

## ORIGINAL

# Estimation of cardiometabolic risk in 25.030 Spanish kitchen workers

*Estimación del riesgo cardiometabólico en 25.030 trabajadores de cocina españoles*

Rubi Zoe Manzanero<sup>1</sup> , Ángel Arturo López-González<sup>2</sup> , Pilar Tomás-Gil<sup>2</sup> ,  
Hernán Paublini<sup>2</sup> , Andrés Martínez-Jover<sup>2</sup> , José Ignacio Ramírez-Manent<sup>2,3</sup> 

1. PREVIS Gestión de Riesgos, S.L.U. Mallorca

2. ADEMA-Health group. IUNICS. University of Balearic Islands

3. General Practitioner Department, Balearic Islands Health Service, 07003 Palma, Balearic Islands, Spain

## Corresponding author

Ángel Arturo López-González

E-mail: angarturo@gmail.com

Received: 18 - VII - 2023

Accepted: 20 - VIII - 2023

doi: 10.3306/AJHS.2023.38.06.101

## Summary

**Introduction:** Cardiometabolic diseases have a high prevalence in the world and a large number of factors are involved in their genesis, some of them sociodemographic. The aim of this study was to determine the level of cardiometabolic risk in kitchen workers belonging to the low socioeconomic level.

**Methods:** Descriptive, cross-sectional study of 25030 Spanish kitchen workers with a mean age slightly over 39 years in whom different cardiometabolic risk scales were determined, such as metabolic syndrome, atherogenic risk, nonalcoholic fatty liver disease, insulin resistance, or cardiovascular risk scales such as REGICOR, SCORE, or vascular age.

**Results:** Almost all the cardiometabolic risk scales show high prevalences in this group of workers; these figures take on special importance taking into account that the age of the participants is not very high.

**Conclusions:** There is a moderate to high prevalence of elevated values of the different cardiometabolic risk scales analyzed, especially in men.

**Key words:** Cardiometabolic risk, metabolic syndrome, insulin resistance, nonalcoholic fatty liver disease, atherogenic risk.

## Resumen

**Introducción:** Las enfermedades cardiometabólicas presentan una elevada prevalencia en el mundo y en su génesis están involucrados gran número de factores, algunos de ellos sociodemográficos. El objetivo de este estudio es conocer el nivel de riesgo cardiometabólico de los trabajadores de cocina que pertenecen al nivel socioeconómico bajo.

**Material y métodos:** Estudio descriptivo y transversal en 25030 trabajadores de cocina españoles con una edad media algo superior a los 39 años en los que se determinan diferentes escalas de riesgo cardiometabólico como síndrome metabólico, riesgo aterogénico, hígado graso no alcohólico, resistencia a la insulina o escalas de riesgo cardiovascular como REGICOR, SCORE o edad vascular.

**Resultados:** Casi todas las escalas de riesgo cardiometabólico muestran prevalencias elevadas en este colectivo de trabajadores, estas cifras adquieren especial importancia teniendo en cuenta que la edad de los participantes no es muy elevada.

**Conclusiones:** Existe una moderada-alta prevalencia de los valores elevados de las distintas escalas de riesgo cardiometabólico analizadas, especialmente en los hombres.

**Palabras clave:** Riesgo cardiometabólico, síndrome metabólico, resistencia a la insulina, enfermedad del hígado graso no alcohólico, riesgo aterogénico.

**Cite as:** Manzanero RZ, López-González AA, Tomás-Gil P, Paublini H, Martínez-Jover A, Ramírez-Manent JI. Estimation of cardiometabolic risk in 25.030 Spanish kitchen workers. *Academic Journal of Health Sciences* 2023; 38 (6):101-110 doi: 10.3306/AJHS.2023.38.06.101

## Introduction

According to different international organizations, including the World Health Organization, cardiometabolic diseases (CHD) are considered to be the main cause of morbidity and mortality on the planet<sup>1</sup>. In the first decades of the 21st century, they represent the most probable cause of death in our country, accounting for almost 28% of the total<sup>2</sup>. The appearance and development of the different SCDs will be influenced by environmental<sup>3</sup> as well as pathophysiological and biochemical<sup>4</sup> factors, which will result in these diseases having a complex and multifactorial genesis.

Health inequalities associated with socioeconomic status are currently one of the greatest challenges facing public health<sup>5</sup>. It has long been known that people belonging to the lowest social strata will have very poor health indicators, both in terms of healthy habits<sup>6</sup>, morbidity and mortality indicators<sup>7</sup> and accessibility to social and health services<sup>8</sup>.

The different items that assess socioeconomic status, including income, educational level and job qualifications, are co-participants in these inequalities<sup>9</sup>.

The so-called white-collar workers, also known as manual workers, have a higher degree of professional qualification and, in most studies, have different rates of morbidity and mortality of cardiometabolic origin compared with blue-collar or manual workers, who have a much lower level of professional qualification. These manual workers, whether men or women, have higher levels of morbidity and mortality<sup>10</sup>.

There is abundant literature on work-related diseases, also known as occupational diseases, in workers who work in the different areas of the hotel and catering industry. The high prevalence of dermatitis<sup>11</sup> and musculoskeletal problems is well known, whether epicondylitis or carpal tunnel syndrome in waiters<sup>12</sup>, or the injuries derived from overexertion and repetitive movements in housekeepers that result in a high prevalence of lumbar pathologies<sup>13</sup>.

However, there are almost no studies that assess the level of cardiometabolic risk of these hospitality professionals, which is why the aim of this study is to determine precisely this, the level of cardiometabolic risk in a large group of 25.030 kitchen workers from different companies in different Spanish autonomous communities.

## Methods

In the period from January 2019 to December 2019, this descriptive and cross-sectional study was carried out in a large group of 25.030 kitchen workers from different autonomous communities of our country, practically all

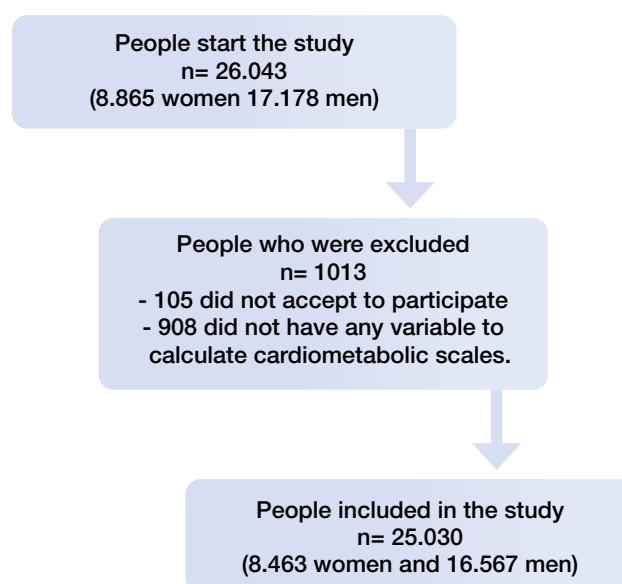
the Spanish regions were represented, especially the Balearic Islands, Andalusia, Canary Islands, Valencian Community, Catalonia, Madrid, Castilla La Mancha, Castilla León and the Basque Country. The waiters included in this study were selected from among those who attended the periodic health examinations carried out in the different companies that participated.

The inclusion criteria established were:

- To be aged between 18 and 69 years.
- To have an employment contract in one of the participating companies.
- Accepting participation in the study and the transfer of the use of the data for epidemiological purposes.

The flow diagram of the study participants is shown in figure 1.

Figure 1: Flow chart of the study participants.



### Determination of variables

The medical professionals from the different participating companies determined the anthropometric, analytical and clinical variables necessary to calculate the different cardiometabolic risk scales. The measurement techniques were standardized to minimize potential biases in obtaining the variables.

The measurement was made when the person was in an upright position and with the abdomen relaxed. A SECA model scale-measuring scale was used to measure weight and height. The abdominal waist circumference was measured in this position with a tape measure placed parallel to the floor at the level of the last rib.

An OMROM-M3 sphygmomanometer was used to measure blood pressure. After ten minutes of rest, three

measurements were taken with a one-minute interval between each and the mean of the three was obtained.

After a fast of at least twelve hours, various techniques were used to measure blood glucose, triglycerides and total cholesterol, as well as precipitation methods for HDL-cholesterol. LDL-cholesterol was calculated using the Friedewald formula, which is valid for triglyceride values up to 400.

Each analysis parameter was expressed in milligrams per deciliter.

Cholesterol values of 200 mg/dL or more, LDL values of 130 mg/dL or more, and triglycerides of 150 mg/dL or more, or if they were being treated for any of these analytical alterations, were established as altered values.

The recommendations of the American Diabetes Association<sup>14</sup> were used to classify blood glucose levels. Diabetics were those who had a previous diagnosis, had a blood glucose greater than 125 mg/dL, had an HbA1c of at least 6.5%, or were receiving treatment to reduce blood glucose.

Dividing weight (in kg) by height squared (in meters), the body mass index (BMI) was calculated. The cut-off point for obesity was 30 kg/m<sup>2</sup> or higher.

#### **Scales for calculating the percentage of body fat:**

- CUN BAE (Estimador de Adiposidad Corporal de la Clínica Universitaria de Navarra)<sup>15</sup>.

$-44.988 + (0.503 \times \text{age}) + (10.689 \times \text{sex}) + (3.172 \times \text{BMI}) - (0.026 \times \text{BMI}^2) + (0.181 \times \text{BMI} \times \text{sex}) - (0.02 \times \text{BMI} \times \text{age}) - (0.005 \times \text{BMI}^2 \times \text{sex}) + (0.00021 \times \text{BMI}^2 \times \text{age})$ . Male =0 Female =1.

- ECORE-BF (Equation Córdoba for Estimation of Body Fat)<sup>16</sup>

$97.102 + 0.123 (\text{age}) + 11.9 (\text{sex}) + 35.959 (\text{LnBMI})$  Man =0 Woman =1.

- Palafolls formula<sup>17</sup>

Man =  $[(\text{BMI}/\text{waist}) \times 10] + \text{BMI}$ .

Woman =  $[(\text{BMI}/\text{waist}) \times 10] + \text{BMI} + 10$ .

- Deuremberg formula<sup>18</sup>

$1.2 \times (\text{BMI}) + 0.23 \times (\text{age}) - 10.8 \times (\text{sex}) - 5.4$  Man =0 Woman =1.

- Relative fat mass (RFM)<sup>19</sup>

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

Other indicators related to overweight and obesity:

-Visceral adiposity index (VAI)<sup>20</sup>

Men:  $(\text{Waist}/(39.68 + (1.88 \times \text{BMI}))) \times (\text{Triglycerides}/1.03) \times (1.31/\text{HDL})$

Women:  $(\text{Waist}/(36.58 + (1.89 \times \text{BMI}))) \times (\text{Triglycerides}/0.81) \times (1.52/\text{HDL})$

- Body roundness index (BRI)<sup>21</sup>

$\text{BRI} = 364.2 - 365.5 \times \sqrt{1 - ((\text{waist}/(2\pi))^2 / (0.5 \times \text{height})^2)}$ .

- Body Surface Index (BSI)<sup>22</sup>. is determined using the DuBois formula, where weight is expressed in kilograms and height in centimeters.

$\text{BSA} = \text{weight}^{0.425} \times \text{height}^{0.725} \times 0.0007184$

$\text{BSI} = \text{weight}/\sqrt{\text{BSA}}$

- Conicity index<sup>23</sup>

$\text{CI} = (\text{Waist}/0.109) \times 1/\sqrt{\text{weight}/\text{height}}$

- Body shape index (ABSI)<sup>24</sup>

$\text{ABSI} = \text{Waist}/\text{BMI}^{2/3} \times \text{height}^{1/2}$

-Normalized weight-adjusted index (NWA)<sup>25</sup>

$\text{NWA} = (\text{weight}/10) - (10 \times \text{height}) + 10$

Weight in kg and height in meters.

#### **Other indicators related to cardiovascular risk:**

-Triglyceride glucose index<sup>26</sup>, Triglyceride glucose index-BMI<sup>27</sup>, Triglyceride glucose index-waist<sup>28</sup>

$\text{TyGindex} = \text{LN} (\text{triglycerides} [\text{mg/dl}] \times \text{glycaemia} [\text{mg/dl}]/2)$ .

$\text{TyGindex} - \text{BMI} = \text{TyGindex} \times \text{BMI}$

$\text{TyGindex} - \text{waist} = \text{TyGindex} \times \text{waist}$

- Waist triglyceride index<sup>29</sup>

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

- Cardiometabolic index<sup>30</sup>.

$\text{Waist}/\text{height} \times \text{triglycerides}/\text{HDL}$

#### **Nonalcoholic fatty liver disease risk scales:**

- Fatty liver index<sup>31</sup>.

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

- Hepatic steatosis index (HSI)<sup>32</sup>

$\text{HSI} = 8 \times \text{AST}/\text{ALT} + \text{BMI} (+2 \text{ if } 2 \text{ diabetes and } +2 \text{ if female})$

- Zhejiang University index (ZJU)<sup>33</sup>

$\text{BMI} + \text{Blood glucose (mmol L)} + \text{Triglycerides (mmol L)} + 3 \text{AST}/\text{ALT} + 2 \text{ if female}$

- Fatty liver disease index (FLD)<sup>34</sup>

$\text{BMI} + \text{triglycerides} + 3 \times (\text{AST}/\text{ALT}) + 2 \times \text{Hyperglycemia (presence=1; absence=0)}$ .

If  $\text{BMI} \geq 28 = 1 \text{ point}$ ,  $\text{AST}/\text{ALT} \geq 0.8 = 2 \text{ points}$ , type 2 diabetes mellitus = 1 point. Cut-off point for high risk 2 points.

- Lipid accumulation product (LAP)<sup>35</sup>.

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

### **Atherogenic indices<sup>36</sup>**

- Total cholesterol/HDL (high values from 5 in men and 4.5 in women),
- LDL/HDL and Triglycerides/HDL (high values from 3 and above)
- logTriglycerides/HDL (high values from 3)
- Total cholesterol-HDL (high values from 130)

### **Metabolic syndrome**

- The metabolic syndrome was determined using three models<sup>37</sup>

a) NCEP ATP III (National Cholesterol Educational Program Adult Treatment Panel III) considers metabolic syndrome when there are three or more of the following events: blood pressure higher than 130/85 mmHg; triglycerides higher than 150 mg/dl or specific treatment for this lipid disorder; low HDL and glycemia higher than 100 mg/dl or specific treatment for this glycemic disorder.

b) The International Diabetes Federation (IDF) establishes as a requirement a waist circumference greater than 80 centimeters in women and greater than 94 centimeters in men, in addition to two of the other factors mentioned above for ATP III (triglycerides, HDL, blood pressure and glycemia).

c) The JIS (Joint Interim Statement) model establishes criteria similar to NCEP ATPIII but with abdominal waistline cut-off points similar to IDF.

Atherogenic dyslipidemia<sup>38</sup> is established when high triglyceride values (>150 mg/dL) coincide with low HDL values; if high LDL values are also added, we speak of a lipid triad<sup>39</sup>.

### **Cardiovascular risk scales:**

The REGICOR<sup>40</sup> scale, an adaptation to the Spanish population of the Framingham scale, evaluates the risk of suffering a cardiovascular event during a 10-year period. It can be used from 35 to 74 years of age. The risk is considered moderate from 5% and high from 10%.

We used the SCORE2<sup>41</sup> (Systematic Coronary Risk Evaluation) scale, which assesses the risk of suffering a fatal stroke within 10 years.

The Spanish cardiovascular risk equation, also known as ERICE, is based on seven studies carried out in population-based cohorts in Spain<sup>42</sup>. It estimates the risk of suffering a fatal or non-fatal stroke within a decade. The tables are used in individuals between thirty and eighty years of age. Age, sex, smoking, diabetes, systolic blood pressure, antihypertensive treatment, and total cholesterol are used to determine risk. The cut-off points suggested by the

group responsible for the study were used to classify the level of cardiovascular risk using the ERICE tables: risk was considered moderate if it exceeded 5%; moderate-high if between 15% and 19%; high if between 20% and 39%; and very high if it exceeded 39%.

We calculate vascular age using the Framingham model<sup>43</sup>, for which we need data such as age, sex, HDL-c, total cholesterol, systolic blood pressure values, antihypertensive treatment, smoking and diabetes. It can be calculated from the age of thirty years onwards.

We also calculated vascular age using the SCORE model<sup>44</sup>. To calculate it, age, sex, systolic blood pressure, smoking and total cholesterol are used. It can be calculated using a scale from 40 to 65 years.

A very important concept that applies to both vascular ages is avoidable years of life lost (ALLY)<sup>45</sup>, which can be defined as the difference between vascular and chronological age.

We consider a person to be a smoker if he or she has smoked at least one cigarette in the last month or if he or she has stopped smoking less than a year ago.

### **Ethical considerations and aspects**

All steps of this study were guided by the 2013 Declaration of Helsinki and the ethical standards of the institutional research committee. Data anonymity and confidentiality were guaranteed at all times. The Balearic Islands Research Ethics Committee (CEI-IB), which received IB indicator 4383/20, approved the study. Each participant had his or her data coded, so that only the person responsible for the study could identify each participant. The research team is committed to complying with Organic Law 3/2018, of December 5, which protects both digital rights and personal data. This means that they have the right to access, rectify, cancel and oppose the data collected in this study.

### **Statistical analysis**

Student's t-test was used to calculate the mean and standard deviation for quantitative variables. For qualitative variables, the chi-square test was used. Multivariate analysis was performed using binary logistic regression. Statistical analysis was performed with the SPSS 28.0 program and a statistical significance level of  $p < 0.05$  was accepted.

## **Results**

**Table I** shows the characteristics of the sample. The mean age was approximately 39 years, with the majority group being between 18 and 49 years of age. More than one in three workers were smokers (slightly higher in men). In general, the variables show more favorable values in women.

**Table I:** Characteristics of the population.

|                                 | Men n=16,567 | Women n=8,463 | p-value |
|---------------------------------|--------------|---------------|---------|
|                                 | Mean (SD)    | Mean (SD)     |         |
| Age (years)                     | 38.7 (11.4)  | 39.6 (11.6)   | <0.0001 |
| Height (cm)                     | 174.0 (7.2)  | 160.8 (6.4)   | <0.0001 |
| Weight (kg)                     | 80.1 (15.6)  | 68.5 (14.9)   | <0.0001 |
| Waist circumference (cm)        | 85.5 (11.8)  | 76.5 (11.3)   | <0.0001 |
| Systolic blood pressure (mmHg)  | 127.5 (15.0) | 119.7 (15.4)  | <0.0001 |
| Diastolic blood pressure (mmHg) | 76.9 (10.8)  | 73.1 (10.3)   | <0.0001 |
| Total cholesterol (mg/dl)       | 189.8 (39.2) | 190.7 (37.5)  | 0.101   |
| HDL-cholesterol (mg/dl)         | 50.1 (7.9)   | 55.6 (7.5)    | <0.0001 |
| LDL-cholesterol (mg/dl)         | 116.3 (37.4) | 116.8 (36.1)  | 0.274   |
| Triglycerides (mg/dl)           | 120.9 (88.9) | 92.2 (52.9)   | <0.0001 |
| Glycaemia (mg/dl)               | 92.3 (22.9)  | 88.5 (17.1)   | <0.0001 |
| ALT (U/L)                       | 31.2 (20.7)  | 21.3 (12.5)   | <0.0001 |
| AST (U/L)                       | 25.3 (16.0)  | 19.0 (7.5)    | <0.0001 |
| GGT (U/L)                       | 35.8 (38.6)  | 21.7 (17.7)   | <0.0001 |
|                                 | %            | %             | p-value |
| 18-29 years                     | 25.6         | 23.8          | 0.340   |
| 30-39 years                     | 27.3         | 25.9          |         |
| 40-49 years                     | 27.5         | 27.4          |         |
| 50-59 years                     | 16.3         | 19.0          |         |
| 60-69 years                     | 3.3          | 3.9           |         |
| Non-smokers                     | 65.2         | 65.8          |         |
| Smokers                         | 34.8         | 34.2          |         |

HDL-c: High density lipoprotein cholesterol. LDL: Low density lipoprotein cholesterol. AST: Aspartate Aminotransferase. ALT: Alanine Aminotransferase. GGT: Gamma Glutamyl Transpeptidase.

**Table II:** Differences in mean values of the scales related with cardiovascular risk by sex using the T-Student test.

|                                           | Men n=16,567  | Women n=8,463 | p-value |
|-------------------------------------------|---------------|---------------|---------|
|                                           | Mean (SD)     | Mean (SD)     |         |
| Waist to height ratio (WtHR)              | 0.49 (0.06)   | 0.47 (0.07)   | <0.0001 |
| Body mass index (BMI)                     | 26.5 (4.8)    | 26.5 (5.6)    | 0.543   |
| CUN BAE                                   | 24.9 (7.2)    | 36.7 (7.5)    | <0.0001 |
| ECORE-BF                                  | 24.9 (7.2)    | 36.8 (7.6)    | <0.0001 |
| Relative fat mass                         | 22.6 (5.4)    | 33.2 (5.7)    | <0.0001 |
| Palafolls formula                         | 29.6 (5.1)    | 40.0 (5.9)    | <0.0001 |
| Deurenberg formula                        | 24.5 (6.9)    | 35.5 (7.7)    | <0.0001 |
| Body fat index                            | 21.9 (8.6)    | 28.4 (8.4)    | <0.0001 |
| Body surface index                        | 57.2 (8.4)    | 52.0 (8.6)    | <0.0001 |
| Normalized weight adjusted index          | 0.62 (1.47)   | 0.77 (1.46)   | <0.0001 |
| Body roundness index                      | 3.3 (1.2)     | 3.0 (1.3)     | <0.0001 |
| Body shape index                          | 0.073 (0.007) | 0.068 (0.006) | <0.0001 |
| Visceral adiposity index                  | 7.1 (6.3)     | 2.8 (1.8)     | <0.0001 |
| Conicity index                            | 1.2 (0.1)     | 1.1 (0.1)     | <0.0001 |
| METS-VF                                   | 6.1 (0.8)     | 5.6 (0.9)     | <0.0001 |
| Waist triglyceride index                  | 118.8 (93.6)  | 80.8 (50.6)   | <0.0001 |
| Waist weight index                        | 9.6 (0.8)     | 9.3 (0.7)     | <0.0001 |
| n° factors metabolic syndrome NCEP ATPIII | 1.2 (1.2)     | 1.0 (1.2)     | <0.0001 |
| n° factors metabolic syndrome JIS         | 1.7 (1.3)     | 1.1 (1.2)     | <0.0001 |
| Total cholesterol/HDL-c                   | 3.9 (1.1)     | 3.5 (0.9)     | <0.0001 |
| Triglycerides/HDL-c                       | 2.5 (2.1)     | 1.7 (1.1)     | <0.0001 |
| LDL-c/HDL-c                               | 2.4 (1.0)     | 2.2 (0.8)     | <0.0001 |
| Total cholesterol-HDL-c                   | 139.7 (41.1)  | 135.1 (39.1)  | <0.0001 |
| Cardiometabolic index                     | 1.3 (1.1)     | 0.8 (0.6)     | <0.0001 |
| Triglyceride glucose index (TyG index)    | 8.4 (0.6)     | 8.2 (0.5)     | <0.0001 |
| TyG index-BMI                             | 224.4 (49.4)  | 217.9 (51.9)  | <0.0001 |
| TyG index-waist circumference             | 723.1 (124.6) | 627.6 (109.0) | <0.0001 |
| TyG index-WtHR                            | 4.2 (0.7)     | 3.9 (0.7)     | <0.0001 |
| METS-IR                                   | 38.9 (9.0)    | 37.1 (9.1)    | <0.0001 |
| ALLY vascular age SCORE                   | 7.5 (6.9)     | 4.7 (5.3)     | <0.0001 |
| SCORE scale                               | 1.8 (2.3)     | 0.6 (1.0)     | <0.0001 |
| ALLY vascular age Framingham              | 6.5 (10.3)    | 2.4 (12.5)    | <0.0001 |
| REGICOR scale                             | 3.2 (2.2)     | 2.9 (2.2)     | <0.0001 |
| ERICE scale                               | 4.3 (5.1)     | 3.1 (3.9)     | <0.0001 |
| Fatty liver index                         | 36.6 (28.8)   | 22.7 (24.4)   | <0.0001 |
| Hepatic steatosis index                   | 37.4 (7.3)    | 37.8 (6.9)    | 0.275   |
| Zhejiang University index                 | 37.6 (6.3)    | 38.4 (6.3)    | 0.014   |
| Fatty liver disease                       | 32.5 (5.9)    | 31.5 (6.1)    | <0.0001 |
| BARD scoring                              | 1.7 (1.1)     | 1.9 (1.0)     | <0.0001 |
| Lipid accumulation product                | 30.1 (33.1)   | 20.4 (19.7)   | <0.0001 |

CUN BAE: Clínica Universitaria Navarra Body Adiposity Estimator; Ecore-BF: Equation Córdoba for Estimation of Body Fat; METS-VF: Metabolic score- visceral fat. ALLY: Avoidable lost life years. SCORE: Systematic COronary Risk Evaluation. REGICOR: REGistre Gironi del COR. HDL-c: High density lipoprotein cholesterol. LDL: Low density lipoprotein cholesterol. METS-IR: Metabolic score for Insulin Resistance. TyG: Triglyceride glucose index.

**Table III:** Differences in the prevalence of altered values of different scales related with cardiovascular risk by sex using the chi-square test.

|                                       | Men n=16.567 | Women n=8.463 | p-value |
|---------------------------------------|--------------|---------------|---------|
|                                       | %            | %             |         |
| Waist to height ratio > 0.50          | 40.9         | 28.6          | <0.0001 |
| Body mass index obesity               | 20.2         | 22.7          | <0.0001 |
| CUN BAE obesity                       | 48.9         | 57.7          | <0.0001 |
| ECORE-BF obesity                      | 48.6         | 56.7          | <0.0001 |
| Relative fat mass obesity             | 34.6         | 56.4          | <0.0001 |
| Palafolls formula obesity             | 82.9         | 80.1          | <0.0001 |
| Deuremberg formula obesity            | 44.5         | 74.3          | <0.0001 |
| METS-VF high                          | 8.3          | 2.1           | <0.0001 |
| Diabesity                             | 3.1          | 2.0           | <0.0001 |
| Hypertension                          | 25.8         | 14.8          | <0.0001 |
| Total cholesterol ≥ 200 mg/dl         | 37.6         | 38.1          | 0.416   |
| LDL-c ≥ 130 mg/dl                     | 34.7         | 33.7          | 0.115   |
| Triglycerides ≥ 150 mg/dl             | 22.6         | 9.3           | <0.0001 |
| Glycaemia 100-125 mg/dl               | 16.4         | 11.9          | <0.0001 |
| Glycaemia ≥ 126 mg/dl                 | 3.9          | 2.0           | <0.0001 |
| Metabolic syndrome NCEP ATPIII        | 14.9         | 13.1          | <0.0001 |
| Metabolic syndrome IDF                | 12.2         | 12.4          | 0.569   |
| Metabolic syndrome JIS                | 25.9         | 15.0          | <0.0001 |
| Atherogenic dyslipidemia              | 6.7          | 4.6           | <0.0001 |
| Lipid triad                           | 2.0          | 1.3           | <0.0001 |
| Hipertriglyceridemic waist            | 7.4          | 2.0           | <0.0001 |
| Total cholesterol/HDL-c moderate-high | 15.4         | 13.1          | <0.0001 |
| Triglycerides/HDL-c high              | 24.9         | 8.5           | <0.0001 |
| LDL-c/HDL-c high                      | 25.0         | 14.9          | <0.0001 |
| Total cholesterol-HDL-c high          | 57.5         | 52.8          | <0.0001 |
| METS-IR high                          | 11.6         | 9.7           | <0.0001 |
| TyG index high                        | 25.1         | 14.9          | <0.0001 |
| SCORE scale moderate-high             | 25.4         | 5.8           | <0.0001 |
| REGICOR scale moderate-high           | 20.0         | 17.8          | 0.004   |
| ERICE scale moderate-high             | 11.9         | 4.0           | <0.0001 |
| Fatty liver index high risk           | 23.5         | 11.2          | <0.0001 |

CUN BAE Clínica Universitaria Navarra Body Adiposity Estimator; Ecore-BF Equation Córdoba for Estimation of Body Fat; METS-VF Metabolic score- visceral fat. ALLY Avoidable lost life years. SCORE Systematic COronary Risk Evaluation. REGICOR REGistre Gironi del COR. HDL-c High density lipoprotein cholesterol. LDL Low density lipoprotein cholesterol. METS-IR Metabolic score for Insulin Resistance. TyG Triglyceride glucose index

**Table II** shows the mean values of all the cardiometabolic risk scales studied, separated by sex. Both the scales that assess overweight-obesity (except those that estimate body fat) and those that determine the risk of insulin resistance, nonalcoholic fatty liver disease, cardiovascular risk or atherogenic risk show significantly higher values in men working in the kitchen. In all cases except BMI and HSI, the differences found between men and women were statistically significant.

**Table III** shows the prevalence of high values for the different cardiometabolic risk scales considered in this study in both sexes. A situation similar to that previously mentioned for the means is observed, that is, the prevalences are significantly higher in the group of male kitchen workers, in all cases except for hypercholesterolemia, elevated LDL and metabolic syndrome with the IDF criteria.

**Table IV** shows the results of the multivariate study using the binary logistic regression technique. We can see that the variable that most increases the risk of presenting elevated values of the cardiometabolic scales is age, which also shows statistically significant differences in all cases. Male sex also had an influence on most of the cardiometabolic risk parameters analyzed (all except

hypercholesterolemia and metabolic syndrome with IDF criteria). Tobacco consumption affected a limited number of parameters. The highest odds ratios were found for SCORE and Deuremberg for age and for SCORE for the male sex.

## Discussion

Male kitchen workers can be classified as having moderate cardiometabolic risk and women as moderate-low. Since the mean age of the workers is low, we should consider the prevalence of high values on the scales estimating body fat, dyslipidemia, atherogenic risk and cardiovascular risk to be high.

After an exhaustive analysis of the existing literature, it has not been possible to find any study that specifically assesses the level of cardiometabolic risk in this group of workers; therefore, we should establish comparisons between our results and those obtained in groups of manual workers.

A South African study<sup>46</sup> carried out in more than 600 manual and nonmanual workers with an average age of 38 years (similar to ours) showed somewhat different

Table IV: Binary logistic regression.

|                                     | ≥ 50 years          | Male                | Smokers          |
|-------------------------------------|---------------------|---------------------|------------------|
|                                     | OR (95% CI)         | OR (95% CI)         | OR (95% CI)      |
| WtHR < 0.50                         | 1                   | 1                   | 1                |
| WtHR ≥ 0.50                         | 1.50 (1.41-1.60)    | 1.76 (1.66-1.86)    | ns               |
| BMI non obesity                     | 1                   | 1                   | 1                |
| BMI obesity                         | 1.66 (1.55-1.78)    | 0.88 (0.82-0.94)    | 0.92 (0.86-0.98) |
| CUN BAE non obesity                 | 1                   | 1                   | 1                |
| CUN BAE obesity                     | 4.67 (4.34-5.03)    | 0.72 (0.68-0.76)    | 0.91 (0.86-0.96) |
| RFM non obesity                     | 1                   | 1                   | 1                |
| RFM obesity                         | 4.36 (4.06-4.68)    | 0.74 (0.70-0.78)    | 0.91 (0.86-0.96) |
| Deurenberg formula non obesity      | 1                   | 1                   | 1                |
| Deurenberg formula obesity          | 10.46 (9.53-11.48)  | 0.25 (0.24-0.27)    | 0.89 (0.84-0.94) |
| METS-VF normal                      | 1                   | 1                   | 1                |
| METS-VF high                        | 3.64 (3.27-4.06)    | 4.59 (3.91-5.39)    | ns               |
| Non hypertension                    | 1                   | 1                   | 1                |
| Hypertension                        | 3.68 (3.44-3.94)    | 2.21 (2.05-2.37)    | ns               |
| Total cholesterol < 200 mg/dl       | 1                   | 1                   | 1                |
| Total cholesterol ≥ 200 mg/dl       | 2.77 (2.60-2.95)    | ns                  | ns               |
| LDL-c < 130 mg/dl                   | 1                   | 1                   | 1                |
| LDL-c ≥ 130 mg/dl                   | 2.78 (2.61-2.96)    | 1.09 (1.03-1.15)    | ns               |
| Triglycerides < 150 mg/dl           | 1                   | 1                   | 1                |
| Triglycerides ≥ 150 mg/dl           | 1.89 (1.75-2.04)    | 2.97 (2.74-3.23)    | ns               |
| Glycaemia < 126 mg/dl               | 1                   | 1                   | 1                |
| Glycaemia ≥ 126 mg/dl               | 6.59 (5.94-7.31)    | 1.85 (1.64-2.08)    | ns               |
| Non metabolic syndrome NCEP ATPIII  | 1                   | 1                   | 1                |
| Metabolic syndrome NCEP ATPIII      | 3.89 (3.61-4.19)    | 1.25 (1.15-1.35)    | ns               |
| Non metabolic syndrome IDF          | 1                   | 1                   | 1                |
| Metabolic syndrome IDF              | 2.23 (2.06-2.42)    | ns                  | ns               |
| Non atherogenic dyslipidemia        | 1                   | 1                   | 1                |
| Atherogenic dyslipidemia            | 2.66 (2.38-2.96)    | 1.57 (1.39-1.77)    | ns               |
| Non lipid triad                     | 1                   | 1                   | 1                |
| Lipid triad                         | 2.92 (2.41-3.54)    | 1.65 (1.32-2.05)    | 1.27 (1.05-1.54) |
| Total cholesterol/HDL-c normal      | 1                   | 1                   | 1                |
| Total cholesterol/HDL-c high        | 3.50 (3.24-3.77)    | 1.29 (1.19-1.39)    | ns               |
| Triglycerides/HDL-c normal          | 1                   | 1                   | 1                |
| Triglycerides/HDL-c high            | 2.16 (2.01-2.32)    | 3.76 (3.45-4.09)    | ns               |
| LDL-c/HDL-c normal                  | 1                   | 1                   | 1                |
| LDL-c/HDL-c high                    | 3.23 (3.02-3.46)    | 2.06 (1.92-2.22)    | ns               |
| SCORE scale low                     | 1                   | 1                   | 1                |
| SCORE scale moderate-high           | 67.27 (55.39-81.71) | 13.64 (11.51-16.16) | 7.13 (6.17-8.23) |
| REGICOR scale low                   | 1                   | 1                   | 1                |
| REGICOR scale moderate-high         | 2.22 (2.06-2.40)    | 1.20 (1.10-1.30)    | 1.43 (1.33-1.55) |
| Fatty liver index low-moderate risk | 1                   | 1                   | 1                |
| Fatty liver index high risk         | 1.58 (1.46-1.71)    | 2.48 (2.29-2.70)    | ns               |
| LAP low                             | 1                   | 1                   | 1                |
| LAP high                            | 1.61 (1.51-1.72)    | 1.20 (1.14-1.27)    | ns               |
| BARD score low                      | 1                   | 1                   | 1                |
| BARD score high                     | 1.33 (1.06-1.67)    | 0.55 (0.44-0.69)    | ns               |
| Non diabetes                        | 1                   | 1                   | 1                |
| Diabetes                            | 5.72 (4.90-6.68)    | 1.71 (1.44-2.04)    | ns               |
| METS-IR bajo                        | 1                   | 1                   | 1                |
| METS-IR alto                        | 1.74 (1.59-1.90)    | 1.26 (1.15-1.37)    | ns               |
| TyG index low                       | 1                   | 1                   | 1                |
| TyG index high                      | 2.46 (2.30-2.64)    | 2.02 (1.88-2.16)    | ns               |

CUN BAE Clinica Universitaria Navarra Body Adiposity Estimator; ECORE-BF Equation Córdoba for Estimation of Body Fat; METS-VF Metabolic score- visceral fat. ALLY Avoidable lost life years. SCORE Systematic COronary Risk Evaluation. REGICOR REGistre Glroni del COR. HDL-c High density lipoprotein cholesterol. LDL Low density lipoprotein cholesterol. METS-IR Metabolic score for Insulin Resistance. TyG Triglyceride glucose index. LAP Lipid accumulation product

results to those found by us, since the manual workers did have a higher prevalence of arterial hypertension but not of hypercholesterolemia or excess weight. On the other hand, a study carried out in Indonesia in a very large sample of more than 137,000 workers did observe that blue-collar or manual workers had a higher prevalence of cardiovascular disease<sup>47</sup>.

Two studies carried out by the same group, one in more than 5000 farmers<sup>48</sup> and the other in almost 1100 Bolivian

miners<sup>49</sup>, showed that these groups of manual workers had high values on scales related to cardiometabolic risk such as metabolic syndrome, nonalcoholic fatty liver disease, insulin resistance and even on cardiovascular risk scales such as REGICOR and SCORE; these data are similar to those obtained by us in this study.

A study in Japan<sup>50</sup> that included more than 1.1 million people found that nonmanual workers had a higher risk of coronary heart disease but a lower risk of stroke.

An Australian investigation<sup>51</sup> that included half a million workers found a higher prevalence of type 2 diabetes and higher levels of cardiometabolic risk among manual workers.

In a study of Danes aged 18 to 25 years, the relationship between low socioeconomic status and the prevalence of cardiometabolic risk was assessed, and the relationship was found to be inverse, meaning that the risk was higher in people from the most disadvantaged socioeconomic strata<sup>52</sup>.

In the poorest socioeconomic groups, a higher prevalence of cardiometabolic disorders, especially metabolic syndrome, is observed, according to a study carried out in 2650 Chinese adults<sup>53</sup>. Another study carried out in young people in Iran<sup>54</sup> found the same correlation between metabolic syndrome and low socioeconomic status.

Our group has carried out several studies<sup>55-58</sup> in different groups of workers and has found a correlation between belonging to the most disadvantaged social classes and the high prevalence of various cardiometabolic risk scales, such as nonalcoholic fatty liver disease, obesity, vascular age and metabolic syndrome, among others.

A meta-analysis<sup>59</sup> that included 22 studies assessed the need for interventions to reduce the high prevalence of cardiometabolic risk factors such as arterial hypertension, hypercholesterolemia and obesity in manual workers. Something similar was found in another publication carried out in Korea<sup>60</sup>.

## Strengths and limitations

The large number of cardiometabolic risk scales analyzed and the sample size in both sexes are two of the advantages of the study. This study is certainly the first to specifically evaluate cardiometabolic levels in waiters, which makes it a model for future research on this group of workers.

The main limitation is that most of the cardiometabolic risk parameters were not calculated using objective methods, but rather using risk scales.

## Conclusions

The kitchen workers analyzed in this study, despite having a low mean age, have high prevalence of the different cardiometabolic risk scales.

The variables that most increase the risk of presenting high values of all the cardiometabolic risk scales are age, followed by sex (male), while smoking has no influence in most cases.

## Conflict of Interest

The authors declared that there is no conflict of interest.

## References

1. Kraus WE, Powell KE, Haskell WL, Janz KF, Campbell WW, Jakicic JM, et al. Physical Activity, All-Cause and Cardiovascular Mortality, and Cardiovascular Disease. *Med Sci Sports Exerc.* 2019 Jun;51(6):1270-1281. doi: 10.1249/MSS.0000000000001939.
2. De qué mueren los españoles? Causas de muerte, datos y estadísticas. Available at: <https://www.epdata.es/datos/muereespanoles-causas-muerte-datos-estadisticas/241/espana/106>
3. Rodríguez-Jiménez L, Romero-Martín M, Gómez-Salgado J. Impacto medioambiental de los servicios de Urgencias en la Salud Pública: una herramienta de valoración. *Rev Esp Salud Publica.* 2023 Jun 2;97:e202306044.
4. Katakami N. Mechanism of Development of Atherosclerosis and Cardiovascular Disease in Diabetes Mellitus. *J Atheroscler Thromb.* 2018 Jan 1;25(1):27-39. doi: 10.5551/jat.RV17014.
5. López-González ÁA, Bannasar-Veny M, Tauler P, Aguilo A, Tomàs-Salvà M, Yáñez A. Socioeconomic inequalities and age and gender differences in cardiovascular risk factors. *Gac Sanit.* 2015;29(1):27-36.
6. Hermesen S, van Kraaij A, Camps G. Low- and Medium-Socioeconomic-Status Group Members' Perceived Challenges and Solutions for Healthy Nutrition: Qualitative Focus Group Study. *JMIR Hum Factors.* 2022 Dec 2;9(4):e40123. doi: 10.2196/40123.
7. Stringhini S, Carmeli C, Jokela M, Avendaño M, Muennig P, Guida F, et al. Socioeconomic status and the 25 × 25 risk factors as determinants of premature mortality: a multicohort study and meta-analysis of 1·7 million men and women. *Lancet.* 2017 Mar 25;389(10075):1229-1237. doi: 10.1016/S0140-6736(16)32380-7.
8. Cano-Serral G, Rodríguez-Sanz M, Borrell C, Pérez Mdel M, Salvador J. Socioeconomic inequalities in the provision and uptake of prenatal care. *Gac Sanit.* 2006;20(1):25-30.
9. Ke Y, Shi L, Peng L, Chen S, Hong J, Liu Y. Associations between socioeconomic status and physical activity: A cross-sectional analysis of Chinese children and adolescents. *Front Psychol.* 2022 Sep 1;13:904506. doi: 10.3389/fpsyg.2022.904506.
10. Paglione L, Angelici L, Davoli M, Agabiti N, Cesaroni G. Mortality inequalities by occupational status and type of job in men and

- Mujeres: results from the Rome Longitudinal Study. *BMJ Open*. 2020;10(6):e033776. doi:10.1136/bmjopen-2019-033776
11. Schwensen JF, Menné T, Veien NK, Funding AT, Avnstorp C, Østerballe M, et al. Occupational contact dermatitis in blue-collar workers: results from a multicentre study from the Danish Contact Dermatitis Group (2003-2012). *Contact Dermatitis*. 2014 Dec;71(6):348-55. doi: 10.1111/cod.12277.
  12. Rezazadeh M, Aminianfar A, Pahlevan D. Short-term effects of dry needling of thenar muscles in manual laborers with carpal tunnel syndrome: a pilot, randomized controlled study. *Physiother Theory Pract*. 2023 May;39(5):927-937. doi: 10.1080/09593985.2022.2033897.
  13. Chela-Alvarez X, Bullete O, Garcia-Illan E, Vidal-Thomàs M, Llobera J, Arenal Group. Hotel housekeepers and occupational health: experiences and perceived risks. *Ann Occup Environ Med*. 2022 Oct 25;34:e29. doi: 10.35371/aoem.2022.34.e29.
  14. American Diabetes Association Professional Practice Committee. 2. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes-2022. *Diabetes Care*. 2022 Jan 1;45(Suppl 1):S17-S38. doi: 10.2337/dc22-S002.
  15. Gong J, Han Y, Gao G, Chen A, Fang Z, Lin D, et al. Sex-specific difference in the relationship between body fat percentage and arterial stiffness: Results from Fuzhou study. *J Clin Hypertens (Greenwich)*. 2023 Mar;25(3):286-294. doi: 10.1111/jch.14649.
  16. Molina-Luque R, Yañez AM, Bennisar-Veny M, Romero-Saldaña M, Molina-Recio G, López-González AA. A Comparison of Equation Córdoba for Estimation of Body Fat (ECORE-BF) with Other Prediction Equations. *Int J Environ Res Public Health*. 2020 Oct 29;17(21):7940. doi: 10.3390/ijerph17217940.
  17. Mill-Ferreira E, Cameno-Carrillo V, Saúl-Gordo H, Camilavado MC. Estimation of the percentage of body fat based on the body mass index and the abdominal circumference: Palafolls Formula. *Semergen*. 2019;45(2):101-8.
  18. López-González AA, Ramírez Manent JI, Vicente-Herrero MT, García Ruiz E, Albaladejo Blanco M, López Safont N. [Prevalence of diabetes in the Spanish working population: influence of sociodemographic variables and tobacco consumption]. *An Sist Sanit Navar*. 2022 Apr 27;45(1):e0977. Spanish. doi: 10.23938/ASSN.0977.
  19. Suthahar N, Wang K, Zwartkruis VW, Bakker SJL, Inzucchi SE, Meems LMG, et al. Associations of relative fat mass, a new index of adiposity, with type-2 diabetes in the general population. *Eur J Intern Med*. 2023 Mar;109:73-78. doi: 10.1016/j.ijim.2022.12.024.
  20. Zhang X, Sun Y, Li Y, Wang C, Wang Y, Dong M, et al. Association between visceral adiposity index and heart failure: A cross-sectional study. *Clin Cardiol*. 2023 Mar;46(3):310-319. doi: 10.1002/clc.23976.
  21. Gao W, Jin L, Li D, Zhang Y, Zhao W, Zhao Y, et al. The association between the body roundness index and the risk of colorectal cancer: a cross-sectional study. *Lipids Health Dis*. 2023 Apr 18;22(1):53. doi: 10.1186/s12944-023-01814-2.
  22. Xiong J, Wang H, Zhu Y, Zhou Y, Pang Y, Zhang L. The Right Internal Jugular at the Cricoid Cartilage Level May Represent the Optimal Central Vein Puncture Site in Pediatric Patients. *Front Pediatr*. 2022 Feb 22;10:833845. doi: 10.3389/fped.2022.833845.
  23. Martins CA, do Prado CB, Santos Ferreira JR, Cattafesta M, Dos Santos Neto ET, Haraguchi FK, et al. Conicity index as an indicator of abdominal obesity in individuals with chronic kidney disease on hemodialysis. *PLoS One*. 2023 Apr 19;18(4):e0284059. doi: 10.1371/journal.pone.0284059.
  24. Nagayama D, Fujishiro K, Watanabe Y, Yamaguchi T, Suzuki K, Saiki A, et al. A Body Shape Index (ABSI) as a Variant of Conicity Index Not Affected by the Obesity Paradox: A Cross-Sectional Study Using Arterial Stiffness Parameter. *J Pers Med*. 2022 Dec 5;12(12):2014. doi: 10.3390/jpm12122014.
  25. Doménech-Asensi G, Gómez-Gallego C, Ros-Berruazo G, García-Alonso FJ, Canteras-Jordana M. Critical overview of current anthropometric methods in comparison with a new index to make early detection of overweight in Spanish university students: the normalized weight-adjusted index. *Nutr Hosp*. 2018 Mar 1;35(2):359-367. English. doi: 10.20960/nh.1189.
  26. Ramdas Nayak VK, Satheesh P, Shenoy MT, Kalra S. Triglyceride Glucose (TyG) Index: A surrogate biomarker of insulin resistance. *J Pak Med Assoc*. 2022 May;72(5):986-988. doi: 10.47391/JPMMA.22-63.
  27. Cheng Y, Fang Z, Zhang X, Wen Y, Lu J, He S, et al. Association between triglyceride glucose-body mass index and cardiovascular outcomes in patients undergoing percutaneous coronary intervention: a retrospective study. *Cardiovasc Diabetol*. 2023 Mar 30;22(1):75. doi: 10.1186/s12933-023-01794-8.
  28. Yan S, Wang D, Jia Y. Comparison of insulin resistance-associated parameters in US adults: a cross-sectional study. *Hormones (Athens)*. 2023 Jun;22(2):331-341. doi: 10.1007/s42000-023-00448-4.
  29. Li Y, Zheng R, Li S, Cai R, Ni F, Zheng H, et al. Association Between Four Anthropometric Indexes and Metabolic Syndrome in US Adults. *Front Endocrinol (Lausanne)*. 2022 May 24;13:889785. doi: 10.3389/fendo.2022.889785.
  30. Lazzar S, D'Alleva M, Isola M, De Martino M, Caroli D, Bondesan A, et al. Cardiometabolic Index (CMI) and Visceral Adiposity Index (VAI) Highlight a Higher Risk of Metabolic Syndrome in Women with Severe Obesity. *J Clin Med*. 2023 Apr 23;12(9):3055. doi: 10.3390/jcm12093055.
  31. Hong N. High Fatty Liver Index and Fracture Risk: Clinical Implications. *Gut Liver*. 2023 Jan 15;17(1):6-7. doi: 10.5009/gnl220533.
  32. Preveden T, Veres B, Ruzic M, Pete M, Bogic S, Kovacevic N, et al. Triglyceride-Glucose Index and Hepatic Steatosis Index for the assessment of liver steatosis in HCV patients. *Minerva Gastroenterol (Torino)*. 2023 Jun;69(2):254-260. doi: 10.23736/S2724-5985.22.03168-0.
  33. Li X, Qin P, Cao L, Lou Y, Shi J, Zhao P, et al. Dose-response association of the ZJU index and fatty liver disease risk: A large cohort in China. *J Gastroenterol Hepatol*. 2021 May;36(5):1326-1333. doi: 10.1111/jgh.15286.
  34. Lee I, Cho J, Park J, Kang H. Association of hand-grip strength and non-alcoholic fatty liver disease index in older adults. *J Exerc Nutrition Biochem*. 2018 Dec 31;22(4):62-68. doi: 10.20463/jenb.2018.0031.
  35. Chen ZY, Liu L, Zhuang XX, Zhang YC, Ma YN, Liu Y, et al. Lipid accumulation product is a better predictor of metabolic syndrome in Chinese adolescents: a cross-sectional study. *Front Endocrinol (Lausanne)*. 2023 Jun 23;14:1179990. doi: 10.3389/fendo.2023.1179990.
  36. López González AA, Rivero Ledo YI, Vicente Herrero MT, Gil Llinás M, Tomás Salvá M, Riutord Fe B. Índices aterogénicos en trabajadores de diferentes sectores laborales del área Mediterránea Española. *Clin Investig Arterioscler*. 2015 May-Jun;27(3):118-28. doi: 10.1016/j.arteri.2014.10.004.
  37. Martínez-Jover A, López-González A, Tomás-Gil P, Coll-Villalonga JL, Martí-Lliteras P, Ramírez-Manent JI. Association between different

- cardiometabolic risk scales and metabolic syndrome scales in 418,343 Spanish workers. *AJHS* 2023;38(4):152-7 doi: 10.3306/AJHS.2023.38.04.152
38. Paublini H, López González AA, Busquets-Cortés C, Tomas-Gil P, Riutord-Sbert P, Ramírez-Manent JL. Relationship between Atherogenic Dyslipidaemia and Lipid Triad and Scales That Assess Insulin Resistance. *Nutrients*. 2023 Apr 27;15(9):2105. doi: 10.3390/nu15092105.
39. Fresneda S, Abbate M, Busquets-Cortés C, López-González AA, Fuster-Parra P, Bennasar-Veny M, et al. Sex and age differences in the association of fatty liver index-defined non-alcoholic fatty liver disease with cardiometabolic risk factors: a cross-sectional study. *Biol Sex Differ*. 2022 Nov 4;13(1):64. doi: 10.1186/s13293-022-00475-7.
40. Tapias-Merino E, De Hoyos-Alonso MDC, Contador-Castillo I, Rodríguez-Sánchez E, Sanz-Cuesta T, Becerro-Muñoz CM, et al. Cardiovascular risk in subjects over 55 years of age and cognitive performance after five years. NEDICES2-RISK study. Study protocol. *PLoS One*. 2022 Nov 28;17(11):e0274589. doi: 10.1371/journal.pone.0274589.
41. SCORE2 working group and ESC Cardiovascular risk collaboration. SCORE2 risk prediction algorithms: new models to estimate 10-year risk of cardiovascular disease in Europe. *Eur Heart J*. 2021 Jul 1;42(25):2439-2454. doi: 10.1093/eurheartj/ehab309.
42. Gabriel R, Brotons C, Tormo MJ, Segura A, Rigo F, Elosua R, et al. La ecuación ERICE: la nueva ecuación autóctona de riesgo cardiovascular para una población mediterránea envejecida y de bajo riesgo en España. *Rev Esp Cardiol*. 2015;68(3):205-15.
43. 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>
44. Cuende JL. La edad vascular frente al riesgo cardiovascular: aclarando conceptos. *Rev Esp Cardiol*. 2016;69(3):243-6.
45. Cuende JL. Vascular Age, RR, ALLY, RALLY and Vascular Speed, Based on SCORE: Relations Between New Concepts of Cardiovascular Prevention. *Rev Esp Cardiol (Engl Ed)*. 2018 May;71(5):399-400. English, Spanish. doi: 10.1016/j.rec.2017.02.043.
46. Aginsky KD, Constantinou D, Delpont M, Watson ED. Cardiovascular Disease Risk Profile and Readiness to Change in Blue- and White-Collar Workers. *Fam Community Health*. 2017 Jul/Sep;40(3):236-244. doi: 10.1097/FCH.0000000000000148.
47. Prihartono NA, Fitriyani F, Riyadina W. Cardiovascular Disease Risk Factors Among Blue and White-collar Workers in Indonesia. *Acta Med Indones*. 2018 Apr;50(2):96-103.
48. Mobebebi V, Aramayo A, Morales J. Determination of scales related to cardiovascular risk and fatty liver in 5,370 spanish farmers. *AJHS* 2021;36(2):26-33 doi: 10.3306/AJHS.2021.36.02.26
49. Mobebebi V, Lagrava R, Aramayo A, Liceras C, Apaza B. Results of a health intervention program in 1094 bolivian mining workers. *AJHS* 2022;37(1):48-51 doi: 10.3306/AJHS.2022.37.01.48
50. Zaitzu M, Kato S, Kim Y, Takeuchi T, Sato Y, Kobayashi Y, et al. Occupational Class and Risk of Cardiovascular Disease Incidence in Japan: Nationwide, Multicenter, Hospital-Based Case-Control Study. *J Am Heart Assoc*. 2019 Mar 19;8(6):e011350. doi: 10.1161/JAHA.118.011350.
51. Kelsall HL, Fernando PHS, Gwini SM, Sim MR. Cardiovascular Disease and Type 2 Diabetes Risk Across Occupational Groups and Industry in a Statewide Study of an Australian Working Population. *J Occup Environ Med*. 2018 Mar;60(3):286-294. doi: 10.1097/JOM.0000000000001228.
52. Kempel MK, Winding TN, Böttcher M, Andersen JH. Subjective social status and cardiometabolic risk markers in young adults. *Psychoneuroendocrinology*. 2022 Mar;137:105666. doi: 10.1016/j.psyneuen.2022.105666.
53. Hao Z, Wang M, Zhu Q, Li J, Liu Z, Yuan L, et al. Association Between Socioeconomic Status and Prevalence of Cardio-Metabolic Risk Factors: A Cross-Sectional Study on Residents in North China. *Front Cardiovasc Med*. 2022 Mar 7;9:698895. doi: 10.3389/fcvm.2022.698895.
54. Shafiee G, Qorbani M, Heshmat R, Mohammadi F, Sheidaei A, Motlagh ME, et al. Socioeconomic inequality in cardio-metabolic risk factors in a nationally representative sample of Iranian adolescents using an Oaxaca-Blinder decomposition method: the CASPIAN-III study. *J Diabetes Metab Disord*. 2019 Apr 28;18(1):145-153. doi: 10.1007/s40200-019-00401-6.
55. Martínez-Almoyna E, Tomás-Gil P, Coll-Villalonga JL, Ramírez-Manent JL, Riera K, López-González AA. Variables that influence the values of 7 scales that determine the risk of nonalcoholic fatty liver disease and liver fibrosis in 219,477 spanish workers. *AJHS* 2023;38(4):9-16 doi: 10.3306/AJHS.2023.38.04.9
56. Vicente-Herrero MT, Ramírez MV, Capdevila L, Partida-Hanon A, Reinoso-Barbero L, López-González AA. Lifestyle, overweight and obesity in spanish workers: related variables. *AJHS* 2022;37(4):135-43 doi: 10.3306/AJHS.2022.37.04.135
57. Montero-Muñoz N, López-González AA, Tomás-Gil P, Martínez-Jover A, Paublini H, Ramírez Manent JL. Relationship between sociodemographic variables and tobacco consumption with vascular age values using the Framingham model in 336,450 spanish workers. *AJHS* 2023;38(5):61-6 doi: 10.3306/AJHS.2023.38.05.61
58. Martínez-Jover A, López-González AA, Tomás-Gil P, Coll-Villalonga JL, Martí-Lliteras P, Ramírez-Manent JL. Variables influencing the appearance of metabolic syndrome with three different definitions in 418,343 spanish workers. *AJHS* 2023;38(4):129-35 doi: 10.3306/AJHS.2023.38.04.129
59. Crane MM, Halloway S, Walts ZL, Gavin KL, Moss A, Westrick JC, et al. Behavioural interventions for CVD risk reduction for blue-collar workers: a systematic review. *J Epidemiol Community Health*. 2021 Dec;75(12):1236-1243. doi: 10.1136/jech-2021-216515.
60. Hwang WJ, Kim JA. Developing a Health-Promotion Program Based on the Action Research Paradigm to Reduce Cardiovascular Disease Risk Factors among Blue Collar Workers. *Int J Environ Res Public Health*. 2019 Dec 6;16(24):4958. doi: 10.3390/ijerph16244958.