Cardiovascular Risk Factors in Spain in the First Decade of the 21st Century, a Pooled Analysis With Individual Data From 11 Population-Based Studies: the DARIOS Study

María Grau, a Roberto Elosua, a,b Antonio Cabrera de León, c,d María Jesús Guembe, e,f José Miguel Baena-Díez, a,g Tomás Vega Alonso, b Francisco Javier Félix, b Belén Zorrilla, b Fernando Rigo, b José Lapetra, l,m Diana Gavrila, b,n Antonio Segura, g Héctor Sanz, a Daniel Fernández-Bergés, p Montserrat Fitó, m,q and Jaume Marrugat3,*

a Grupo de Epidemiología y Genética Cardiovascular, Programa de Investigación en Procesos Inflamatorios y Cardiovasculares, Instituto Municipal de Investigación Médica, Barcelona, Spain
b Unidad de Investigación de Atención Primaria y del Hospital Universitario Nuestra Señora de Candelaria, Santa Cruz de Tenerife, Spain
c Área de Medicina Preventiva y Salud Pública, Universidad de La Laguna, Tenerife, Spain
d Dirección General de Salud Pública y Investigación Sanitaria, Consejería de Sanidad de la Región de Murcia, Murcia, Spain
e Centro de Salud Villanueva Norte, Servicio Extremeno de Salud, Villanueva de la Serena, Badajoz, Spain
f Unidad de Investigación Don Benito Villanueva, Programa de Investigación Cardiovascular, Fundesalud, Gerencia Área Sanitaria Don Benito-Villanueva, Badajoz, Spain
g Grupo de Riesgo Cardiovascular y Nutrición, Programa de Investigación en Procesos Inflamatorios y Cardiovasculares, Instituto Municipal de Investigación Médica, Barcelona, Spain
h Servicio de Epidemiología, Consejería de Salud y Consumo de la Región de Murcia, Murcia, Spain
i Centro de Salud La Marina e Institut d’Investigació en Atenció Primària Jordi Gol, Institut Català de la Salut, Barcelona, Spain
j Servicio de Investigación, Instituto de Ciencias de la Salud de Castilla-La Mancha, Talavera de la Reina, Toledo, Spain
k Unidad de Investigación Don Benito Villanueva, Programa de Investigación Cardiovascular, Fundesalud, Gerencia Área Sanitaria Don Benito-Villanueva, Badajoz, Spain
l A full list of the DARIOS study researchers is available from: http://www.regicor.org/darios_inv
m * Corresponding author: Grupo de Epidemiología y Genética Cardiovascular, Programa de Investigación en Procesos Inflamatorios y Cardiovasculares, Instituto Municipal de Investigación Médica, Dr. Aiguader 88, 08003 Barcelona, Spain.
E-mail address: jmarrugat@imim.es (J. Marrugat).

ABSTRACT

Introduction and objectives: To estimate the prevalence of cardiovascular risk factors in individuals aged 35-74 years in 10 of Spain’s autonomous communities and determine the geographic variation of cardiovascular risk factors distribution.

Methods: Pooled analysis with individual data from 11 studies conducted in the first decade of the 21st century. The average response rate was 73%. Lipid profile (with laboratory cross-validation), glucose level, blood pressure, waist circumference, height, and weight were measured and standard questionnaires administered. Age-standardized prevalence of smoking, diabetes, hypertension, dyslipidemia, and obesity in the European population were calculated. Furthermore, the coefficient of variation between component studies was determined for the prevalence of each risk factor.

Results: In total, 28,887 participants were included. The most prevalent cardiovascular risk factors were high blood pressure (47% in men, 39% in women), total cholesterol ≥250 mg/dL (43% and 40%, respectively), obesity (29% and 29%, respectively), tobacco use (33% and 21%, respectively), and diabetes (16% and 11%, respectively). Total cholesterol ≥190 and ≥250 mg/dL were the respective minimum and maximum coefficients of variation (7%-24% in men, 7%-26% in women). Average concordance in lipid measurements between laboratories was excellent.

Conclusions: Prevalence of high blood pressure, dyslipidemia, obesity, tobacco use and diabetes is high. Little variation was observed between autonomous communities in the population aged 35-74 years. However, presence of the most prevalent cardiovascular risk factors in the Canary Islands, Extremadura and Andalusia was greater than the mean of the 11 studies.

© 2010 Sociedad Española de Cardiología. Published by Elsevier España, S.L. All rights reserved.
Factores de riesgo cardiovascular en España en la primera década del siglo XXI: análisis agrupado con datos individuales de 11 estudios de base poblacional, estudio DARIOS

RESUMEN

Introducción y objetivos: Analizar la prevalencia de factores de riesgo cardiovascular en personas de 35-74 años en 10 comunidades autónomas españolas y determinar el grado de variabilidad geográfica en la distribución de los factores de riesgo cardiovascular.

Métodos: Análisis agrupado con datos individuales de 11 estudios desarrollados en la primera década del siglo XXI con un promedio de tasa de participación del 73%. Se midió el perfil lipídico (con validación cruzada de laboratorios), glucemia, presión arterial, perímetro de la cintura, peso y talla y se administraron cuestionarios estandarizados. Se estimó la prevalencia estandarizada a la población europea de tabaquismo, diabetes, hipertensión arterial, dislipidemia y obesidad. Además, se estimó el coeficiente de variación entre estudios componentes en la prevalencia de cada factor de riesgo.

Resultados: Se incluyó a 28.887 participantes. Los factores de riesgo cardiovascular más prevalentes fueron: hipertensión arterial (el 47% en varones y el 39% en mujeres), dislipidemia con colesterol total >250 mg/dl (el 43 y el 40%), obesidad (el 29% en ambos sexos), tabaquismo (el 33 y el 21%) y diabetes mellitus (el 16 y el 11%). El colesterol total >190 y >250 mg/dl presentó el coeficiente de variación mínimo y máximo, respectivamente (el 7-24% en varones y el 7-26% en mujeres). La concordancia media en las determinaciones lipídicas entre laboratorios fue excelente.

Conclusiones: La prevalencia de hipertensión arterial, dislipidemia, obesidad, tabaquismo y diabetes mellitus, es elevada, con variabilidad relativamente baja en la población de 35 a 74 años entre comunidades autónomas. Canarias, Extremadura y Andalucía presentan mayor número de factores de riesgo cardiovascular significativamente más prevalentes que el promedio de los 11 estudios componentes.

© 2010 Sociedad Española de Cardiología. Publicado por Elsevier España, S.L. Todos los derechos reservados.

The objective is to analyze combined cardiovascular risk factors prevalence in 11 studies conducted in 10 of Spain’s autonomous communities in the first decade of the 21st century and determine the level of geographic variability of cardiovascular risk factors distribution.

MÉTODOS

Estudio Población

Pooled analysis with individual data from 11 population-based studies conducted in different geographical areas of Spain (in parentheses) since 2000 with similar methodological designs: ARTPER10 (Catalonia-Barcelona), CDC de Canarias11 (the Canary Islands), CORSAB12 (Balearic Islands), DINO13 (Region of Murcia), DRECA-214 (Andalusia), HERMEX15 (Extremadura), PREDIMERC16 (Community of Madrid), RECCyL17 (Castle and Leon), REGICOR18 (Catalonia-Girona), RIVANA18 (Community of Navarra) and TALAVERA19 (Castle-La Mancha) (Table 1). These studies included patients aged 35-74 years, except ARTPER, which enrolled participants in the 49-74 age range. All participants gave written informed consent to take part in the component studies. The DARIOS study was approved by the Municipal Healthcare Institute’s Clinical Research Ethics Committee (authorization n° 2009/3640).

Mediciones

Preguntas y Examen Físico

The component studies’ questionnaires were based on standardized World Health Organization (WHO) surveys.20 Sociodemographic variables and data on tobacco use and history of HBP, dyslipidemia, and diabetes were recorded. Prevalence of current smokers, ex-smokers (>1 year), and non-smokers was calculated.

Trained healthcare workers conducted the physical examinations. The participants’ waist circumference, weight, and height were measured. Body mass index (BMI) was calculated, dividing

**Abbreviations**

BMI: body mass index  
CV: coefficient of variation  
HBP: high blood pressure  
HDLc: high-density lipoprotein cholesterol  
LDLc: low-density lipoprotein cholesterol  
NHS: National Health Survey
Blood samples were taken following a > 10 h fast. Analysis was performed in local laboratories on fresh blood or aliquots of serum stored at −80 °C in samples not previously thawed. Triglycerides, glucose, and total cholesterol were measured using enzymatic methods. All local laboratories satisfied external quality-control requirements. When triglycerides were < 300 mg/dL, low density lipoprotein cholesterol (LDLc) was calculated using the Friedewald formula, to avoid underestimating LDLc.

A concordance study of the CDC-Canarias, CORSAIb, DRECA-2, HERMEX, PREDIMERIC, RECCyL, and RIVANA laboratories (64% of the sample) was conducted. From each study, 100 samples were analyzed for total cholesterol, high density lipoprotein cholesterol (HDLc), and triglycerides using the IMIM laboratory–originally used by REGICOR and TALAVERA (22% of the sample)–as reference. The IMIM laboratory used esterase-oxidase-peroxidase (CHOD-PAP, ABX-Horiba, Montpellier, France) to measure cholesterol. Triglycerides were measured with glycerol-phosphate oxidase-peroxidase (GPO-PAP, ABX-Horiba), Direct LDLc measurement was with selective accelerator detergent (ABX-Horiba). The ARTPER and DINO studies (14% of the sample) were unable to provide samples for the concordance study.

Prevalence was calculated for: a) diagnosed diabetes mellitus (participants diagnosed by a standardized questionnaire); b) real diabetes mellitus (participants diagnosed or with glucose level >126 mg/dL), and c) impaired fasting glucose (participants not diagnosed with diabetes mellitus and with glucose level 110–125 mg/dL). Prevalence was calculated for: a) diagnosed dyslipidemia (participants diagnosed by a standardized questionnaire), and b) real dyslipidemia (participants diagnosed or presenting total cholesterol ≥190, >240 or >250 mg/dL or LDLc ≥115 or ≥160 mg/dL, depending on clinical practice guidelines). Prevalence of hypoalphalipoproteinemia was determined (LDLc < 40 in men and < 50 mg/dL in women).

**Laboratory Measurements**

**Statistical Analysis**

Age-standardized prevalence was determined for each RF in each component study. To do this, individuals were categorized in 5-year age groups and a rough prevalence figure calculated. This was later standardized by the direct method, with reference to the European population. These figures were accompanied by the 95% confidence interval for the cardiovascular risk factors, stratified by sex for each component study and for the combined studies. Heterogeneity between individual studies was determined with the Levene test for homogeneity of variances between all participating centers for the principle variables. Individuals were classified in 8 groups by age and sex. To calculate the mean or general prevalence of each cardiovascular risk factors and the corresponding confidence intervals, we combined the estimates...
obtained individually for each study using the DerSimonian-Laird random-effects method to compensate for differences in sample size. Prevalences were compared by age group with NHS results for 2006. Continuous variables are described as mean and 95% confidence interval, also standardized for the European population.

The standardized ratio of prevalences was calculated, centering the mean of all component studies to 100% and calculating deviations from this point for each component study and risk factor: tobacco use, systolic blood pressure $\geq 140$ mmHg or diastolic blood pressure $\geq 90$ mmHg, total cholesterol $\geq 250$ and $\geq 190$ mg/dL, BMI $\geq 30$, and glucose level $\geq 126$ mg/dL.

The coefficient of variation ($CV$) was estimated to determine variability between component studies in the prevalence of each risk factor, calculating the percentage deviation of each study versus the average of all studies using the following formula:

$$CV = \frac{\text{standard deviation of prevalences}}{\text{mean of prevalences}} \times 100$$

This $CV$ corresponded to the standard deviation of the 11 studies. Pearson’s correlation coefficients were calculated to analyze deviations in each study with respect to mortality from ischemic heart disease for 2007, standardized for the European population, in each autonomous community. Data from ARTPER were excluded because of differences in the age distribution (individuals aged $> 49$ years) with respect to the other studies.

Concordance of lipid measurements with the reference laboratory was measured using the coefficient of determination $R^2$, intraclass correlation coefficient, and Bland-Altman graphics that analyze the relation between mean values of the original measurement and the reference mean, and the differences between the two. The effect of outliers was analyzed through a graphic representation of residuals. Points that differed by $> 40$ mg/dL for total cholesterol, $> 10$ mg/dL for HDLc, and $> 40$ mg/dL for triglycerides, between the original measurement and that of the reference laboratory were considered sampling errors and eliminated; the graphics were redrawn. When 95% of differences were within $\pm 5$% of the reference laboratory mean determination, participating center and reference laboratory results were considered equivalent. When the value range was outside of $\pm 5$%, the Deming regression was used to correct the original values.$^{20}$ If systematic bias was observed in the figures.

Statistical Analysis was conducted with R Version 2.10 (R Foundation for Statistical Computing, Vienna, Austria).

### RESULTS

The study enrolled 28 887 participants from the following 10 autonomous communities: Andalusia, Balearic Islands, Canary Islands, Castile-La Mancha, Castile and Leon, Catalonia, Extremadura, Community of Madrid, Region of Murcia and Community of Navarra. Their total population represents approximately 70% of the Spanish population aged 35–74. Table 1 presents the characteristics of each component study. Significant heterogeneity ($P < 0.05$) was found for systolic blood pressure in all age groups of women, whereas in men it was found in all age groups except the 55–64 year range. Significant heterogeneity was found for diastolic blood pressure in men aged $< 45$ years and in all age groups in women. For total cholesterol, we found heterogeneity only in women aged $> 45$ years.

Table 2 presents values of glucose level, blood pressure and prevalences of impaired fasting glucose, diabetes mellitus and diagnosed and real HBP by sex. Independently of the diagnosis of diabetes mellitus, women in the CDC, DINO and HERMEX studies presented a prevalence of baseline glucose level $\geq 126$ mg/dL significantly greater than the mean (Fig. 1). Similarly, independently of the diagnosis of HBP, prevalence of systolic blood pressure $\geq 126$ mg/dL was outside of $95$% confidence interval.

### Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>Men, n</th>
<th>Women, n</th>
<th>Glucose level, mg/dL</th>
<th>SBP, mmHg</th>
<th>DBP, mmHg</th>
<th>Total cholesterol, mg/dL</th>
<th>HDLc, mg/dL</th>
<th>Triglycerides, mg/dL</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>CDC</td>
<td>1493</td>
<td>1739</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>ARTPER (45-74 years)</td>
<td>2054</td>
<td>2661</td>
<td>105 (104-106)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>DINO</td>
<td>120</td>
<td>109</td>
<td>105 (95-110)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>HERMEX</td>
<td>139</td>
<td>149</td>
<td>105 (95-110)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>DRECA-2</td>
<td>152</td>
<td>182</td>
<td>105 (95-110)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>RECCyL</td>
<td>123</td>
<td>152</td>
<td>105 (95-110)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>TALAVERA</td>
<td>128</td>
<td>182</td>
<td>105 (95-110)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>REGICOR</td>
<td>131</td>
<td>195</td>
<td>105 (95-110)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>RIVANA</td>
<td>128</td>
<td>182</td>
<td>105 (95-110)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>TALAVERA</td>
<td>123</td>
<td>152</td>
<td>105 (95-110)</td>
<td>126 (124-128)</td>
<td>80 (79-81)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Glucose Level, mg/dL</th>
<th>SBP, mmHg</th>
<th>DBP, mmHg</th>
<th>Total Cholesterol, mg/dL</th>
<th>HDLc, mg/dL</th>
<th>Triglycerides, mg/dL</th>
<th>BMI</th>
</tr>
</thead>
<tbody>
<tr>
<td>glucose level, mg/dL</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>diabetes mellitus</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>HBP, diagnosed</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>real HBP, diagnosed</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>HBP, diagnosed + SBP</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>diabetes mellitus</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>HBP, diagnosed</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>real HBP, diagnosed</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
<tr>
<td>HBP, diagnosed + SBP</td>
<td>110 (108-112)</td>
<td>126 (124-128)</td>
<td>190 (187-193)</td>
<td>42 (40-44)</td>
<td>45 (43-48)</td>
<td>28</td>
</tr>
</tbody>
</table>

Values are expressed as mean (95% confidence interval).
Panel A. Men

Panel B. Women

Figure 1. Death from ischemic heart disease, standardized for the European population by autonomous community, and standardized ratio of prevalence (mean percentage deviation with 95% confidence interval of percentage deviations) for tobacco use of ≥1 cigarettes/day, systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg, total cholesterol ≥250 mg/dL, and ≥190 mg/dL, body mass index ≥30, baseline glucose level ≥126 mg/dL. The component studies compare each risk factor with global prevalence in the DARIOS study (100% indicated by the vertical line) in rank order of population-wide cardiovascular mortality. At the foot of each factor appears mean prevalence of the corresponding factor for the 2 age groups (35–74 years and 45–74 years). BMI, body mass index; Cig, cigarette; CV, coefficient of variation; DBP, diastolic blood pressure; IHD, ischemic heart disease; SBP, systolic blood pressure.

Prevalence of real dyslipidemia varied notably between total cholesterol or LDLc and the chosen cutoff point (Table 4). Fig. 2 shows the distribution of total cholesterol and its fractions in men and women. Prevalence of dyslipidemia (total cholesterol ≥250 mg/dL) was significantly greater than the mean in men in the HERMEX, PREDIMERC, and PREDIMERC studies, and in women in the DINO study. Even so, men and women in the HERMEX, PREDIMERC, and RIVANA studies fell considerably. Even so, men and women in the HERMEX, PREDIMERC, and RIVANA studies; men in the TALAVERA study, and women in the RECCYL and TALAVERA studies (Fig. 1).

Analysis of concordance of lipid measurements showed limits of concordance of the 95%, coefficient of determination R², and intraclass correlation coefficient between ±14 and ±33; 0.82 and 0.97, and 0.91 and 0.98, respectively, for total cholesterol, between ±5 and ±8; 0.84 and 0.94, and 0.92 and 0.97 for HDLC, and between ±10 and ±25; 0.94 and 0.99, and 0.97 and 0.99 for triglycerides.

Prevalence of real dyslipidemia varied notably between total cholesterol or LDLc and the chosen cutoff point (Table 4). Fig. 2 shows the distribution of total cholesterol and its fractions in men and women. Prevalence of dyslipidemia (total cholesterol ≥250 mg/dL) was significantly greater than the mean in men in the HERMEX, PREDIMERC, and PREDIMERC studies, and in women in the DINO study. Even so, men and women in the HERMEX, PREDIMERC, and RIVANA studies; men in the TALAVERA study, and women in the DINO study presented prevalences significantly greater than the mean for DARIOS.

Prevalence of cardiovascular risk factors in the population aged 35–74 years was similar in the component studies (coefficient of variation 7%–24% in men and 7%–26% in women) (Fig. 1). In women, prevalence of obesity and glucose level ≥126 mg/dL correlated significantly with death from ischemic heart disease in
These data improve both cardiovascular risk factors.

Despite the prevalence of total cholesterol, triglycerides, and glucose level, the distribution of most cardiovascular risk factors presents <20% variability in the population aged 35–74 years in the Spanish autonomous communities. Our results put standardized prevalence of HBP at 43% and of dyslipidemia (total cholesterol ≥250 mg/dL) at 41%. Finally, >25% of the population were smokers, 29% were obese, and 13% had diabetes. Over 75% of the population were far from the cutoff points of total cholesterol ≤190 mg/dL or LDLc ≤115 mg/dL proposed by the more demanding clinical practice guidelines. These data improve our understanding of risk factor prevalence in the current century. They add information obtained with a more rigorous methodology that was used previously. The low incidence of coronary disease and high life expectancy associated with being born into the Spanish population suggest that aspects of the underlying mechanisms of coronary disease development should be studied in greater depth.

We found no great differences between the autonomous communities in prevalence of diabetes mellitus, HBP, dyslipidemia, obesity, and tobacco use, with coefficients of variation ranging from 7% to 26%. Geographical variability in prevalence of tobacco use, diabetes mellitus, and dyslipidemia with total cholesterol >250 mg/dL was similar to that reported in the ERICE study, conducted with data from the 1990’s. Preventive prevalence of total cholesterol >200 mg/dL was significantly less variable in DARIOS than in ERICE (CV, 10% and 22%, P = .003), whereas prevalence of HBP (CV, 18% and 8%, P < .001) and obesity (CV, 19% and 13%, P = .021) was significantly more variable in DARIOS. The autonomous communities of the Canary Islands, Andalusia, and Extremadura stand out for the greater prevalence of obesity, diabetes mellitus, HBP, or dyslipidemia in both men and women. Moreover, they also present greater mortality for ischemic heart disease than the other communities in the component studies.

Differences in age range, method of standardization, and the absence of laboratory cross-validation makes it difficult to compare our results with those of other, similar studies. Despite this, our results indicate greater prevalence of obesity and diabetes mellitus in the first decade of the 21st century than that reported some decades ago. Both cardiovascular risk factors correlate with mortality from ischemic heart disease in the population aged 35–74 years in the autonomous communities, especially among women. The ecological nature of this relationship prevents us from making definitive conclusions about the consequences of this finding. Should they be confirmed, these results would indicate we need a more intensive approach to the prevention of obesity and diabetes mellitus in Spain. Cohort studies with long-term follow-up are needed to provide greater insight into the role of both of these cardiovascular risk factors in the development of ischemic heart disease.

In DARIOS, prevalence of HBP and nondiagnosed diabetes mellitus was lower than that observed previously. It has fallen from approximately 56% and 43% in the 1990’s to 38% and 26% currently in hypertensive men and women, respectively; and from 28% and 21% to 19% and 10%, respectively, in men and women with diabetes. The screening for both illnesses, encouraged by the Spanish Society of Family and Community Medicine’s Program of Preventative Activities and Health Promotion, together with the

**DISCUSSION**

The distribution of most cardiovascular risk factors presents <20% variability in the population aged 35–74 years in the Spanish autonomous communities. Our results put standardized prevalence of HBP at 43% and of dyslipidemia (total cholesterol ≥250 mg/dL) at 41%. Finally, >25% of the population were smokers, 29% were obese, and 13% had diabetes. Over 75% of the population were far from the cutoff points of total cholesterol ≤190 mg/dL or LDLc ≤115 mg/dL proposed by the more demanding clinical practice guidelines. These data improve our understanding of risk factor prevalence in the current century. They add information obtained with a more rigorous methodology that was used previously. The low incidence of coronary disease and high life expectancy associated with being born into the Spanish population suggest that aspects of the underlying mechanisms of coronary disease development should be studied in greater depth.

We found no great differences between the autonomous communities in prevalence of diabetes mellitus, HBP, dyslipidemia, obesity, and tobacco use, with coefficients of variation ranging from 7% to 26%. Geographical variability in prevalence of tobacco use, diabetes mellitus, and dyslipidemia with total cholesterol >250 mg/dL was similar to that reported in the ERICE study, conducted with data from the 1990’s. Preventive prevalence of total cholesterol >200 mg/dL was significantly less variable in DARIOS than in ERICE (CV, 10% and 22%, P = .003), whereas prevalence of HBP (CV, 18% and 8%, P < .001) and obesity (CV, 19% and 13%, P = .021) was significantly more variable in DARIOS. The autonomous communities of the Canary Islands, Andalusia, and Extremadura stand out for the greater prevalence of obesity, diabetes mellitus, HBP, or dyslipidemia in both men and women. Moreover, they also present greater mortality for ischemic heart disease than the other communities in the component studies.

Differences in age range, method of standardization, and the absence of laboratory cross-validation makes it difficult to compare our results with those of other, similar studies. Despite this, our results indicate greater prevalence of obesity and diabetes mellitus in the first decade of the 21st century than that reported some decades ago. Both cardiovascular risk factors correlate with mortality from ischemic heart disease in the population aged 35–74 years in the autonomous communities, especially among women. The ecological nature of this relationship prevents us from making definitive conclusions about the consequences of this finding. Should they be confirmed, these results would indicate we need a more intensive approach to the prevention of obesity and diabetes mellitus in Spain. Cohort studies with long-term follow-up are needed to provide greater insight into the role of both of these cardiovascular risk factors in the development of ischemic heart disease.

In DARIOS, prevalence of HBP and nondiagnosed diabetes mellitus was lower than that observed previously. It has fallen from approximately 56% and 43% in the 1990’s to 38% and 26% currently in hypertensive men and women, respectively; and from 28% and 21% to 19% and 10%, respectively, in men and women with diabetes. The screening for both illnesses, encouraged by the Spanish Society of Family and Community Medicine’s Program of Preventative Activities and Health Promotion, together with the...
Table 4
Lipid Profile and Prevalence of Dyslipidemia Standardized to the European Population by Component Study and General Study in Men and Women Aged 35-74 Years

<table>
<thead>
<tr>
<th>ARTPER (45-74 years)</th>
<th>CDC</th>
<th>CORSAIB</th>
<th>DINO</th>
<th>DRECA-2</th>
<th>HERMEX</th>
<th>PREDIMERC</th>
<th>RECCyL</th>
<th>REGICOR</th>
<th>RIVANA</th>
<th>TALAVERA</th>
<th>General</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Men, n</strong></td>
<td>1493</td>
<td>2054</td>
<td>804</td>
<td>443</td>
<td>736</td>
<td>1046</td>
<td>966</td>
<td>1198</td>
<td>2685</td>
<td>1765</td>
<td>235</td>
</tr>
<tr>
<td>HDLc, mg/dL</td>
<td>50 (49-51)</td>
<td>48 (47-48)</td>
<td>47 (47-48)</td>
<td>49 (48-50)</td>
<td>50 (49-50)</td>
<td>53 (52-53)</td>
<td>46 (45-47)</td>
<td>48 (48-49)</td>
<td>47 (47-48)</td>
<td>49 (48-50)</td>
<td>52 (51-53)</td>
</tr>
<tr>
<td>LDLc &lt; 40 mg/dL, %</td>
<td>18 (16-20)</td>
<td>23 (21-25)</td>
<td>25 (22-28)</td>
<td>19 (16-23)</td>
<td>17 (15-20)</td>
<td>10 (9-12)</td>
<td>26 (23-29)</td>
<td>20 (17-22)</td>
<td>27 (25-29)</td>
<td>18 (16-20)</td>
<td>11 (7-16)</td>
</tr>
<tr>
<td>LDLc, mg/dL</td>
<td>136 (134-138)</td>
<td>134 (132-136)</td>
<td>139 (136-141)</td>
<td>142 (138-145)</td>
<td>134 (132-137)</td>
<td>149 (146-151)</td>
<td>150 (148-153)</td>
<td>130 (128-132)</td>
<td>138 (137-140)</td>
<td>143 (141-145)</td>
<td>151 (147-156)</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>140 (135-145)</td>
<td>152 (147-157)</td>
<td>163 (155-170)</td>
<td>140 (130-151)</td>
<td>158 (151-166)</td>
<td>133 (127-138)</td>
<td>139 (133-144)</td>
<td>150 (144-155)</td>
<td>130 (126-133)</td>
<td>132 (128-136)</td>
<td>125 (115-136)</td>
</tr>
<tr>
<td><strong>Women, n</strong></td>
<td>1739</td>
<td>2661</td>
<td>865</td>
<td>502</td>
<td>1158</td>
<td>1238</td>
<td>1238</td>
<td>1209</td>
<td>2097</td>
<td>293</td>
<td>15 462</td>
</tr>
<tr>
<td>TC, mg/dL</td>
<td>222 (221-224)</td>
<td>210 (209-212)</td>
<td>215 (213-218)</td>
<td>216 (213-219)</td>
<td>216 (214-219)</td>
<td>225 (223-227)</td>
<td>225 (222-227)</td>
<td>204 (202-206)</td>
<td>209 (208-211)</td>
<td>216 (215-218)</td>
<td>219 (215-224)</td>
</tr>
<tr>
<td>HDLc, mg/dL</td>
<td>50 (50-51)</td>
<td>54 (54-55)</td>
<td>56 (55-57)</td>
<td>59 (58-60)</td>
<td>59 (58-59)</td>
<td>60 (59-61)</td>
<td>54 (54-55)</td>
<td>56 (54-55)</td>
<td>57 (56-57)</td>
<td>59 (59-60)</td>
<td>60 (59-62)</td>
</tr>
<tr>
<td>LDLc, mg/dL</td>
<td>140 (138-141)</td>
<td>132 (131-134)</td>
<td>136 (134-139)</td>
<td>137 (134-140)</td>
<td>135 (133-137)</td>
<td>145 (143-147)</td>
<td>150 (147-152)</td>
<td>126 (124-128)</td>
<td>134 (132-135)</td>
<td>138 (137-140)</td>
<td>141 (137-145)</td>
</tr>
<tr>
<td>Triglycerides, mg/dL</td>
<td>118 (115-112)</td>
<td>123 (120-126)</td>
<td>117 (113-121)</td>
<td>101 (97-106)</td>
<td>117 (113-121)</td>
<td>102 (99-105)</td>
<td>108 (105-112)</td>
<td>113 (110-115)</td>
<td>98 (96-100)</td>
<td>97 (94-99)</td>
<td>94 (88-101)</td>
</tr>
</tbody>
</table>

DL, dyslipidemia; HDLc, high density lipoprotein cholesterol; LDLc, low density lipoprotein cholesterol; Real DL, diagnosed DL + TC or LDLc above the limit indicated or HDLc below the value indicated; TC, total cholesterol.

Values are expressed as mean (95% confidence interval).
In DARIOS, prevalence of diabetes mellitus, HBP, and dyslipidemia differed substantially from that obtained by the 2006 NHS. This difference may be due to the fact that DARIOS obtained information via questionnaires, which was complemented by blood tests (lipids and glucose level) and measurements of blood pressure, weight, height, and waist circumference. Nonetheless, prevalence estimated exclusively from self-reported information (eg, tobacco use) was similar in both DARIOS and the NHS.

Table 5
Comparison of Prevalence Stratified by Age Between DARIOS and the National Health Survey 2006 (NHS 2006)

<table>
<thead>
<tr>
<th></th>
<th>Smoker N=639</th>
<th>High blood pressure N=640</th>
<th>Dyslipidemia N=640</th>
<th>Obesity N=640</th>
<th>Type II diabetes mellitus N=639</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-44 years</td>
<td>40%</td>
<td>41%</td>
<td>24%</td>
<td>10%</td>
<td>32%</td>
</tr>
<tr>
<td>45-54 years</td>
<td>38%</td>
<td>41%</td>
<td>42%</td>
<td>20%</td>
<td>46%</td>
</tr>
<tr>
<td>55-64 years</td>
<td>29%</td>
<td>31%</td>
<td>61%</td>
<td>38%</td>
<td>49%</td>
</tr>
<tr>
<td>65-74 years</td>
<td>22%</td>
<td>21%</td>
<td>72%</td>
<td>44%</td>
<td>47%</td>
</tr>
<tr>
<td>Women</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>35-44 years</td>
<td>36%</td>
<td>34%</td>
<td>12%</td>
<td>8%</td>
<td>19%</td>
</tr>
<tr>
<td>45-54 years</td>
<td>26%</td>
<td>31%</td>
<td>31%</td>
<td>18%</td>
<td>37%</td>
</tr>
<tr>
<td>55-64 years</td>
<td>9%</td>
<td>13%</td>
<td>55%</td>
<td>35%</td>
<td>55%</td>
</tr>
<tr>
<td>65-74 years</td>
<td>3%</td>
<td>5%</td>
<td>72%</td>
<td>56%</td>
<td>59%</td>
</tr>
</tbody>
</table>

* Total cholesterol ≥250 mg/dL.

Characteristics and Limitations of the Study

The DARIOS study includes 11 studies with population-based random samples conducted in the first decade of the 21st century. Despite the fact that not all of Spain is covered in the study, the sample appears to be representative of approximately 70% of the Spanish population aged 35-74 years. Furthermore, the response rate was generally good (73%); in only 3 studies (representing 21% of participants) was it < 70%. We do not believe the use of healthcare ID cards in 6 of the 11 studies constitutes a selection bias, as > 98% of the population uses public health services, according to the NHS. All the component studies followed a standard WHO method and took measurements with calibrated apparatus. Moreover, we performed an analysis of concordance of lipid profile results using a reference laboratory to correct the few deviations observed. Lipid values prior to standardization and adaptation can be consulted in individual study reports. Prevalence of HBP based on 2 blood pressure measurements presented differences if it was calculated from the mean of both or if only the lower of the two measurements was used. In order to minimize the “white-coat” effect, we chose the lower of the 2 blood pressure measurements.
CONCLUSIONS

In the Spanish population aged 35–74 years, standardized prevalence of HBP and dyslipidemia was > 40%; for obesity and tobacco use, 27%; and for diabetes, 13% in the first decade of the 21st century. Variability between autonomous communities in prevalence of cardiovascular risk factors was relatively low, although differences between those areas with the most extreme levels of prevalence were considerable. The Canary Islands, Extremadura, and Andalusia had a greater accumulation of significantly more prevalent factors than the mean for the 11 component studies.

ACKNOWLEDGEMENTS

The authors wish to thank Susanna Tello, Marta Cabañero and Leny Franco for their contribution to the data management of this project.

FUNDING

This study was financed in its entirety with unconditional support from AstraZeneca.

Data from the original component studies was obtained with financial support from: FEDER, Ministerio de Ciencia e Innovación, Instituto de Salud Carlos III (Red HERACLES RD06/0009; Fondos for investigación, Acuerdo del Consejo Interterritorial de 8 de abril de 2003; EMER07/046 RCESP C3/09); Fondo de Investigación Sanitaria (FIS-FEDER) (PI01/0711, PI02/1158, PI02/1179, PI02/1717, PI03/20471, PI05/2364, PI05/2751, PI07/040, PI07/0934, PI07/1213, G03-045, FIS-ETES 2007, CP06/00100, CM08/00141); Ministerio de Sanidad y Consumo, Plan Nacional PI07/0934, PI07/1213, G03-045, FIS-ETES 2007, CP06/00100, CM08/00141); Ministerio de Sanidad y Consumo, Plan Nacional I + D + i 2004-7 (IP071218); Agencia de Avaluació de Tecnologia i Recerca Mèdica (034/33/02); Agència de Gestió d’Ajusts Universitaris i de Recerca (2005SGR00577); Departamento de Salud de la Generalitat de Catalunya; Fundación Canaria de Investigación y Salud (45/98); Departamento de Salud del Gobierno de Navarra; Junta de Castilla y León; Beica Intensificación de la investigación (INT 07/289); Subdirección General de Promoción de la salud y Prevención. Consejería de Sanidad de la Comunidad de Madrid; Govern Balear; Servicio Andaluz de Salud; Programa de Investigación Comunitaria INTERREG IIIA (SP5.E51); Consejería de Salud de la Junta de Andalucía, Ayuda a Proyectos de Investigación (290/04 y 036/06); Sociedad Andaluza de Medicina Familiar y Comunitaria (SAMFYC 2008); Sociedad Española de Medicina de Familia y Comunitaria (semFYC 2009); Consejería de Sanidad y Consumo del Gobierno de Extremadura and Andalusia; Sociedad Española de Medicina Familiar y Comunitaria SAMFYC 2008; Sociedad Española de Medicina de Familia y Comunitaria semFYC 2009; Consejería de Sanidad y Consumo del Gobierno de Extremadura and Andalusia; Conselleria de Salud y Bienestar Social, Junta de Comunidades de Castilla-La Mancha.

CONFLICTS OF INTEREST

None declared.

REFERENCES


