

# Coronary Disease Risk Attributable to Cardiovascular Risk Factors in the Spanish Population

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**Introduction and objectives.** The proportion of the ischemic heart disease (IHD) burden attributable to cardiovascular risk factors in Spain has traditionally been extrapolated from populations in other countries. The aim of this study was to estimate the IHD risk attributable to smoking, hypercholesterolemia, hypertension, diabetes, and excess weight using data from studies carried out in the Spanish population.

**Methods.** Data on the prevalence of cardiovascular risk factors in the general population were obtained from a meta-analysis of 48 cross-sectional studies carried out in Spain, and data on corresponding prevalences among IHD patients were derived from the PRIAMHO II and PREVESE II multicenter hospital registries. Crude and adjusted relative risks of IHD were obtained from follow-up data collected over 5 years in a primary-care cohort of 6124 adults without cardiovascular disease. The crude and adjusted population attributable fractions for various risk factors were calculated for both sexes combined and for men and women separately.

**Results.** Among men, 42.5% (95% confidence interval [CI], 6.8–59.6) of the adjusted incidence of IHD was attributable to overweight, 33.9% (95% CI, 22.6–41.0) to smoking, 19.4% (95% CI, 8.2–26.5) to hypercholesterolemia, and 15.5% (95% CI, 1.6–24.6) to hypertension. Among women, 36.5% (95% CI, –8.0–56.3) of IHD cases were attributable to overweight, 24.8% (95% CI, 12.0–31.9) to diabetes, and 20.1% (95% CI, 6.1–28.6) to hypercholesterolemia.

**Conclusions.** The cardiovascular risk factors found to contribute most to IHD in the Spanish population were excess weight in both sexes, followed by smoking in men.

**Key words:** *Population attributable fraction. Coronary heart disease. Cardiovascular risk factors. Spanish population.*

## Riesgo coronario atribuible a los factores de riesgo cardiovascular en población española

**Introducción y objetivos.** La carga de enfermedad coronaria atribuible a los factores de riesgo cardiovascular en España ha sido extrapolada tradicionalmente de otras poblaciones. Este estudio pretende estimar el riesgo coronario atribuible al tabaquismo, la hipercolesterolemia, la hipertensión, la diabetes y el sobrepeso, utilizando datos procedentes de poblaciones Españolas.

**Métodos.** Las prevalencias de los factores de riesgo en la población general se obtuvieron de un metaanálisis de 48 estudios transversales realizados en España, y las prevalencias en enfermos coronarios se tomaron de los registros hospitalarios multicéntricos PRIAMHO II y PREVESE II. Los riesgos relativos brutos y ajustados de enfermedad coronaria se obtuvieron del seguimiento durante 5 años de una cohorte de atención primaria de 6.124 personas adultas libres de enfermedad cardiovascular. Las fracciones atribuibles brutas y ajustadas se calcularon para ambos sexos y para varones y mujeres por separado.

**Resultados.** En los varones, el 42,5% (intervalo de confianza [IC] del 95%, 6,8%-59,6%) de la incidencia ajustada de enfermedad coronaria se atribuyó al sobrepeso; el 33,9% (IC del 95%, 22,6%-41%), al tabaquismo, el 19,4% (IC del 95%, 8,2%-26,5%), a la hipercolesterolemia, y el 15,5% (IC del 95%, 1,6%-24,6%), a la hipertensión. En las mujeres, el 36,5% (IC del 95%, –8%-56,3%) de los casos de cardiopatía isquémica se atribuyeron al sobrepeso, el 24,8% (IC del 95%, 12%-31,9%), a la diabetes y el 20,1% (IC del 95%, 6,1%-28,6%), a la hipercolesterolemia.

**Conclusiones.** El sobrepeso y el tabaquismo en varones son los factores de riesgo cardiovascular a los que cabe atribuir un mayor impacto poblacional en la enfermedad coronaria.

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**Palabras clave:** *Fracción atribuible poblacional. Enfermedad coronaria. Factores de riesgo cardiovascular. Población española.*

#### ABBREVIATIONS

CI: confidence interval  
PAF: population attributable fraction  
RR: relative risk

## INTRODUCTION

Cardiovascular disease is one of the leading causes of death, morbidity, and health expenditure in industrialized countries.<sup>1</sup> Although its incidence is lower in Spain and other Mediterranean regions than in other countries with equivalent development levels and similar exposure to risk factors,<sup>2</sup> it continues to be one of the leading causes of mortality and hospitalization, and a cause for concern in health care planning.<sup>3</sup>

At present, the prevention of cardiovascular disease is based on the detection, treatment, and control of modifiable vascular risk factors: smoking habit, hypercholesterolemia, hypertension, diabetes, and overweight. Although the approach to prevention should be multifactorial, health interventions involve prioritization, and thus the impact of each possible intervention on risk in the population should be known.<sup>4</sup> The population attributable fraction (PAF) provides an epidemiological measure of the percentage of potentially avoidable cases of the disease in the total population if a given risk factor could be totally eliminated,<sup>5-7</sup> assuming that the relationship is causal and the effect of exposure is completely reversible. Thus, PAF is especially relevant when a disease involving several risk factors is under study, since it indicates which factor, once eliminated, would have the greatest impact on disease reduction.<sup>5</sup>

The currently available information on coronary risk attributable to each cardiovascular risk factor in the Spanish population is very scarce. On the one hand, several studies have mainly focused on mortality attributable to risk factors, basically tobacco and alcohol, and others have focused on mortality attributable to vascular risk factors,<sup>8</sup> but not on the incidence of cardiovascular events. Furthermore, effect estimates have been extrapolated from other populations, mainly from the Framingham study, that may not be applicable to the Spanish population which has considerably lower cardiovascular mortality and incidence rates.<sup>9,10</sup> Finally, only 1 study has published results on the fraction of coronary risk attributable to vascular risk factors, but using the Framingham function, using unadjusted data and restricted to the 25-64 year age-group.<sup>10</sup>

The aim of the present study was to estimate coronary risk attributable to smoking, hypercholesterolemia, hypertension, diabetes, and overweight, using recently published data on prevalences of risk factors<sup>11-13</sup> and the relative risk of coronary heart disease,<sup>14</sup> taken from cross-sectional and cohort studies conducted in the Spanish population.

## METHODS

### Prevalence of Cardiovascular Risk Factors in Spain

Data on the proportion of the general Spanish population exposed to different cardiovascular risk factors were obtained from a metaanalysis of 48 prevalence studies published between 1990 and 2003, which included 130 945 people from several Spanish populations. The methodology and results of this metaanalysis have been described previously.<sup>11</sup> Briefly, the study was based on bibliographic searches of cross-sectional studies, with probabilistic sampling of the Spanish population and objective measurement of serum cholesterol, blood pressure, basal glucose, weight, and height, rather than reported values. The general combined prevalences and prevalence by sex were obtained using a random effects model weighted by the proportion of the population strata under analysis (geographical area and age group) within the total Spanish general population.

The thresholds or cutoff points for each risk factor were defined according to established diagnostic criteria. The Third Report of the National Cholesterol Education Program,<sup>15</sup> defined hypercholesterolemia as serum total cholesterol concentrations  $\geq 240$  mg/dL. Following the criteria of the Seventh Report of the Joint National Committee,<sup>16</sup> hypertension was defined as systolic blood pressure  $\geq 140$  mm Hg or diastolic blood pressure  $\geq 90$  mm Hg. According to the recommendations of the American Diabetes Association,<sup>17</sup> diabetes mellitus was defined as basal glucose  $\geq 126$  mg/dL. In addition, overweight was defined as a body mass index  $\geq 25$ , and smoking as daily tobacco consumption.

General prevalences and prevalences by sex for smoking, hypercholesterolemia, hypertension, and diabetes among individuals with coronary heart disease were obtained from the PRIAMHO II study (from the Spanish Proyecto de Registro de Infarto Agudo de Miocardio Hospitalario [Acute Myocardial Infarction Hospital Registry Project]), using diagnostic criteria similar to those described. The PRIAMHO II national multicenter hospital registry collected information on 6209 patients with acute myocardial infarction admitted to the coronary intensive care units of 58 randomly selected Spanish public hospitals in 2000.<sup>12,18</sup> The prevalence of overweight in coronary patients was obtained from the PREVESE II study (from the Spanish Prevención Secundaria del Infarto de Miocardio en

España [Secondary Prevention of Myocardial Infarction in Spain]), since this information was not collected by the PRIAMHO II study. The PREVESE II hospital registry, which was completed in 1998, included a sample of 2054 patients with acute myocardial infarction admitted to the coronary care units of 74 nation-wide Spanish hospitals.<sup>13</sup>

### Relative Risk of Coronary Heart Disease

The relative risk of coronary heart disease associated with each cardiovascular risk factor was obtained from the ZACARIS cohort (Zaragoza Cardiovascular Risk Factors Study). The methodology and population base of this study have been described previously<sup>14</sup> (freely available at <http://www.bio-medcentral.com/1471-2458/6/38>). Briefly, this was a prospective cohort study that included the total reference population of 8 physicians based in primary-care centers in Zaragoza, Spain. A total of 6124 patients over 25 years old without cardiovascular disease were included. Patients were followed up for 5 years (from May 1994 to May 1999) to determine all the incident cases of fatal and non-fatal coronary heart disease; 138 (2.2%) patients were lost to follow-up. Cohort distribution by age and sex indicated that the 35-39 year age-group and >80 year age-group were slightly underrepresented, whereas women were slightly overrepresented in relation to the general population of Zaragoza, although these differences did not reach statistical significance.

At the beginning of the study and during follow-up, repeated measurements were collected from each participant regarding tobacco use, serum total cholesterol, systolic and diastolic blood pressure, fasting blood glucose, and weight, and height following standardized analysis procedures and data collection.<sup>14</sup> The mean values of these repeated measurements were used to classify the subjects according to the dichotomous categories of cardiovascular risk factors already referred to. The study only took into account the first incident events—non-recurrent—of ischemic heart disease (codes 410-414 of the Ninth Revision of the International Classification of Diseases), defined as any episode diagnosed as acute myocardial infarction (according to the MONICA criteria which were current when the study was designed), non-Q-wave infarction, unstable angina, angina, or coronary angioplasty. All the cases were reviewed and compared to their corresponding medical record.<sup>14</sup>

The crude relative risks were calculated as the ratio of cumulative incidences of coronary heart disease between those exposed or unexposed to the cardiovascular risk factor. The adjusted relative risks were obtained using the Cox proportional hazard model adjusted for age, sex, and major vascular risk factors: hypertension, hypercholesterolemia, diabetes, and smoking. In the multivariate analysis, missing data on explanatory

variables were replaced through multiple imputation, taking as predictors age, sex, and incidence of coronary events. All effects measurements were calculated for men and women in combination and separately.

### Statistical Analysis

The Levin formula for the PAF for dichotomous exposures was used to obtain a crude estimate of the proportion of cases of coronary heart disease in the Spanish population that can be attributed to exposure to a given cardiovascular risk factor<sup>19</sup>:

$$PAF_c = \frac{p(RR_c - 1)}{1 + p(RR_c - 1)}$$

where  $p$  is the prevalence of the risk factor in the Spanish general population obtained from the metaanalysis<sup>11</sup> and  $RR_c$  is the crude relative risk of coronary heart disease associated with the risk factor in the ZACARIS study.<sup>14</sup> In cohort studies, the Levin formula is equivalent to the classic formula (total incidence–incidence in unexposed people/total incidence), but the Levin formula made it possible to integrate more representative prevalence data.

Similar to  $RR_c$ , the crude estimations of attributable coronary risk are prone to confounding biases,<sup>6</sup> since age, sex, and major cardiovascular risk factors tend to be correlated. The Miettinen formula was used to obtain the PAF for an adjusted estimation of the proportion of potentially avoidable coronary events in the Spanish population if the subjects were unexposed to the risk factor, keeping age, sex, and the remaining cardiovascular risk factors constant<sup>20,21</sup>:

$$PAF_a = p_c - (p_c / RR_a)$$

where  $p_c$  is the prevalence of the risk factor among coronary patients obtained from the PRIAMHO II<sup>12,18</sup> and PREVESE II<sup>13</sup> registries, and  $RR_a$  is the relative risk of coronary heart disease among people exposed or unexposed to the risk factor adjusted for age, sex, and the other factors in the ZACARIS cohort.<sup>14</sup>

The Miettinen formula provides unbiased estimations of the population attributable risk in the presence of confounders, assuming that there is no interaction between the exposure variables.<sup>21</sup> As the effect of cardiovascular risk factors differs by sex, the crude, and adjusted attributable coronary risk factors were also separately calculated for men and women, using the prevalences and the specific relative risks for each sex.

The substitution method was used to calculate the 95% confidence intervals (CI) for the population attributable fractions,<sup>22</sup> which assumes that variability in the estimation of prevalence is negligible compared to variability in the estimation of relative risk.

**TABLE 1. Prevalence, Relative Risk of Coronary Heart Disease, and Coronary Risk Attributable to Cardiovascular Risk Factors in the Spanish Population (Both Sexes)<sup>a</sup>**

Risk Factor <sup>b</sup>	Prevalence, <sup>c</sup> %		Relative Risk <sup>c</sup> (95% CI)		Attributable Fraction, <sup>e</sup> %, (95% CI)	
	General Population	Coronary Patients	Crude	Adjusted	Crude	Adjusted
Smoking habit	32.7	44	1.71 (1.2-2.44)	2.6 (1.75-3.85)	18.9 (6.2-32)	27.1 (18.9-32.6)
Hypercholesterolemia	24.8	40.2	1.53 (1.11-2.1)	1.97 (1.42-2.73)	11.6 (2.7-21.4)	19.8 (11.9-25.5)
Hypertension	34.1	46	1.45 (1.06-1.99)	1.24 (0.88-1.73)	13.3 (1.9-25.2)	8.9 (-6.3-19.4)
Diabetes	9.9	29.4	1.96 (1.32-2.91)	1.52 (1-2.33)	8.7 (3.1-15.9)	10.1 (0-16.8)
Overweight	57.8	77.3	2.71 (1.59-4.61)	2.21 (1.28-3.83)	49.7 (25.5-67.6)	42.3 (16.9-57.1)

<sup>a</sup>CI indicates confidence interval.

<sup>b</sup>Smoking habit (daily consumption), hypercholesterolemia (total cholesterol  $\geq$ 240 mg/dL), hypertension (systolic blood pressure  $\geq$ 140 mm Hg or diastolic blood pressure  $\geq$ 90 mm Hg), diabetes (basal glucose  $\geq$ 126 mg/dL), and overweight (body mass index  $\geq$ 25).

<sup>c</sup>Prevalence of the risk factor in the Spanish general population (obtained by metaanalysis<sup>11</sup>) and in coronary patients (obtained from the PRIAMHO II<sup>12,18</sup> and PREVESE II<sup>13</sup> registries).

<sup>d</sup>Crude relative risk of coronary heart disease adjusted for age, sex, and remaining risk factors (obtained from the ZACARIS<sup>14</sup> cohort).

<sup>e</sup>Crude population coronary-attributable risk (based on population prevalence and crude relative risk) adjusted for age, sex, and remaining risk factors (based on prevalence in coronary patients and adjusted relative risk).

## RESULTS

Table 1 shows the prevalence, relative risks, and coronary risks attributable to the different major cardiovascular risk factors in the total Spanish population. Overweight has a very high prevalence, both in the general population (57.8%) and in patients with ischemic heart disease (77.3%), and was associated with a marked increase in coronary risk ( $RR_c=2.71$  and  $RR_a=2.21$ ). Thus, 49.7% (95% CI, 25.5-67.6) of the coronary events in the Spanish population were attributable to overweight; after adjusting for age, sex, and the other cardiovascular risk factors, this figure was 42.3% (95% CI, 16.9-57.1). Tobacco use and hypercholesterolemia presented relatively high prevalences (32.7% and 24.8% in the general population, respectively) and were strongly associated with coronary risk ( $RR_c=2.60$  and  $RR_a=1.97$ , respectively). Thus, 27.1% (95% CI, 18.9-32.6) of the adjusted incidence of coronary heart disease was attributable to smoking and 19.8% (11.9-25.5) to hypercholesterolemia. Hypertension had a high prevalence (34.1%) and moderate relative risk (1.24), resulting in an adjusted attributable coronary risk of 8.9%; diabetes had a greater relative risk (1.52), but was less prevalent (9.9%), and caused 10.1% of the coronary events (Table 1).

Table 2 and Table 3 show the specific PAF in men and women, respectively. Overweight was the cardiovascular risk factor with the greatest impact on the population in both sexes, attributable for 42.5% of the coronary events in men and 36.5% in women, after adjusting for age and the remaining risk factors. Smoking was the second factor with greatest potential impact on men since, due to its high prevalence, it caused 33.9% of the adjusted incidence of coronary heart disease. Among women, however, diabetes occupied second place; this was associated with a strong increase in risk and, thus, had an adjusted attributable coronary fraction of 24.8%. Hypercholesterolemia accounted for a large coronary

heart disease burden in both sexes, accounting for 19.4% of the coronary events in men and 20.1% in women. Hypertension also substantially contributed to the incidence of coronary heart disease among men, with an adjusted attributable risk of 15.5%.

## DISCUSSION

The results of this study show that a high proportion of the incidence of coronary heart disease in the Spanish population is attributable to the set of major cardiovascular risk factors. In general, these results agree with those reported in similar studies in international contexts,<sup>23,24</sup> the United States of America (NHANES<sup>25,26</sup> and ARIC<sup>27</sup> studies), in African countries,<sup>28</sup> and in Europe.<sup>29</sup>

In the present study, overweight was found to be the cardiovascular risk factor with the greatest contribution to the incidence of coronary heart disease. This is the expected result, since overweight, in addition to being strongly related to the risk of coronary heart disease, has a very high prevalence in the Spanish population. Thus, this work estimates that if the total population was within the normal range of the Body Mass Index (<25), the cases of ischemic heart disease would be reduced by 43% in men and 37% in women, regardless of age and the prevalence of hypertension, hypercholesterolemia and diabetes. The World Health Report 2002,<sup>1</sup> published by the World Health Organization, already noted that overweight was responsible for the deaths of 220 000 people in the United States and Canada in 2000, and 320 000 people in 20 western European countries, leading it to be called 'the epidemic of the 21st century.'<sup>30</sup> The coronary heart disease burden attributable to overweight could even increase in the near future, given the progressive increase in the prevalence of obesity in Spain in recent years, especially in the infant population.<sup>31</sup> Thus, the present study supports the growing importance given to overweight as a coronary risk factor,<sup>32</sup> and the need to

**TABLE 2. Prevalence, Relative Risk of Coronary Heart Disease, and Coronary Risk Attributable to Cardiovascular Risk Factors in the Spanish Population (Men)<sup>a</sup>**

Risk Factor <sup>b</sup>	Prevalence, <sup>c</sup> %		Relative risk <sup>d</sup> (95% CI)		Attributable Fraction, <sup>e</sup> % (95% CI)	
	General Population	Coronary Patients	Crude	Adjusted	Crude	Adjusted
Smoking habit	41.1	53.6	1.97 (1.27-3.04)	2.72 (1.73-4.26)	28.4 (10-45.6)	33.9 (22.6-41)
Hypercholesterolemia	27.3	39.8	1.44 (0.95-2.2)	1.95 (1.26-3)	10.8 (-1.5-24.7)	19.4 (8.2-26.5)
Hypertension	34.8	41	1.46 (0.97-2.21)	1.61 (1.04-2.5)	13.9 (-1.1-29.6)	15.5 (1.6-24.6)
Diabetes	11.7	25.5	1.15 (0.62-2.13)	0.92 (0.47-1.78)	1.7 (-4.7-11.6)	NA <sup>f</sup>
Overweight	66.9	75	2.56 (1.24-5.28)	2.31 (1.1-4.86)	51.1 (13.9-74.1)	42.5 (6.8-59.6)

<sup>a</sup>CI indicates confidence interval.

<sup>b</sup>Smoking habit (daily consumption), hypercholesterolemia (total cholesterol  $\geq$ 240 mg/dL), hypertension (systolic blood pressure  $\geq$ 140 mm Hg or diastolic blood pressure  $\geq$ 90 mm Hg), diabetes (basal glucose  $\geq$ 126 mg/dL), and overweight (body mass index  $\geq$ 25).

<sup>c</sup>Prevalence of the risk factor in men in the Spanish general population (obtained by metaanalysis<sup>11</sup>) and in men with coronary heart disease (obtained from the PRIAMHO II<sup>12,18</sup> and PREVESE II<sup>13</sup> registries).

<sup>d</sup>Crude relative risk of coronary heart disease in men adjusted for age, sex, and remaining risk factors (obtained from the ZACARIS<sup>14</sup> cohort).

<sup>e</sup>Crude population coronary-attributable risk in men (based on population prevalence and crude relative risk) adjusted for age and the remaining risk factors (based on prevalence in coronary patients and adjusted relative risk).

<sup>f</sup>The population attributable fraction cannot be applied to estimations of relative risk <1.

**TABLE 3. Prevalence, Relative Risk of Coronary Heart Disease, and Coronary Risk Attributable to Cardiovascular Risk Factors in the Spanish Population (Women)<sup>a</sup>**

Risk Factor <sup>b</sup>	Prevalence, <sup>c</sup> %		Relative Risk <sup>d</sup> (95% CI)		Attributable Fraction, <sup>e</sup> % (95% CI)	
	General Population	Coronary Patients	Crude	Adjusted	Crude	Adjusted
Smoking habit	24.3	15.7	0.65 (0.26-1.61)	2.03 (0.77-5.32)	Na <sup>f</sup>	8 (-4.7-12.7)
Hypercholesterolemia	23.4	41.9	1.73 (1.07-2.81)	1.92 (1.17-3.14)	14.6 (1.6-29.7)	20.1 (6.1-28.6)
Hypertension	33	61.1	1.38 (0.85-2.25)	0.8 (0.47-1.36)	11.2 (-5.2-29.2)	NA <sup>f</sup>
Diabetes	8.4	41.2	3.3 (1.94-5.63)	2.51 (1.41-4.45)	16.2 (7.3-28)	24.8 (12-31.9)
Overweight	48.3	72	2.73 (1.25-5.98)	2.03 (0.9-4.59)	45.5 (10.7-70.6)	36.5 (-8-56.3)

<sup>a</sup>CI indicates confidence interval.

<sup>b</sup>Smoking habit (daily consumption), hypercholesterolemia (total cholesterol  $\geq$ 240 mg/dL), hypertension (systolic blood pressure  $\geq$ 140 mm Hg or diastolic blood pressure  $\geq$ 90 mm Hg), diabetes (basal glucose  $\geq$ 126 mg/dL), and overweight (Body Mass Index  $\geq$ 25).

<sup>c</sup>Prevalence of the risk factor in women in the Spanish general population (obtained by metaanalysis<sup>11</sup>) and in women with coronary heart disease (obtained from the PRIAMHO II<sup>12,18</sup> and PREVESE II<sup>13</sup> registries).

<sup>d</sup>Crude relative risk of coronary heart disease in women adjusted for age, sex, and remaining risk factors (obtained from the ZACARIS<sup>14</sup> cohort).

<sup>e</sup>Crude population coronary-attributable risk in women (based on population prevalence and crude relative risk) adjusted for age and remaining risk factors (based on prevalence in coronary patients and adjusted relative risk).

<sup>f</sup>The population attributable fraction cannot be applied to estimations of relative risk <1.

implement effective strategies to deal with the current obesity epidemic through reductions in excess calorie intake and promoting physical activity. However, the association between overweight and coronary risk is less clear in the BMI 25-30 range, especially in men, and dose-response effect studies are required to help clarify these controversial results.

Smoking is the second risk factor with greatest impact on men, and accounts for 34% of the ischemic heart disease events. Smoking carries less coronary heart disease burden among women, due to the lower prevalence of tobacco use. Nevertheless, according to a recent report, mortality attributable to smoking has begun to decrease among Spanish men in 2001, due to a reduction in its high prevalence, whereas in women there has been a rise in attributable mortality in line with the gradual increase in tobacco use.<sup>33</sup> Similar results regarding smoking-

attributable cardiovascular mortality have been obtained in non-Spanish studies, both in magnitude, relative ranking and distribution by sex.<sup>34</sup>

Hypercholesterolemia causes 20% of the cases of ischemic heart disease in the Spanish population and occupies third place in men and in women, regardless of age and other risk factors. This result is in line with the figure of 16% regarding total mortality attributable to high cholesterol levels in developed countries,<sup>1,23</sup> and thus hypercholesterolemia is of marked relevance, since it is a currently modifiable and reversible risk factor.

Our study indicates that a quarter of coronary events in women are due to diabetes, which is in line with diabetes-attributable coronary mortality in industrialized countries<sup>35</sup> and in the European context,<sup>36</sup> where a greater population impact of diabetes on coronary risk in women has also been reported. Given the current epidemic of

obesity and its importance as a risk factor for diabetes, it is foreseeable that the disease burden attributable to diabetes will rise in the future. Regarding hypertension, our estimation of 16% of attributable coronary risk in men is much lower than that obtained in other studies.<sup>37</sup> This could be due to an underestimation of coronary risk associated with hypertension in the ACARIS<sup>14</sup> cohort or, more probably, due to the fact that almost half the disease burden associated with high blood pressure occurs at values lower than the conventional hypertension threshold (140/90 mm Hg) used in this study.<sup>37</sup> The cut-off points used in this study were the same as those used in the PRIAMHO, PREVESE, and ZACARIS studies, and followed the international recommendations that were current at the time.<sup>15-17</sup> Current recommendations use lower cut-off points for hypertension and hyperlipidemia: the impact of using lower thresholds on our results cannot be deduced, since it can be expected that the prevalences would increase and RR would decrease, but estimating by what magnitude this would occur would remain a matter for speculation.

The strengths of this study reside in the size of the populations included, drawing on the total Spanish population data, and the fact of analyzing the incidence of coronary heart disease instead of mortality, using a prospective cohort design. Nevertheless, the study has a number of limitations that should be taken into account. First, it was not possible to estimate diabetes-attributable coronary risk in men and hypertension-attributable coronary risk in women, as reliable estimations of the relative risks were not available. In general, due to the limited accuracy of some estimations, we decided to avoid estimations on the absolute number of cases attributable to each risk factor, and limited the results to ranking each factor and its relative contribution. Second, the estimated adjusted attributable fractions were based on the prevalences of exposure in coronary patients at the time of hospital admission, although these could differ from the prevalences in etiologically more relevant periods and when more time has passed since the coronary episode. Nevertheless, by comparing the prevalences in the general population and in coronary patients, it follows that these biases cannot be very large. Furthermore, it was not possible to calculate the fraction attributable to all the risk factors in combination, due to the lack of information on their combined prevalences. Finally, it is worth noting that although we used large hospital registries with broad national coverage and a primary care cohort with an age and sex distribution similar to that of the general population, population-based studies were not used which partly restricts the generalizability of the results of this study.

## CONCLUSIONS

The results indicate that overweight in both sexes and smoking in men are the cardiovascular risk factors with

the greatest impact on coronary heart disease in the general population. Of additional relevance is the currently increasing trend in overweight. These results may be useful for health care planning and prioritizing action regarding coronary heart disease prevention at the community level.

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