  Male = 0 Female = 1
- Palafolls formula[12]
  Men = (BMI/waist] × 10) + BMI. Women = (BMI/waist] × 10) + BMI + 10.
- Deuremberg formula[13]
  $1.2 \times (\text{BMI}) + 0.23 \times (\text{age}) - 10.8 \times (\text{gender}) - 5{,}4$ Male = 0 Female = 1
- Relative fat mass[14]

Women: $76 - (20 \times (\text{height/waist}))$ Men: $64 - (20 \times (\text{height/waist}))$

Other indicators related to overweight and obesity:

Visceral adiposity index[15] (VAI)

$$\text{Females}: \text{VAI} = \left(\frac{\text{WC}}{36.58 + (1.89 \times \text{BMI})}\right) \times \left(\frac{\text{TG}}{0.81}\right) \times \left(\frac{1.52}{\text{HDL}}\right).$$

$$\text{Males}: \text{VAI} = \left(\frac{\text{WC}}{39.68 + (1.88 \times \text{BMI})}\right) \times \left(\frac{\text{TG}}{1.03}\right) \times \left(\frac{1.31}{\text{HDL}}\right)$$

Body roundness index[16] $\text{BRI} = 364.2 - 365.5 \times \sqrt{1 - [(\text{waist}/(2\pi)2)/(0.5 \times \text{height})^2]}$

Body surface index[17] (BSI). BSA is calculated using the DuBois formula where w (weight) represents weight in kg and h (height) represents the height in cm. $BSA = w^{0.425} * h^{0.725} * 0.007184$ $BSI = \frac{WEIGHT}{18\sqrt{BSA}}$

Conicity index[18]

$$\frac{\text{waist circumference (in meters)}}{0.109} \times 1/\sqrt{\frac{\text{weight (in kilogram)}}{\text{height (in meters)}}}$$

Body shape index[19] (ABSI)

$$ABSI \equiv \frac{WC}{BMI^{2/3} \times height^{1/2}}$$

Other indicators related to cardiovascular risk:

Triglyceride glucose index,[20] Triglyceride glucose index-IBMI, Triglyceride glucose index-waist[21]

$$\text{TyGindex} = \text{LN}\,(\text{TG[mg/dl]} \times \text{glycaemia [mg/dl]}/2).$$
$$\text{TyGindex} - \text{IMC} = \text{TyGindex} \times \text{BMI}$$
$$\text{TyGindex} - \text{pcintura} = \text{TyGindex} \times \text{waist}$$

Waist triglyceride index[22]

$$\text{waist(cm)} \times \text{triglycerides (mmol)}$$

Cardiometabolic index[23]

$$WtWR/(Triglycerides/HDL\text{-}c)$$

Fatty liver scales include:

Fatty liver index[24]

$$\text{FLI} = (e^{0.953*\log e^{(\text{triglycerides})+0.139*\text{BMI}+0.718*\log e^{(\text{ggt})+0.053*\text{waist}}}} \text{ circumference} - 15.745)/1 + e^{0.953*\log e^{(\text{triglycerides})+0.139*\text{BMI}+0.718*\log e^{(\text{ggt})+0.053*\text{waist}}}} \text{ circumference} - 15.745) \times 100$$

Lipid accumulation product[25]

- Men: (waist (cm) − 65) × (triglycerides (mMol)).
- Women: (waist (cm) − 58) × (triglycerides (mMol)).

The atherogenic indexes determined were:

Cholesterol/HDL (considered as high values >5 in men and >4.5 in women),

LDL/HDL and triglycerides/HDL (high values >3)

Cardiometabolic indicators:

Hypertriglyceridemic waist phenotype[26]

Waist > 102 cm (men) > 88 cm (women)
and
Triglycerides > 150 mg/dl o treatment
of hipertriglyceridemic

Metabolic syndrome was determined using three models:

a) NCEP ATP III (National Cholesterol Educational Program Adult Treatment Panel III), which considers metabolic syndrome when three or more of the following factors are present: waist circumference is greater than 88 cm in women and 102 in men; triglycerides >150 mg/dL or specific treatment for this lipid disorder; blood pressure >130/85 mm Hg; HDL <40 mg/dL in women or <50 mg/dL in men or specific treatment is followed, and fasting blood glucose >100 mg/dL or specific glycaemic treatment.
b) The International Diabetes Federation[27] (IDF), which considers the presence of central obesity necessary, defined as a waist circumference of >80 cm in women and >94 cm in men, in addition to two of the other factors mentioned above for ATP III (triglycerides, HDL, blood pressure, and glycemia).
c) The JIS model,[28] which follows the same criteria as NCEP ATPIII but the waist circumference cutoff points start at 80 cm in women and 94 cm in men.

Atherogenic dyslipidemia[29] is characterized by high triglyceride concentrations (>150 mg/dL), low HDL (<40 mg/dL in men and <50 mg/dL in women), and normal or slightly elevated LDL. If LDL values are high (>160 mg/dL) we speak of lipid triad.

The cardiovascular risk scales used were:

REGICOR scale is an adaptation of the Framingham scale to the Spanish population[30] and assesses the risk of suffering a cerebrovascular event over a 10-year period. It can be applied between 35 and 74 years of age. The risk is considered moderate at 5% or above and high at 10% or above[31].

The SCORE scale for low-risk countries is used in Spain[32,33] and determines the risk of suffering a fatal cerebrovascular event in a 10-year period. It can be calculated between 40 and 65 years of age. Moderate risk is defined at 4% and high risk at 5% or above. For vascular age, calibrated Tables[34] are used to assess the degree of aging of the arteries and can be calculated from the age of 30 years. Vascular age with the Framingham model to calculate it we need age, sex, HDL-c, total cholesterol, systolic blood pressure values, antihypertensive treatment, smoking, and diabetes. It can be calculated from the age of 30 years.

Vascular age with the SCORE model.[35] For its calculation, age, sex, systolic blood pressure, smoking, and total cholesterol are used. As with the scale from which it is derived, it can be calculated in persons between 40 and 65 years of age.

An interesting concept applicable to both vascular ages is ALLY[36] which can be defined as the difference between biological age and vascular age.

A smoker is considered to be any person who has regularly consumed at least 1 cigarette/day (or the equivalent in other types of consumption) in the last month, or has quit smoking less than 12 months ago.

Statistical Analysis

A descriptive analysis of the categorical variables was performed, calculating the frequency and distribution of responses for each of them. For quantitative variables, the mean and standard deviation were calculated, and for qualitative variables, the percentage was calculated. The bivariate association analysis was performed using the χ^2 test (with correction of Fisher exact statistic when conditions required so) and Student *t* test for independent samples. For the multivariate analysis, binary logistic regression was used with the Wald method, with the calculation of the Odds ratio and the Hosmer–Lemeshow goodness-of-fit test. The statistical analysis was performed with the SPSS 27.0 program, with an accepted statistical significance level of 0.05.

Ethical Aspects

The study was approved by the Clinical Research Ethics Committee of the Illes Balears health area no. IB 4383/20. All procedures were performed in accordance with the ethical standards of the institutional research committee and with the 2013 Declaration of Helsinki. All patients signed written informed consent documents prior to their participation in the study.

RESULTS

The mean values of the different parameters analyzed were significantly higher in men, with the exception of total cholesterol. The percentage of smokers is somewhat higher in women, although without statistically significant differences. The complete data on the characteristics of the sample are presented in Table 1.

The mean values of all the scales analyzed (overweight-obesity, fatty liver, cardiovascular risk scales, metabolic indicators, and atherogenic indices) are generally much higher in men, these differences being statistically significant in all cases. Only the percentage of body fat presented higher values in women, as is well known. The complete data are presented in Table 2.

The prevalence of altered values for all the scales follows a pattern similar to that seen with the mean values, that is, higher values generally among men and with statistically significant differences. We highlight the high rates of obesity with all the scales in

TABLE 1. Characteristics of Construction Workers by Sex

	Women n = 2595 Mean (SD)	Men n = 53667 Mean (SD)	*P* value
Age	41.1 (10.1)	41.6 (10.7)	0.048
Height	161.7 (6.9)	173.6 (6.9)	<0.0001
Weight	68.9 (15.4)	80.6 (14.5)	<0.0001
Waist circumference	76.9 (10.6)	85.6 (11.12)	<0.0001
Systolic blood pressure	117.8 (15.9)	129.2 (15.9)	<0.0001
Diastolic blood pressure	72.7 (10.6)	78.2 (11.0)	<0.0001
Total cholesterol	193.4 (37.0)	193.6 (39.7)	0.734
HDL-c	56.7 (8.2)	50.2 (8.3)	<0.0001
LDL-c	117.2 (36.4)	118.9 (37.5)	0.022
Triglycerides	97.5 (53.3)	125.9 (95.8)	<0.0001
Glycemia	88.1 (19.3)	94.9 (22.5)	<0.0001
GGT	21.71 (31.4)	39.2 (46.5)	<0.0001
	Percentage	**Percentage**	***P* value**
18–29 y	14.3	14.8	<0.0001
30–39 y	29.3	28.0	
40–49 y	35.3	31.9	
50–69 y	21.1	25.3	
Non-smokers	65.4	65.7	0.748
Smokers	34.6	34.3	

GGT, Gamma-glutamyl transpeptidase; HDL-c, High-density lipoprotein cholesterol; LDL-c, Low-density lipoprotein cholesterol.

TABLE 2. Mean Values of the Different CVR Scales According to Sex in Construction Workers

	Women n = 2595 Mean (SD)	Men n = 53667 Mean (SD)	*P* value
Waist to height ratio	0.48 (0.06)	0.49 (0.6)	<0.0001
Body mass index	26.3 (5.6)	26.7 (4.4)	<0.0001
CUN BAE	36.7 (7.3)	25.7 (6.5)	<0.0001
ECORE-BF	36.7 (7.6)	25.7 (6.2)	<0.0001
Relative fat mass	33.2 (5.4)	22.8 (5.0)	<0.0001
Palafolls formula	39.8 (5.9)	29.8 (4.6)	<0.0001
Deuremberg formula	35.7 (7.5)	25.4 (6.3)	<0.0001
Body surface index	52.1 (8.8)	57.5 (7.8)	<0.0001
Body roundness index	3.0 (1.2)	3.3 (1.2)	<0.0001
Body shape index	0.069 (0.005)	0.073 (0.006)	<0.0001
Visceral adiposity index	3.0 (2.0)	7.5 (7.0)	<0.0001
Conicity index	1.1 (0.1)	1.2 (0.1)	<0.0001
Fatty liver index	23.1 (25.0)	38.3 (27.6)	<0.0001
Lipid accumulation product	22.4 (22.8)	31.5 (35.2)	<0.0001
Triglyceride glucose index	8.2 (0.5)	8.5 (0.6)	<0.0001
Triglyceride glucose index-BMI	218.3 (53.5)	228.3 (46.6)	<0.0001
Triglyceride glucose index-waist	635.4 (107.7)	729.8 (120.5)	<0.0001
Triglyceride glucose index-WtHR	3.9 (0.7)	4.2 (0.7)	<0.0001
Waist triglyceride index	86.3 (54.6)	124.0 (100.7)	<0.0001
ALLY vascular age SCORE	4.2 (5.0)	7.9 (7.0)	<0.0001
SCORE scale	0,4 (0.9)	1.8 (2.3)	<0.0001
ALLY vascular age Framingham	1.7 (12.3)	6.8 (10.6)	<0.0001
REGICOR scale	2.4 (2.1)	3.4 (2.3)	<0.0001
n° factors of metabolic syndrome NCEP ATPIII	1.0 (1.2)	1.3 (1.2)	<0.0001
n° factors of metabolic syndrome JIS	1.1 (1.2)	1.8 (1.3)	<0.0001
Cardiometabolic index	0.9 (0.7)	1.3 (1.3)	<0.0001
Atherogenic index total cholesterol/HDL-c	3.5 (1.0)	4.0 (1.2)	<0.0001
Atherogenic index triglycerides/HDL-c	1.8 (1.2)	2.7 (2.3)	<0.0001
Atherogenic index LDL-c/HDL-c	2.1 (0.8)	2.5 (1.0)	<0.0001

ALLY, Avoidable lost life years; CUN BAE, Clinica Universidad de Navarra-Body Adiposity Estimator; ECORE-BF, Equation Cordoba for Estimation of Body Fat; HDL-c, High-density lipoprotein cholesterol; LDL-c, Low-density lipoprotein cholesterol; NCEP ATPIII, Nationa Cholesterol Education Program Adult Treatment Panel III; REGICOR, Registre Gironi del Cor.

both sexes and the high prevalence of hypertension, over 30%, and hypercholesterolemia, over 41% in men. These figures are very high for a population with an average age of somewhat above 40 years. The total data can be consulted in Table 3.

In the multivariate analysis the variable that shows a relationship with all the scales is age with odds ratio ranging from 1.36 (CI 95% 1.31–1.41) for obesity with the RFM model to 14.08 (CI 95% 13.25–14.96) for REGICOR scale moderate-high and 67.92 (CI 95% 61.34–75.20) for SCORE scale moderate-high. Male gender affects all scales except total cholesterol greater than 200 mg/dL, IDF metabolic syndrome, and atherogenic dyslipidemia. All data are available in Table 4.

DISCUSSION

This study presents the variables related to cardiovascular risk in construction workers of both sexes. The results show that the overall cardiovascular risk level of these workers can be considered high, especially in the group of men.

Most of the parameters analyzed show a higher prevalence of altered values than expected in a group of people with an average age that is not too high.

The prevalence of smokers in this study is 34.6% in women and somewhat higher in men (36.1%), which is higher than those shown in a Dutch study[37] carried out with 20 male workers in which the prevalence was 32%; however, it is lower than other results shown in most of the studies analyzed, thus a study from Hong Kong[38] of 927 workers, of whom 124 were women, presented a prevalence of 38.4% while another also from Hong Kong[39] of 626 workers, with 9.8% women, raised the figure to 40.1%. A similar prevalence to the above (40.1%) was found in a Belgian study[40] of 9952 workers (1.3% women) and in another Swedish study of 84741 workers where the prevalence increased to 41%.[41] Much higher prevalences have been found in 330 Catalan workers[42] (45.4%), in 75,236 Sweden[43] (more than 50%), 19,943 Germans[44] (57.3%), 16,520 in another German study[45] (58%), and in another 75 Murcians[46] (68%)

The prevalence of obesity that we have found with the different scales is high. As we have not found studies that analye obesity with body fat estimation scales in construction workers, we will only compare our results using BMI and waist height index. In our study, the prevalence of obesity using BMI is 20.1% in men and 19.6% in women. These values are higher than those found in different studies: 6.5% in the Hong Kong study,[38] 14.8% (11.5% in women and 17.9% in men) in 54 Ecuadorian workers,[47] 15% in the Belgiam study,[45] 15.5% (8.5% in women and 18.3% in men) in the Spanish population,[48] and 17% among the Dutch study.[37] The values were similar to those found in Belgian workers[40] with a prevalence of 19.8%, and lower than those found in 983 Irish workers[49] (21.8%) and in Murcia[46] with 27.4%. The abdominal obesity we found was 41.5% in men and 27.4% in women, which is much higher than that found in another Spanish study.[48]

The prevalence of high blood pressure that we observed was 30.1% among men and 18.2% among women. These values are higher than those found by other authors: 8.8% in women and 27% in men Spanish workers,[48] 24.2% in Catalan workers,[42] and 25.4% in

TABLE 3. Prevalence of Altered Values of the Different CVR Scales by Sex in Construction Workers

	Women n = 2595 % (CI 95)	Men n = 53667 % (CI 95)	*P* value
Waist to height ratio >0.50	27.4 (26.9–27.9)	41.5 (41.3–41.7)	<0.0001
Body mass index obesity	19.6 (19.0–20.2)	20.1 (20.0–20.2)	<0.0001
CUN BAE obesity	57.6 (56.9–58.5)	53.3 (53.2–53,4)	<0.0001
ECORE-BF obesity	56.5 (55.5–57.5)	53.3 (53.2–53.4)	<0.0001
Relative fat mass obesity	43.5 (42.8–44.2)	51.5 (51.4–51.6)	<0.0001
Palafolls formula obesity	78.4 (77.4–79.8)	87.2 (87.1–87.2)	<0.0001
Deuremberg formula obesity	76.1 (74.6–77.6)	50.2 (50.1–50.3)	<0.0001
Hypertension	18.2 (17.8–18.6)	30.1 (30.0–30.2)	<0.0001
Total cholesterol ≥200 mg/dL	39.3 (38.7–39.9)	41.5 (41.4–41.6)	0.030
LDL-c ≥130 mg/dL	32.7 (32.2–33.2)	37.5 (37.4–37.6)	<0.0001
Triglycerides ≥150 mg/dL	10.9 (10.6–11.3)	24.7 (24.6–24.8)	<0.0001
Glycemia 100–125 mg/dL	11.4 (11.1–11.7)	22.0 (21.9–22.1)	<0.0001
Glycemia ≥126 mg/dL	2.3 (2.2–2.4)	4.3 (4.3–4.3)	<0.0001
Metabolically healthy	46.6 (45.6–47.6)	28.7 (28.6–28.8)	<0.0001
Metabolic syndrome NCEP ATPIII	12.6 (12.3–12.9)	17.5 (17.4–17.6)	<0.0001
Metabolic syndrome IDF	12.0 (11.6–12.4)	13.2 (13.1–13.3)	0.040
Metabolic syndrome JIS	14.1 (13.7–14.5)	28.7 (28.6–28.8)	<0.0001
Atherogenic dyslipidemia	6.3 (6.1–6.3)	7.5 (7.5–7.6)	0.024
Lipid triad	1.6 (1.5–1.7)	2.3 (2.3–2.3)	0.019
Hipertriglyceridemic waist	3.3 (3.1–3.5)	8.5 (8.4–8.6)	<0.0001
Atherogenic index total cholesterol/HDL-c moderate-high	13.9 (13.4–14.5)	17.4 (17.3–17.5)	<0.0001
Atherogenic index triglycerides/HDL-c high	9.8 (9.4–10.2)	27.3 (27.2–27.4)	<0.0001
Atherogenic index LDL-c/HDL-c high	14.6 (14.2–15.0)	27.2 (27.1–27.3)	<0.0001
SCORE scale moderate-high	4.3 (4.1–4.5)	27.6 (27.5–27.8)	<0.0001
REGICOR scale moderate-high	12.0 (11.7–12.4)	23.1 (23.0–23.3)	<0.0001
Fatty liver index high risk	12.0 (11.6–12.4)	25.0 (24.9–25.1)	<0.0001

CUN BAE, Clinica Universidad de Navarra-Body Adiposity Estimator; ECORE-BF, Equation Cordoba for Estimation of Body Fat; HDL-c, High-density lipoprotein cholesterol; IDF, International Diabetes Federation; JIS, Joint Interim Statement; LDL-c, Low-density lipoprotein cholesterol; NCEP ATPIII, Nationa Cholesterol Education Program Adult Treatment Panel III; REGICOR, Registre Gironi del Cor; SCORE, Systematic Coronary Risk Evaluation.

TABLE 4. Logistic Regression Analysis

	Age (≥50 years)		Male		Smokers	
	OR (CI 95%)	*P* value	OR (CI 95%)	*P* value	OR (CI 95%)	*P* value
Waist to height ratio >0.50	1.40 (1.34–1.45)	<0.0001	1.86 (1.70–2.03)	<0.0001		ns
Body mass index obesity	1.70 (1.63–1.78)	<0.0001	0.88 (0.80–0.96)	0.007		ns
CUN BAE obesity	3.63 (3.48–3.79)	<0.0001	0.79 (0.73–0.86)	<0.0001	0.93 (0.90–0.97)	0.024
ECORE-BF obesity	3.54 (3.39–3.69)	<0.0001	0.83 (0.76–0.90)	<0.0001	0.93 (0.90–0.97)	<0.0001
Relative fat mass obesity	1.36 (1.31–1.41)	<0.0001	1.37 (1.26–1.48)	<0.0001		ns
Palafolls formula obesity	2.15 (2.01–2.30)	<0.0001	1.84 (1.67–2.03)	<0.0001	0.90 (0.86–0.95)	<0.0001
Deuremberg formula obesity	7.36 (7.01–7.73)	<0.0001	0.26 (0.24–0.29)	<0.0001	0.93 (0.90–0.97)	<0.0001
Hypertension	3.28 (3.15–3.42)	<0.0001	1.91 (1.72–2.12)	<0.0001		ns
Total cholesterol ≥200 mg/dL	2.06 (1.98–2.14)	<0.0001		ns	1.05 (1.01–1.08)	0.017
LDL-c ≥130 mg/dL	2.16 (2.08–2.25)	<0.0001	1.20 (1.10–1.31)	<0.0001		ns
Triglycerides ≥150 mg/dL	1.55 (1.48–1.62)	<0.0001	2.65 (2.34–3.00)	<0.0001		ns
Glycemia 100–125 mg/dL	3.41 (3.28–3.55)	<0.0001	2.06 (1.85–2.30)	<0.0001		ns
Glycemia ≥126 mg/dL	4.85 (4.45–5.27)	<0.0001	1.77 (1.36–2.29)	<0.0001		ns
Metabolic syndrome NCEP ATPIII	3.29 (3.14–3.44)	<0.0001	1.41 (1.25–1.59)	<0.0001		ns
Metabolic syndrome IDF	1.88 (1.79–1.98)	<0.0001		ns		ns
Metabolic syndrome JIS	3.19 (3.07–3.33)	<0.0001	2.44 (2.17–2.73)	<0.0001		ns
Atherogenic dyslipidemia	2.09 (1.96–2.23)	<0.0001		ns	1.09 (1.02–1.16)	0.011
Lipid triad	2.05 (1.83–2.30)	<0.0001	1.40 (1.03–1.92)	0.034	1.32 (1.18–1.48)	<0.0001
Hipertriglyceridemic waist	1.38 (1.29–1.47)	<0.0001	2.69 (2.17–3.52)	<0.0001		ns
Atherogenic index total cholesterol/ HDL-c moderate-high	2.65 (2.52–2.77)	<0.0001	1.26 (1.12–1.41)	<0.0001		ns
Atherogenic index triglycerides/HDL-c high	1.87 (1.79–1.95)	<0.0001	3.40 (2.98–3.88)	<0.0001		ns
Atherogenic index LDL-c/HDL-c high	2.66 (2.56–2.78)	<0.0001	2.14 (1.91–2.39)	<0.0001		ns
SCORE scale moderate-high	67.92 (61.34–75.20)	<0.0001	17.83 (13.48–23.59)	<0.0001	7.58 (6.97–8.24)	<0.0001
REGICOR scale moderate-high	14.08 (13.25–14.96)	<0.0001	2.42 (2.06–2.85)	<0.0001	5.11 (4.81–5.42)	<0.0001
Fatty liver index high risk	1.62 (1.55–1.69)	<0.0001	2.41 (2.10–2.78)	<0.0001		ns

CUN BAE, Clinica Universidad de Navarra-Body Adiposity Estimator; ECORE-BF, Equation Cordoba for Estimation of Body Fat; HDL-c, High-density lipoprotein cholesterol; IDF, International Diabetes Federation; JIS, Joint Interim Statement; LDL-c, Low-density lipoprotein cholesterol; NCEP ATPIII, Nationa Cholesterol Education Program Adult Treatment Panel III; Ns, non-significance; REGICOR, Registre Gironi del Cor; SCORE, Systematic Coronary Risk Evaluation.

Belgians.[45] They are similar to those obtained from workers in Murcia[46] (29.33%) and lower than those in Ecuador[47] (19.2% in women and 32.1% in men), Ireland[49] (42%), and Hong Kong[38] (38.4%).

In our study, elevated cholesterol values affected 41.3% of men and 39.5% of women, figures higher than those found in workers in Hong Kong[39] (32.3%), similar to those found in Ecuador[47] (38.5 in women and 39.3 in men) and lower than those found in another study in Hong Kong (Yi et al, 2016) (43%), Catalonia[42] (49.6%), Germany[45] (more than 50%), Murcia[46] (56%), and the Spanish population[48] (50.8% in women and 65.6% in men).

Elevated triglyceride values were found in 24.7% of our male workers and 10.9% of our female workers, figures higher than those presented in another study in the Spanish population[48] (1.5% in women and 10.8% in men, although the cutoff point was set at 200 mg/dL instead of 150 mg/dL as we did) and lower than the study in Ecuador[47] (42.3% in women and 42.9% in men) and Murcia[46] (36%, although here the cutoff point was also set at 200 mg/dL).

The prevalence of elevated glycemia values that we have observed represents 11.4% in women and 22.0% in men for values between 100 and 125 mg/dL and 2.3% in women and 4.3% in men for values above 125 mg/dL. These values are higher than those seen in workers in Hong Kong[39] (7.8% have more than 100 mg/dL), Murcia[46] (2.7% diabetes), and the Spanish population[48] (values above 125 mg/dL 0.6% in women and 3.0% in men) and lower than those of another study in Hong Kong[38] (6.0% diabetes), Catalonia[42] (7.5% diabetes), and Ecuador[47] (42.3% of women and 60.7% of men with values above 100 mg/dL).

We have only found two articles that assess the prevalence of metabolic syndrome in construction workers, and both applying the IDF criteria, so we will compare our results exclusively with those obtained with this model. In our work the prevalence is 13.2% in men and 12.% in women, these values are clearly lower than those presented in workers in Ireland[49] (21%) and Ecuador.[47]

The mean GGT values found by us are 39.2 U/L, far from those found in the Murcia study[46] (69.2 U/L).

A study similar to ours carried out in a working population with a majority of workers in social class III (farmers) showed levels of cardiovascular risk similar to those obtained by us using most of the scales presented in this study.[50]

The limitations of our study include the fact that it was carried out in the Spanish working population, which prevents us from generalizing our results to the general population and to the population of other countries, and that we did not assess physical activity and diet, which are variables that affect cardiovascular risk.

As strong points, we highlight the large sample size, especially among the female sex, which makes it the study carried out in construction workers with the largest number of women. A large number of variables were also analyzed, more than in any other study carried out in this group (eight overweight-obesity scales, four cardiovascular risk scales, three metabolic syndrome models, and three atherogenic indices, among others).

REFERENCES

1. Randstad RRHH Digital. (2019). Los trabajadores en la construcción rozan los 1.3 millones tras crecer un 5% en el último año. Available at: http://www.rrhhdigital.com/secciones/mercado-laboral/138605/Los-trabajadores-en-la-construccion-rozan-los-13-millones-tras-crecer-un-5-en-el-ultimo-ano?target=_self.
2. Encuesta de Población Activa (EPA) Instituto Nacional de Estadística. (2019). Available at: https://www.ine.es/prensa/epa_prensa.htm.
3. Sánchez E. *Estimació del risc cardiovascular a l'atenció primària. Document d'avaluació. Consulta técnica.* Barcelona: Agencia d'avaluació de Tecnología i Recerca Mèdica; 2003.
4. Willich SN, Wegscheider K, Stallmann M, Keil T. Noise burden and the risk of myocardial infarction. *Eur Heart J*. 2006;27:276–282.
5. Rodríguez-Amaya RM. Variables cardiovasculares en trabajadores de la construcción en Santander (Colombia). Perfil comparativo años 2011 y 2012. *Hipertens Riesgo Cardiovasc*. 2015;32:105–112.
6. Luengo-Pérez LM, Urbano-Gálvez JM, Pérez-Miranda M. Validación de índices antropométricos alternativos como marcadores del riesgo cardiovascular. *Endocrinol Nutr.* 2009;56:439–446.
7. James PA, Oparil S, Carter BL, et al. Evidence-based guideline for the management of high blood pressure in adults: report from the panel members appointed to the Eighth Joint National Committee (JNC 8). *JAMA*. 2014;311:507–520.
8. Mach F, Baigent C, Catapano AL, et al. 2019 ESC/EAS Guidelines for the Management of Dyslipidaemias: lipid modification to reduce cardiovascular risk. *Eur Heart J*. 2020;41:111–188.
9. American Diabetes Association. Diagnosis and classification of diabetes mellitus. *Diabetes Care*. 2010;33(Suppl 1):S62–S69.
10. Gómez-Ambrosi J, Silva C, Catalán V, et al. Clinical usefulness of a new equation for estimating body fat. *Diabetes Care*. 2012;35:383–388.
11. Molina-Luque R, Romero-Saldaña M, Álvarez-Fernández C, Bennasar-Veny M, Álvarez-López Á, Molina-Recio G. Equation Córdoba: a simplified method for estimation of body fat (ECORE-BF). *Int J Environ Res Public Health*. 2019;16:4529.
12. Mill-Ferreyra E, Cameno-Carrillo V, Saúl-Gordo H, Camí-Lavado MC. Estimation of the percentage of body fat based on the body mass index and the abdominal circumference: Palafolls formula. *Semergen*. 2019;45:101–108.
13. Deurenberg P, Wetstrate JA, Seidell JC. Body mass index as a measure of body fatness: age- and sex-specific prediction formulas. *Br J Nutr.* 1991;65:105–114.
14. Woolcott OO, Bergman RN. Relative fat mass (RFM) as a new estimator of whole-body fat percentage – a cross-sectional study in American adults individuals. *Sci Rep*. 2018;8:10980.
15. Amato M, Giordano C, Galia M, et al. Visceral Adiposity Index A reliable indicator of visceral fat function associated with cardiometabolic risk. *Diabetes Care*. 2010;33:920–922.
16. Rico-Martín S, Calderón-García JF, Sánchez-Rey P, Franco-Antonio C, Martínez-Alvarez M, Sánchez-Muñoz-Torrero JF. Effectiveness of body roundness index in predicting metabolic syndrome: a systematic review and meta-analysis. *Obes Rev.* 2020;21:e13023.
17. Shirazu I, Sackey THA, Tiburu EK, Mensah YB, Forson A. The use of Body Surface Index as a better clinical health indicators compare to body mass index and body surface area for clinical application. *Int J S Res Sci Eng Technol*. 2018;4:131–136.
18. Andrade MD, Freitas MC, Sakumoto AM, et al. Association of the conicity index with diabetes and hypertension in Brazilian women. *Arch Endocrinol Metab.* 2016;60:436–442.
19. Bertoli S, Leone A, Krakauer NY, et al. Association of Body Shape Index (ABSI) with cardio-metabolic risk factors: a cross-sectional study of 6081 Caucasian adults. *PLoS One*. 2017;12:e0185013.
20. Unger G, Benozzi SF, Peruzza F, Pennacchiotti GL. Triglycerides and glucose index: a useful indicator of insulin resistance. *Endocrinol Nutr.* 2014;61:533–540.
21. Zheng S, Shi S, Ren X, et al. Triglyceride glucose-waist circumference, a novel and effective predictor of diabetes in first-degree relatives of type 2 diabetes patients: cross-sectional and prospective cohort study. *J Transl Med*. 2016;14:260.
22. Yang RF, Liu XY, Lin Z, Zhang G. Correlation study on waist circumference-triglyceride (WT) index and coronary artery scores in patients with coronary heart disease. *Eur Rev Med Pharmacol Sci*. 2015;19:113–118.
23. Wakabayashi I, Daimon T. The "cardiometabolic index" as a new marker determined by adiposity and blood lipids for discrimination of diabetes mellitus. *Clin Chim Acta*. 2015;438:274–278.
24. Bedogni G, Bellentani S, Miglioli L, et al. The Fatty Liver Index: a simple and accurate predictor of hepatic steatosis in the general population. *BMC Gastroenterol*. 2006;6:33.
25. Chiang JK, Koo M. Lipid accumulation product: a simple and accurate index for predicting metabolic syndrome in Taiwanese people aged 50 and over. *BMC Cardiovasc Disord*. 2012;12:78.
26. Sam S, Haffner S, Davidson MH, et al. Hypertriglyceridemic waist phenotype predicts increased visceral fat in subjects with type 2 diabetes. *Diabetes Care*. 2009;32:1916–1920.
27. Zimmet P, Alberti KG, Serrano-Ríos M. A new international diabetes federation worldwide definition of the metabolic syndrome: the rationale and the results. *Rev Esp Cardiol*. 2005;58:1371–1376.

28. Cabrera-Roe E, Stusser B, Cálix W, et al. Concordancia diagnóstica entre siete definiciones de síndrome metabólico en adultos con sobrepeso y obesidad. *Rev Peru Med Exp Salud Publica*. 2017;34:19–27.
29. Bestehorn K, Smolka W, Pittrow D, Schulte H, Assmann G. Atherogenic dyslipidemia as evidenced by the lipid triad: prevalence and associated risk in statin-treated patients in ambulatory care. *Curr Med Res Opin*. 2010;26:2833–2839.
30. Marrugat J, Subirana I, Comín E, et al. Validity of an adaptation of the Framingham cardiovascular risk function: the VERIFICA Study. *J Epidemiol Community Health*. 2007;61:40–47.
31. Marrugat J, D'Agostino R, Sullivan L, et al. An adaptation of the Framingham coronary risk function to southern Europe Mediterranean areas. *J Epidemiol Community Health*. 2003;57:634–638.
32. Sans S, Fitzgerald AP, Royo D, Conroy R, Graham I. Calibrating the SCORE cardiovascular risk chart for use in Spain. *Rev Esp Cardiol*. 2007;60:476–485.
33. Buitrago F, Cañón-Barroso L, Díaz-Herrera N, Cruces E. Analysis of predictive value of Framingham-REGICOR and SCORE functions in primary health care. *Med Clin (Barc)*. 2007;129:797.
34. Ramírez M. La edad vascular como herramienta de comunicación del riesgo cardiovascular. Centro Integral para la Prevención de Enfermedades Crónicas. 2010. Available at: http://pp.centramerica.com/pp/bancofotos/267-2570.pdf.
35. Cuende JL. La edad vascular frente al riesgo cardiovascular: aclarando conceptos. *Rev Esp Cardiol*. 2016;69:243–246.
36. Cuende JL. Edad vascular, RR, ALLY, RALLY y velocidad de envejecimiento, basados en el SCORE: relaciones entre nuevos conceptos de prevención cardiovascular. *Rev Esp Cardiol*. 2018;71:399–400.
37. Tonnon SC, Proper KI, Van der Ploeg HP, Westerman MJ, Sijbesma E, Van der Beek AJ. A qualitative study of the anticipated barriers and facilitators to the implementation of a style intervention in the dutch construction workers. *BMC Public Health*. 2014;14:1317–1329.
38. Yi W, Chan A. Health profile of construction workers in Hong Kong. *Int J Res Public Health*. 2016;13:1232–1246.
39. Wai-Yee Chung J, Yee-Man Wong B, Chun-Man Yan V, Ming-Yan Chung L, Chi-Fuk So H, Chan A. Cardiovascular Health of construction workers in Hong Kong: a cross sectional study. *Int J Res Public Health*. 2018;15:1251–1270.
40. Vandersmissen GJM, Schouteden M, Verbeek C, Bulterys S, Godderis L. Prevalence of high cardiovascular risk by economic sector. *Int Arch Occup Environ Health*. 2020;93:133–142.
41. Bolinder G, Alfredson L, Englund A, De Faire U. Smokeless tobacco use and increased cardiovascular mortality among Swedish construction workers. *Am J Public Health*. 1994;84:399–404.
42. Molina-Aragonés JM. Riesgo cardiovascular, ocupación y riesgos laborales en una población laboral de Cataluña. *Med Segur Trab*. 2008;LIV(n° 212):91–98.
43. Schiöler L, Söderberg M, Rosengren A, Järvholm B, Torén K. Psychosocial work environment and risk of ischemic stroke and coronary heart disease: a prospective longitudinal study of 75236 construction workers. *Scand J Work Environ Health*. 2015;41:280–287.
44. Arndt V, Rothenbacher D, Daniel U, Zschenderlein B, Schubert S, Brenne RH. All-cause and cause specific mortality in a cohort of 20000 construction workers; results from a 10 years follow up. *Occup Environ Med*. 2004;61:419–425.
45. Claessen H, Brenner H, Drath Ch, Arndt V. Gamma-glutamyl transferase and disability pension: a cohort study of construction workers in Germany. *Hepatology*. 2015;51:482–490.
46. Levy-Espinos DI. *Factores de riesgo cardiovascular en distintos grupos profesionales. Trabajo fin de máster. Máster Universitario en Prevención de Riesgos Laborales.* Universidad Miguel Hernández; 2017. Available at: dspace.umh.es/bitstream/11000/5633/LEVY ESPINOSA%2C DAVID TFM.pdf.
47. Rodríguez-Nieves RR, Torres-Ruiz E, Sarmiento-Segarra KB, et al. Prevalencia de síndrome metabólico en trabajadores de una empresa de construcción en Guayaquil, Ecuador. *Rev Latinoam de Hipertens*. 2019;14:1–7.
48. Sánchez-Chaparro MA, Román-García J, Calvo-Bonacho E, et al. Prevalencia de factores de riesgo vascular en la población laboral española. *Rev Esp Cardiol*. 2006;59:421–430.
49. Thabit H, Burns N, Shah S, et al. Prevalence and predictors of diabetes and cardiovascular risk among construction workers in Ireland: the Construction Workers Health Trust screening study. *Diab Vasc Dis Res*. 2013;10:337–345.
50. Mohebbi V, Aramayo A, Morales J. Determination of scales related to cardiovascular risk and fatty liver in 5.370 Spanish farmers. *Acad J Health Sci*. 2021;36:26–33.

