Individual Socioeconomic Factors Conditioning Cardiovascular Disease Risk

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BACKGROUND
Our objective is to ascertain whether the socioeconomic situation of individuals has an influence on the cardiovascular disease (CVD) risk estimation.

METHODS
The subjects were part of VAMPAHICA study and had been recently diagnosed as hypertensive. The study subjects were seen in primary care centers, were aged between 15 and 75 years and have never been treated for hypertension (HT). Normotensive individuals were also included in the study sample. All individuals answered a questionnaire that included questions related to sociodemographic and socioeconomic variables as well as habit and lifestyle variables. Of a total of 424 individuals initially invited to answer the questionnaire, 388 finally did so. Due to missing data in the dependent variables, 304 individuals were included in the European Society of Hypertension (ESH) risk tables and 287 in the Systematic Coronary Risk Evaluation (SCORE) tables. The response variable CVD risk, which is a polytomic variable, was estimated using an ordered probit model.

RESULTS
We found that individual's socioeconomic status, expressed mainly as their level of education, was an independent variable that had repercussions on the estimated CVD risk. This finding was more evident in the SCORE tables, and when risk was stratified according to the ESH tables the repercussions were only marginal. In particular, we found that individuals with only primary education had a 27% higher probability of CVD risk (≥5%) in the SCORE tables, whereas individuals with a higher level of education had 50% less probability of high risk.

CONCLUSIONS
The CVD risk estimation tables for the general population (SCORE) reflect the socioeconomic factor better than the CVD risk stratification tables for HT (ESH tables). Target organ damage (TOD) is an important factor for stratifying risk in the ESH tables; however, the SCORE tables do not take this into account. Therefore, socioeconomic factors may already be incorporated in the ESH tables through an intermediate variable, such as TOD.

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From an ecological point of view, it is more or less accepted that the level of deprivation in a given geographical area determines the quality of life and health of its inhabitants, so that the more deprived areas generally have fewer social opportunities and more health problems than more favored regions.[1–3]

The possible influence of the ecological (also termed contextual) component of deprivation on an individual's health is much disputed.[4] Some research argues that individual risk factors do not explain differences in risk between different areas,[5] but others suggest that individual and ecological characteristics have independent effects.[6,7]

On an individual level, there is evidence, albeit scarce, that some socioeconomic factors, besides known risk factors of a more "biological" nature, such as smoking, alcohol consumption, hypertension (HT), low physical activity, and genetic factors, may be associated with cardiovascular disease (CVD).[8] Many more studies have found statistically significant associations between different socioeconomic variables and "biological" CVD risk factors,[9–15] especially HT.

There are very few references to the relationship between an individual's socioeconomic status and CVD risk,[16,17] and there are no study that estimate this influence on the CVD risk according to the tables most commonly used in Europe, i.e., European Society of Hypertension (ESH),[18] and Systematic Coronary Risk Evaluation (SCORE).[19]

Our objective was to ascertain whether an individual's socioeconomic situation influences CVD risk estimation according to the ESH and SCORE tables, and thereby assess whether these CVD risk tables reflect the risk of individuals of different socioeconomic levels.

METHODS

The subjects of this study were taken from the VAMPAHICA study, which has already been described elsewhere.[20] Briefly, it was a multicenter prospective observational study carried out between September 2003 and June 2007, which involved 14 primary care centers in the Girona Health Region (Spain) and a total of 140 researchers. The study included hypertensive individuals who had met a series of inclusion and exclusion

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criteria,[20] along with normotensive individuals who were used as controls.

The VAMPAHICA study included all hypertensive patients examined by professionals participating in the study who met the following criteria at the time of inclusion: (i) aged between 15 and 75 years, (ii) with clinical HT, (iii) recently diagnosed with HT but no treatment received for HT, and (iv) had correct blood pressure (BP) self-measurement readings. Those individuals who were excluded were unable, in the opinion of the health professionals, to carry out BP self-measurement, or suffered any of the following: diabetes mellitus (to avoid confusing damage caused by diabetes with that caused by HT in examination of the eye ground), secondary HT, prior CVD, renal insufficiency, hepatic insufficiency, alcoholism or severe mental illness, severe endocrine or hematological disease, and other severe diseases or restrictions which in the opinion of a doctor was cause for exclusion.

All individuals were invited to respond to a questionnaire that provided information on sociodemographic and socioeconomic variables, as well as on habit and lifestyle variables. The questionnaire, which was designed specifically for the project and was validated by a pilot test, was administered in two phases: the first between April and October 2006 and the second between March and October 2007.

Variables. As dependent variables of interest, we considered the stratification of CVD risk according to ESH tables[18] and the risk of CVD mortality according to SCORE tables.[19]

The explanatory variables were taken directly from the VAMPAHICA study and from the questionnaire. The former included: sex, age, clinical BP (measured at the primary care center); HT status (categorized as normotensive individuals with BP <140/90 mm Hg measured in the health professional's office, and BP <135/85 mm Hg measured at home; sustained-hypertensive individuals BP ≥140/90 mm Hg and BP ≥135/85 mm Hg, respectively, and white-coat hypertensive individuals BP ≥140/90 mm Hg and BP <135/85 mm Hg, respectively);[18] body mass index (BMI); creatinine; cholesterol (total and high-density lipoprotein (HDL)); triglycerides; glucose; microalbuminuria; and the presence of target organ damage (TOD).[20] TOD was considered to be any of the following irregularities: serum creatinine >107 µmol/l in women and >115 µmol/l in men; left ventricular hypertrophy according to electrocardiographic criteria; the presence of microalbuminuria defined using the normal values of the ESH; altered renal function, expressed as a glomerular filtration calculated to be <60 ml/min; or advanced lesions in the retinography (eye fundus (FO), grades III/IV, which includes hemorrhages, exudates and papilla edema). In all cases, irregularities were detected in the initial assessment of the patient, at diagnosis and before any treatment.

The diagnosis of clinical HT was made during the patients' consultation with the nurse. Two BP readings were taken at intervals of 2 min on three different days; with results ≥140 and/or ≥90 mm Hg. If the difference between the readings on the same day exceeded 5 mm Hg, an additional reading was made to obtain the average. The clinical BP value was the average of all readings taken.

The variables obtained from the questionnaire were self-perceived health status; visits to a general practitioner in the past 3 months; habit and lifestyle variables (smoking, alcohol consumption, and physical activity); and socioeconomic variables (birthplace, education level, and professional category). Most of the explanatory variables were categorized (see **Tables 1** and **2**).

Statistical analysis. Bivariate analyses of the data were carried out considering the CVD risk according to ESH tables (categorized as reference, low, moderate, high, or very high risk) and the SCORE tables for low-risk countries (categorized as <1, 1, 2, 3–4, ≥5%) as dependent variables. For qualitative explanatory variables, the Pearson χ^2-test of equality of proportions was used, and for quantitative explanatory variables, Fisher's F-test in one-way analysis of variance was used.

A multivariate analysis was then carried out. The response variable, CVD risk, being a polytomic variable in both cases, was estimated using an ordered probit model[21] in which it was assumed that CVD risk is in reality a continuous, unobserved variable (see **Appendix**).

The models were validated and goodness of fit was checked for all cases. The models were estimated using iteratively reweighted least squares.[22] The data from the database were processed using SPSS (version 14; SPSS, Chicago, IL) and the statistical analysis was carried out using freeware R (version 2.6.0), in the MASS library.

RESULTS

From a total of 424 individuals initially invited to answer the questionnaire, 388 finally did so (response rate of 91.51%): 277 hypertensive (71.4%) (response rate 93.27%) and 111 normotensive individuals (response rate 87.40%); 49.7% men and 50.3% women. There were no differences between respondents and nonrespondents with respect to hypertensive status (P = 0.50 in the χ^2-test for equality of proportions), sex (P = 0.41), or age (P = 0.91 in the t-test for equality of means in independent samples).

Due to missing data in the dependent variables, 304 individuals were included (146 male, 48%) in the ESH risk tables and 287 individuals (139 male, 48.4%) in the SCORE tables. In order to check that missing data were effectively at random,[23] i.e., that the probability of missingness did not depend on the result of interest, we estimated logistic regressions in which the dependent variable was the missingness indicator of both the ESH risk and SCORE risk, and the rest of the variables were explanatory variables. None of the estimates was statistically significant, giving some evidence against the possibility of selection bias.

Due to the small sample size, we computed the statistical power of our study by bilaterally testing the main hypothesis of the study, that is, that there are no differences in the proportions of high and very high CVD risk among individuals with lower levels of education (i.e., illiterate

Table 1 | Description of the individuals and variable distributions according to CVD risk (ESH Tables)

	Total	Reference	Low	Moderate	High	Very high	*P* value[a]
VAMPAHICA variables							
Individuals (%)	304 (100)	95 (31.25)	23 (7.57)	97 (31.91)	46 (15.13)	43 (14.14)	
Sex (%)							
Men	48.0	37.9	43.5	50.5	76.1	37.2	<0.01
Women	52.0	62.1	56.5	49.5	23.9	62.8	
Age (years)[b]	58 (10.7)	53 (10.4)	53 (9.4)	61 (10.6)	61 (10.3)	61 (7.7)	<0.01
Hypertensive status (%)							
Normotensive	38.5	100.0	56.5	4.1	0.0	11.6	<0.01
Sustained-hypertensive	38.8	0.0	17.4	58.8	67.4	60.5	
White-coat hypertensive	22.7	0.0	26.1	37.1	32.6	27.9	
Blood pressure at the professional's office							
Reference	36.2	100.0	52.2	3.1	0.0	0.0	<0.01
[140–159 mm Hg)/[90/99 mm Hg)	63.2	0	39.1	96.9	100.0	100.0	
[160–180 mm Hg)/[100/110 mm Hg)	0.7	0	8.7	0.0	0.0	0.0	
Garrow index (%)							
Normal weight	20.5	36.7	9.1	12.4	17.4	14.3	<0.01
Overweight	47.8	41.1	68.2	52.6	56.5	31.0	
Obese	31.6	22.2	22.7	35.1	26.1	54.8	
BMI (kg/m^2)[b]	**28.4 (4.42)**	**26.7 (4.04)**	**28.9 (3.11)**	**29.1 (4.41)**	**27.9 (2.96)**	**30.8 (5.66)**	**<0.01**
Creatinine (mg/dl)[b]	0.9 (0.19)	0.0 (0.0)	0.9 (0.22)	0.9 (0.17)	0.9 (0.17)	1.0 (0.25)	0.63
Total cholesterol (mg/dl)[b]	226 (40.8)	0 (0.0)	203 (19.3)	232 (47.7)	227 (34.5)	217 (31.2)	0.13
HDL cholesterol (mg/dl)[b]	63 (14.1)	0 (0.0)	68 (14.9)	64 (14.4)	62 (14.7)	62 (12.6)	0.75
Triglycerides (mg/dl)[b]	122.0 (72.78)	0.0 (0.0)	104.4 (31.87)	117.1 (73.12)	119.7 (38.77)	138.4 (100.27)	0.54
Glucose (mg/dl)[b]	90.4 (11.62)	0.0 (0.0)	94.4 (10.41)	90.9 (12.25)	87.5 (11.89)	91.3 (9.96)	0.24
MAU (%)							
Normal	98.4	0.0	100.0	100.0	100.0	93.0	0.01
Abnormal	1.6	0.0	0.0	0.0	0.0	7.0	
MAU (mg/g)[b]	**79 (3.79)**	**0 (0.0)**	**7.83 (0.0)**	**3.54 (2.85)**	**2.21 (1.68)**	**6.54 (9.93)**	**0.10**
TOD (%)							
No TOD	68.1	100.0	87.0	86.6	13.0	4.7	<0.01
One TOD	25.7	0.0	13.0	10.3	82.6	62.8	
>1 TOD	6.3	0.0	0.0	3.1	4.3	32.6	
Questionnaire variables							
Self-perceived health status (%)							
Excellent	3.6	7.4	0.0	4.1	0.0	0.0	<0.01
Very good	12.9	27.7	4.3	5.2	6.5	9.3	
Good	55.4	48.9	65.2	48.5	80.4	53.5	
Fair	21.5	16.0	26.1	30.9	6.5	25.6	
Bad	6.6	0.0	4.3	11.3	6.5	11.6	
Visit to family doctor in the past 3 months (%)							
No	26.9	12.5	44.4	23.6	40.7	31.0	0.04
Yes	73.1	87.5	55.6	76.4	59.3	69.0	
Smoking (%)							
Nonsmoker	69.8	81.2	78.3	68.8	50.0	69.8	<0.01
Smoker	10.2	13.0	13.0	2.1	25.0	7.0	
Exsmoker	20.0	5.8	8.7	29.2	25.0	23.3	

Table 1 | Continued on next page

Table 1 | Continued

	Total	Reference	Low	Moderate	High	Very high	*P* value[a]
Birthplace (%)							
City of Girona	11.6	6.3	0.0	13.5	19.6	17.1	0.15
Rest of the province of Girona	59.8	63.2	60.9	63.5	47.8	56.1	
Rest of Catalonia	7.3	11.6	13.0	4.2	4.3	4.9	
Rest of Spain	17.6	13.7	21.7	16.7	21.7	22.0	
Other place	3.7	5.3	4.3	2.1	6.5	0.0	
Education level (%)							
Lower than primary	17.8	3.2	17.4	18.6	34.8	30.2	<0.01
Primary	53.0	60.0	47.8	61.9	34.8	39.5	
Professional training	15.8	14.7	21.7	11.3	17.4	23.3	
Secondary-high school	5.3	8.4	0.0	5.2	6.5	0.0	
University	8.2	13.7	13.0	3.1	6.5	7.0	
Professional category (%)							
Primary sector	4.2	1.1	5.3	6.5	9.1	0.0	<0.01
Self-employed	11.9	5.4	10.5	22.8	2.3	12.8	
Business owner	7.7	7.6	5.3	4.3	22.7	0.0	
Professional	4.2	7.6	0.0	3.3	2.3	2.6	
Manual worker	68.5	71.7	73.7	62.0	59.1	84.6	
Has never worked	3.5	6.5	5.3	1.1	4.5	0.0	

ANOVA, analysis of variance; BMI, body mass index; CVD, cardiovascular disease; ESH, European Society of Hypertension; HDL, high-density lipoprotein; MAU, microalbuminuria; TOD, target organ damage.
[a]In the qualitative variables, χ^2-test of equality of proportions; in the quantitative, one-way ANOVA test. [b]Mean (s.d.).
Percentage by columns: bold, $P < 0.1$; shaded, $P < 0.05$.

or not completed primary school) or a primary education and manual occupations compared to individuals with a secondary or university education and other occupations. Assuming a type I error equal to 5%, the statistical power for the study with the ESH risk tables was 83% and for the SCORE tables, it was 81%.

Table 1 provides a description of the individuals with variables distributed according to the CVD risk estimated with the ESH tables. Women are mainly in the lower CVD risk groups except for the very high-risk group, where they were more numerous than males (62.8% vs. 37.2%; $P < 0.0001$). Age, BMI, and the condition of being a smoker or exsmoker were significantly higher in the high-risk groups. White-coat hypertensive individuals were distributed quite uniformly in all the risk groups. All individuals with the microalbuminuria factor had a very high CVD risk. The individuals with more than one TOD had a significantly higher CVD risk. The individuals with a reference risk had a better self-perception of their health status than individuals with very high risk, who generally perceived their health as fair or bad. With regard to the level of education level, the individuals with lower education level were less represented in the reference group compared to individuals with university studies, while they were over-represented in the high- and very high-risk groups. Those born in the city of Girona were mainly in the moderate- to very high-risk categories. However, those who were born in the rest of Catalonia and, to a lesser extent, those who were born outside Spain, generally had reference to moderate risk. There were no clear patterns in the risk categorization among those who had visited a family doctor in the past 3 months, between different professional categories or smoking status (except exsmokers, who were mainly in the moderate to very high-risk categories).

With respect to SCORE (**Table 2**), it can be observed that women were in groups with a lower CVD risk rating, while men were in the higher risk groups. Age, BMI, and the condition of being a smoker or exsmoker were significantly greater in groups with a higher risk factor. Individuals with no TOD were more highly represented in lower risk groups (<1 and 1%) and less in the higher rated groups (≥5%), while those with a TOD were more highly represented in the higher risk factor groups (2, 3–4, ≥5%). The self-perception of health as good or very good was located significantly in the lower risk factor groups. The individuals with a lower education level were mainly in the higher risk factor groups (≥5%), while those with university studies were mainly in the lower risk factor groups (<1%). As in the ESH CVD risk, those who were born in the city of Girona had moderate- to very high-risk (i.e., from 2%); however, there was not a systematic relationship for the rest of the categories of this variable. There were also no clear patterns in the risk categorization among those who visited a family doctor in the past 3 months, according to different professional categories (with the exception of self-employed individuals,

Table 2 | Description of individuals and variable distributions according to CVD risk (SCORE tables)

	Total	<1%	1%	2%	3–4%	≥5%	*P* value[a]
VAMPAHICA variables							
Individuals (%)	287 (100)	140 (48.78)	19 (6.62)	51 (17.77)	36 (12.54)	41 (14.29)	
Sex (%)							
Men	48.4	33.6	36.8	23.5	88.9	100.0	<0.01
Women	51.6	66.4	63.2	76.5	11.1	0.0	
Age (years)[b]	58 (10.6)	52 (9.8)	52 (4.7)	65 (8.2)	63 (7.3)	67 (6.0)	<0.01
Hypertensive status (%)							
Normotensive	39.0	78.6	5.3	0.0	2.8	0.0	<0.01
Sustained-hypertensive	39.4	14.3	42.1	66.7	61.1	70.7	
White-coat hypertensive	21.6	7.1	52.6	33.3	36.1	29.3	
Blood pressure at the professional's office							
Reference	38.3	77.9	0.0	0.0	2.8	0.0	<0.01
[140–159 mm Hg)/[90/99 mm Hg)	61.3	22.1	94.7	100.0	97.2	100.0	
[160–180 mm Hg)/[100/110 mm Hg)	0.3	0.0	5.3	0.0	0.0	0.0	
Garrow index (%)							
Normal weight	19.9	28.1	15.8	11.8	11.1	12.5	0.12
Overweight	48.8	44.4	42.1	51.0	55.6	57.5	
Obese	31.3	27.4	42.1	37.3	33.3	30.0	
BMI (kg/m^2)[b]	28.37 (4.35)	27.53 (3.98)	29.93 (7.00)	29.27 (4.19)	28.71 (3.08)	29.06 (4.72)	0.03
Creatinine (mg/dl)[b]	0.9 (0.20)	0.9 (0.22)	0.9 (0.15)	0.9 (0.23)	0.9 (0.18)	0.9 (0.17)	0.60
Total cholesterol (mg/dl)[b]	225 (42.0)	225 (36.2)	214 (41.2)	224 (48.4)	226 (40.1)	232 (38.9)	0.65
HDL cholesterol (mg/dl)[b]	63 (14.1)	64 (17.1)	61 (12.3)	63 (12.3)	65 (17.3)	59 (10.9)	0.39
Triglycerides (mg/dl)[b]	124.6 (74.17)	126.1 (91.72)	159.5 (129.58)	118.0 (64.64)	123.9 (59.47)	116.2 (39.06)	0.27
Glucose (mg/dl)[b]	90.2 (11.53)	94.9 (10.82)	88.8 (11.23)	90.3 (10.82)	87.7 (12.58)	89.3 (11.59)	0.13
MAU (%)							
Normal	98.3	100.0	100.0	96.1	100.0	97.6	0.54
Abnormal	1.7	0.0	0.0	3.9	0.0	2.4	
MAU (mg/g)[b]	3.98 (5.26)	0.79 (1.73)	4.66 (3.85)	6.92 (9.91)	3.94 (1.41)	4.44 (6.04)	0.18
TOD (%)							
No TOD	70.0	92.9	52.6	37.3	55.6	53.7	<0.01
One TOD	23.3	3.6	42.1	43.1	38.9	43.9	
>1 TOD	6.6	3.6	5.3	19.6	5.6	2.4	
Questionnaire variables							
Self-perceived health status (%)							
Excellent	3.5	5.0	0.0	0.0	8.3	0.0	<0.01
Very good	12.9	20.9	15.8	2.0	5.6	4.9	
Good	54.2	52.5	57.9	41.2	55.6	73.2	
Fair	22.4	15.8	21.1	39.2	27.8	19.5	
Bad	7.0	5.8	5.3	17.6	2.8	2.4	
Visit to family doctor in the past 3 months (%)							
No	**27.6**	**22.1**	**42.9**	**17.9**	**38.5**	**44.4**	**0.07**
Yes	**72.4**	**77.9**	**57.1**	**82.1**	**61.5**	**55.6**	

Table 2 | Continued on next page

Table 2 | Continued

	Total	<1%	1%	2%	3–4%	≥5%	*P* value[a]
Smoking (%)							
Nonsmoker	70.9	81.6	76.5	88.2	51.4	34.1	<0.01
Smoker	10.9	11.4	0.0	3.9	2.9	29.3	
Exsmoker	18.2	7.0	23.5	7.8	45.7	36.6	
Birthplace (%)							
City of Girona	12.3	10.0	0.0	10.2	11.1	30.0	0.04
Rest of the province of Girona	59.2	59.3	68.4	67.3	63.9	40.0	
Rest of Catalonia	7.4	10.0	10.5	2.0	8.3	2.5	
Rest of Spain	18.0	15.7	21.1	20.4	13.9	25.0	
Other place	3.2	5.0	0.0	0.0	2.8	2.5	
Education level (%)							
Lower than primary	16.4	5.0	15.8	33.3	11.1	39.0	<0.01
Primary	54.4	57.9	57.9	52.9	55.6	41.5	
Professional training	15.7	15.7	21.1	7.8	25.0	14.6	
Secondary-high school	5.2	7.1	0.0	3.9	8.3	0.0	
University	8.4	14.3	5.3	2.0	0.0	4.9	
Professional category (%)							
Primary sector	4.5	2.3	0.0	15.2	0.0	5.1	<0.01
Self-employed	11.9	6.8	6.3	21.7	19.4	12.8	
Business owner	7.8	6.8	0.0	8.7	13.9	7.7	
Professional	4.5	6.1	12.5	0.0	0.0	5.1	
Manual worker	67.7	72.7	75.0	50.0	66.7	69.2	
Has never worked	3.7	5.3	6.3	4.3	0.0	0.0	

ANOVA, analysis of variance; BMI, body mass index; CVD, cerebrovascular disease; HDL, high-density lipoprotein; MAU, microalbuminuria; SCORE, Systematic Coronary Risk Evaluation; TOD, Target organ damage.
[a]In the qualitative variables, χ^2-test of equality of proportions; in the quantitative, one-way ANOVA test. [b]Mean (s.d.).
Percentage by columns: bold, $P < 0.1$; shaded, $P < 0.05$.

who had a risk of ≥2%, and individuals who had never worked, who had a risk <2%) or smoking status.

The estimation results of the ordered probit are shown in Tables 3 (ESH) and 4 (SCORE). In Table 3, males have a higher probability of CVD risk than the reference group. In the 60–67 age group, the possibility of low, moderate, or high risk increased compared to the reference group, and members of this age group were less represented in the very high-risk group. Individuals who had visited a family doctor in the 3 months previous to the questionnaire showed a trend (although only marginally, $P < 0.10$) of moderate, high, or very high risk. Smokers tended to be ($P < 0.10$) in the low, moderate, high, and very high-risk groups, which increased along the spectrum (odds ratio of 1.52–9.41). With respect to socioeconomic variables, individuals with a primary education level tended ($P < 0.10$) to be in the low, moderate, high, or very high-risk groups compared to the reference group, while this was not true for individuals with a university education. Individuals in the professional category had a higher probability of being in the low- or moderate-risk groups, and less probability of being in the high or very high-risk groups. The white-coat HT, obesity, self-perceived health status, and place of birth variables were not related to a greater probability of being in a specific CVD risk group.

When SCORE CVD risk was modeled, because the original variable was endogenous ($P = 0.06$ in the logistic regression), the probability of visiting a family doctor rather than the visit itself was introduced as explanatory variable. Males had a greater probability of greater risk (3–4% and ≥5%) (Table 4). Individuals over 67 years had greater probabilities of having CVD risk ≥5%. Individuals whose probability of visiting a GP was either >75% or between 25 and 50% tended to have a lower CVD risk factor. When the probability was between 50 and 75%, the CVD risk was greater. A primary education level was associated with a higher CVD risk factor (≥5%), while individuals with a university education had less probabilities of CVD risk (≥5%). In the professional category, the self-employed and professionals had less probability of CVD risk (≥5%) and manual workers had a greater probability of a higher CVD risk. The white-coat HT, obesity, self-perceived health status, smoking, and birthplace (this latter one only marginally) variables were not related to the probability of presenting a specific CVD risk.

Table 3 | Relative cardiovascular risk according to ESH, estimated by odds ratios (95% confidence interval)

Cardiovascular disease risk (reference)	Low	Moderate	High	Very high
Sex (man)				
Women	0.91 (0.85, 0.96)	0.64 (0.61, 0.68)	0.44 (0.41, 0.47)	0.30 (0.28, 0.32)
Age (<60)				
60–67	1.13 (1.01, 1.25)	1.23 (1.11, 1.36)	1.19 (1.07, 1.32)	0.96 (0.92, 0.99)
>67	1.06 (0.97, 1.16)	0.94 (0.85, 1.02)	0.80 (0.53, 1.07)	1.16 (0.96, 1.35)
Hypertensive status (normotensive/sustained-hypertensive)				
White-coat hypertensive	0.94 (0.86, 1.02)	0.84 (0.67, 1.02)	0.90 (0.73, 1.08)	1.03 (0.94, 1.12)
Garrow index (normal weight/overweight)				
Obese	1.02 (0.80, 1.24)	1.08 (0.85, 1.31)	1.12 (0.88, 1.36)	1.01 (0.79, 1.22)
Self-perceived health status (excellent/very good/good)				
Fair/bad	1.18 (0.79, 1.56)	1.15 (0.77, 1.52)	1.19 (0.80, 1.58)	1.72 (0.96, 2.49)
Visit to family doctor (no)				
Yes	**0.99 (0.97, 1.02)**	**1.02 (1.00, 1.04)**	**1.12 (0.96, 1.28)**	**1.02 (1.00, 1.04)**
Smoking (nonsmoker)				
Smoker	**1.52 (0.99, 2.05)**	**2.43 (0.99, 3.86)**	**4.12 (1.00, 7.24)**	**9.42 (0.99, 17.84)**
Exsmoker	0.88 (0.65, 1.10)	1.06 (0.79, 1.33)	1.63 (0.91, 2.34)	2.38 (0.97, 3.78)
Birthplace (City of Girona)				
Rest of the province of Girona	1.05 (0.80, 1.30)	1.07 (0.81, 1.33)	0.83 (0.63, 1.03)	0.65 (0.29, 1.01)
Rest of Catalonia	0.67 (0.14, 1.20)	0.38 (0.02, 1.08)	0.22 (0.01, 1.09)	0.19 (0.01, 1.06)
Rest of Spain	1.12 (0.86, 1.38)	1.07 (0.82, 1.33)	0.68 (0.32, 1.04)	0.37 (0.09, 1.25)
Foreign	0.32 (0.11, 1.06)	0.45 (0.16, 1.04)	0.47 (0.17, 1.08)	0.29 (0.10, 1.03)
Education level (lower education)				
Primary	**1.07 (0.99, 1.15)**	**1.25 (1.00, 1.50)**	**1.20 (1.00, 1.40)**	**1.10 (0.99, 1.20)**
Secondary/professional training/university	0.89 (0.55, 1.23)	0.83 (0.52, 1.14)	0.93 (0.58, 1.28)	0.88 (0.55, 1.21)
Professional category (primary sector)				
Never worked	1.01 (0.83, 2.37)	1.01 (0.91, 2.13)	1.01 (0.74, 5.22)	1.01 (0.98, 1.99)
Self-employed/professionals	1.62 (0.91, 2.42)	2.01 (0.98, 3.08)	1.53 (0.90, 2.67)	0.99 (0.48, 1.47)
Business owner	1.61 (0.88, 2.27)	2.34 (0.91, 4.04)	3.01 (0.92, 5.13)	2.31 (0.93, 3.51)
Manual workers	1.14 (1.10, 1.22)	1.12 (1.04, 1.30)	0.95 (0.90, 0.98)	0.63 (0.53, 0.81)

The results have been adjusted for blood pressure taken at the health professional's office, creatinine, cholesterol, HDL cholesterol, triglycerides, glucose, MAU and presence of TOD.
ESH, European Society of Hypertension; HDL, high-density lipoprotein; MAU, microalbuminuria; TOD, target organ damage.
Percentage by columns: bold, $P < 0.1$; shaded, $P < 0.05$ (reference category in brackets).

DISCUSSION

In this study, we have shown that the socioeconomic status of the individual, expressed mainly as education level, has repercussions as an independent variable for the estimation of CVD risk. When risk was stratified according to ESH tables, however, the repercussions were found to be only marginal. Therefore, we conclude that CVD risk estimation tables for the general population (SCORE) reflect the socioeconomic factor better than the CVD risk stratification tables for hypertensive individuals (ESH).

Socioeconomic factors may already be incorporated in the ESH tables through an intermediate variable, such as the TOD. In fact, upon adjusting the results in the multivariate analysis for ESH CVD risk, in which TOD, among other variables, was controlled for, the association was reduced to having only a marginal statistical significance (**Table 3**). Likewise, the lower probability of men presenting any level of CVD risk in the ESH tables (**Table 1**) could be due to women having a greater number of TOD, especially advanced lesions in the retinography, and therefore being assigned to a higher risk group.

In contrast, when the CVD risk tables for the general population (SCORE) were applied to hypertensive individuals they were sensitive to socioeconomic factors. In particular, we found that individuals with only a primary level of education had a 27% higher probability of CVD risk (≥5%), whereas those with a higher level of education had 50% less probability of high risk (see **Table 4**). Furthermore, participants with a higher level of education showed an inverse gradient: the higher the CVD risk, the less the probability compared with those with lower education. Note, however, that the relationship between the

Table 4 | Relative cardiovascular risk according to SCORE, estimated by odds ratios (95% confidence interval)

Cardiovascular disease risk (<1%)	1%	2%	3–4%	≥5%
Sex (man)				
Women	0.97 (0.94, 1.00)	0.89 (0.83, 0.95)	1.02 (1.00, 1.04)	1.13 (1.06, 1.21)
Age (<60)				
60–67	1.55 (1.13, 1.96)	1.79 (1.31, 2.27)	2.06 (1.51, 2.61)	1.80 (1.32, 2.28)
>67	0.54 (0.40, 0.69)	0.61 (0.44, 0.77)	0.87 (0.75, 0.99)	1.30 (1.08, 1.51)
Hypertensive status (normotensive/sustained-hypertensive)				
White-coat hypertensive	1.17 (0.86, 1.49)	1.01 (0.74, 1.28)	0.53 (0.39, 1.18)	0.16 (0.01, 1.198)
Garrow index (normal weight/overweight)				
Obese	0.84 (0.62, 1.07)	0.77 (0.46, 1.08)	0.74 (0.44, 1.04)	0.61 (0.15, 1.08)
Self-perceived health status (excellent/very good/good)				
Fair/bad	1.56 (0.94, 2.18)	1.71 (0.95, 2.47)	1.66 (0.81, 2.50)	1.76 (0.89, 2.64)
Probability of visiting a family doctor, GP (<25%)[a]				
25–50%	0.42 (0.30, 0.53)	0.34 (0.25, 0.44)	0.28 (0.21, 0.36)	0.29 (0.21, 0.36)
50–75%	4.51 (3.30, 5.72)	9.14 (6.69, 11.60)	8.19 (5.99, 10.38)	2.82 (2.06, 3.57)
>75%	0.81 (0.64, 0.97)	0.56 (0.41, 0.71)	0.43 (0.32, 0.55)	0.24 (0.18, 0.30)
Smoking (nonsmoker)				
Smoker	3.26 (0.98, 5.55)	4.07 (0.98, 7.16)	2.49 (0.92, 4.06)	2.19 (0.97, 3.40)
Exsmoker	0.85 (0.62, 1.08)	0.72 (0.42, 1.02)	0.49 (0.26, 1.02)	0.94 (0.69, 1.19)
Birthplace (City of Girona)				
Rest of the province of Girona	1.06 (0.78, 1.35)	1.00 (0.73, 1.27)	0.94 (0.69, 1.19)	0.77 (0.46, 1.07)
Rest of Catalonia	0.42 (0.21, 1.03)	0.46 (0.25, 1.07)	0.97 (0.71, 1.23)	1.28 (0.94, 1.63)
Foreign	**0.96 (0.90, 1.02)**	**0.89 (0.77, 1.01)**	**0.61 (0.20, 1.02)**	**0.03 (0.01, 1.03)**
Education level (lower education)				
Primary	1.06 (1.02, 1.10)	0.92 (0.86, 0.99)	0.90 (0.81, 1.00)	1.27 (1.03, 1.51)
Secondary/professional training/ university	0.98 (0.97, 0.99)	0.80 (0.68, 0.91)	0.53 (0.39, 0.67)	0.51 (0.37, 0.64)
Professional category (primary sector)				
Never worked	1.01 (0.80, 3.12)	1.00 (0.77, 4.11)	1.011 (0.65, 5.32)	1.00 (0.98, 2.09)
Self-employed/professionals	0.72 (0.51, 0.91)	0.80 (0.60, 0.99)	0.81 (0.61, 0.99)	0.18 (0.07, 0.33)
Business owner	0.71 (0.30, 1.12)	0.70 (0.41, 1.13)	0.78 (0.29, 1.31)	0.14 (0.10, 1.09)
Manual workers	0.78 (0.56, 0.98)	0.76 (0.60, 0.99)	0.84 (0.71, 0.99)	2.34 (1.54, 3.99)

The results have been adjusted for blood pressure taken at the health professional's office, creatinine, cholesterol, HDL cholesterol, triglycerides, glucose, MAU and presence of TOD.
CVD, cardiovascular disease; GP, general practitioner; HDL, high-density lipoprotein; MAU, microalbuminuria; SCORE, Systematic Coronary Risk Evaluation; TOD, target organ damage.
[a]Adjusted in a logistic regression including all the explanatory variables and CVD risk according to SCORE.
Percentage by columns: bold, $P < 0.1$; shaded, $P < 0.05$ (reference category in brackets).

level of education and the CVD risk was not linear. Those with a primary education had a lower probability than those with less than a primary education for both, moderate and high risk (i.e., 2–4%). However, they had a higher probability than those with less than primary education for low (i.e., 1%) and very high risk (i.e., ≥5%).

The effect of professional category on the probability of CVD risk was not clear. Compared with the reference category, the primary sector (i.e., workers in agriculture and cattle raising), business owners, and those who had never worked (mainly older women and to a lesser extent disabled people) had no statistical differences. Self-employed people, professionals, and manual workers, however, had a lower probability of higher CVD risk than workers in the primary sector. Note, however, that (again compared with primary sector workers) manual workers had a higher probability of very high CVD risk, breaking the inverse gradient found in lower CVD risk. This relationship was also found for those individuals with only a primary education and those >67 years. This suggests that there is some effect modification. However, introducing this interaction into the models was not found to be statistically significant, perhaps due to the limited sample size. Nevertheless, we believe that, in fact, this finding could reinforce the possibility of an inverse relationship between the socioeconomic status of an individual and his/her CVD risk according to SCORE.

Higher CVD risk profiles for individuals with a lower socioeconomic status were also found in various other studies. In a random sample of men and women residing in six districts of the

Czech Republic who participated in the MONICA (Multinational MONItoring of trends and determinants in CArdiovascular disease) study in 1992, Bobak *et al.*[9] found that, except for HDL cholesterol in women and BMI in men, all the "biological" CVD risk factors were associated with a lower education level. Only smoking, in both sexes, waist-to-hip ratio in women, and height in men were associated with material conditions (constructed from car ownership and crowding). The statistical significance of this last association, however, disappeared when education level was controlled for. Schooling *et al.*[14] examined the health associations of socioeconomic status (estimated from education level and manual/nonmanual occupation) of Chinese adults, aged ≥50 years, during the period 2005–2006 and found that, in men, a higher socioeconomic level is associated with lower BP and glucose levels and also with a larger waist circumference and a lower HDL cholesterol level. Muening *et al.*[15] showed that levels of "good" HDL cholesterol increase with income and education, even after controlling for the known risk factors of elevated cholesterol (diet, exercise, family history). Dragano *et al.*[12] in a multilevel analysis of nine German cities (during the period 2002–2005) and the Czech Republic (2000–2003), analyzed the influence of contextual socioeconomic factors on CVD risk factors, controlling for individual factors. They found that the lower the individual's education level, the higher the risk of suffering from HT, obesity, smoking, and low physical activity. In Germany, Schneider *et al.*[10] found that the prevalence of HT in the group with a lower socioeconomic status group was greater than in other groups with a higher status (30.4% vs. 19.1%). Breckenkamp *et al.*,[13] using a multilevel analysis to evaluate the effect of contextual and individual variables of CVD risk in Germany (during the period 1984–1986), found that individual measures of CVD risk factors are explained largely by an individual's social status. In particular, BMI (both sexes), systolic BP (only in men), and cholesterol (only in women) increase with individual socioeconomic status. In contrast, diastolic BP in women is associated with a higher socioeconomic status. Powder *et al.*[24] found a higher prevalence of multiple risk factors for CVD (i.e., smoking, HT, low HDL cholesterol, obesity, and diabetes) in manual social groups. They point out, however, that this higher prevalence was due to the higher prevalence of individual risk factors rather than a greater tendency of those with an individual risk factor to face additional risks.

Summing up all these studies, education is the variable that best represents an individual's socioeconomic status. Furthermore, in some studies, the statistical significance of the association between CVD risk factors and other socioeconomic variables disappears when the level of education is controlled for.[9,12]

Some studies reported ethnicity as another socioeconomic variable related to CVD risk factors. Jackson *et al.*[8] found that the only predictor associated in a significantly consistent way with the higher risk of hospitalization for CVD was an indicator of ethnicity (specifically, nonwhite). Wyatt *et al.*[25] found that Afro-Americans have a higher prevalence of HT than other ethnic groups in the United States. Morenoff *et al.*,[11] however, showed that the statistical significance of this association disappears when contextual factors are included. Stevens *et al.*[26] found larger associations with BMI in the incidence of HT in Chinese Asians compared with white Americans and black Americans. Sharma *et al.*[17] found that there is an increased CVD risk factor clustering among Americans with a low socioeconomic status, particularly among non-Hispanic blacks. Among people with a high socioeconomic status, Mexican Americans and non-Hispanic blacks have a higher risk of CVD than non-Hispanic whites.

People in our study who were born outside Spain (categorized as "foreign" in **Tables 3** and **4**) were mostly from the European Union, and therefore generally had a higher socioeconomic status than those in the reference category (i.e., individuals who were born in the city of Girona). This could explain why the probability of having a higher CVD risk (≥5%) was much lower in this group than in the reference category. Again, it could be evidence of an inverse relationship between the socioeconomic status of an individual and his/her CVD risk according to SCORE.

There are various mechanisms through which higher socioeconomic status could contribute to a lower prevalence of HT[27] and a lower CV risk. More economically favored individuals, in general, do more physical exercise, have access to a better diet, have less exposure to chronic stress and benefit more from social support.[28]

The study has various limitations that must be considered. It is not a population study and selection bias may therefore exist. Hypertensive patients were recruited at the time of diagnosis and normotensive patients were recruited when they went to a health center for some reason. In any case, it must be considered that primary care centers see 99.2% of the population, which reduces possible bias.[29] A major and common problem with the ESH CVD stratification is that TOD is insufficiently screened. Although, in fact, in the VAMPAHICA study only normotensive individuals were not exhaustively screened for the presence of all kinds of TOD. Finally, the use of a scoring system rather than actual CVD events could be an important limitation, as the scoring system is based on individual factors of a more "biological" nature.

In spite of the limitations, we believe that there is evidence that the socioeconomic status of individuals, expressed mainly as their level of education, has repercussions as an independent variable on the estimation of CVD risk according to SCORE. Therefore, the socioeconomic status of an individual, in terms of level of education, should be included in the standard protocols of CVD risk stratification. Furthermore, there is some evidence of the possibility of an inverse relationship between the socioeconomic status of individuals and their CVD risk. This needs to be investigated further, perhaps using actual CVD events instead of a scoring system.

APPENDIX

The model is constructed based on a latent regression[21] of CV risk at the time of diagnosis.

In the case of a single explanatory variable, the model would be formulated as follows:

$$y_i^* = \beta_0 + \beta_1 x_1 + \epsilon_i$$

The response variable, CV risk at the time of diagnosis, y_i^*, is not observed, although stratification of risk, y_i, is, and can take the following values:

$$\begin{aligned} y_i &= 0 \quad si\ y_i^* \le 0 \\ y_i &= 1 \quad si\ 0 < y_i^* \le \mu_1 \\ y_i &= 2 \quad si\ \mu_1 < y_i^* \le \mu_2 \\ &\ldots \\ y_i &= J \quad si\ \mu_{J-1} \le y_i^* \end{aligned}$$

In this case, J would be equal to 4, corresponding to the categories of CVD risk according to high ESH and according to SCORE ≥5%.

Supposing that the nonobserved variable, y_i^* or CVD risk at the time of diagnosis, is distributed normally (with zero average and unitary variance, for simplification):

$$\begin{aligned} &\text{Prob}\left(y_i = 0 | x_i\right) = \Phi\left(-\left(\beta_0 + \beta_1 x_i\right)\right) \\ &\text{Prob}\left(y_i = 1 | x_i\right) = \Phi\left(\mu_{i,1} - \left(\beta_0 + \beta_1 x_i\right)\right) - \Phi\left(\beta_0 + \beta_1 x_i\right) \\ &\text{Prob}\left(y_i = 2 | x_i\right) = \Phi\left(\mu_{i,2} - \left(\beta_0 + \beta_1 x_i\right)\right) - \Phi\left(\mu_{i,1} - \left(\beta_0 + \beta_1 x_i\right)\right) \\ &\ldots \\ &\text{Prob}\left(y_i = J | x_i\right) = 1 - \Phi\left(\mu_{i,J-1} - \left(\beta_0 + \beta_1 x_i\right)\right) \end{aligned}$$

Denoting with $\Phi(.)$ the normal cumulative distribution function.

For all the probabilities to be positive, the restriction $0 < \mu_{i,1} < \mu_{i,2} < \ldots < \mu_{i,J-1}$ must be fulfilled.

The final model can be specified as follows:[30]

$$probit\left(y_i \le J | x\right) = \xi_j - \eta_i$$

with ξ_j being a constant specific to the category of the dependent variable j and η, the linear predictor, containing the explanatory variables; in the case of one explanatory variable, for example,

$$\eta_i = \beta_1 x_1$$

A similar specification (substituting *probit* with *logit*) follows the proportional odds model.[22,31] Moreover, the standard probit model (equivalent to the logistic model) is a particular case of this model when $J = 1$.

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