European Journal of
Preventive
Cardiology

Original scientific paper

European Journal of Preventive Cardiology
0(00) 1–10

DOI: 10.1177/2047487315601078
ejpc.sagepub.com
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# Educational level and risk profile and risk control in patients with coronary heart disease

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**Abstract**

**Background:** The purpose of this study was to ascertain way in which conventional risk factors, readiness to modify behaviour and to comply with recommended medication, and the effect of this medication were associated with education in patients with established coronary heart disease (CHD).

**Methods:** The EUROASPIRE IV (EUROpean Action on Secondary Prevention by Intervention to Reduce Events) study was a cross-sectional survey undertaken in 24 European countries to ascertain how recommendations on secondary CHD prevention are being followed in clinical practice. Consecutive patients, men and women ≤80 years of age who had been hospitalized for an acute coronary syndrome or revascularization procedure, were identified retrospectively. Data were collected through an interview with examinations at least six months and no later than three years after hospitalization.

**Results:** A total of 7937 patients (1934 (24.37%) women) were evaluated. Patients with primary education were older, with a larger proportion of women. Control of risk factors, as defined by Joint European Societies 4 and 5 guidelines, was significantly better with higher education for current smoking ($p = 0.001$), overweight and obesity ($p = 0.047$ and $p = 0.029$, respectively), low physical activity ($p < 0.001$) and low high-density lipoprotein (HDL)-cholesterol ($p = 0.011$) in men, and for obesity ($p = 0.005$), high blood pressure ($p < 0.005$ and $p < 0.001$), low physical activity ($p = 0.001$), diabetes ($p < 0.001$) and low HDL-cholesterol ($p = 0.023$) in women. Patients with primary and secondary education were more often treated with diuretics and antidiabetic drugs. Better control of hypertension was achieved in patients with higher education.

**Conclusion:** Particular risk communication and control are needed in secondary CHD prevention for patients with lower educational status.

**Keywords**

Coronary heart disease, coronary heart disease risk factors, secondary coronary heart disease prevention, educational level, risk factors control, guidelines, EUROASPIRE IV

Received 4 May 2015; accepted 27 July 2015

## Introduction

Socioeconomic status (SES) is an accepted and important factor influencing cardiovascular and coronary heart disease (CHD) morbidity and mortality.[1,2] Socioeconomic status is a complex phenomenon composed of many variables with education, income and occupation being the most important measures.[3] Higher education enables access to better social, professional, economic, cultural and psychological position and helps to reach a higher SES. Over time, and also

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due to difficulties in obtaining and comparing some other socioeconomic characteristics (e.g. income, property, job position in due time), education has become the most commonly used measure of SES in epidemiological studies. In developed countries, these studies have shown an inverse relation between education and lifestyle-related risk factors as well as between education and the risk of cardiovascular and CHD and mortality.[3–12] Among various SES measures, a low level of education was most consistently related to CHD risk factors and CHD morbidity and mortality.[3,4,10]

The short- and long-term mortality after an acute myocardial infarction (AMI) and the risk of reinfarction increases with lower SES and education.[11,12] Secondary prevention of CHD is of paramount importance,[13,14] yet the relationship between educational level and coronary risk factor control and secondary medical prevention after acute coronary syndromes and coronary revascularization procedures has been studied only occasionally.[15–17] An analysis based on the EUROpean Action on Secondary Prevention by Intervention to Reduce Events (EUROASPIRE) II (1999–2000) study found lower global coronary risk in patients with higher education, but virtually the same effectiveness of treatment in all educational groups.[15] Other studies investigating drug use in secondary prevention found no major differences in drug use according to education levels.[16,17] The recent EUROASPIRE IV survey, carried out in 2012–2013 in 24 European countries allows to assess the extent to which educational status is actually associated with lifestyle factors, implementation of recommended lifestyle changes and pharmacotherapies, as recommended by the recent European guidelines on secondary CHD prevention.[18,19] It also offers an unique opportunity to compare the recent EUROASPIRE IV data with the EUROASPIRE II results and to find whether the social differences as defined by educational status are becoming more or less pronounced in patients with established CHD.

## Methods

### *Sample selection and data collection*

The design and protocol of the EUROASPIRE surveys are described in detail elsewhere.[20,21] The cross sectional EUROASPIRE IV study was conducted between May 2012–April 2013 in 24 European countries: Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Finland, France, Germany, Greece, Ireland, Latvia, Lithuania, the Netherlands, Poland, Romania, Russia, Serbia, Slovenia, Spain, Sweden, Turkey, Ukraine and the UK. Within each country, one or more geographical areas with a defined population (at least half a million people) were selected. Each area included at least one hospital offering interventional cardiology and cardiac surgery, and one or more hospitals admitting patients with AMI and coronary ischaemia. One or more hospitals in each area were included in the study, so that any patient presenting within the area with acute symptoms of coronary disease, or requiring revascularization, had an approximately equal chance of being included.

Consecutive patients, men and women $\leq 80$ years of age at the time of their index event or procedure, with the following first or recurrent diagnoses or treatment for CHD were retrospectively identified from registers, hospital records and discharge lists or other sources: (a) elective or emergency coronary artery bypass grafting (CABG), (b) elective or emergency percutaneous coronary intervention (PCI), (c) acute myocardial infarction (AMI), International statistical classification of diseases, World Health Organization 2008 (ICD-10 I21), and (d) acute myocardial ischaemia (ICD-10 I20).

The study interview and examination took place at least six months and no more than three years after the index event. In each country, the objective was to identify a sufficient number of coronary patients in order to obtain prospective interview data on 400 living patients.

### *Patient interview and examination*

The survey was performed in compliance with the standard EUROASPIRE IV study protocol. At interview, the respondents were asked about their history including their personal and demographic characteristics, personal and family history of cardiovascular disease, data on adherence to principles of a healthy lifestyle, and pharmacotherapy. The number of years spent at school and the highest education degree obtained were also recorded. Standardized measurements were made as per protocol using calibrated devices, blood samples were obtained, and the patients completed questionnaires.

1. Body height and weight were measured in light-fabric attire without shoes (SECA 701 scales and measuring stick, model 220). Waist circumference was measured using a metal tape at mid-distance between the spina iliaca anterior and the lower edge of the ribcage.
2. Blood pressure (BP) was measured twice, after at least a 10-minute rest in a sitting position, on the right arm using an automated digital sphygmomanometer (Omron M6). When the difference between the first and second measurements was greater than 10 mm Hg, BP was measured again twice. The mean of the first or last two measurements was used for analyses.

3. Breath carbon monoxide was measured in expired air in ppm using a smokerlyser (Micro+, Bedfont Scientific).
4. Blood samples were obtained by venipuncture after fasting at least 12 h. The serum separated from venous blood samples was stored at –70°C to be subsequently shipped (frozen) to the central laboratory at the Disease Risk Unit, National Institute for Health and Welfare, Helsinki, Finland. Measurements were performed on a clinical chemistry analyzer (Architect c8000, Abbott Laboratories, Abbott Park, Illinois, USA). Total cholesterol (TC) was determined enzymatically, high-density lipoprotein-cholesterol (HDL-C), and triglyceride (TG) levels using kits manufactured by Abbott Laboratories, low-density lipoprotein-cholesterol (LDL-C) level was calculated using a modified Friedewald method (i.e. TC–HDL-C–TG/2.2). The Helsinki-based laboratory participates in the Lipid Standardization Program run by Center for Disease Control and Prevention, Atlanta, Georgia, USA, and the External Quality Assessment Schemes organized by Labquality, Helsinki, Finland.
5. Venous blood glucose was determined by a photometric point-of-care technique (Glucose 201, Hemocue), glycated haemoglobin (HbA1c) by an immunoturbidimetric method. Diabetic patients were defined as those reporting diabetes diagnosed previously by a physician whereas new-onset diabetes was defined as fasting glucose levels $\geq$7.0 mmol/l not previously detected.
6. A Standardized International Physical Activity Questionnaire (IPAQ)[22] was completed for each patient to quantify the level of physical activity.

### Data management and statistical analyses

Data excerpted from the medical records of patients and those obtained during interview were entered into electronic case report forms (CRFs), which were forwarded to the data processing centre (Euro Heart Survey Department, European Heart House, Nice, France), checked for completeness, internal consistency and accuracy to be subsequently processed.

Patients were divided into three educational groups: primary education defined as primary school or less, secondary education characterized as secondary school level, and higher education as university/college levels or equivalent. The number of years spent in full time education for educational level reached varied among participating countries. The median was eight years (interquartile range (IQR): 6–10 years) for primary, 12 years (IQR: 11–13 years) for secondary, and 16 years (IQR: 15–18 years) for higher education.

Risk factors control targets not reached were categorized according to 2007 and 2012 European guidelines on cardiovascular disease prevention in clinical practice (Joint European Societies (JES) 4 and JES 5)[18,19] as follows: overweight = body mass index (BMI) $\geq 25\,kg/m^2$, obesity = BMI $\geq 30\,kg/m^2$; smoking = self-reported smoking or carbon monoxide (CO) in breath $>$10 ppm; diabetes = self-reported diabetes; high BP = systolic BP $\geq$ 130 mm Hg and/or diastolic BP $\geq$ 80 mm Hg (JES4) and systolic BP $\geq$ 140 mm Hg and/or diastolic BP $\geq$ 90 mm Hg (140/80 mm Hg in patients with diabetes) (JES5); high TC $\geq$ 4.5 mmol/l (JES4); high LDL-C $\geq$ 2.5 mmol/l (JES4) and LDL-C $\geq$ 1.8 mmol/l (JES5); low HDL-C $<$ 1 mmol/l in men and $<$1.2 mmol/l in women; low physical activity = lowest level of physical activity according to IPAQ.

All statistical analyses were undertaken using SAS statistical software in the Department of Public Health, Ghent University, Belgium. Analyses were based on generalized linear mixed models in order to account for the clustering of patients within countries. All analyses were adjusted for age and gender. The analyses on cardiovascular risk factors by educational level were additionally adjusted for diagnosis and BMI. Using the logistic models, adjusted odds ratios (ORs) and 95% confidence intervals (CIs) were calculated.

### Ethical issues

The study was performed in conformity with the principles of good clinical practice; the study protocol was approved by the respective local ethics committees, and all participants signed their informed consent forms. Data were stored in accordance with the applicable regulations.

## Results

### Sample structure

After reviewing $n = 16{,}426$ hospitalization medical records, a total of $n = 7998$ patients (48.7%) were interviewed, of whom $n = 7937$ provided valid data on educational level. Mean time between the index event (i.e. acute coronary event and/or revascularization) and the interview was 1.35 years. Distribution of educational levels by diagnosis, gender and age is presented in Table 1. The proportion of primary, secondary, and higher educational level in the whole sample was 17.45%, 60.25%, and 22.3%, respectively. This proportion varied across different countries. The proportion of primary education was higher in females and in patients over 60 years, and lower in patients who underwent an interventional procedure (PCI or CABG).

Table 1. Distribution of educational level by diagnosis, gender, and age.

| | Educational level | | |
|---|---|---|---|
| | Primary[a] | Secondary[b] | Higher[c] |
| All | 17.45% (1385/7937) | 60.25% (4782/7937) | 22.3% (1770/7937) |
| By diagnosis | | | |
| CABG | 14.76% (150/1016) | 64.96% (660/1016) | 20.28% (206/1016) |
| PCI | 15.44% (662/4288) | 61.73% (2647/4288) | 22.83% (979/4288) |
| AMI | 21.64% (393/1816) | 57.32% (1041/1816) | 21.04% (382/1816) |
| Ischaemia | 22.03% (180/817) | 53.12% (434/817) | 24.85% (203/817) |
| By gender | | | |
| Male | 16.13% (968/6003) | 59.82% (3591/6003) | 24.05% (1444/6003) |
| female | 21.56% (417/1934) | 61.58% (1191/1934) | 16.86% (326/1934) |
| By age groups | | | |
| $<$60 years | 12.59% (325/2582) | 64.99% (1678/2582) | 22.42% (579/2582) |
| $\geq$60 years | 19.79% (1060/5355) | 57.96% (3104/5355) | 22.24% (1191/5355) |

AMI: acute myocardial infarction; CABG: coronary artery bypass grafting; ischaemia: acute myocardial ischaemia; PCI: elective or emergency percutaneous coronary intervention. [a]'No formal schooling' or 'Less than primary school' or 'Primary school completed'. [b]'Secondary school completed' or 'High school completed' or 'Intermediate between secondary level (e.g. technical training)'. [c]'College/university completed' or 'Postgraduate degree'.

### *Risk profile and risk factors control*

The distribution of quantitative risk factors by educational level and gender is given in Table 2. Men and women with primary education were older than those with secondary and higher education. In women educational level was inversely associated with an increase in BMI, waist circumference, systolic and diastolic BP, fasting TGs, and fasting glucose. No such consistent trend was found in men. A positive trend with education was found concerning HDL-C in both genders. The control of risk factors, as defined by the JES 4 and JES 5 guidelines, is shown in Table 3. In men, overweight and obesity, smoking, low HDL-C and low physical activity were significantly associated with lower educational levels. In women, obesity, diabetes, high BP, low HDL-C and low physical activity were significantly associated with lower educational levels. Significantly lower adherence to healthy diet recommendations, particularly in reducing salt intake, was found in primary educational level (Supplementary Material, Table 1 and 2).

Adjusted ORs and 95% CIs for the association between education and categorical risk factors are given in Table 4. Taking higher education as a reference level, the lower educational levels (secondary and primary education) increased the relative risk of all factors. In men a significantly increased risk was observed for overweight, obesity, smoking, diabetes, low HDL-C and low physical activity. In women a significantly higher risk was observed for overweight, obesity, diabetes, high BP, low HDL-C and low physical activity.

### *Drugs used for secondary prevention*

Use of secondary preventive medication according to educational level is presented in Table 5. No major differences in drug use were found, only patients with primary and secondary education were more often treated with diuretics and antidiabetic drugs. Regarding doses of medications, e.g. angiotensin converting enzyme inhibitors (ACEIs), no difference in doses was seen between the educational levels (Supplementary Material).

The proportion of treated patients who reached target values for BP, TC and HbA1c are shown in Table 6. BP targets were reached more often with higher educational level, no significant differences were observed in terms of TC targets and diabetes control.

### *Comparison with the EUROASPIRE II study*

Compared to the previous EUROASPIRE II report (1999–2000),[15] the differences in cardiovascular risk factor prevalence and control according to educational level remained relatively stable. The differences decreased in men and increased in women, the treatment modalities became more equal across the educational levels.

## Discussion

Education as the most used, reliable and stable measure of SES is known to be related not only to general and cardiovascular, but also to acute and chronic CHD

**Table 2.** Mean (standard deviation (SD)) values of coronary heart disease risk factor measurements by educational level and gender.

| | Educational level | | | |
|---|---|---|---|---|
| | Primary | Secondary | Higher | *p* Value |
| Male | | | | |
| Age (years, mean (SD)) | 65.44 (9.31) | 62.70 (9.76) | 62.97 (9.50) | $p<0.001$ |
| Body mass index (kg/m$^2$, mean (SD)) | 28.74 (4.22) | 29.10 (4.41) | 28.62 (4.21) | $p<0.001$ |
| Waist circumference (cm, mean (SD)) | 102.03 (11.98) | 103.37 (12.16) | 102.00 (11.67) | $p=0.009$ |
| Systolic blood pressure (mm Hg, mean (SD)) | 134.11 (20.12) | 134.57 (18.74) | 133.28 (18.29) | $p=0.060$ |
| Diastolic blood pressure (mm Hg, mean (SD)) | 78.13 (11.38) | 79.46 (10.88) | 79.00 (10.99) | $p=0.444$ |
| Total cholesterol (mmol/l, mean (SD)) | 4.19 (1.08) | 4.33 (1.05) | 4.39 (1.05) | $p=0.067$ |
| HDL cholesterol (mmol/l, mean (SD)) | 1.11 (0.28) | 1.11 (0.26) | 1.13 (0.25) | $p=0.032$ |
| LDL cholesterol[a] (mmol/l, mean (SD)) | 2.36 (0.86) | 2.45 (0.86) | 2.55 (0.90) | $p=0.136$ |
| Fasting triglycerides(mmol/l, mean (SD)) | 1.60 (1.06) | 1.72 (1.28) | 1.58 (0.91) | $p=0.002$ |
| Fasting glucose (mmol/l, mean (SD)) | 6.60 (1.94) | 6.60 (1.96) | 6.50 (2.02) | $p=0.436$ |
| Female | | | | |
| Age (years, mean (SD)) | 68.37 (8.2) | 65.73 (9.17) | 65.79 (8.98) | $p<0.001$ |
| Body mass index (kg/m$^2$, mean (SD)) | 30.22 (5.45) | 29.48 (5.42) | 29.25 (5.92) | $p=0.006$ |
| Waist circumference (cm, mean (SD)) | 99.03 (14.15) | 96.68 (13.46) | 94.76 (12.76) | $p<0.001$ |
| Systolic blood pressure (mm Hg, mean (SD)) | 137.69 (20.44) | 135.08 (19.46) | 131.44 (18.48) | $p=0.004$ |
| Diastolic blood pressure (mm Hg, mean (SD)) | 79.28 (11.98) | 78.17 (10.92) | 77.89 (10.81) | $p=0.047$ |
| Total cholesterol (mmol/l, mean (SD)) | 4.71 (1.28) | 4.69 (1.25) | 4.77 (1.14) | $p=0.089$ |
| HDL cholesterol (mmol/l, mean (SD)) | 1.24 (0.31) | 1.27 (0.32) | 1.32 (0.32) | $p=0.006$ |
| LDL cholesterol[a] (mmol/l, mean (SD)) | 2.70 (1.08) | 2.66 (1.01) | 2.77 (1.02) | $p=0.244$ |
| Fasting triglycerides (mmol/l, mean (SD)) | 1.70 (0.99) | 1.69 (1.52) | 1.48 (0.71) | $p=0.001$ |
| Fasting glucose (mmol/l, mean (SD)) | 6.89 (2.46) | 6.69 (2.48) | 6.29 (1.60) | $p=0.020$ |

HDL: high-density lipoprotein; LDL: low-density lipoprotein. Values of *p* adjusted for age. [a]According to Friedewald's formula, LDL cholesterol = total cholesterol – HDL cholesterol – (triglycerides/5).

morbidity and mortality. In developed countries, persons with low education are at greater risk.[1,2,4,7–12] Persons with low SES and education have a higher prevalence of overweight and obesity, smoking, diabetes, high BP and hyperlipidaemia. This has been consistently found in epidemiological as well as clinical studies in both genders, in most age groups, and most European countries.[3–6,8,15,23–25] Awareness of cardiovascular risk factors is positively associated with higher educational level and vice versa.[26] As cardiovascular risk factors may explain most differences in CHD morbidity and mortality between different social groups, control of these factors, either by lifestyle modification or through medical drug treatments, is essential, especially in secondary CHD prevention.

Compliance with recommendations on lifestyle changes in patients with established CHD remains unsatisfactory[21] and is inversely related to social and educational status.[14,15] Hospital stays for acute coronary events such as AMI have now become very short. Substantially less time is left for guiding the patient and educating on secondary prevention measures during hospitalization. Recommendations and further follow-up are too often restricted only to drug prescription. This might be particularly significant for patients with a low educational level. When health care is readily accessible and no major-out-of-pocket payments are requested, as is common in European countries, then use of recommended drugs does not differ with social status. Still, compliance with treatment may vary due to other sociopsychological factors.

The EUROASPIRE I-IV studies have shown a high prevalence of risk factors in patients with established CHD and presented data on adherence to lifestyle changes and use of drug treatments. Basically, from 1995–1996 to 2012–2013, a major decrease in high BP and high TC and LDL-C, a substantial increase in obesity and diabetes prevalence, and a remarkable increase in the use of cardioprotective medications were documented. The unhealthy lifestyle behaviours of these patients did not improve and even deteriorated in some aspects, use of cardioprotective medication remains only partly effective.[20,21]

Our study shows that the level of education in patients with established CHD who need secondary prevention is negatively associated with control of

**Table 3.** Risk factors targets not reached by educational level and gender.

| | Educational level | | | |
|---|---|---|---|---|
| | Primary | Secondary | Higher | $p$ Value |
| Male | | | | |
| Overweight[a] | 82.14% (791/963) | 83.71%(2995/3578) | 81.65% (1175/1439) | $p = 0.047$ |
| Obesity[b] | 34.16% (329/963) | 36.81%(1317/3578) | 33.36% (480/1439) | $p = 0.029$ |
| Smoking[c] | 17.67% (171/968) | 18.3% (657/3591) | 15.51% (224/1444) | $p = 0.001$ |
| Diabetes[d] | 27.86% (268/962) | 26.36% (943/3578) | 22.73% (326/1434) | $p = 0.106$ |
| High blood pressure (JES 5)[e] | 42.1% (405/962) | 43.47% (1552/3570) | 40.35% (577/1430) | $p = 0.075$ |
| High blood pressure (JES 4)[f] | 65.98% (638/967) | 68.46% (2451/3580) | 65.21% (939/1440) | $p = 0.174$ |
| High total cholesterol (JES 4)[g] | 29.88% (280/937) | 36.04% (1216/3374) | 38.99% (524/1344) | $p = 0.292$ |
| High HDL-cholesterol (JES 5)[h] | 73.89% (665/900) | 79.42% (2567/3232) | 82.18% (1079/1313) | $p = 0.959$ |
| High HDL-cholesterol (JES 4)[i] | 33.89% (305/900) | 40.07% (1295/3232) | 43.41% (570/1313) | $p = 0.268$ |
| Low HDL cholesterol[j] | 39.38% (369/937) | 36.82% (1242/3373) | 32.96% (443/1344) | $p = 0.011$ |
| Low physical activity[k] | 26.63% (188/706) | 16.33% (448/2744) | 15.31% (180/1176) | $p < 0.001$ |
| Female | | | | |
| Overweight[a] | 81.93% (340/415) | 79.48% (941/1184) | 75.69% (246/325) | $p = 0.110$ |
| Obesity[b] | 48.92% (203/415) | 43.07% (510/1184) | 39.69% (129/325) | $p = 0.005$ |
| Smoking[c] | 11.03% (46/417) | 11.67% (139/1191) | 9.82% (32/326) | $p = 0.531$ |
| Diabetes[d] | 37.14% (153/412) | 29.65% (352/1187) | 22.09% (72/326) | $p < 0.001$ |
| High blood pressure (JES 5)[e] | 52.54% (217/413) | 42.66% (506/1186) | 36.92% (120/325) | $p < 0.001$ |
| High blood pressure (JES 4)[f] | 72.29% (300/415) | 68.1% (809/1188) | 59.08% (192/325) | $p = 0.005$ |
| High total cholesterol (JES 4)[g] | 49.13% (197/401) | 48.12% (526/1093) | 50.33% (151/300) | $p = 0.313$ |
| High HDL-cholesterol (JES 5)[h] | 81.49% (317/389) | 84.56% (893/1056) | 88.18% (261/296) | $p = 0.111$ |
| High HDL-cholesterol (JES 4)[i] | 50.39% (196/389) | 46.97% (496/1056) | 54.05% (160/296) | $p = 0.071$ |
| Low HDL cholesterol[j] | 48.38% (194/401) | 42.18% (461/1093) | 37.33% (112/300) | $p = 0.023$ |
| Low physical activity[k] | 38.16% (108/283) | 24.44% (218/892) | 14.73% (38/258) | $p = 0.001$ |

BMI: body mass index; JES: Joint European Societies; HDL: high-density lipoprotein; LDL: low-density lipoprotein Values of $p$ adjusted for age through multilevel logistic regression modelling. [a]$BMI \geq 25\,kg/m^2$. [b]$BMI \geq 30\,kg/m^2$. [c]Self-reported smoking or CO in breath $> 10$ ppm. [d]Self-reported diabetes. [e]Systolic blood pressure $\geq 140$ mm Hg and/or diastolic blood pressure $\geq 90$ mm Hg (140/80 mm Hg in patients with diabetes). [f]Systolic blood pressure $\geq 130$ mm Hg and/or diastolic blood pressure $\geq 80$ mm Hg. [g]Total cholesterol $\geq 4.5$ mmol/l. [h]LDL-C $\geq 1.8$ mmol/l. [i]LDL-C $\geq 2.5$ mmol/l. [j]HDL-C $< 1$ mmol/l in men and $< 1.2$ mmol/l in women. [k]Lowest level of physical activity according to IPAQ.

most risk factors, and that these associations, except for smoking, are more significant in women than in men. Factors are obviously intertwined: e.g. a higher salt intake might, to some extent, explain the higher BPs and more frequent use of diuretics in the lower educational strata. Based on our results, we have to stress a possibly more discriminative role of education in CVD risk factor control in women than in men. Secondary preventive education strategies in patients with lower education, compared with higher educational strata, are obviously more difficult to implement and of a more limited effect. A more intensive and personal approach to persons with lower education is desirable. As proposed by Capewell et al.,[27] alternatively, legislative (bans and restrictions for tobacco and unhealthy food) and fiscal measures (different value added tax (VAT) for unhealthy food and tobacco on the one hand, and for foods considered healthy on the other) can be particularly effective in persons with low SES.

On the other hand, most cardioprotective drugs were used in our patients fairly equally and in similar dosage across the educational spectrum and the effectiveness of such treatment did not differ substantially. Patients with lower education have higher CHD morbidity and mortality and might be in greater need of treatments. However, when we found similar treatment in all educational strata it could mean that the patients with primary education are actually undertreated.

Because the median of years spent at school in different countries varied considerably and overlapped, we divided the sample by the educational level reached: into primary, secondary, and higher categories. The reported educational level reached is probably a better proxy for individual SES than the number of years spent at school, because the achieved higher educational level generally results in a better working position, higher income and higher social status. We preferred educational status to income or working position which are

**Table 4.** Odds ratios for risk factors targets not reached by educational level (calculated from logistic regression analysis).

| | Educational level | | |
|---|---|---|---|
| | Primary | Secondary | Higher |
| Male | | | |
| Overweight[a] | 1.29 (1.02–1.63) | 1.22 (1.03–1.44) | 1 |
| Obesity[b] | 1.19 (0.98–1.45) | 1.20 (1.05–1.38) | 1 |
| Smoking[c] | 1.55 (1.20–1.99) | 1.30 (1.09–1.55) | 1 |
| Diabetes[d] | 1.11 (0.90–1.37) | 1.18 (1.01–1.37) | 1 |
| High blood pressure (JES 5)[e] | 1.14 (0.95–1.38) | 1.16 (1.02–1.33) | 1 |
| High blood pressure (JES 4)[f] | 1.15 (0.95–1.40) | 1.13 (0.99–1.30) | 1 |
| High total cholesterol (JES 4)[g] | 1.19 (0.97–1.46) | 1.06 (0.92–1.22) | 1 |
| High LDL-cholesterol (JES 5)[h] | 1.02 (0.81–1.29) | 0.99 (0.83–1.18) | 1 |
| High LDL-cholesterol (JES 4)[i] | 1.19 (0.97–1.46) | 1.06 (0.92–1.22) | 1 |
| Low HDL cholesterol[j] | 1.33 (1.09–1.62) | 1.17 (1.01–1.34) | 1 |
| Low physical activity[k] | 1.72 (1.32–2.24) | 1.11 (0.91–1.35) | 1 |
| Female | | | |
| Overweight[a] | 1.50 (1.01–2.23) | 1.31 (0.96–1.79) | 1 |
| Obesity[b] | 1.74 (1.24–2.44) | 1.24 (0.94–1.62) | 1 |
| Smoking[c] | 1.25 (0.73–2.14) | 1.00 (0.65–1.55) | 1 |
| Diabetes[d] | 2.22 (1.53–3.22) | 1.53 (1.12–2.08) | 1 |
| High blood pressure (JES 5)[e] | 2.06 (1.46–2.90) | 1.36 (1.03–1.80) | 1 |
| High blood pressure (JES 4)[f] | 1.76 (1.24–2.51) | 1.45 (1.10–1.92) | 1 |
| High total cholesterol (JES 4)[g] | 1.30 (0.92–1.83) | 1.09 (0.82–1.44) | 1 |
| High LDL-cholesterol (JES 5)[h] | 0.64 (0.40–1.04) | 0.88 (0.58–1.33) | 1 |
| High LDL-cholesterol (JES 4)[i] | 1.28 (0.90–1.82) | 0.93 (0.70–1.24) | 1 |
| Low HDL cholesterol[j] | 1.60 (1.13–2.26) | 1.21 (0.91–1.60) | 1 |
| Low physical activity[k] | 2.75 (1.71–4.42) | 1.88 (1.25–2.82) | 1 |

BMI: body mass index; JES: Joint European Societies; HDL: high-density lipoprotein; LDL: low-density lipoprotein Odds ratio (95% confidence interval) adjusted for age, gender, diagnosis, centre, taking higher education as reference. [a]BMI $\geq$ 25 kg/m$^2$. [b]BMI $\geq$ 30 kg/m$^2$. [c]self-reported smoking or CO in breath $>$10 ppm. [d]Self-reported diabetes. [e]Systolic blood pressure $\geq$ 140 mm Hg and/or diastolic blood pressure $\geq$ 90 mm Hg (140/80 mm Hg in patients with diabetes). [f]Systolic blood pressure $\geq$ 130 mm Hg and/or diastolic blood pressure $\geq$ 80 mm Hg. [g]Total cholesterol $\geq$ 4.5 mmol/l. [h]LDL-C $\geq$ 1.8 mmol/l; [i]LDL-C $\geq$ 2.5 mmol/l. [j]HDL-C $<$ 1 mmol/l in men and $<$ 1.2 mmol/l in women. [k]Lowest level of physical activity according to IPAQ.

**Table 5.** Use of secondary preventive medication by educational level by both gender.

| | Educational level | | | |
|---|---|---|---|---|
| | Primary | Secondary | Higher | $p$ Value |
| Antiplatelet drugs | 93.95% (108/1371) | 93.63% (306/4759) | 94.33% (94/1765) | $p = 0.180$ |
| Any hypertensive drugs | 75.43% (1013/1343) | 78.67% (3681/4679) | 78.84% (1375/1744) | $p = 0.737$ |
| Beta-blockers | 81.98% (1124/1371) | 83.72% (3984/4759) | 80.11% (1414/1765) | $p = 0.060$ |
| ACE inhibitors[a] | 56.67% (777/1371) | 60.24% (2867/4759) | 57.00% (1006/1765) | $p = 0.125$ |
| Diuretics | 31.8% (436/1371) | 30.26% (1440/4759) | 26.86% (474/1765) | $p = 0.014$ |
| Calcium antagonists | 21.37% (293/1371) | 23.03% (1096/4759) | 21.81% (385/1765) | $p = 0.589$ |
| Any lipid-lowering drugs | 85.12% (1167/1371) | 87.29% (4154/4759) | 85.67% (1512/1765) | $p = 0.002$ |
| Statins | 83.73% (1148/1371) | 86.47% (4115/4759) | 84.99% (1500/1765) | $p < 0.001$ |
| Antidiabetic drugs | 27.2% (373/1371) | 23.6% (1125/4759) | 19.8% (350/1765) | $p = 0.020$ |

Values of $p$ adjusted for age and gender through logistic regression modelling. [a]Angiotensin converting enzyme inhibitors.

**Table 6.** Proportion of patients who reached target values for blood pressure, cholesterol and glycated haemoglobin (HbA1c).

| | Educational level | | | |
|---|---|---|---|---|
| | Primary | Secondary | Higher | *p* Value |
| Blood pressure[a] | | | | |
| No antihypertensive drugs | 67.17% (221/329) | 71.07% (705/992) | 74.18% (273/368) | $p = 0.134$ |
| Antihypertensive drugs | 50.50% (508/1006) | 52.69% (1930/3663) | 56.23% (767/1364) | $p = 0.021$ |
| Blood pressure[b] | | | | |
| No antihypertensive drugs | 43.94% (145/330) | 43.46% (432/994) | 50.27% (185/368) | $p = 0.30$ |
| Antihypertensive drugs | 27.89% (282/1011) | 28.08% (1031/3672) | 31.73% (435/1371) | $p = 0.119$ |
| Total cholesterol[c] | | | | |
| No lipid-lowering drugs | 43.65% (86/197) | 31.74% (179/564) | 23.71% (55/232) | $p = 0.186$ |
| Lipid-lowering drugs | 68.26% (770/1128) | 65.24% (2532/3881) | 64.68% (910/1407) | $p = 0.307$ |
| HbA1c[d] | | | | |
| No self reported diabetes | 97.17% (894/920) | 98.11% (3175/3236) | 97.94% (1237/1263) | $p = 0.710$ |
| Self-reported diabetes | 54.41% (222/408) | 52.15% (631/1210) | 52.72% (194/368) | $p = 0.100$ |
| HbA1c[e] | | | | |
| No self reported diabetes | 92.61% (852/920) | 94.75% (3066/3236) | 94.85% (1198/1263) | $p = 0.015$ |
| Self-reported diabetes | 36.03% (147/408) | 35.12% (452/1210) | 35.87% (132/368) | $p = 0.470$ |

Values of *p* adjusted for age and gender through logistic regression modelling. [a]Systolic blood pressure ≥ 140 mm Hg and/or diastolic blood pressure ≥ 90 mm Hg (140/80 mm Hg in patients with diabetes). [b]Systolic blood pressure ≥ 130 mm Hg and/or diastolic blood pressure ≥ 80 mm Hg. [c]Total cholesterol < 4.5 mmol/L. [d]HbA1c < 7%; [e]HbA1c < 6.5%.

affected by large economic differences among participating countries, are less reliably specified and fluctuate considerably during lifetime. Educational status as a proxy for SES has the advantage of being an exact, reliable, and in the middle-aged and older individuals, fixed measure. In some European countries involved in the EUROASPIRE IV study, a more complex assessment of SES given the availability of further exact SES parameters could be performed, but this was not possible in most of the countries involved.

The strengths of this study are the wide scope of European countries covering virtually the whole continent, and the strict protocol which allows international and longitudinal comparisons.

The study has also several limitations. Unlike PCI, CABG and AMI (ST segment elevation myocardial infarction and non-STsegment elevation myocardial infarction; STEMI and non-STEMI), the term acute myocardial ischaemia remained poorly validated as clinical and electrocardiography (ECG) signs of myocardial ischaemia in the absence of myocardial necrosis and mostly relied on physicians' judgment in the discharge summary.

The observed differences in risk factors and treatment are not representative of the entire populations of participating countries, because patients were recruited mainly from tertiary cardiac centres and university hospitals. The implementation of secondary preventive measures may be therefore overestimated, compared to the country-wide situation. Conversely, the inclusion of minor hospitals without interventional facilities could make the differences between educational groups even more pronounced. In general, the regional differences in coronary care in European countries with developed systems of acute coronary care (transportation to direct PCI, advanced revascularization programs), diminish.[28]

Classifying patients into primary, secondary and higher education still does not exclude overlaps between primary and secondary, as well as between secondary and higher education.

Based only on patients' reports at interview, the data on use of secondary preventive medications may be overestimated and could further explain the limited effectiveness of treatments. The same may apply to data on compliance with lifestyle changes such as diet or physical activities.

## Conclusions

The EUROASPIRE I–IV data have shown that evidence-based secondary preventive measures in coronary patients remain underused in Europe. In our study, patients with lower education were at a higher global cardiovascular risk than those with higher education. The differences were more pronounced in women. The major differences were found in risk factors of obesity and diabetes. The medical treatments are fairly similar in all educational strata. When compared to the EUROASPIRE II education substudy

(1999–2000), our study has found only modest changes. The differences in risk factor control according to education decreased in men and increased in women, and the treatment modalities became more equal across the educational levels. This study indicates the need to pay special attention to coronary patients with lower education, possibly with obesity and diabetes control as a major target.


## Acknowledgements

The authors thank the administrative staff, physicians, nurses, and other personnel at the hospitals in which the study was carried out, and all the patients who participated in the EUROASPIRE studies. The EUROASPIRE IV survey was carried out under the auspices of the European Society of Cardiology, EURObservational Research Programme. The sponsors of the EUROASPIRE surveys had no role in the design, data collection, data analysis, data interpretation, decision to publish, or writing the manuscript.

## Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: All authors have completed the Unified Competing interest form at www.icmje.org/coi_disclosure.pdf and declare that (1) JB a OM were supported by the grant No. NT 13186 by the Internal Grant Agency, Ministry of Health, Czech Republic; DDB and KK had grant support from the European Society of Cardiology, DDS is supported by the Research Foundation Flanders, Belgium (2) ZR, KK and RC had the following financial activities outside the submited work in the previous three years: ZR had personal fees from Sanofi, Astra Zeneca, Abbot and Aegirion, KK had travel grants from Roche and Boehringer Ingelheim, RC had grants from Krka, Novo Mesto, Slovenia, personal fees from Servier International, Medtronic, Medtronic Czechia, Abbot Products Opperations AG, MSD Czech Republic, TEVA Pharmaceuticals Czech Republic.

## Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The EUROASPIRE IV survey was supported by AstraZeneca, Bristol-Myers Squibb/Emea Sarl, GlaxoSmithCline, F Hoffman-La Roche (Gold Sponsors), Merck, Sharp & Dohme and Amgen (Bronze Sponsors) (unrestricted research grants to the European Society of Cardiology).


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