EUROASPIRE IV: A European Society of Cardiology survey on the lifestyle, risk factor and therapeutic management of coronary patients from twenty four European countries

Kornelia Kotseva^{1,2}, David Wood^{1,2}, Dirk De Bacquer^{1,3}, Guy De Backer^{1,3}, Lars Rydén^{1,4}, Catriona Jennings^{1,2}, Viveca Gyberg⁴, Philippe Amouyel⁵, Jan Bruthans^{1,6}, Almudena Castro Conde⁷, Renata Cífková^{1,6}, Jaap W Deckers^{1,8}, Johan De Sutter^{1,9}, Mirza Dilic^{1,10}, Maryna Dolzhenko¹¹, Andrejs Erglis^{1,12}, Zlatko Fras^{1,13}, Dan Gaita^{1,14}, Nina Gotcheva¹⁵, John Goudevenos^{1,16}, Peter Heuschmann¹⁷, Aleksandras Laucevicius^{1,18}, Seppo Lehto¹⁹, Dragan Lovic^{1,20}, Davor Miličić^{1,21}, David Moore²², Evagoras Nicolaides^{1,23}, Raphael Oganov²⁴, Andrzej Pajak²⁵, Nana Pogosova^{1,26}, Zeljko Reiner^{1,27}, Martin Stagmo²⁸, Stefan Störk²⁹, Lale Tokgözoğlu^{1,30}, Dusko Vulic^{1,31}, on behalf of the EUROASPIRE Investigators

¹ Fellow of the European Society of Cardiology, Les Templiers, 2035 route des Colles, CS
80179 BIOT, 06903 Sophia Antipolis Cedex, France

² International Centre for Circulatory Health, National Heart and Lung Institute, Imperial College London, 59-61 North Wharf Road, W2 1LA, London, UK

 ³ Department of Public Health, University of Ghent, De Pintelaan 185, Gent B 9000, Belgium
 ⁴ Cardiology Unit, Department of Medicine Solna, Karolinska Institutet, Stockholm 171 76, Sweden

⁵ Institut Pasteur de Lille, Inserm U744, Université Lille Nord de France, 1 rue du Professeur Calmette B.P. 245, Lille F-59019, France

⁶ Center for Cardiovascular Prevention, 1st Medical Faculty Charles University and Thomayer Hospital, Vídeňská 800, 140 59 Prague, Czech Republic ⁷ Cardiac Rehabilitation Unit, Cardiology Department, Hospital Universitario La Paz, Madrid, Spain

⁸ Thoraxcenter's Department of Cardiology, Dr Molewaterplein 50, 3000 DR Rotterdam, The Netherlands

⁹ Department of Internal Medicine, University of Ghent, De Pintelaan 185, Gent B 9000, Belgium

¹⁰ Clinical Center University of Sarajevo, Bolnička 25, 71000 Sarajevo, Bosnia and Herzegovina

¹¹ Department of Cardiology, Shupyk's National Medical Academy of Postgraduate Education, 9 Dorohozhyts'ka str, Kiev, 04112, Ukraine

¹² University of Latvia, Pauls Stradins Clinical University Hospital, Pilsonu Street 13, Riga, LV1002, Latvia

¹³ University Medical Centre, Zaloška 7, Ljubljana 1000, Slovenia

¹⁴ Universitatea de Medicina si Farmacie "Victor Babes", Institutul de Boli Cardiovasculare, Timisoara, Romania

¹⁵ Department of Cardiology, National Heart Hospital, 65, Konyovitsa, Sofia 1309, Bulgaria

¹⁶ Cardiology Department of Medical School University of Ioannina, Greece

¹⁷ Institute of Clinical Epidemiology and Biometry, University of Würzburg; Comprehensive

Heart Failure Center, University of Würzburg; Clinical Trial Center Würzburg, University

Hospital Würzburg, Josef-Schneider-Str. 2, 97080 Würzburg, Germany

¹⁸ Clinic of Cardiovascular Diseases of Vilnius University; Heart and Vascular Medicine of

Vilnius University Hospital Santariskiu Clinics, Santariskiu 2, 08661 Vilnius, Lithuania

¹⁹ Kuopio University Hospital, Rakennus 5/6. Kerros, Puijonlaaksontie 2, Kuopio 70210,

Finland

²⁰ Clinic for Internal Medicine Intermedica, Jovana Ristica 20/2, 18000 Nis, Serbia

²¹ University of Zagreb School of Medicine & University Hospital Centre Zagreb,

Kispaticeva 12, HR-10000 Zagreb, Croatia

²² The Adelaide and Meath Hospital, Tallaght, Dublin 24, Ireland

²³ University of Nicosia Medical School, Nicosia General Hospital, 2029 Strovolos, Nicosia,
 Cyprus

²⁴ National Research Center for Preventive Medicine of the Ministry of Healthcare of the Russian Federation, 10 Petroverigsky per, 101990 Moscow, Russia

²⁵ Jagiellonian University Medical College, Faculty of Health Sciences, Department of Epidemiology and Population Studies, Grzegórzecka 20, Cracow 31-531, Poland

²⁶ Federal Health Center and Department of Chronic Noncommunicable Diseases Prevention, National Research Center for Preventive Medicine, 10 Petroverigsky per, 101953Moscow, Russia

²⁷ University Hospital Centre Zagreb, School of Medicine, University of Zagreb, Kišpatićeva
12, 10000 Zagreb, Croatia

²⁸ Department of Heart failure and valve disease, Skåne University Hospital, Lund, Sweden

²⁹ Comprehensive Heart Failure Center and Department of Medicine I, University of

Würzburg, Straubmühlweg 2a, D-97078 Würzburg

³⁰ Hacettepe University, 06690 Ankara, Turkey

³¹ Center for medical research, School of Medicine, University of Banja Luka, Vuka Karadzica 6, 78000 Banja Luka, Republic of Srpska, Bosnia and Herzegovina

For correspondence:

Dr Kornelia Kotseva, MD, PhD, FESC

Senior Clinical Research Fellow and Consultant Cardiologist

Cardiovascular Medicine, National Heart and Lung Institute, Imperial College London St Mary's Campus, International Centre for Circulatory Health 59-61 North Wharf Road, London W2 1LA Tel: +44 (0) 2075943439; Fax: +44 (0) 2075941317

E mail: <u>k.kotseva@imperial.ac.uk</u>

Abstract

Aims To determine whether the Joint European Societies guidelines on cardiovascular prevention are being followed in everyday clinical practice of secondary prevention and to describe the lifestyle, risk factor and therapeutic management of coronary patients across Europe.

Methods and Results EUROASPIRE IV was a cross-sectional study undertaken at 78 centres from 24 European countries. Patients <80 years with coronary disease who had CABG, PCI or an acute coronary syndrome were identified from hospital records and interviewed and examined \geq 6 months later. 16,426 medical records were reviewed and 7998 patients (24.4% females) interviewed. At interview, 16.0% of patients smoked cigarettes, and 48.6% of those smoking at the time of the event were persistent smokers. 59.9% reported little or no physical activity. 37.6% were obese (BMI \geq 30 kg/m²) and 58.2% centrally obese (waist circumference \geq 102 cm in men or \geq 88 cm in women). 42.7% had blood pressure \geq 140/90 mm Hg (\geq 140/80 in people with diabetes); 80.5% had LDL-cholesterol \geq 1.8 mmol/L and 26.8% reported having diabetes. Cardioprotective medication was: anti-platelets 93.8%; beta-blockers 82.6%; ACE inhibitors/ARBs 75.1%; and statins 85.7%. 50.7% of patients were advised to participate in a cardiac rehabilitation programme and 81.3% of those advised attended at least half of the sessions.

Conclusion A large majority of coronary patients do not achieve the guideline standards for secondary prevention with high prevalences of persistent smoking, unhealthy diets, physical inactivity and consequently most patients being overweight or obese with a high prevalence of diabetes. Risk factor control is inadequate despite high reported use of medications and there are large variations in secondary prevention practice between centres. Less than half of the coronary patients access cardiac prevention and rehabilitation programmes. All coronary and vascular patients require a modern preventive cardiology programme, appropriately adapted to medical and cultural settings in each country, to achieve healthier lifestyles, better risk factor control and adherence with cardioprotective medications.

Key words: EUROASPIRE; cardiovascular prevention; rehabilitation; guidelines

Introduction

The main objectives of cardiovascular disease (CVD) prevention are to reduce morbidity and mortality, improve quality of life, and increase longevity in good health.

The European Society of Cardiology (ESC) has promoted CVD prevention in clinical practice since 1994.¹⁻⁵ The aim of the Joint European Societies Guidelines (JES) on CVD prevention is to improve the practice of preventive cardiology through development of national guidelines, implementation and evaluation. Patients with coronary or other atherosclerotic disease are the highest clinical priority for prevention with defined goals for lifestyle, medical risk factor management and the use of cardiovascular protective medication.

The EUROASPIRE (European Action on Secondary and Primary Prevention by Intervention to Reduce Events) cross sectional surveys, starting in 1995-96, have evaluated guideline implementation. Time trends across three surveys have shown adverse lifestyle trends in coronary patients, a substantial increase in obesity, and the highest prevalence of persistent smoking in younger patients.⁶⁻¹⁰ Despite a substantial increase in antihypertensive drug use, blood pressure management remained unchanged over this period with almost half of all patients still above the blood pressure target. The largest proportionate increase in prescribing was lipid-lowering drugs, principally statins, with a corresponding improvement in lipid control although most patients still not below the LDL-cholesterol target. Nearly a third of patients in EUROASPIRE III had a history of diabetes mellitus with poor glucose control.

The Euro Heart Survey of Diabetes and the Heart, a multicentre prospective observational study in 4,961 coronary patients from 25 countries conducted in 2003 – 2004, demonstrated that abnormal glucose regulation affected a majority of patients with coronary artery disease and routine use of an oral glucose tolerance test is a simple and cost-effective way to improve detection of such metabolic abnormalities.¹¹ Patients with diabetes compared to those without diabetes had a much poorer prognosis, which improved considerably with multifactorial evidence based management.^{12,13} Since then Joint ESC and European Association for the Study of Diabetes (EASD) guidelines for management of patients with diabetes, pre-diabetes and CVD have been published.¹⁴

The EUROASPIRE IV survey incorporated the EuroHeart Survey on Diabetes to create the first European Survey of CVD Prevention and Diabetes. The assessment of dysglycaemia using an oral glucose tolerance test in all patients with self reported diabetes will be reported elsewhere.

The main objectives of EUROASPIRE IV were to *identify* risk factors in coronary patients with and without diabetes, describe their *management* through lifestyle and use of drug therapies and provide an objective assessment of clinical *implementation* of current scientific knowledge. This article presents the principal results of this fourth survey.

Study population and methods

Geographical area and hospital sampling frame

EUROASPIRE IV was a cross-sectional study carried out in 24 European countries: Belgium, Bosnia & 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 were selected and all hospitals serving these populations were identified. A sample of one or more hospitals, or all hospitals, was taken so that any patient presenting within the area with acute symptoms of coronary disease, or requiring revascularisation in the form of balloon angioplasty (PCI) or coronary artery surgery (CABG), had an approximately equal chance of being included. Patients admitted to a hospital outside this geographical area were not included in the sample.

Consecutive patients, men and women (\geq 18 years and <80 years of age at the time of their index event or procedure), with the following first or recurrent clinical diagnoses or treatments for CHD were retrospectively identified from diagnostic registers, hospital discharge lists or other sources: (i) elective or emergency CABG, (ii) elective or emergency PCI, (iii) acute myocardial infarction (AMI: ICD-10 I21), and (iv) acute myocardial ischaemia (ICD-10 I20). The starting date for identification was \geq six months and < three years prior to the expected date of the study interview. 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.

Data collection

Centrally trained research staff undertook data collection. They reviewed patient medical records and interviewed and examined the patients at hospital or home \geq six months after their index coronary event or procedure, using standardised methods and the same instruments in all centres. Information on personal and demographic details, smoking status, history of obesity, hypertension, dyslipidaemia, glucose metabolism and medication was obtained from medical records. Self reported information on lifestyle, other risk factor management and medication was obtained at interview. The case record form was translated into all national languages and the self reported questionnaires were all validated versions for each country. All equipment was calibrated according to the manufacturer's recommendations. The following measurements were performed:

- a) Height and weight in light indoor clothes without shoes (SECA scales 701 and measuring stick model 220). Overweight was defined as a body mass index (BMI) ≥ 25 kg/m2 and obesity as a BMI ≥ 30 kg/m2.
- b) Waist circumference was measured using a metal tape applied horizontally at the point midway in the mid-axillary line between the lowest rim of the rib cage and the tip of the hip bone (superior iliac crest) with the patient standing.¹⁵ Abdominal overweight was defined as a waist circumference of ≥ 80 cm for women and ≥ 94 cm for men and central obesity as a waist circumference of ≥ 88 cm for women and ≥ 102 cm for men.
- c) Blood pressure was measured twice on the right upper arm in a sitting position using an automatic digital sphygmomanometers (Omron M6) and the mean was used for all analyses. Raised blood pressure was defined as systolic blood pressure (SBP) ≥130 mmHg and/or diastolic blood pressure (DBP) ≥80 mmHg (JES 4 guidelines) and ≥140/90 mmHg (≥140/80 mmHg in patients with diabetes mellitus; JES 5 guidelines)
- d) Breath carbon monoxide was measured in ppm using a smokerlyser (Bedfont Scientific, Model Micro +). Smoking at the time of interview was defined as self-reported smoking, and/or a breath carbon monoxide exceeding 10 ppm.¹⁶ Persistent smoking was defined as smoking at interview among patients reporting to be smokers in the month prior to the index event.
- e) Venous (fasting) blood was drawn for serum total and high-density lipoprotein (HDL) cholesterol, triglycerides, glycated haemoglobin (HbA1c) and LDL cholesterol (LDL-C) was calculated according to Friedewald's formula.¹⁷ Elevated LDL-C concentration was

defined as $\geq 2.5 \text{ mmol/l}$ and $\geq 2.0 \text{ mmol/l}$, if feasible (JES4 Guidelines) and as $\geq 1.8 \text{ mmol/l}$ (JES5 Guidelines). Elevated fasting glucose among patients with diabetes was defined as $\geq 6.0 \text{ mmol/l}$ and elevated HbA1c as $\geq 6.5\%$ (JES4 Guidelines) and $\geq 7.0\%$ (JES5 Guidelines).

f) Habitual physical activity was assessed by the International Physical Activity Questionnaire (IPAQ).¹⁸ The physical activity target was defined as moderate or vigorous physical activity for at least 20 minutes once or more times a week.

The central laboratory was the Disease Risk Unit, National Institute for Health and Welfare, Helsinki, Finland, and is accredited by the Finnish Accreditation Service and fulfils the requirements of the standard SFS-EN ISO/IEC 17025:2005. Venous blood samples were taken in a sitting position with light stasis into a tube containing clot activator (Venosafe, Terumo Europe, Leuven, Belgium) for lipid assays and into a potassium EDTA tube (Venosafe) for HbA1c assay. Serum was separated by centrifuging at 2000 g for 10 min at room temperature. After that serum was aliquoted into two bar-code-labelled tubes and stored together with whole EDTA blood tubes locally at a minimum of -70 °C and then transported frozen to the central laboratory where all measurements were performed on a clinical chemistry analyzer (Architect c8000; Abbott Laboratories, Abbott Park, Illinois, USA). Total cholesterol, HDL-cholesterol and triglycerides were analysed in serum, and HbA1c in whole blood with the following methods: enzymatic method for total cholesterol, a homogenous method for direct measurement of HDL cholesterol, an enzymatic glycerol phosphate oxidase method for triglycerides, and an immunoturbidimetric method for HbA1c.

The laboratory takes part in Lipid Standardization Program organized by CDC, Atlanta, Georgia, USA and External Quality Assessment Schemes organized by Labquality, Helsinki, Finland. During the course of the study, comprising two months in 2013, the coefficient of variation (mean \pm SD) and systematic error (bias) (mean \pm SD) were 1.3% \pm 0.2 and 1.7% \pm 1.1 for total cholesterol, 1.6% \pm 0.5 and – 1.5% \pm 1.6 for HDL cholesterol, 2.3% \pm 0.1 and – 1.2% \pm 2,6 for triglycerides, and 1.9% \pm 0.1 and 1.4% \pm 0.2 for HbA1c, respectively.

Data management

Data management was undertaken by the EuroObservational Research Programme at the European Heart House, Nice, France. All data were collected electronically through web based data entry using a unique identification number for country, centre and individual. The data were submitted via the Internet to the data management centre where checks for completeness, internal consistency and accuracy were run. All data were stored under the provisions of the National Data Protection Regulations.

Statistical analyses

Sample size calculations indicated that a sample of 400 patients attending interview was sufficient to estimate prevalences of risk factors with precision of at least 5% and with a confidence interval of 95%. Descriptive statistics were used to estimate the prevalences of risk factors and medication use by country, gender and age at interview. Patients attending interview were compared with patients not interviewed based on information from the discharge letters using Fisher's exact test for proportions. Geographical variation in prevalences was quantified using the Median Odds Ratio (MOR) with 95% confidence intervals, both estimated from a hierarchical model accounting for clustering of patients within countries. The MOR can be interpreted as the median of the theoretical distribution expressing prevalence odds ratios between all possible pairs of centres. All statistical analyses were undertaken using SAS statistical software (release 9.3) in the Department of Public Health, Ghent University, Belgium.

Ethical Procedures

National Co-ordinators were responsible for obtaining Local Research Ethics Committees approvals. Written, informed consent was obtained from each participant by the investigator by a signed declaration. The research assistants signed in the Case Record Form to confirm that informed consent was obtained and stored the original signed declaration consent in the patient file.

Outcome measures

The main outcome measures were the proportions of coronary patients achieving the lifestyle, risk factors and therapeutic targets as defined in the JES Guidelines on CVD prevention (2007 and 2012).

Results

The survey was undertaken at 78 centres in 24 European countries. A total of 16,426 medical records were reviewed and 7,998 coronary patients interviewed (interview rate 48.7%). The median time (interquartile range) between index event and interview was 1.35 years (0.95- 1.93 years), ranging from 0.82 years to 2.25 years. A description of the study population enrolled from medical records and numbers of patient interviewed by country, gender and age at index event is presented in *supplementary table 1*.

Overall, risk factor recording *at discharge* was incomplete with large variations between countries. Smoking status and obesity were recorded in 74.0% and 61.9% of the patients, respectively, and in one fifth of them there was no information recorded on blood pressure (12.8%), lipids (19.4%) or glucose metabolism (19.7%) in the discharge documents. In those with recorded information, the prevalence of smoking was 29.6%, obesity 32.6%, hypertension 77.8%, dyslipidaemia 72.8% and diabetes 30.7%.

Patient interviews and examinations were conducted on 7,998 coronary patients (24.4% women). The median time (interquartile range) between the index event and interview was 1.4 years (0.9- 1.9 years), ranging from 0.8 years in Turkey to 2.2 years in Spain. The mean (SD) age at interview was 64.0 (9.6) ranging from 58.7 (10.1) years in Turkey to 67.4 (8.9) years in Germany. The most common reasons for not being interviewed were: no response to the invitation letter (34.9%), refused to attend for personal or other reasons (30.3%), patient died (10.4%), no time (8.9%), change in health status (5.4%) and living outside the catchment area (2.7%). Characteristics of interviewed patients by age, gender and information on CVD risk factors and medication from discharge letters is presented in Table 1. The interview participation was significantly lower in women, in smokers and those with abnormal glucose metabolism. Overall, patients with hypertension, hyperlipidaemia and on cardioprotective medication were more willing to participate while smokers were less likely to attend.

The prevalences of smoking, overweight and obesity in coronary patients are shown in Figure 1 and *supplementary table 2*. The overall prevalence of smoking (self-reported and/or CO in breath > 10 ppm) at interview was 16.0% and highest in patients <50 years (33.6%). The prevalence of persistent smoking among those who were smoking in the month prior to the coronary event was 49.3% and about half (50.9%) reported an intention to quit smoking within the next six months. The majority of smokers had received verbal (88.5%) or written (42.6%) advice to stop smoking, but only a small minority (18.6%) was advised to

11

attend a smoking cessation clinic or use pharmacological support in the form of nicotinereplacement therapy (NRT; 22.9%), varenicline (6.2%) or bupropion (4.7%). Two-thirds of persistent smokers (66.7%) reported reducing the amount of smoking after their cardiac event and 7.2% attended a smoking cessation clinic. NRT, bupropion and varenicline were prescribed to 14.4%, 1.7% and 3.1% of these patients, while 28.0% of the persistent smokers reported taking no action to stop smoking since their coronary event.

Nearly nine out of ten coronary patients were aware of their weight (93.4%) and blood pressure (86.7%). However, less than half of them knew their total cholesterol (48.9%), fasting glucose (49.6%) and waist circumference (29.3%). A majority of patients had tried to change their diet since their coronary event by reducing the intake of salt (71.8%), fat (78.9%), sugar (66.1%), alcohol (53.5%) and calories (63.3%), as well as changing fat composition (71.1%) and increasing consumption of fruit and vegetables (77.8%) and fish (66.8%).

The majority of coronary patients increased their physical activity by following specific advice from a health or exercise professional (23.5%), attending a fitness club or leisure centre or joining a community walking group (52.8%), or simply increasing everyday physical activity (17.4%). However, only 38% of them (men 44.4%; women 30.2%) reported moderate or vigorous physical activity according to IPAQ categories and less than half (41.2%) undertook *regular* exercise to increase their physical fitness.

The prevalence of overweight and obesity in coronary patients was 82.1% and 37.6%, respectively. A total of 82.0% had abdominal overweight and 58.2% central obesity. Less than half (48.1%) of obese patients had followed dietary recommendations since their coronary event, 48.4% increased their regular physical activity levels to lose weight and 3.0% used appetite suppressants or other anti-obesity medications. Nearly one in five of obese patients reported never being told they were overweight. Only half of them (49.8%) tried to lose weight within the month prior to the interview and less than two-thirds (61.9%) reported considering losing weight within the next six months.

The prevalences of elevated blood pressure, LDL cholesterol and diabetes are presented in Figure 2 and *supplementary table 2*. Figures 3, 4 and 5 and *supplementary tables 3* show the therapeutic control of blood pressure, LDL-cholesterol and diabetes. The reported medication at interview is presented in Figure 6 and *supplementary table 4*. Overall, 78.1% of coronary patients were on blood pressure lowering and 86.6% on lipid lowering medications,

mainly statins (85.7%). More than nine out of ten patients were on antiplatelet medication, four-fifths on beta-blockers and three-quarters on angiotensin converting enzyme (ACE) inhibitors or angiotensin receptor blockers (ARBs).

50.7% of coronary patients were advised to participate in a cardiac prevention and rehabilitation programme and 81.3% of those advised attended at least half of the sessions. At the time of interview (one or more health professionals could be indicated) 73.0% were under the care of a cardiologist, 62.1% a general practitioner, 10.1% a diabetologist/endocrinologist, 4.5% a specialist cardiac nurse, 4.3% other professional and 5.5% reported no specialist care for their cardiac disease.

Discussion

Although there is compelling scientific evidence for prevention and rehabilitation following the development of coronary disease EUROASPIRE IV reveals a large majority of coronary patients in Europe failing to achieve the lifestyle, risk factor and therapeutic targets set by the JES guidelines.^{4,5} There is a large variation between European countries both in lifestyle and risk factor management, the use of cardioprotective medications, the provision of cardiac prevention and rehabilitation and other preventive services. Information on risk factors and management in discharge documents is incomplete, especially for lifestyles.

There is a wealth of evidence that achieving a healthier lifestyle reduces the risk of recurrent cardiovascular events in coronary patients and improves quality of life and longevity. Almost half of those who smoked before the event were still smokers at follow-up and the prevalence of smoking among these persistent smokers was highest in younger patients < 50 years, both men and women. Stopping smoking after a myocardial infarction is a really effective preventive action. ¹⁹⁻²¹ A meta-analysis of smoking cessation after a myocardial infarction showed a relative risk reduction for coronary mortality of 46% ¹⁹ and a Cochrane meta-analysis reported a 36% reduction in all cause mortality.²⁰ Yet despite this evidence less than one in five of those still smoking were advised to attend a smoking cessation clinic, and only a small minority did so. Pharmacotherapies to support smoking cessation were not widely used. All cigarette smokers with vascular disease should be professionally supported to stop smoking. In a randomised controlled trial of a nurse-led behavioural smoking intervention in high risk persistent smokers, supplemented with optional Varenicline, 51% of vascular patients had stopped smoking at 16 weeks.²¹ A specialist

smoking cessation clinic for patients with CVD achieved abstinence in one third using Varenicline, and this was associated with significant reductions in re-hospitalisation and all cause mortality after two years.²²

A majority of coronary patients in EUROASPIRE IV reported increasing physical activity levels and changing diet since hospitalisation. However, less than four out of ten achieved a physical activity level of moderate or vigorous intensity during at least 20 minutes one or more times a week. Patients should receive professional advice on healthy eating and how to safely increase their physical activity to reduce the prevalence of overweight and obesity and overall risk of CVD. In EUROASPIRE IV a majority of coronary patients were overweight or obese, many with central obesity as well, contributing to the highest prevalence of diabetes ever recorded in these surveys. Many obese patients were uninformed about their weight and nearly half did not follow any dietary recommendations or increase their physical activity levels. Many had no plans to lose weight.

In EUROASPIRE IV although information on hypertension was well recorded in discharge documents less than one third of coronary patients on blood pressure medication had reached the recommended target at that time of <130/80 mmHg. The 2012 JES Guidelines recommended a more conservative target of <140/90 mmHg (<140/80 mmHg in patients with diabetes) based on recent trial evidence ²³, but even this was not achieved by more than two-fifths of the patients despite a recent meta-analysis of trial evidence showing a reduction of systolic blood pressure by 10 mm Hg, or diastolic blood pressure by 5 mm Hg, reduces CHD events (fatal and non-fatal) by about a quarter and stroke by about one third.²⁴

Statin therapy can safely reduce the five-year incidence of coronary events, revascularisation and stroke by about one fifth per mmol/L of LDL cholesterol reduction, regardless of the starting level.²⁵ Information on dyslipidaemia was recorded in most of the patient's medical notes but at interview less than two-thirds of coronary patients had reached the conservative LDL cholesterol target of <2.5 mmol/L despite lipid-lowering therapy. Patients with a baseline LDL-cholesterol < 2.0 mmol/l will have the same proportionate reduction in CVD risk as those with higher levels ²⁶ and therefore the JES 2012 prevention guidelines recommended lowering LDL-cholesterol to ≤ 1.8 mmol/L in patients with established CVD.⁵ In EUROASPIRE IV only a fifth of those on lipid-lowering medication achieved this lower target and therefore coronary patients require more intensive cholesterol management. Self reported diabetes was found in about a quarter of these coronary patients. Glucose control in previously diagnosed diabetes was poor with just over a third achieving the JES4 target for HbA1c <6.5% and still less than half using the new JES5 target HbA1c of <7.0 mmol/L. The latter target still reduces the risk of microvascular but, to a lesser extent, macrovascular complications.²⁷⁻²⁹

Cardioprotective drug therapies are recommended in the JES4 and JES5 guidelines for CVD prevention.^{4,5} A majority of patients in EUROASPIRE IV reported taking these drug classes. Explanations for inadequate blood pressure and lipid control may include starting with a low dose and not up-titrating, not using a combination of drug therapies with different modes of action for blood pressure, and poor patient adherence. The latter is associated with higher cardiovascular event rates, all-cause mortality, and increased health care costs. ^{30,31} A meta-analysis of observational studies demonstrated that good adherence to drug therapy is associated with positive health outcomes.³² Thus, there is further potential to reduce recurrent cardiovascular events through optimizing dosages to those used in trials and promoting adherence to prescriptions.

In order to achieve healthier lifestyles, more effective risk factor management and adherence with medications patients require comprehensive prevention and rehabilitation programmes. There is compelling scientific evidence that secondary prevention and cardiac rehabilitation are effective services for patients with CHD. Meta-analyses of randomized controlled trials show that structured compared to standard care, is associated with a reduction in all-cause and cardiac mortality.³³⁻³⁵ More recently an observational analysis from the OASIS trial in acute coronary syndrome patients showed that adherence to behavioural advice (diet, exercise, and smoking cessation) was associated with a substantially lower risk of recurrent cardiovascular events.³⁶ Quitting smoking decreased the risk of myocardial infarction compared with persistent smoking (odds ratio, 0.57; 95% CI, 0.36 to 0.89), and similarly for diet and exercise adherence (odds ratio, 0.52; 95% CI, 0.4 to 0.69) compared to non-adherence. However, despite the strength of the trial and observational evidence, cardiac prevention and rehabilitation in Europe continues to be widely underused with enormous heterogeneity in service provision between countries. Overall less than half of coronary patients access such services and there are large differences in other preventive practices as well. Regrettably, these results are similar to those of EUROASPIRE III, which showed that only one-third actually attended some form of cardiac prevention and rehabilitation.³⁷ So there is considerable potential to further reduce the risk of recurrent CVD through formal

prevention and rehabilitation services. Recent studies, such as EUROACTION and EUROACTION Plus, and GlObal Secondary Prevention strategiEs to Limit (GOSPEL), provide contemporary scientific evidence for a comprehensive and sustained approach to preventive and rehabilitative care in which structured programmes achieve healthier lifestyles and more effective risk factor control compared to usual care.^{21,38,39} A health economics analysis from EUROASPIRE III showed the benefits of closing the treatment gap for prevention with an average incremental cost-effectiveness ratio (ICER) of Euro12,484 per quality-adjusted life year (QALY).⁴⁰ Therefore, all coronary patients should be offered a structured, multidisciplinary prevention and rehabilitation programme.

The results of EUROASPIRE IV are in accordance with earlier multinational surveys of secondary prevention practice conducted in Europe, United States and other parts of the world. ⁴¹⁻⁴⁵ The results of the REACH (Reduction of Atherothrombosis for Continued Health) Registry⁴¹, WHO-PREMISE (the WHO study on Prevention of Recurrences of Myocardial Infarction and Stroke)⁴², STABILITY (STabilization of Atherosclerotic plaque By Initiation of darapLadIb TherapY) trial⁴³ and PURE (The Prospective Urban Rural Epidemiology)^{44,45} demonstrated high prevalences of under treatment and poor control of cardiovascular risk factors in coronary patients in many regions of the world. These regional differences were more marked for obesity and LDL cholesterol attainment. Findings from the PURE study among 7519 patients with self-reported CVD (CHD or stroke) from 17 high, middle or low-income countries worldwide showed lower use of cardioprotective medications compared to EUROASPIRE IV, with only 25% being on antiplatelet drugs, 17% on beta-blockers, 20% on ACE inhibitors or ARBs and 15% on statins.⁴⁵

The EUROASPIRE IV survey has several limitations. First, patients were recruited from selected geographical areas and hospitals and results cannot be regarded as representative of countries. In every country at least one cardiac centre providing cardiac surgery and interventional cardiology was selected and many were academic specialist centres. Although this is a source of bias it is likely to be conservative as the standard of care in these academic centres is probably higher, and therefore results for patients seen in everyday clinical practice are likely to be poorer. The average interview rate was low at 48.7%, reflecting falling participation in medical research generally⁴⁶, but also restrictions imposed by Ethics Committees and privacy laws in different countries on the ways in which, and how often, patients can be approached. This also introduces a potential bias but non-participants are more likely to have unhealthy lifestyles and poorer risk factor control and

therefore our data are under estimating the true status of preventive cardiology practice across Europe. The main strength of the EUROASPIRE surveys is that data is based on interviews and standardized examinations, including central laboratory analyses, rather than data from medical records which are often incomplete for risk factor recording. Therefore, this survey provides high quality comparative information on preventive care.

Conclusions

EUROASPIRE IV continues to show that implementation of evidence based guidelines on secondary prevention is far from optimal with high prevalences of smoking, especially among younger coronary patients, obesity, central obesity and diabetes. Although, most patients are receiving cardioprotective drugs therapeutic targets for risk factors are not being achieved in far too many patients. Less than half of all coronary patients benefit from cardiac prevention and rehabilitation.

A new approach to cardiovascular prevention is required which integrates cardiac rehabilitation and secondary prevention into modern preventive cardiology programmes with appropriate adaptation to medical and cultural settings in each country. Preventive cardiology should involve multidisciplinary teams of health care professionals, focussing on lifestyles of patients and their families, in order to achieve the lifestyle, risk factor, and therapeutic targets for coronary and other vascular patents which will reduce their risk of recurrent CVD events, improve quality of life and survival.

Supplementary Material

Supplementary Material is available at European Heart Journal online

Statement of responsibility

The authors had full access to the data and took responsibility for its integrity. All authors have read and agreed to the written manuscript.

Funding

The EUROASPIRE IV survey was carried out under the auspices of the European Society of Cardiology, EURObservational Research Programme. The survey was supported through unrestricted research grants to the European Society of Cardiology from AstraZeneca, Bristol-Myers Squibb/ Emea Sarl, GlaxoSmithKline, F. Hoffman-La Roche (Gold Sponsors), Merck, Sharp & Dohme and Amgen (Bronze Sponsors). 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.

Acknowledgements

The EUROASPIRE Study Group is grateful to the administrative staff, physicians, nurses, and other personnel in the hospitals in which the survey was carried out and to all patients who participated in the surveys.

Conflict of interest

All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf and declare that (1) KK, DDB, CJ, VG, LR and DW had grand support from the European Society of Cardiology for the submitted work; VG was supported by a grant from the Swedish Heart and Lung Foundation; AP was supported by a grant from Polish National Science Centre (Contract DEC-2011/03/B/N27/06101); JB was supported by the grant No NT 13186 by the Internal Grant Agency, Ministry of Health, Czech Republic; DM had grants from Servier, MSD, Sanofi-Aventis, Menarini; PA had grant from AstraZeneca; SS had grants from German Ministry of Research and Education via the Comprehensive Heart Failure Center, University of Würzburg; (2) DW, LR, KK, VG, PA, MD, MS, PH, RC, AE, DG, ZR, LT had the following financial activities outside the submitted work in the previous 3 years: DW, honoraria for invited lectures or advisory boards: AstraZeneca, Merck Sharp and Dohme, Kowa Pharmaceuticals, Menarini, Zentiva; consultancy: Merck Sharp and Dohme; LR, grants from Swedish Heart Lung Foundation, Swedish Diabetes Association, Roche AG, Bayer AG and Karolinska Institute Funds, personal fees from Roche, SanofiAventis, and Bayer AG; KK, travel grants from Roche and Boehringer Ingelheim; VG, lecture fees from MSD Sweden; PA had grants and personal fees from Fondation Plan Alzheimer, Servier, Alzprotect, Total, Hoffman Roche, Daichi Sankyo, Genoscreen; MD, grants from Universal Agency "Profarma", MS was temporarily employed

by MSD Sweden AB as associate Director, medical affairs, during part of the study period; PH receives/ received in the recent years research support from the German Ministry of Research and Education (Center for Stroke Research Berlin; Comprehensive Heart Failure Center Würzburg), the European Union (European Implementation Score Collaboration), the German Stroke Foundation, the Charité - Universitätsmedizin Berlin, the Berlin Chamber of Physicians, and the University Hospital of Würzburg; RC had grants from Krka, Novo Mesto, Slovenia, personal fees from Servier International, Medtronic, Medtronic Czechia, Abbott Products Operations AG, MSD Czech Republic, TEVA Pharmaceuticals Czech Republic; ZR had personal fees from Sanofi, AstraZeneca, Abbott, and Aegirion; AE had grants and personal fees from Abbott Vascular, Boston Scientific, Biosensors, Biotronik, Cordis J&J, Medtronik; DG had personal fees from AstraZaneca, Abbott , Novartis and Sanofi, LT had lecture honoraria from Abbott, MSD, Bayer, AstraZaneca, Boehringer Ingelheim, Pfizer, Sanofi, Servier, Kowa and Actelion, and (3) ACC, JWD, JDS, MD, ZF, DL, NG, AL, DL, EN, RO, NP, DV have no financial interests that are relevant to the submitted work.

References

- [1] Pyörälä K, De Backer G, Graham I, Poole-Wilson PA, Wood D. Prevention of coronary heart disease in clinical practice. Recommendations of the Task Force of the European Society of Cardiology, European Atherosclerotic Society and European Society of Hypertension. *Eur Heart J* 1994; 15: 1300-31.
- [2] Wood D, De Backer G, Faergeman D, Graham I, Mancia G. Pyörälä K. Prevention of coronary heart disease in clinical practice. Recommendations of the Second Joint Task Force of European and other Societies on coronary prevention. *Eur Heart J* 1998; 19: 1434-503, doi: 10.1053/euhj.1998.1243.
- [3] De Backer G, Ambrosioni E, Borch-johnsen K, Brotons C, Cifkova R, Dallongeville J, Ebrahim S, Faergeman O, Graham I, Mancia G, Manger Cats V, Orth-Gomér K, Perk J, Pyörälä K, Rodicio J L, Sans S, Sansoy V, Sechtem U, Silber S, Thomsen T, Wood D. European guidelines on cardiovascular disease prevention in clinical practice. Third Joint Task Force of European and other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of eight societies and by invited experts). *Eur J Cardiovasc Prev Rehabil* 2003; 10 (Suppl 1): S1-S78.

- [4] Graham I, Atar D, Borch-Johnsen K, Boysen G, Burell G, Cifkova R, Dallongeville J, De Backer G, Ebrahim S, Gjelsvik B, Herrmann-Lingen C, Hoes A, Humphries S, Knapton M, Perk J, Priori S, Pyorala K, Reiner Z, Ruilope L, Sansk-Mendez S, Op Reimer WS, Weissberg P, Wood D, Yarnell J, Zamorano JL. European Guidelines on Cardiovascular Disease Prevention in Clinical Practice: Fourth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (Constituted by representatives of nine societies and by invited experts). *Eur J Cardiovasc Prev Rehabil* 2007; **14** (Suppl 2): S1-S113.
- [5] Perk J, De Backer G, Gohlke H, Graham I, Reiner Ž, Verschuren W M M, Albus C, Benlian P, Boysen G, Cifkova R, Deaton C, Ebrahim S, Fisher M, Germano G, Hobbs R, Hoes A, Karadeniz S, Mezzani A, Prescott E, Ryden L, Scherer M, Syvänne M, Scholte Op Reimer WJM, Vrints C, Wood D, Zamorano JL, Zannad F. European Guidelines on cardiovascular disease prevention in clinical practice (version 2012). The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts). Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2012; 33: 1635-701.
- [6] EUROASPIRE Study Group. EUROASPIRE. A European Society of Cardiology survey of secondary prevention of coronary heart disease: Principal results. *Eur Heart J* 1997; 18; 1569-82.
- [7] EUROASPIRE Study Group. Lifestyle and risk factor management and use of drug therapies in coronary patients from 15 countries. Principal results from EUROASPIRE II. Euro Heart Survey Programme. *Eur Heart J* 2001; 22: 554-72.
- [8] EUROASPIRE Study Group. Clinical reality of coronary prevention guidelines: a comparison of EUROASPIRE I and II in nine countries. *Lancet* 2001; **357**: 995-1001.
- [9] Kotseva K, Wood D, De Backer G, De Bacquer D, Pyorala K, Keil U, on behalf of EUROASPIRE III Study Group. EUROASPIRE III: a survey on the lifestyle, risk factors and use of cardioprotective drug therapies in coronary patients from 22 European countries. *Eur J Cardiovasc Prev Rehabil* 2009; 16: 121-37.
- [10] Kotseva K, Wood D, De Backer G, De Bacquer D, Pyorala K, Keil U, on behalf of EUROASPIRE Study Group. Cardiovascular prevention guidelines in daily practice: a

comparison of EUROASPIRE I, II, and III surveys in eight European countries. *Lancet* 2009; **373**: 929-40.

- [11] Bartnik M, Ryden L, Ferrari R, Malmberg K, Pyorala K, Simoons M, Standl E, Soler-Soler J, Ohrvik J. The prevalence of abnormal glucose regulation in patients with coronary artery disease across Europe. The Euro Heart Survey on diabetes and heart. *Eur Heart J* 2004;25:1880-90.
- [12] Lenzen M, Rydén L, Ohrvik J, Bartnik M, Malmberg K, Scholte Op Reimer W, Simoons M. Diabetes known or newly detected, but not impaired glucose regulation, has a negative influence on 1-year outcome in patients with coronary artery disease: a report from the Euro Heart Survey on Diabetes and the Heart. *Eur Heart J* 2006; 27: 2969–74.
- [13] Anselmino M, Bartni M, Öhrvik J, Rydén L. The Euro Heart Survey on Diabetes and the Heart. Intern Diabetes Monitor 2010; 22: 1-9.
- [14] Rydén L, Standl E, Bartnik M, Van den Berghe G, Betteridge J, de Boer MJ, Cosentino F, Jonsson B, Laakso M, Malmberg K, Priori S, Östergren J, Tuomilehto J, Thrainsdottir I. Guidelines on diabetes, pre-diabetes, and cardiovascular diseases. The Task Force on Diabetes and Cardiovascular Diseases of the European Society of Cardiology (ESC) and of the European Association for the Study of Diabetes (EASD). *Eur Heart J* 2007; 28:88-136.
- [15] Lean MEJ, Han TS, Morrison CE. Waist circumference as a measure for indicating need for weight management. *BMJ* 1995; **311**: 158-61.
- [16] Middleton ET, Morice AH. Breath carbon monoxide as an indication of smoking habit. *Chest* 2000; **117**: 758-63.
- [17] Friedewald WT, Levy RI, Fredrickson DS. Estimation of the concentration of lowdensity lipoprotein cholesterol in plasma, without use of the preparative ultracentrifuge. *Clin Chem* 1972; 18: 499-502
- [18] Sjöström M, Bull F, Craig C, for the IPAQ Committees (2002). Towards standardized global assessment of health-related physical activity the International Physical Activity Questionnaire (IPAQ). Med Sci Sports Exerc; 33.
- [19] Wilson K, Gibson N, Willan A, Cook D. Effect of smoking cessation on mortality after myocardial infarction: meta-analysis of cohort studies. *Arch Intern Med* 2000;160:939-44.
- [20] Chritchley J, Capewell S. Mortality risk reduction associated with smoking cessation in patients with coronary heart disease: A Systematic Review. JAMA 2003; 290:86-97.

- [21] Jennings C, Kotseva K, DeBacquer D, Hoes A, de Velasco J, Brusaferro S, Mead A, Jones J, Tonstad S, Wood D, on behalf of EUROACTION PLUS Study Group. Effectiveness of a preventive cardiology programme for high CVDrisk persistent smokers: the EUROACTION PLUS Varenicline trial. *Eur Heart J*, doi:10.1093/eurheartj/ehu051
- [22] Rigotti NA, Munafo MR, Stead LF. Smoking cessation interventions for hospitalized smokers: a systematic review. *Arch Intern Med* 2008; 168: 1950-60.
- [23] Mancia G, Fagard R, Narkiewicz K, Redon J, Zanchetti A, Böhm M, Christiaens T, Cifkova R, De Backer G, Dominiczak A, Galderisi M, Grobbee DE, Jaarsma T, Kirchhof P, Kjeldsen S, Laurent S, Manolis, AJ, Nilsson PM, Ruilope LM, Schmieder RE, Sirnes PA, Sleight P, Viigimaa M, Waeber B, Zannad F. ESH/ESC Guidelines for the management of arterial hypertension. The Task Force for the management of arterial hypertension of the European Society of Hypertension (ESH) and of the European Society of Cardiology (ESC). *Eur Heart* 2013; 34: 2159-2219.
- [24] Law MR, Morris JK, Wald NJ. Blood pressure lowering drugs in the prevention of cardiovascular disease: meta-analysis of 147 randomised trials in the context of expectations from prospective epidemiological studies. *BMJ* 2009;338;b1665;
- [25] Cholesterol Treatment Trialists' (CTT) Collaboration. Efficacy ant safety of cholesterol=lowering treatment: prospective meta-analysis of data from 90 056 participants in 14 randomised trials of statins. *Lancet* 2005; 366: 1267-78.
- [26] Cholesterol Treatment Trialists' (CTT) Collaboration. Efficacy and safety of more intensive lowering of LDL cholesterol: a meta-analysis of data from 170 000 participants in 26 randomised trials. *Lancet* 2010; 376: 1670–81.
- [27] Ryden L, Grant P, Anker S, Berne C, Cosentino F, Danchin N, Deaton C, Escaned J, Hammes HP, Huikuri H, Marre M, Marx N, Mellbin L, Ostergren J, Patrono C, Seferovic P, Uva MS, Taskinen MR, Tendera M, Tuomilehto J, Valensi P, Zamorano JL. ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD. The task force on diabetes, pre-diabetes, and cardiovascular diseases of the European Society of Cardiology (ESC) and developed in collaboration with the European Association for the Study of Diabetes (EASD). *Eur Heart J* 2013 doi:10.1093/eurheartj/eht108
- [28] Turnbull FM, Abraira C, Anderson RJ, Byington RP, Chalmers JP, Duckworth WC, Evans GW, Gerstein HC, Holman RR, Moritz TE, Neal BC, Ninomiya T, Patel AA, Paul

SK, Travert F, Woodward M. Intensive glucose control and macrovascular outcomes in type 2 diabetes. *Diabetologia* 2009;52:2288–2298.

- [29] Kelly TN, Bazzano LA, Fonseca VA, Thethi TK, Reynolds K, He J. Systematic review: glucose control and cardiovascular disease in type 2 diabetes. *Ann Intern Med* 2009;151:394–403.
- [30] Ho PM, Magid DJ, Shetterly SM, Olson KL, Maddox TM, Peterson PM, Masoudi FA, Rumsfeld JS. Medication nonadherence is associated with a broad range of adverse outcomes in patients with coronary artery disease. *Am Heart J* 2008; 155:772-779.
- [31] Rasmussen JN, Chong A, Alter DA. Relationship between adherence to evidencebased pharmacotherapy and long-term mortality after acute myocardial infarction. JAMA 2007; 297:177.
- [32] Simpson SH, Eurich DT, Majumdar SR, Padwal RS, Tsuyuki RT, Varney J, Johnson JA. A meta-analysis of the association between adherence to drug therapy and mortality. *BMJ* 2006;333:15 (38875.675486.55; doi: 10.1136/bmj.38875.675486.55)
- [33] Heran BS, Chen JM, Ebrahim S, Moxham T, Oldridge N, Rees K, Thompson DR, Taylor RS. Exercise-based cardiac rehabilitation for coronary heart disease. *Cochrane Database Syst Rev (Online)*. 2011; (7): CD001800.
- [34] Taylor RS, Brown A, Ebrahim S, Jolliffe J, Noorani H, Rees K, Skidmore B, Stone JA, Thompson DR, Oldridge N. Exercise-based rehabilitation for patients with coronary heart disease: systematic review and meta-analysis of randomized controlled trials. *Am J Med* 2004; **116**: 682-92.
- [35] Clark AM, Hartling L, Vandermeer B, McAlister FA. Meta-analysis: secondary prevention programs for patients with coronary artery disease. *Ann Intern Med* 2005; 143: 659-72.
- [36] Chow CK, Jolly S, Rao-Melacini P, Fox KAA, Anand SS, Yusuf S. Association of Diet, Exercise, and Smoking Modification With Risk of Early Cardiovascular Events After Acute Coronary Syndromes. *Circulation* 2010; **121**: 750-8.
- [37] Kotseva K, Wood D, De Backer G, De Bacquer D. Use and effects of cardiac rehabilitation in patients with coronary heart disease: results from the EUROASPIRE III survey. *Eur J Prev Cardiology* 2012 (June 18). doi:10.1177/2047487312449591
- [38] Wood DA, Kotseva K, Connolly S, Jennings C, Mead A, Jones J, Holden A, De Bacquer D, Collier T, De Backer G, Faergeman O, on behalf of EUROACTION Study Group. Nurse-coordinated multidisciplinary, family-based cardiovascular disease prevention programme (EUROACTION) for patients with coronary heart disease and

asymptomatic individuals at high risk of cardiovascular disease: a paired, clusterrandomised controlled trial. *Lancet* 2008; **371**: 1999-2012.

- [39] Giannuzzi P, Temporelli PL, Marchioli R, Maggioni AP, Balestroni G, Ceci V, Chieffo C, Gattone M, Griffo R, Schweiger C, Tavazzi L, Urbinati S, Valagussa F, Vanuzzo D, for the GOSPEL Investigators. Global secondary prevention strategies to limit event recurrence after myocardial infarction: results of the GOSPEL study, a multicenter, randomized controlled trial from the Italian Cardiac Rehabilitation Network. *Arch Intern Med* 2008; **168**: 2194-204.
- [40] De Smedt D, Kotseva K, De Bacquer D, Wood D, De Backer G, Dallongeville J, Lehto S, Pajak A, Reiner Z, Vanuzzo D, Georgiev B, Gotcheva N, Annemans L. Costeffectiveness of optimizing prevention in patients with coronary heart disease: the EUROASPIRE III health economics project. *Eur Heart J* 2012; **33**: 2865-72.
- [41] Mehta RH. Bhatt DL. Steg PG. Goto S. Hirsch AT. Liau CS. Rother J. Wilson PW. Richard AJ. Eagle KA. Ohman EM. REACH Registry Investigators. Modifiable risk factors control and its relationship with 1 year outcomes after coronary artery bypass surgery: insights from the REACH registry. *Eur Heart J* 2008; 29:3052-60.
- [42] Mendis S, Abegunde D, Yusuf S, Ebrahim S, Shaper G, Ghannem H, Shengelia B(WHO-PREMISE (Phase I) Study Group). Bulletin World Health Organization 2005; 83: 820-828.
- [43] Vedin O, Hagstrom E, Stewart R, Brown R, Krug-Gourley S, Davies R, Wallentin L, White H, Held C. Secondary prevention and risk factor target achievement in a global, high-risk population with established coronary heart disease: baseline results from the STABILITY study. *Eur J Prev Cardiology* 2013; 20: 678-85.
- [44] Teo K. Lear S. Islam S. Mony P. Dehghan M. Li W. Rosengren A. Lopez-Jaramillo P. Diaz R. Oliveira G. Miskan M. Rangarajan S. Iqbal R. Ilow R. Puone T. Bahonar A. Gulec S. Darwish EA. Lanas F. Vijaykumar K. Rahman O. Chifamba J. Hou Y. Li N. Yusuf S. PURE Investigators. Prevalence of a healthy lifestyle among individuals with cardiovascular disease in high-, middle- and low-income countries: The Prospective Urban Rural Epidemiology (PURE) study. JAMA 2013;309:1613-21.
- [45] Yusuf S, Islam S, Chow CK, Rangarajan S, Dagenais G, Diaz R, Gupta R, Kelishadi R, Iqbal R, Avezum A, Kruger A, Kutty R, Lanas F, Lisheng L, Wei L, Lopez-Jaramillo P, Oguz A, Rahman O, Swidan H, Yusoff K, Zatonski W, Rosengren A Teo KK. Prospective Urban Rural Epidemiology (PURE) Study Investigators. Use of secondary prevention drugs for cardiovascular disease in the community in high-income, middle-

income, and low-income countries (the PURE Study): a prospective epidemiological survey. *Lancet* 2011; **378**: 1231-43.

[46] Galea S, Tracy M. Participation Rates in Epidemiologic Studies. Ann Epidemiol 2007;17:643–653.

Appendix

EUROASPIRE was originally an initiative of the ESC Working Group on Epidemiology and Prevention and the first EUROASPIRE survey was undertaken as part of work of the Joint ESC/EAS/ESH Implementation Group on Coronary Prevention. The structure of the administrative organisation is described below followed by a list of participating study centres and organisations, and investigators and other research personnel.

Writing Committee: K Kotseva, D Wood, D De Bacquer, G De Backer, L Ryden, C Jennings, V Gyberg

Scientific Steering/ Expert Committees:

K Kotseva (London, UK, Chair EUROASPIRE IV Steering Committee), G De Backer (Ghent, Belgium, Chair EUROASPIRE IV Executive Committee), P Amouyel (Lille, France), J Bruthans (Prague, Czech Republic), A Castro Conde (Madrid, Spain), R Cifkova (Prague, Czech Republic), D De Bacquer (Ghent, Belgium), J De Sutter (Ghent, Belgium), J W Deckers (Rotterdam, Netherlands), M Dilic (Sarajevo, Bosnia and Herzegovina), M Dolzhenko (Kiev, Ukraine), A Erglis (Riga, Latvia), T Ferreira (Nice, France), Z Fraz (Ljubljana, Slovenia), D Gaita (Timisoara, Romania), S Gielen (Halle/Wittenberg, Germany), N Gotcheva (Sofia, Bulgaria), I Goudevenos (Ioannina, Greece), V Gyberg (Stockholm, Sweden), P Heuschmann (Würzburg, Germany), A Laucevicius (Vilnius, Lithuania), S Lehto (Kuopio, Finland), D Lovic (Nis, Serbia), M Manini (Nice, France), A P Maggioni (Florence, Italy), D Miličić (Zagreb, Croatia), D Moore (Dublin, Ireland), E Nicolaides (Nicosia, Cyprus), A Pajak (Cracow, Poland), N Pogosova (Moscow, Russia), Ž Reiner (Zagreb, Croatia), L Rydén (Stockholm, Sweden), O Schnell (Munich Neuherberg, Germany), M Stagmo (Malmo, Sweden), S Störk (Würzburg, Germany), J Sundvall (Helsinki, Finland), L Tokgözoğlu (Ankara, Turkey), J Tuomilehto (Helsinki, Finland), D Vulic (Banja Luka, Bosnia and Herzegovina), D Wood (Principal Investigator, London, UK).

Coordinating centre: Cardiovascular Medicine, International Centre for Circulatory Health, National Heart and Lung Institute, Medical Faculty, Imperial College London, London, UK: D A Wood, K Kotseva, C Jennings, A Adamska.

Diabetes centre: Department of Cardiology, Karolinska University Hospital, Stockholm,

Sweden: L Rydén, V Gyberg, J Tuomilehto, O Schnell.

Data management centre: EURObservational Research Programme Department, European Heart House, Sophia Antipolis, Nice, France: A Maggioni, T Ferreira, M Manini, C Taylor, M Konte, M Glemot

Computing and statistical centre Department of Public Health, Ghent University, Belgium: D De Bacquer, G De Backer.

Central laboratory: Disease Risk Unit, National Institute for Health and Welfare, Helsinki, Finland: J Sundvall, L Lund, J Leiviskä.

Study centres, organisations, investigators and other research personnel (National Coordinators in each country are indicated by apteryx):

Belgium University Hospital Ghent: D De Bacquer*, G De Backer, M De Pauw, C Ghysbrecht, P Vervaet; A Z Maria Middelares: J De Sutter*, S Pardaens, A M Willems; A Z Sint Lucas: P Cambier, R Claeys, N Deweerdt, J Nimmegeers, H Vandekerckhove, H Verloove, L Versee.

Bosnia and Herzegovina Center for Medical Research and Develoment Health Care, Banja Luka: D Vulic *, D Djekic. Clinical Center, Banja Luka: G Malesevic, S Pejicic, S Srdic; Clinical Center University of Sarajevo: M Dilic*, A Begic, E Hodzic, M Kulic, N Sabanovic-Bajramovic, E Tahirovic; University Clinical Center of Tuzla: I Iveljic, J Kovcic, Z Kusljugic, M Nurkic.

Bulgaria National Heart Hospital, Sofia: N Gotcheva*, V Baycheva, B Georgiev, G Vladimirov; Military Medical Academy: D Gotchev, S Ivanov.

Croatia University Hospital Centre Zagreb, University of Zagreb School of Medicine: Ž Reiner*, D Miličić *, J Samardžić; University Hospital Centre Sestre Milosrdnice, Zagreb: B Perić; University Hospital Dubrava, Zagreb: M Sičaja. *Cyprus* Nicosia General Hospital: E Nicolaides*, C Eftychiou, N Eteocleous, P Georgiou, C Hadjilouca, J A Moutiris, R Nicolaou, K Papadopoulos, M Patsalou.

Czech Republik Center for Cardiovascular Prevention, Charles University in Prague, First Faculty of Medicine and Thomayer Hospital, Prague: J Bruthans*, R Cífková*, A Krajcoviechova, P Wohlfahrt; Department of Internal Medicine II, Faculty of Medicine in Pilsen, Charles University, Pilsen: J Filipovský, M Krizek, Z Kviderova, O Mayer, P Vágovičová, J Vanek, J Seidlerova, K Timoracká; Department for Preventive Cardiology, Institute of Clinical and Experimental Medicine, Prague: V Adamkova, J Belohoubek, M Galovcova, V Zelenkova.

Finland Kuopio University Hospital: S Lehto*, E Kiljander, P Kiljander, P Kylmaoja H R Lehto, S Olkkonen; Iisalmi Hospital: J Pennanen; Varkaus Hospital: M Herranen.

France Institut Pasteur de Lille, Inserm U744, Université Lille Nord de France: P Amouyel*, A L Astolfi , S Balik, S Beauchant , J Dallongeville, C Devoghelaere , N Fievet , P Garboni, B Lemaire, N Marecaux, M Montaye ; Hopital Saint Philibert, Lomme; Hopital Cardiologique, CHRU, Lille; Centre Hospitalier Gustave Dron, Tourcoing; Hopital Victor Provo, Roubaix.

Germany Klinik Kitzinger Land: W Karmann, S Held. University of Würzburg: P Heuschmann*, K Eichstädt, L Deckert, D Fischer, A Gerhardt, J Kircher, Y Memmel, K Nolte, M Schich, V Wahl, M Wagner; University Hospital Würzburg: S Störk*, G Ertl, S Güntner, R Leyh.

Greece Ioannina University Hospital: J Goudevenos*, K Kalantzi. Athens Euroclinic: D Athanassias, G Goumas, P Krimbas, D Richter, D Sakellariou; Alexandra Hospital: J Agrios, I Matthaios, E Papadopoulou, S Toumanidis, E Tsouna-Hatjis; AHEPA Hospital, Aristotle University: A Boufidou, K Makedou, L Lilis.

Ireland Tallaght Hospital: D Moore*, G Broderick, N Fallon, S Storey.

Latvia Daugavpils Regional Hospital: I Baronenko, G Dormidontova, A Dulkevica, V Dzerve; Pauls Stradins Clinical University Hospital: A Erglis*, T Andrejeva, N Bricina, J

Jakovleva, A Jaunromane, E Keive, M Klovane, D Lurina, L Makarova, D Matisone, I Mintale, E Pahomova-Strautina, L Putane, M Stabulniece, D Vasiljevs, G Vevere, J Vilks.

Lithuania Vilnius University Hospital Santariskiu Klinikos: A Laucevicius*, I Alitoit, J Badariene, I Grabliauskaite, I Jursyte, E Paleviciute, Z Petrulioniene, P Serpytis, R Serpytis, S Solovjova, V Smagriunaite; Hospital of Lithuanian Health Science University: R Babarskiene, I Ceponiene, O Gustiene, R Karaliute, E Rumbinaite, R Slapikas, V Smalinskas, R Verseckaite.

Poland Department of Epidemiology and Population Studies, Institute of Public Health, Jagiellonian University Medical College, Kraków: A Pająk*, E. Brzezicka, R Łysek, W Misiowiec, R Wolfshaut-Wolak; Department of Coronary Disease, Institute of Cardiology, Jagiellonian University Medical College, John Paul II Hospital: J Nessler; Department of Cardiac and Vascular Diseases, Institute of Cardiology, Jagiellonian University, Medical College, John Paul II Hospital: P Podolec; Department of Cardiology, J. Dietl Hospital, Kraków: E Mirek-Bryniarska; Department of Cardiology, Narutowicz City Specialty Hospital, Kraków: J Grodecki; 1st Department of Cardiology and Hypertension, Jagiellonian University Medical College, Kraków: D Czarnecka, A Łukaszewska, P Jankowski; Department of Cardiology, Ludwik Rydygier Memorial Specialized Hospital, Kraków: P Bogacki.

Romania Universitatea de Medicina si Farmacie "V. Babes" Timisoara; Institutul de Boli Cardiovasculare Timisoara: D Gaita*, C Avram, E Barzuca, L Gaita, F Jurca-Simina, O C Iancu, A Lazar, M Iurciuc, S Iurciuc, M Mal, S Mancas, A Mihaescu, D Mociar, S Mosteoru , S Pescariu, L Petrescu, C Sasec, A Schiller; Universitatea de Medicina si Farmacie "C. Davila" Bucuresti; Spitalul Universitar de Urgenta Bucuresti: L Amarie, A Andronic, S Calin , A Ciobanu, A Cotoban, S Guberna, L Lungeanu, D Mihalcea, N Niculescu, R Rimbas, C Udroiu, D Vinereanu.

Russia National Research Centre for Preventive Medicine, Moscow: N Pogosova*, A Ausheva, S Boytsov, A Kursakov, R Oganov. Moscow Regional Cardiological Centre: Y Pozdnyakov, N Skazin.

Serbia Clinic for internal disease InterMedica, Nis: D Lovic*, B Lovic, M Nedeljkovic, M Ostojic; Cardiopulmonary Rehabilitation Clinical Centre Niska Banja: D Djordjevic, S Kostic, I Tasic; University Hospital Medical Center "Bezanijska Kosa", Belgrade: M Zdravkovic; Institute for Rehabilitation, Belgrad: M Anđić, T Filipović, O Ilić-Stojanović, M Ješić-Jukić, N Jevsnik, M Lazović, A Radović, D Radović, D Rosić, D Spiroski, S Stevović, T Vidaković, V Vuković-Dejanović.

Slovenia University Medical Centre, Division of Internal Medicine, Ljubljana: Z Fras*, B Jug, A Juhant, A Poljancic, L Poljancic.

Spain Hospital la Paz - Hospital Cantoblanco, Madrid: A Castro Conde*, R Dalmau Gonzalez-Gallarza, A M Iniesta Manjavacas.

Sweden Skane University Hospital, Malmo: M Stagmo*, H Jernhed, E Stensgaard; Karolinska Hospital, Stockholm: V Gyberg*, V Boström, C Edman Jönsson, C Hage.

The Netherlands Thorax Centre, ERASMUS MC, Rotterdam: J W Deckers*, S. Khatibi F, Yongzhao; Sint Franciscus Gasthuis, Rotterdam: M. Veerhoek; Maasstadziekenhuis, Rotterdam: P C Smits; Academic Medical Centre, University of Amsterdam, Amsterdam: M Minneboo, R J G Peters, W Scholte op Reimer, M Snaterse-Zuidam.

Turkey Hacettepe Üniversitesi Tıp Fakültesi: L Tokgözoğlu*, S Asil, B Kaya, D Koçyiğit; Ankara Üniversitesi Tıp Fakültesi: Ç Erol, V Kozluca, C Tulunay Kaya; İzmir Atatürk Eğitim ve Araştırma Hastanesi: İ Akyıldız, O Ergene, E Varış; Dokuz Eylül Üniversitesi Tıp Fakültesi: B Akdeniz, Ö Göldeli, Ö Kozan, E Özpelit; Dr.Siyami Ersek Hastanesi Göğüs Kalp Cerrahi Merkezi: S Altay, N Çam, M Eren; Ege Üniversitesi Tıp Fakültesi: M Kayıkçıoğlu, H Kültürsay; Florance Nightingale Hospital: V Aytekin, A Burak Çatakoğlu; Gazi Üniversitesi Tıp Fakültesi: A Abacı, M Candemir, S Ünlü; Göztepe Eğitim Araştırma Hastanesi: A Oğuz; Gülhane Askeri Tıp Akademisi-ANKARA: C Barçın, S Yaşar, M Yokuşoğlu; Türkiye Yüksek İhtisas Hastanesi: S Aydoğdu, A Temizhan, S Ünal; İstanbul Üniversitesi Cerrahpaşa Tıp Fakültesi: H Altuğ Çakmak, M Çimci, Z Öngen; Gebze Anadolu Sağlık Merkezi: G Ateş, N Koylan; İstanbul Üniversitesi İstanbul Tıp Fakültesi: S Emet, B Umman; İstanbul Üniversitesi Kardiyoloji Enstitüsü: C Bostan, V Sansoy; İstanbul M.Akif Ersoy Kalp Eğitim ve Araştırma Hastanesi: M Kemal Erol, A Kemal Kalkan; İstanbul Kartal Koşuyolu Eğitim ve Araştırma Hastanesi: C Kaymaz, N Poçi.

Ukraine National Scientific Center "M.D. Strazhesko Institute Of Cardiology, MAS of Ukraine": M Dolzhenko*, T Getman, L Konoplyanik, L Klimenko, L Lobach, Y Luchinskaya, L Lurie, M Lutay, E Mitchenko, O Nemchena, N Nosenko, N Perepelchenko, S Potashev, A Radchenko, V Romanov, V Shumakov, T Simagina Y Sirenko, O Sychov. Kiev City Heart Centre: N Mohnacheva, A Verezhnikova, O Zharinov; SI "The Institute of Gerontology named after D.F.Chebotarev NAMS of Ukraine": V Lishnevskaya, I Mikropulo, V Prihodko, I Shapovalenko.

United Kingdom ICCH, Imperial College London: D Wood*, A Adamska, J Evans, K Ioannides, C Jennings, A Kasonta, K Kotseva, H Onyango, A Rapacz, B Wrotniak; Hillingdon Hospital, Middlesex: S Dubrey; Harefield Hospital, Middlesex: M Barbir; Charing Cross Hospital, London: S Connolly; Central Middlesex Hospital, London: M Dancy; Royal Brompton Hospital, London: P Collins; West Middlesex Hospital, Isleworth: R Kaprielian.

Figure legends

Figure 1. Prevalence (%) of smoking*, persistent smoking**, overweight[†], obesity[†][†], abdominal overweight[‡] and central obesity[‡][‡] by sex *at interview*

* Smoking: self-reported smoking or > 10 ppm carbon monoxide in breath; **Persistent smoking: self-reported smoking or > 10 ppm carbon monoxide in breath in patients reporting to have been smoking in the month prior to the index event; †Overweight: body mass index $(BMI) \ge 25 \text{ kg/m}^2$; ††Obesity: $BMI \ge 30 \text{ kg/m}^2$; ‡Abdominal overweight: waist circumference $\ge 80 \text{ cm}$ for women and $\ge 94 \text{ cm}$ for men; ‡‡Central obesity: waist circumference $\ge 88 \text{ cm}$ for women and $\ge 102 \text{ cm}$ for men.

Figure 2. Prevalence (%) of elevated blood pressure (BP), raised LDL-cholesterol (LDL-C) and self-reported diabetes by sex *at interview*

Figure 3. Proportions (%) at blood pressure target (<130/80 mmHg, <140/90 mmHg, <160/100 mmHg) in patients on blood pressure lowering medication) by sex *at interview*

Figure 4. Proportions (%) at LDL-cholesterol target (<1.8 mmol/L, <2.0 mmol/L, <2.5 mmol/L, <3.0 mmol/L} in patients on lipid lowering medication by sex *at interview*

Figure 5. Glycaemic control (HbA1c, %) in people with history of diabetes (glycaemic control: HbA1c <6.1%, <6.5%, <7.0%, <8.0%, <9.0%)

Figure 6. Reported cardioprotective medication (%) by sex at interview

| | Interview, % | | |
|-----------------------------------|--------------|------------|--------------|
| | No | Yes | |
| | N=4357 | N=7998 | Significance |
| Age at index event mean (SD) | 62 1 (10 5) | 62 5 (9 6) | P-0.26 |
| Women, % | 28.5 | 24.4% | P<0.0001 |
| | | | |
| | | | |
| Information from discharge letter | | | |
| Smoking, % | 37.7 | 26.2 | P<0.0001 |
| Obesity, % | 31.7 | 33.8 | P=0.07 |
| Hypertension, % | 75.4 | 78.6 | P=0.0002 |
| Hyperlipidaemia, % | 72.1 | 74.2 | P=0.02 |
| Abnormal glucose metabolism, % | 34.2 | 28.2 | P<0.0001 |
| Aspirin/antiplatelets, % | 96.4 | 98.0 | P<0.0001 |
| Beta-blockers, % | 82.1 | 86.3 | P<0.0001 |
| ACE Inhibitors, % | 60.2 | 64.9 | P<0.0001 |
| AT II receptor antagonists, % | 10.7 | 12.0 | P=0.04 |
| Diuretics, % | 29.7 | 29.7 | P=0.99 |
| Statins, % | 87.5 | 90.0 | P<0.0001 |
| | | | |

Table 1. Characteristics of interviewed patients by age, sex and information on CVDrisk factors and medication from discharge letters

* excluding patients that have died or moved











