European Society of Cardiology: Cardiovascular Disease Statistics 2017

On behalf of the Atlas Writing Group

Atlas is a compendium of cardiovascular statistics compiled by the European Heart Agency, a department of the European Society of Cardiology

Developed in collaboration with the national societies of the European Society of Cardiology member countries

Authors: Timmis A[1] (Chair Writing Group, UK), Townsend N[2] (United Kingdom), Gale CP[3] (UK), Grobbee DE[4] (NL), Maniadakis N[5] (GR), Flather M[6] (UK), Wilkins E[2] (UK), Wright FL[2] (UK), Vos RC[4] (NL), Bax JJ[7] (NL), Blum M[5] (RO), Pinto F[8] (PT), Vardas P[5] (GR)

Affiliations:
[1]Barts Heart Centre and Queen Mary University London, UK
[2]Nuffield Department of Population Health, University of Oxford, UK
[3]Medical Research Council Bioinformatics Centre, Leeds Institute for Cardiovascular and Metabolic Medicine, University of Leeds, UK
[4]Dept of Clinical Epidemiology, University Medical Center Utrecht, NL
[5]European Society of Cardiology Health Policy Unit, European Heart Health Institute, Brussels, BE
[6]Norwich Medical School, University of East Anglia, Norwich, UK
[7]Dept Cardiology, Leiden University Medical Center, NL
[8]Dept Cardiology, University Hospital Santa Maria, University of Lisbon, PT.

Corresponding author: Adam Timmis, Barts Heart Centre, West Smithfield, London EC1A 2BE, UK. Tel: +44(0)20 3765 8715. Email a.d.timmis@qmul.ac.uk

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Abbreviations

AMI	Acute myocardial infarction
BMI	Body mass index
CRT-P	Cardiac resynchronization pacemaker ("biventricular pacemaker")
CRT-D	Cardiac resynchronization pacemaker with built-in implantable cardioverter defibrillator
CVD	Cardiovascular disease
DALY	Disability-adjusted life year
EHRA	European Heart Rhythm Association
ESC	European Society of Cardiology
EUROASPIRE	European Action on Secondary Prevention through Intervention to Reduce Events
FAO	Food and Agriculture Organization of the United Nations
GBD	Global burden of disease
GDP	Gross domestic product
GNI	Gross national income
ICD	Implantable cardioverter-defibrillator
IHD	Ischaemic heart disease
IHME	Institute for Health Metrics and Evaluation
NCD-RisC	Noncommunicable Diseases Risk Factor Collaboration
NCS	National cardiac societies
PCI	Percutaneous coronary intervention
PPP	Purchasing power parity
PYLL	Potential years of life lost
TFYR Macedonia	The Former Yugoslav Republic of Macedonia
UK	United Kingdom
USA	United States of America
WB	World Bank
WHO	World Health Organization

Abstract

Background: The European Society of Cardiology (ESC) Atlas has been compiled by the European Heart Agency to document cardiovascular disease (CVD) statistics of the 56 ESC member countries. A major aim of this 2017 data presentation has been to compare high income and middle income ESC member countries, in order to identify inequalities in disease burden, outcomes and service provision.

Methods: The Atlas utilizes a variety of data sources, including the World Health Organization, the Institute for Health Metrics and Evaluation, and the World Bank to document risk factors, prevalence and mortality of cardiovascular disease and national economic indicators. It also includes novel ESC sponsored survey data of health infrastructure and cardiovascular service provision provided by the national societies of the ESC member countries. Data presentation is descriptive with no attempt to attach statistical significance to differences observed in stratified analyses.

Results: Important differences were identified between the high income and middle income member countries of the ESC with regard to CVD risk factors, disease incidence and mortality. For both women and men, the age-standardised prevalence of hypertension was lower in high income countries (18.3% and 27.3%) compared with middle income countries (23.5% and 30.3%). Smoking prevalence in men (not women) was also lower (26% vs 41.3%), and together these inequalities are likely to have contributed to the higher CVD mortality in middle income countries. Declines in CVD mortality have seen cancer becoming a more common cause of death in a number of high income member countries, but in middle income countries declines in CVD mortality have been less consistent where CVD remains the leading cause of death. Inequalities in CVD mortality are emphasised by the smaller contribution they make to potential years of life lost in high income compared with middle income countries both for women (13% vs. 23%) and men (20% vs. 27%). The downward mortality trends for CVD may, however, be threatened by the emerging obesity epidemic that is seeing rates of diabetes increasing across all ESC member countries. Survey data from the National Cardiac Societies (n=41) showed that rates of cardiac catheterization and coronary artery bypass surgery, as well as the number of specialist centres required to deliver them, were greatest in the high income member countries of the ESC. The Atlas confirmed that these ESC member

countries, where the facilities for the contemporary treatment of coronary disease were best developed, were often those in which declines in coronary mortality have been most pronounced. Economic resources were not the only driver for delivery of equitable cardiovascular healthcare, as some middle income ESC member countries reported rates for interventional procedures and device implantations that matched or exceeded the rates in wealthier member countries.

Conclusion: In documenting national CVD statistics, the Atlas provides valuable insights into the inequalities in risk factors, healthcare delivery and outcomes of CVD across ESC member countries. The availability of these data will underpin the ESC's ambitious mission "to reduce the burden of cardiovascular disease" not only in its member countries, but also in nation states around the world.

1. INTRODUCTION

The declining rates of hospitalization for acute myocardial infarction (AMI) in many developed countries have been attributed, at least in part, to risk factor modification at population level[1, 2]. There is no better example of this than the immediate impact of smoke-free legislation on the incidence of AMI in those countries where it has been successfully implemented [3, 4]. Declines in hospitalization rates have been matched by reductions in case fatality rates [5], both acutely and during follow-up, reflecting the widespread application of evidence-based treatment such as reperfusion therapy and drugs to protect against the progression of coronary disease. Many of these same treatments are also protective against other manifestations of cardiovascular disease, particularly stroke. Appropriate application of preventive and therapeutic strategies largely accounts for the dramatic declines in mortality from coronary artery disease that have been documented in developed countries around the world.

Substantial national resource is needed to organise programmes of risk reduction and to supply investigational technology and facilities for contemporary pharmacological and device treatments. Financial muscle, however, is insufficient without a highly organized legislative structure and implementation strategies to deliver public health measures such as smoke-free legislation and sugar taxes and to prioritize population health above other calls on the national purse. Predictably, therefore, temporal trends for the global epidemic of coronary artery disease vary by region [6] and the steep declines that have been documented in many high income countries have not always been matched in less prosperous economies. Even within high income economies there are disturbing socioeconomic gradients of CVD risk, evidenced in the UK, for example, by the "north-south divide" in life-expectancy[7]. Moreover, across all countries health gains attributable to the prevention and treatment of cardiovascular disease are likely to be eroded by the obesity epidemic and the surge in incident diabetes [8, 9]. Thus, three EUROASPIRE surveys between 1999 and 2013 in patients with established coronary disease from nine different European countries, showed increases in the prevalence of obesity and self-reported diabetes of 7% and 6%, respectively [10].

There is considerable diversity of national resources across Europe, gross domestic product (GDP) per capita ranges from <$5,000 in some eastern countries to >$50 000 in the west (Figure 1). Political and organizational aspects of healthcare show similar variation – the net result being huge disparities in population CVD risks and the resources available for prevention and treatment.

INSERT FIGURE 1 HERE

Documentation of these national disparities is essential if the European Society of Cardiology (ESC) is to succeed in its mission to "reduce the burden of CVD". It is for this purpose that the ESC Atlas of Cardiology has been established. Details of the Atlas, including data collection, validation, organization and outputs, have been previously presented [11]. In summary, it is a database of cardiovascular and health system information, for ESC member countries that synthesizes quantitative material from the World Health Organization (WHO), the Global Burden of Disease study undertaken by the Institute of Health Metrics and Evaluation (IHME) and the World Bank (WB) with national cardiovascular data collected by the ESC and the National Cardiac Societies. This permits:

- Investigation of how system characteristics and policies at national level associate with cardiac care resources, throughputs, and outcomes
- Generation of country-specific reports and cross-country comparative analyses

This comprehensive report of cardiovascular statistics for European member states of the ESC responds to WHO recommendations for development of surveillance and monitoring programmes in order to understand the international distribution of CVD, and predict future trends [12]. We report on country-specific risk factors and health behaviours as they associate with economic status, health spending and cardiovascular outcomes. We examine disparities between the different member states in disease burden and CVD outcomes and seek to identify targets for reducing the burden of CVD and delivering equitable disease management across the continent.

2. DATA SOURCES AND DATA PRESENTATION

Key data sources for the European Society of Cardiology Atlas include:

- European Society of Cardiology (ESC): statistics on national cardiovascular infrastructure and procedures derived from a survey of the National Cardiac Societies of 41 ESC member countries.
- World Health Organisation (WHO): risk factor and mortality statistics.
- Institute for Health Metrics and Evaluation (IHME): morbidity and disease burden statistics from the Global Burden of Disease study.
- World Bank (WB): economic indicators.

Other data sources include the Food and Agriculture Organization of the United Nations (FAO) (http://faostat.fao.org/beta/en/) which provided dietary data and the Health behaviour in school age children (HBSC) survey (www.hbsc.org/) which provided data on childhood obesity.

2.1 ESC Atlas of Cardiology Data

The Atlas contains more than 100 variables relating to human and capital infrastructure and major cardiovascular interventions and services from 41 ESC member countries [11]. Specific variables developed by a task force were included in a questionnaire circulated to the national cardiac societies (NCS) of participating ESC member countries. The data collected were then subjected to quality control procedures, including comparison with other data sources to identify outliers and illogical values. These values were then discussed with the source NCS and corrected where necessary. The data were reviewed by independent experts before final approval by the NCS. All original data sources were recorded for tracking purposes.

The survey yields absolute numbers for resources and procedures. Crude rates per million people are computed from WB population estimates (http://data.worldbank.org/indicator).

2.2 World Health Organisation Data

Mortality data come from the WHO Mortality Database (http://www.who.int/healthinfo/mortality_data/en/) using the September 2016 update of age- and cause-specific mortality data by country. These data are publically available. This manuscript presents mortality data for 47 of the 56 ESC member countries, all from the WHO European Region. No data are presented for Algeria, Egypt, Libya, Morocco, Tunisia, Republic of Kosovo, Lebanon, or Syrian Arab Republic..

The WHO database collates data on the absolute number of medically-certified deaths from national authorities based on their vital registration systems. From these primary data, mortality rates are calculated using country-level data on population size from the same database as denominators. Age-standardised rates are computed using the direct method with the 2013 European Standard Population (ESP) to control for cross-national differences in population age structures. The 2013 ESP was developed as an update to the 1976 ESP by the European Commission for the EU27 and European Free Trade Association countries to better reflect the age structure of the current European population.

The data presented in the WHO Mortality Database and in this manuscript are as submitted by individual countries to WHO. No adjustments have been made to account for potential bias in reporting. As a result, the quality of mortality data varies between countries, with more accurate data for countries with well-functioning vital registration systems compared with those with weaker systems. Even for countries with strong vital registration systems, however, regional patterns of clinical diagnosis may reduce cross-country comparability.

In general, the mortality data are up-to-date, with the most recent data for only seven of the 47 countries dating from 2010 or before. However, in some cases, individual countries are yet to provide their most recent statistics, with the result that the information obtained from the WHO might not be as up-to-date as that available from the databases of these individual countries.

National data on metabolic/biological risk factors are derived from the WHO and

Noncommunicable Diseases Risk Factor Collaboration (NCD-RisC) and are based on aggregated population data. Estimates are age-standardized to facilitate international comparisons. Details of methods and data sources are described elsewhere [8, 13-15]. National physical activity data come from surveys presenting sex- and age-specific estimates relating to WHO activity recommendations, with regression modelling to determine levels of insufficient activity.

2.3 Global Burden of Disease - Institute for Health Metrics and Evaluation Data

Estimates of CVD prevalence come from the Global Burden of Disease study, conducted by the Institute for Health Metrics and Evaluation (IHME) (http://www.healthdata.org/). The estimates are derived using modeling software and data from health surveys, prospective cohorts, health system administrative data, and registries [16,17]. The GBD study also provides estimates of disability adjusted life years (DALYs) from estimates of years living with CVD and years of life lost.

2.4 World Bank Data

Data on various economic indicators come from the WB (http://databank.worldbank.org/data/). These data are drawn from official sources and in converting estimates of gross national income (GNI) and GNI per capita from national currencies to U.S. dollars the WB uses the Atlas conversion factor to help reduce the impact of exchange rate fluctuations in the cross-country comparison of national incomes. The WB also provides national population data which were used for calculating rate estimates for ESC member countries.

2.5 Data Presentation and Analysis

Data from the Atlas are presented for 56 ESC member countries (Table 1, Figure 2)

INSERT TABLE 1 AND FIGURE 2 HERE

Data presentation in this report is descriptive, illustrated by tables and charts from the ESC Atlas, with only limited interpretation in the short commentary paragraphs at the end of each section. No attempt is made to attach statistical significance to differences observed in stratified analyses and there is no assumption of causation when associations are identified. For consistency, averaged statistics across groups of countries are presented as means in the manuscript, but median values are also included in the tables and box plots for national subgroups. Box plots were used almost exclusively for comparison of CVD statistics between high-income and middle-income ESC member countries according to the World Bank 2017 definition [1]. The plots display a box representing median values and first and third quartile values, with whiskers positioned at the furthest data points within 1.5 times the interquartile range. Any countries outside this range are defined as outliers and are plotted individually.

2.6 Limitations

Much of the data in the Atlas are from the WHO, IHME and World Bank which together constitute the most credible sources of national estimates of CVD and associated risk factors. The validity of the statistics these sources provide is a function of the procedures applied in their collection which can be reviewed in the source addresses provided throughout the manuscript in the relevant section headings. General limitations of the data include the adjustment applied by all the main providers to account for missing data, and differences in reporting practices such that precision of the estimates they provide often varies by country. Misclassification bias due to miscoding of diagnostic groups and death certificates is another potential limitation. Data completeness is clearly defined within each section of the manuscript and for most indicators exceeds 80% although it is lower for diabetes in adults (75%), overweight and obesity in children (56%), smoking in children (64%) and physical activity in adults (64%) and children (68%). There is also variably missing data in some of the time-series collections, indicated by blank cells within the relevant tables, such that in some cases our analysis has had to be restricted to patients with data entries at the start, middle and final date of the series. National cardiovascular infrastructure and procedure data are at present available for only 41 (73%) of ESC member countries. The Atlas does not provide information about within-country inequalities [7, 18]. Moreover, inequalities between World Bank classified high- and middle-income countries are determined by comparing national means averaged across the groups, which obscures within-category inequalities. The presentation of minimum and maximum statistics around group means helps mitigate this issue.

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[1] According to the World Bank definition, high-income countries are those in which 2016 GNI per capita was US$12,000 or more. (https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups). Throughout the manuscript the term "middle-income countries" represents a composite of upper- and lower-middle income ESC member countries.

The limitations as they apply to the quality, precision and availability of the data emphasise the need for cautious interpretation of the CVD statistics presented in this report.

3. RISK FACTORS AND HEALTH BEHAVIOURS

The identification of major risk factors that predispose to the development of non-fatal and fatal cardiovascular disease (CVD) was a key contribution of the Framingham Heart Study[19]. The Framingham findings have been extensively validated and their global importance was confirmed in INTERHEART, a case-control study conducted in 52 countries, which showed that only nine potentially reversible risk factors and health behaviours (alcohol, hypertension, dyslipidaemia, diabetes, diet, obesity psychosocial factors, sedentary lifestyle and smoking) account for >90% of the population attributable risk[2] of acute myocardial infarction (AMI) in all regions of the world[20]. This identified AMI, and, by extension, other manifestations of CVD, as a major preventable disorder and there is now extensive evidence that the decline in hospitalization rates for AMI that have been recorded in many developed countries in recent years is largely attributable to health behaviour and risk factor modification at population level [1, 2]. In this section, the prevalence and time course of health behaviours and risk factors of the ESC member countries are presented.

3.1 RISK FACTORS

3.1.1 Blood pressure

Data: Age-standardised prevalence of raised blood pressure (mmHg), 18+ years, by sex; Data source: WHO Global Health Observatory http://www.who.int/gho/database/en/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2014

Data: Mean systolic blood pressure (mmHg), 18+ years, by sex; Data source: WHO Global Health Observatory http://www.who.int/gho/database/en/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2014

Blood pressure levels show a continuous linear relation to the risk of stroke and myocardial infarction[21]. The INTERHEART study estimated that 22% of myocardial infarctions in Europe are related to hypertension, which almost doubles the risk compared with people with no history of hypertension [20]. The added risk of CVD attributable to hypertension can be largely reversed by antihypertensive treatment[22].

[2]Population attributable risk is the portion of the incidence of a disease in the population (exposed and non-exposed) that is due to exposure. It is the percent of the incidence of a disease in the population that would be eliminated if exposure were eliminated.

- **National Statistics** The age-standardised prevalence of raised blood pressure in 2014 varied across ESC member countries[3], ranging from 15.2% in the UK to 31.7% in Estonia. (Table S1[4], Figure 3,). Average blood pressure levels also varied between countries, with a mean systolic level for women of 115 mmHg in France compared with 130 mmHg in Republic of Moldova and for men of 138 mmHg in Slovak Republic compared with 121 mmHg in Turkey (Table S2, Figure 4).
- **Stratification by Sex** The prevalence of hypertension in all ESC member countries for which data were available was lower in women than in men, with averaged rates of 20.2% and 28.4%, respectively. This was reflected in blood pressure levels of 122 mmHg in women and 131 mmHg in men averaged across member countries (Tables S1, S2, Figures 3, 4).
- **Time Series Data** Systolic blood pressure in ESC member countries trended downwards between 1980 and 2014, with mean values falling from 134 to 122 mmHg in women and 137 to 131 mmHg in men (Figure 5a,b).
- **Stratification by National Income Status** The average prevalence of age-standardised raised blood pressure in women and men was 18.3% and 27.3% in high income ESC member countries and 23.5% and 30.3% in middle income countries (Table S1, Figure 6). Average blood pressure levels also varied by national income status, with a mean systolic level for women and men of 120 mmHg and 130 mmHg in high income countries and 126 mmHg and 133 mmHg in middle income countries (Table S2, Figure 7). Between 1980 and 2014, systolic blood pressure, averaged across high income countries, changed downwards from 134 mmHg to 120 mmHg in women and 138 mmHg to 130 mmHg mmHg in men. Changes in middle income countries showed a similar downward trend in women (134 to 126 mmHg), but were less marked in men (135 to 133 mmHg) (Figures 5a,b).

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[3] High blood pressure is defined as a systolic blood pressure of ≥140 mmHg or a diastolic blood pressure of ≥90mmHg; data from population-based surveys and surveillance systems of measured blood pressure
[4] S denotes tables in the supplementary material

3.1.2 Cholesterol

Data: Age-standardised mean blood cholesterol levels (mmol/L), 25+ years, by sex; Data source: WHO Global Health Observatory http://www.who.int/gho/database/en/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2009

Data: Age-standardised prevalence of raised blood cholesterol (≥ 5.0 mmol/L, ≥ 6.2 mmol/L), 25+ years, by sex; Data source: WHO Global Health Observatory http://www.who.int/gho/database/en/. Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2008

The risk of coronary heart disease death increases linearly with increasing blood cholesterol levels [23]. Globally, about 33% of coronary heart disease cases can be attributed to hypercholesterolaemia. Cholesterol is a major target of risk reduction programmes; a 10% reduction in total cholesterol levels in middle aged men results in a 50% reduction in heart disease rates within 5 years [24]. Hypercholesterolaemia is most common in high-income countries, and the WHO reports that Europe tops the league in the Northern Hemisphere with a 54% prevalence followed by the Americas with a 48% prevalence, which contrasts with a 23% prevalence in Africa [24].

- **National Statistics Stratified by Sex** Data for 2009 showed that the mean blood cholesterol concentration averaged across all ESC member countries was 5.1 mmol/L in both women and men, ranging from 4.5 mmol/L and 4.4 mmol/L in women and men from Kyrgyzstan to 5.6 mmol/L in women and men from Iceland (Table S3). The mean age-standardised prevalence of hypercholesterolaemia (≥6.2 mmol/L) averaged across member countries was 16.4% and 15.8% in women and men, ranging from <10% in Azerbaijan, Bosnia and Herzegovina, Republic of Georgia, Kyrgyzstan, Republic of Moldova and Turkey to >20% in Belgium, Finland, France, Germany, Ireland, Norway and United Kingdom (Table S4, Figure 8).
- **Time series Data** Blood cholesterol concentrations averaged across ESC member countries declined from 5.6 to 5.1 mmol/L in women and men between 1980 and 2009 (Figure 9a,b).
- **Stratification by National Income Status** Age-standardised mean blood cholesterol concentrations in women and men were 5.2 and 5.3 mmol/L in high income countries and 4.9 and 4.8 mmol/L in middle income countries (Table S3, Figure 10). This difference between high and middle income countries was reflected in mean age-standardised prevalence rates for hypercholesterolaemia (≥6.2 mmol/L) that were 18.9% and 19.0% in women and men from high income countries and 12.0% and 10.0% in women and men from middle income countries

(Table S4, Figure 11). Between 1980 and 2009, blood cholesterol concentrations, averaged across high income countries, changed from 5.8 to 5.2mmol/L in women and from 5.8 to 5.3 mmol/L in men. Quantitatively similar changes were recorded in women (5.3 to 4.9 mmol/L) and men (5.2 to 4.8 mmol/L) in middle income countries (Figure 9a,b).

3.1.3 Diabetes

Data: Age-standardised prevalence of raised blood glucose, 18+ years, by sex; Data source: WHO Global Health Observatory http://www.who.int/gho/database/en/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2014

Data: Prevalence of diabetes; Data source: World Bank http://data.worldbank.org/indicator; Europe 38/39; Non-European former Russian Republics 9/9; E Med & N Africa 8/8; Year of data: 2014

The WHO reports over 60 million people currently living with diabetes in the European region[25], with type 2 diabetes mellitus accounting for the majority of cases. The high and increasing prevalence of diabetes is largely attributed to overweight (BMI >25kg/m2) and obesity (BMI >30kg/m2), which in turn largely results from excess dietary calories and physical inactivity.

- **National Statistics** The prevalence of diabetes by 2014 estimates was on average 6.5% across the ESC member countries. The prevalence ranged from <3% in Republic of Moldova, Republic of Georgia, Azerbaijan, Albania, Armenia and Ukraine to >14% in Lebanon, Egypt and Turkey (Table S5, Figure 12). The prevalence of raised blood glucose in women averaged 6.5% across ESC member countries, ranging from only 2.8% in Switzerland to 14.2% in Turkey. In men the average prevalence was 7.9%, ranging from 5.2% in Netherlands to 13.3% in Republic of Georgia (Table S6, Figure 13).
- **Temporal Changes by National Income Status** Paired prevalence data for diabetes in 1995-2000 and 2014 were available for 24 countries. During that period, the averaged prevalence increased from 2.0% to 4.1%, with comparable changes in high income (3.0% to 5.7%) and middle income (1.0% to 2.4%) countries (Table S7, Figure 14). Although the prevalence of diabetes was higher in high income countries, the age-standardised prevalence of raised blood glucose[5] was lower compared with middle income countries for both women (5.2% vs.

[5] Raised blood glucose defined as fasting glucose ≥126 mg/dl (7.0 mmol/l) or on medication for raised blood glucose.

8.9%) and men (7.2% vs. 9.2%)(Table S6, Figure 15). These contradictory statistics may reflect under-diagnosis of diabetes and/or less effective glycaemic control in middle income countries.

3.1.4 Obesity

Data: Age-standardised mean BMI (kg/m^2), 18+ years, by sex; Data source: WHO Global Health Observatory http://www.who.int/gho/database/en/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2014

Data: Age-standardised prevalence of overweight and obesity, 18+ years, by sex; Data source: WHO Europe. Health for All Database (HFA-DB) http://data.euro.who.int/hfadb/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2014

Data: Prevalence of overweight or obesity among children, 11, 13 and 15 years, by sex; Data source: HBSC Survey 2014/15 http://www.hbsc.org/publications/international/; Completeness: Europe 32/39; Non-European former Russian Republics 4/9; E Med & N Africa 1/8. Year of data: 2013/14

Across the world, rates of obesity are increasing rapidly [8]. A recent meta-analysis concluded that the consequences for all-cause mortality were severe and consistent across four continents. In Europe and North America, obesity is now second only to smoking as a risk factor for premature death [26].

- **National Statistics** Age-standardised mean body mass index (BMI) averaged across ESC member countries was similar for women and men (25.8 and 26.8 kg/m^2), ranging from 23.8 kg/m^2 in women from Switzerland to 28.5 kg/m^2 in women from Turkey (Table S8, Figure 16). Data for 2014 showed that, across ESC member countries, more than one in five adult women and men were obese[6] as reflected by prevalence rates of 22.9% and 21.4% (Table S9, Figure 17). Female obesity was most common in Turkey where it affected more than one in three women. Male obesity was most common in Czech Republic, Ireland, Luxembourg and United Kingdom where it affected more than one in four men.
- **Time Series Data** Between 1980 and 2014 age-standardised BMI averaged across ESC member countries increased from 25.2to 25.8 kg/m^2 in women and 25.0-26.8 kg/m^2 in men. (Figures 18a,b).
- **Stratification by National Income Status** Mean BMI in women and men averaged across ESC member countries was 25.5 kg/m^2 and 27.0 kg/m^2 in high income countries and 26.4 kg/m^2 and 26.5 kg/m^2 in middle income countries (Table S8). The prevalence of obesity (≥30 kg/m^2) in women and men was 22.9%

[6] WHO definitions of overweight and obesity are BMIs of ≥25 kg/m^2 and ≥30 kg/m^2, respectively.

and 23.1% in high income countries and 23.0% and 18.3% in middle income countries (Table S9, Figure 19).

- **Obesity in Children** Among children aged 15 years living in ESC member countries, an average of 14% in 2013/14 were overweight or obese[7]. Prevalence rates in girls compared with boys were 11% vs 18% and in middle income compared with high income countries were 8% vs. 12% for girls and 16% vs. 19% for boys (Table S10). These differences based on sex and national income status were reflected in cohorts aged 11, 13 and 15 years for whom prevalence rates of overweight and obesity in high income countries were 14%, 12% and 12% in girls and 17%, 17% and 19% in boys. In middle income countries prevalence rates in the same age groups were 12%, 10%, 8% in girls and 20%, 17%, and 16% in boys (Table S10).

3.2 HEALTH BEHAVIOURS

3.2.1 Smoking

Data: Prevalence of smoking, 15+ years, by sex; Data source: WHO Europe, Health for All Database (HFA-DB) http://data.euro.who.int/hfadb/; Completeness: Europe 38/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8. Year of data: 2012-2014

Data: Prevalence of weekly smoking, 15 year olds, by sex; Data source: Inchley J et al. (2016); Currie C et al. (2012) ; Completeness: Europe 31/39; Non-European former Russian Republics 3/9; E Med & N Africa 2/8. Year of data: 2001/02 to 2013/14.

About 27% of Europeans aged over 15 are smokers, putting the continent at the top of the international smoking league, with tobacco-related disease accounting for more deaths than anywhere else in the world [27].

- **National Statistics Stratified by Sex** In men aged ≥15 years, the national prevalence of smoking, based on latest year estimates, averaged 31.5% across the ESC member countries for which data were available. The prevalence ranged from ≤15% in Iceland, Norway and Sweden to >50% in Republic of Georgia, Latvia, Republic of Moldova and Russian Federation. For women, smoking prevalence was lower averaging 15.8% across the ESC member countries. The prevalence ranged from <10% in Albania, Armenia, Belarus, Republic of Georgia, Kazakhstan, Kyrgyzstan and Lithuania to >25% in Bulgaria, Greece, Montenegro, Serbia and

[7] For children aged between 5–19 years overweight is BMI-for-age greater than 1 standard deviation above the WHO Growth Reference median; and obesity is greater than 2 standard deviations above the WHO Growth Reference median.

TFYR Macedonia. Among two of the four ESC member countries where >50% of men were smokers the prevalence among women was <10%, emphasising the importance of cultural factors in determining smoking behaviour, particularly in women (Table S11, Figure 20).

- **Temporal Changes** Paired prevalence data for smoking in 1995-2000 and 2013-2014 were available for only 28 and 27 countries in women and men. During that period, the averaged prevalence of smoking reduced from 21.4% to 16.1% in women and from 37.0% to 26.9% in men (Table S12, Figure 21a,b).
- **Stratification by National Income Status** Comparison of smoking prevalence in high and middle income ESC member countries showed divergent sex differences. Among women aged ≥15 years, smoking prevalence, based on the latest available estimates in each country, was 17.0% in high income countries and 13.6% in middle income countries. For men, the pattern was different with smoking prevalence 26.0% in high income countries and 41.3% in middle income countries (Table S11, Figure 22).
- **Smoking in Children** Among girls and boys aged 15, the prevalence of at least weekly smoking recorded in 2013-14 averaged 12.1% and 13.5%, respectively, across European member countries with considerable variation between countries (Table S13, Figure 23). In Bulgaria, Croatia, Hungary, Italy, Lithuania and Romania ≥20% of boys were smokers compared with ≤5% in Armenia, Iceland and Norway. Similar variation was seen in girls, with ≥20% smoking in Bulgaria, Croatia, France, Hungary and Italy but ≤3% in Armenia, Iceland and Norway. Since the millennium, high income countries have seen declines in smoking prevalence in girls (24.1% to 12.3%) and boys (23.5% to 12.9%). Similar declines have also been seen in middle income countries for girls (18.0% to 11.2%) and boys (28.9% to 16.3%) (Table S13).

3.2.2 Alcohol

Data: Alcohol consumption, litres per capita per year, 15+ years; Data source: WHO Europe, Health for All Database (HFA-DB) http://data.euro.who.int/hfadb/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2012 to 2014

Data: Age-standardised prevalence of heavy episodic drinking in the past 30 days, 15+ years; Data source: WHO Global Health Observatory http://www.who.int/gho/en/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8. Year of data: 2010

According to Dietary Guidelines for Americans 2015-2020, moderate drinking is up to one drink per day for women and up to two drinks per day for men[28]. This is comparable to guideline recommendations in Ireland, Denmark and Czech Republic but greater than the recently updated recommendations in the UK [29]. Excessive alcohol consumption remains a leading cause of premature death, data from the United States showing it is responsible for 1 in 10 deaths among working-age adults [30].

- **National Statistics** In European men and women aged ≥15 years, alcohol consumption, averaged across the ESC member countries for which data were available, was 8.7 L/capita/year based on the latest year estimates[8]. There were, however, large differences between countries, with consumption ranging from <4 L/capita/year in Armenia, Azerbaijan, Israel, Kyrgyzstan, TFYR Macedonia and Turkey to >13 L/capita/year in Belarus and Lithuania (Table S14, Figure 24).
- **Stratification by Sex** Age-standardised data for 2010, averaged across 47 ESC member countries for which data were available, showed that heavy episodic drinking in the past 30 days[9] was less prevalent among women than men (8.3% vs 30.0%) (Table S15, Figure 25). Rates ≥50% were recorded for men in Austria, Czech Republic, Finland, Ireland and Lithuania. Rates tended to be high among women in these same countries and exceeded 20% for women in Austria and Lithuania.
- **Time series Data** There has been little change in alcohol consumption in recent years, with an average 8.6 L/capita/year averaged across ESC member countries in 1996-2000 compared with 8.8 L/capita/year in 2014 (Figure 26).

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[8]Alcohol consumption is defined as the recorded amount of pure alcohol in litres consumed per adult (15+ years) over a calendar year in a country, in litres of pure alcohol. The indicator only takes into account the consumption which is recorded from production, import, export, and sales data, often via taxation.

[9] Heavy episodic drinking is defined as consumption of at least 60 grams of pure alcohol on at least one occasion in the past 30 days; data come from population surveys. Weighted for abstainers and population size

- **Stratification by National Income Status** Alcohol consumption averaged across ESC member countries was 9.9 L/capita/year in high income countries compared with 6.6 L/capita/year in low income countries (Table S14, Figure 27). The average prevalence of heavy episodic drinking in women and men was 10.7% and 34.6% in high income countries compared with 4.0% and and 22.1% in middle income countries (Table S15, Figure 28).

3.2.3 Diet

Data: Diet, fat and energy consumption. Data source: Food and Agriculture Organization of the United Nations (FAO) http://faostat.fao.org/beta/en/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8. Year of data: 2011

In a recent report from the PURE study (31), higher fruit, vegetable, and legume consumption was associated with a lower risk of non-cardiovascular, and total mortality. Benefits appeared to be maximum for both non-cardiovascular mortality and total mortality at three to four servings per day (equivalent to 375–500 g/day). A US study found that the aggregate of 14 sub-components of diet was a more important risk factor for disease than either physical inactivity or high BMI and was associated with 26% of all deaths and 14% of disability adjusted life years [32]. However, the authors cautioned that results for diet are limited by the precision of the measurement and similar caution needs exercising in the interpretation of dietary data recorded in the Atlas[10].

- **Energy Consumption** Data from the Food and Agriculture Organization of the United Nations (FAO) showed that total energy consumption[11] in 2011, averaged across ESC member countries, was 3254 kcal/day. Energy consumption was similar in high (3354 kcal/day) and middle (3077 kcal/day) income countries and has remained fairly constant the last 16 years increasing from 3036 kcal/day in 1995 to 3254 kcal/day in 2011. Average consumption during this period has been higher in high income countries, increasing from 3197 to 3354 kcal/day

[10]National foodconsumption data presented in this section come from the Food and Agriculture Organization of the United Nations (FAO)which collects collect country-level data on food production and trade. The actual food consumption may be lower than the quantity shown as food availability depends on the magnitude of wastage and losses in the household, e.g. during storage, in preparation and cooking, as plate-waste or quantities fed to domestic animals and pets, thrown or given away.

[11]total energy consumption is the amount of food, in kilocalories (kcal) per day, available for each individual in the total population

compared with 2736 to 3077 kcal/day in middle income countries (Table S16, Figures 29a, 30a).

- **Fat Consumption** Estimates for fat consumed across ESC member countries in 2011 averaged 120.5 g/capita/day. Consumption was higher in high income compared with middle income countries (135.7 vs 93.7 g/capita/day). Time series data for the period 1995-2011 showed increasing consumption from a mean of 103.4 to 120.5 g/capita/day between 1995 and 2011. Consumption during this period has been higher in high income countries, increasing from a mean of 123.1 to 135.7 g/capita/day compared with 67.0 to 93.7 g/capita/day in middle income countries (Table S16, Figures 29b, 30b).
- **Vegetable and Fruit Consumption** Estimates for vegetables and fruit consumed across ESC member countries in 2011 averaged 135.9 kg/capita/year and 94.4 kg/capita/year, respectively. For vegetables, consumption was lower in high income compared with middle income countries (115.0 vs 172.6 kg/capita/year), but for fruit the pattern was different with consumption higher in high income countries (103.8 vs. 77.9 kg/capita/year) (Table S16, Figures 29c, 29d, 30c, 30d). Time series data for the period 1995-2011 showed increasing consumption of both vegetables (107.1 to 135.9 kg/capita/year) and fruit (74.5 to 94.4 kg/capita/year) averaged across ESC member countries.

3.2.4 Physical activity

Data: Prevalence of insufficiently active adults, 18+ years, by sex; Data source: WHO Global Health Observatory http://www.who.int/gho/database/en/; Completeness: Europe 32/39; Non-European former Russian Republics 4/9; E Med & N Africa 0/8; Year of data: 2010

Data: Proportion of children who participate in at least one hour of moderate to vigorous physical activity per day, 11, 13 or 15 years olds, by sex, Data source: Inchley J et al. (2016) Growing up unequal: WHO Regional Office for Europe: Copenhagen, Denmark; Completeness: Europe 33/39; Non-European former Russian Republics 4/9; E Med & N Africa 1/8. Year of data: 2013/14,

In a cohort of 334,161 European men and women followed up for 12.4 years, individuals who exercised only moderately reduced the hazard of all-cause mortality by 16–30% compared with those categorized as inactive [33]. The study was consistent with earlier findings that physical inactivity has a major health effect worldwide and that a decrease or removal of this unhealthy behaviour could improve health substantially [34].

- **Physical Activity in Adults** Self reported physical activity using validated questionnaires was graded “insufficient” in a mean of 30.1% of women and 22.7%

of men across ESC member countries (Table S17, Figure 31).[12] In Belgium, Ireland, Italy Portugal, Serbia and UK, ≥30% of men and >40% of women reported insufficient physical activity. In Malta, the prevalence of inactivity was yet higher at 50% and 40% for women and men. The averaged prevalence of insufficiently active women and men was 31.2% and 23.5% in high income countries compared with 26.8% and 20.0% in middle income countries (Table S17, Figure 32).

- **Physical Activity in Children** Data for 2013/14 show that for all ESC member countries, the average proportion of 15 year old children participating in at least one hour of moderate to vigorous physical activity per day[13] tended to be lower in girls compared with boys (Figure 33). This applied across 11, 13 qnd 15 year old age groups, in which proportions undertaking an hour per day or more of vigorous physical activity tended to decline with age in both girls (21%, 15%, 10%) and boys (30%, 25%, 20%) (Table S18). In high income ESC member countries, participation in at least one hour of moderate to vigorous physical activity per day among groups aged 11, 13 and 15 years was 20%, 14% and 9% in girls and 29%, 23% and 19% in boys. In middle income countries participation was higher with proportions of 26%, 21% and 15% in girls and 35%, 30% and 25% in boys (Table S18, Figure 34).

3.3 Commentary

Across ESC member countries, variation in the prevalence of major risk factors for cardiovascular disease represents a failure of effective health policy and public education that condemns large populations to premature death from ischaemic heart disease and stroke. It is salutary to note that the risk factors driving cardiovascular disease are potentially reversible, providing huge opportunity to address these international health inequalities. Indeed it was not long ago that today's high income countries had risk factor prevalence statistics similar to those now recorded in some of the middle income

[12] The prevalence of insufficient physical activity is represented by the percent of defined population attaining less than 150 minutes of moderate-intensity physical activity per week, or less than 75 minutes of vigorous-intensity physical activity per week, or equivalent. Based on self-reported physical activity captured using the GPAQ (Global Physical Activity Questionnaire), the IPAQ (International Physical Activity Questionnaire) or a similar questionnaire (age standardized estimates).

[13] Moderate to vigorous physical activity is defined as any activity that increases the heart rate and makes the person get out of breath some of the time

member countries of the ESC. The steep declines in cardiovascular mortality that many high income countries have enjoyed are largely explained by risk factor modification making the opportunity to eliminate cardiovascular inequalities across Europe and elsewhere in the world one of the key healthcare challenges of the 21st century. The successful implementation of treatments to lower blood pressure and blood lipid concentrations along with smoking cessation measures in high income countries now need exporting to the healthcare systems of middle income countries to allow their populations to share the health benefits. Meanwhile the emerging obesity epidemic affecting high income countries, driven by physical inactivity and dietary indiscretion, needs determined action if the steep downward trend in cardiovascular mortality that has occurred in the last 50 years is to be maintained. The ESC Atlas of cardiovascular statistics clearly identifies the national risk factor profiles and the targets for intervention that need addressing to reduce the health inequalities across ESC member countries.

4. CARDIOVASCULAR DISEASE: NATIONAL PREVALENCE

Cardiovascular disease (CVD) remains one of the most common disorders affecting men and women across Europe and, increasingly, in Eastern Mediterranean and North African countries. Its societal impact is huge both in terms of the direct costs incurred in its management [35-37] and the indirect costs related to absenteeism, lost productivity and mortality. Total costs exceed those for any other major diagnostic group [38]. Thus, the national prevalence statistics and trends over time that are recorded in the Atlas have important implications for the national economies of ESC member countries in addition to their implications for population health.

4.1 Incidence of CVD[14]

Data: Incidence of CVD, IHD and stroke, by sex; Data source: Global Burden of Disease database http://www.healthdata.org/gbd/data; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2015

Data: Incidence of CVD by sex; Data source: Global Burden of Disease database http://www.healthdata.org/gbd/data; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8. Year of data: 1990-2015

- **National Statistics** There were ~11 million new cases of cardiovascular disease (CVD) in the 47 ESC member countries for which 2015 data were available[15]. Ischaemic heart disease accounted for about 50% of these cases and stroke for about 14%. National contributions of incident cases in part reflected the size of the different ESC member countries, Russian Federation contributing the most cases (~2.5 million) and Iceland the fewest (~2,500) (Table S19).
- **Stratification by Sex** Women accounted for more new cases of CVD compared with men (~5.7 million cases vs. ~5.3 million cases) but new cases of IHD were more frequent in men (~2.7million vs. ~2.9 million) while new cases of stroke were more frequent in women (~0.85 million vs. ~0.65million).
- **Time Series Data** There was a steady increase in incident cases of CVD between 1990 and 2015 in both women (~4.9 million to ~5.7 million) and men (~4.3million to ~5.3million). This was seen across all ESC member countries, except for Denmark, Republic of Georgia, Germany, Latvia and the UK which

[14] Disease incidence is the rate of occurrence of new cases in a given population. It conveys information about the risk of contracting the disease.

[15] 2015 data unavailable for Republic of Kosovo, Republic of San Marino, Algeria, Egypt, Lebanon, Libya, Morocco, Syrian Arab Republic Arab Republic, Tunisia

recorded small declines in incident CVD among women and Hungary and the UK which recorded small declines in men (Table S20, Figure 35,ab).

- **Stratification by National Income Status** Incident cases of CVD, averaged across ESC member countries, increased in high and middle income countries by 11% and 22% in women and by 17% and 26% in men (Table S20, Figures 35a,b).

4.2 Prevalence of CVD[16]

Data: Prevalence of CVDs, by sex; Data source: Global Burden of Disease database http://www.healthdata.org/gbd/data: Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2015

Data: Age-standardised prevalence rate per 100 000 of CVDs, by sex; Data source: Global Burden of Disease database http://www.healthdata.org/gbd/data; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2015

Data: Age-standardised prevalence rate per 100 000 of CVD, by sex; Data source: Global Burden of Disease database http://www.healthdata.org/gbd/data; Completeness: Europe 36/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 1990 to 2015,

- **National Statistics** There were ~83.5 million people living with CVD in ESC member countries in 2015. The prevalence was driven predominantly by peripheral vascular disease (~35.7 million), followed by IHD (~29.4 million), other CVD such as pericardial disease, valvular heart disease (~13.3 million), atrial fibrillation (~9.5 million) and stroke (~7.5 million) (Table S21). With age-standardization, the prevalence of CVD per 100,000 people averaged across all ESC member countries in 2015 remained driven by peripheral vascular disease, (5,373) followed by IHD (4,390), other CVD (2,211), atrial fibrillation (1,450) and stroke (1,220) (Table S22).
- **Stratification by Sex** Age standardized prevalence rates for CVD in women exceeded 7,000 per 100,000 people in Czech Republic, Republic of Georgia, Kyrgyzstan and Turkey. In men rates in excess of 9,000 per 100,000 people were recorded in Bulgaria, Croatia, Russian Federation, and Slovak Republic. (Table S22). For all CVD phenotypes, including IHD, stroke, and PVD, age standardised prevalence averaged across ESC member countries was lower in women compared with men. Absolute numbers of prevalent cases, however, showed inequalities between women and men according to CVD phenotype with ~0.9 million and ~5.7 million more prevalent cases of stroke and peripheral vascular

16 Disease prevalence is the proportion of cases in the population at a given time. It indicates how widespread the disease is.

disease in women compared with men and ~3.6 million and ~0.5 million more prevalent cases of IHD and atrial fibrillation in men compared with women.

- **Time Series Data** Age-standardised prevalent cases of CVD per 100,000 people, averaged across all ESC member countries, showed little change between 1990 and 2015 in women (5863 to 5586) or men (7,671 to 7,200). In many countries, a small decline in the age-standardised prevalence was recorded but in six of the 16 middle income countries for which data were available (Armenia, Belarus, Bosnia and Herzegovina, Kazakhstan, Montenegro and Ukraine) small increases in prevalence were recorded in both women and men. Small increases in prevalence were also recorded in TFYR Macedonia (women only) and Kyrgyzstan (men only) (Table S23, Figures 36a,b,).
- **Stratification by National Income Status** Age-standardised prevalent cases of CVD per 100,000 people in high and middle income countries were 5,093 and 6,570 for women compared with 6,563 and 8,358 for men. IHD was less prevalent in high income compared with middle income countries in women (1,212 vs. 2,212) and men (2,267 vs. 3,788). Stroke prevalence showed similar inequality between high and middle income countries in women (448 vs. 843) and men (497 vs. 863) (Table S22, Figure 37).

4.3 Disability-adjusted life years (DALYs) lost to CVD

Data: Age-standardised DALYs lost rate per 100 000 for IHD, stroke and other CVD, by sex; Europe, Data source: Global Burden of Disease database http://www.healthdata.org/gbd/data; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 2015

Age-standardised rate of DALYs lost per 100 000 from CVD, by sex; Data source: Global Burden of Disease database http://www.healthdata.org/gbd/data; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: 1990-2015

Disability-adjusted life-years (DALYs) combine information regarding premature death (years of life lost) and disability caused by the CVD (years lived with CVD) to provide a summary measure of health lost due to that condition[17]. It allows comparison of the overall health and life expectancy of different countries.

- **National Statistics Stratified by Sex** In 2015, DALYs lost to CVD in women and men totalled ~28 million and ~36 million, accounting for ~22% and ~24% of all

[17] One DALY can be thought of as one lost year of "healthy" life. The sum of these DALYs across the population, or the burden of disease, can be thought of as a measurement of the gap between current health status and an ideal health situation where the entire population lives to an advanced age, free of disease and disability.

DALYs lost across ESC member countries (Figures 38a,b). Age-standardised data for 2015 show that across ESC member countries DALYs per 100,000 people lost to IHD were consistently higher than DALYs lost to stroke, as reflected by mean values for women (1,623 vs. 1,040) and for men (3,698 vs. 1,560). Age-standardised DALYs lost to IHD in women and men were notably high in Belarus, Kyrgyzstan and Ukraine and lowest in France. For stroke, age-standardised DALYs lost in women and men were, for both sexes, highest in Kyrgyzstan and lowest in Switzerland (Table S24).

- **Time Series Data** Between 1990 and 2015 reductions in mean age-standardised DALYs per 100,000 people lost due to CVD were recorded across ESC member countries for both women (5,759 to 3,452) and men (9,764 to 6,326) (Table S25, Figures 39a, b).
- **Stratification by National Income Status** For IHD in women and men there were a mean of 1004 and 2407 age standardised DALYs per 100,000 people lost during 2015 in high income member countries compared with 2,715 and 5,977 in middle income member countries. The data for stroke in women and men were 586 and 860 age-standardized DALYs per 100,000 people lost in high income member countries compared with 1,841 and 2,794 in middle income member countries (Table S24, Figure 40).

4.4 Commentary

The statistics recorded within the Atlas provide a timely reminder that incident cardiovascular disease continues to increase across nearly all European member countries of the ESC, despite declines in cardiovascular mortality. This no doubt reflects population growth and ageing because age-standardised data for men and women show consistent declines in CVD prevalence across high income ESC member countries during the last 25 years. In the middle income countries of the ESC, the pattern is different with no clear evidence of decline during the same period. Indeed, just under half of these middle income countries recorded an increase in disease prevalence, with the inequalities in disease burden further emphasised by a greater than three-fold excess of DALYs lost to IHD in middle income compared with high income ESC member countries. This is not only a health issue for the less prosperous middle income countries but also an economic issue, with the total costs of CVD, direct and indirect, being greater than any other diagnostic group [35-39]. This presents the middle income member countries of the ESC with a clear economic imperative to develop policies to protect their populations against the development and progression of CVD. In many of these countries rates of smoking and hypertension are very high (see chapter 3), presenting policy makers with the same targets for prevention that have contributed to the declines in CVD prevalence and mortality across many high income member countries. Addressing these targets at a national level has cost implications that are inevitably more challenging for less prosperous member countries. However, across these countries the age-standardized prevalence statistics are not always closely associated with GDP and Russian Federation, for example, despite its considerable national resources, has one of the highest rates of CVD in the world. Commitment to the cause of tackling CVD, therefore, is not simply a question of resource but also requires sound health policies that are backed up by implementation strategies. This is often not achieved. Thus, while the spread of smoking legislation across Europe, from West to East, is now almost complete its enforcement is variable and in Armenia, for example, the absence of any legal sanctions against those who violate the smoking laws has made them ineffectual [40]. Whether this is contributing to Armenia's inclusion among the minority of member states where CVD prevalence is increasing is hard to say but it illustrates the breakdown between policy and implementation that can undermine CVD prevention. Nevertheless, declines in disease prevalence that seem established in many high income member countries are beginning to develop in some of their middle income neighbours and if this trend continues the benefits in terms of population health and national economies will be substantial.

5. CARDIOVASCULAR HEALTHCARE DELIVERY

The declines in coronary mortality and non-fatal outcomes that have been recorded in Western societies during the last 50 years [6, 41], have not always been shared in other parts of the world, including many East European countries, the Russian republics and China, where mortality trends have been in the opposite direction [6, 42]. These inequalities must in part reflect the adoption of western life-styles in many middle income countries, particularly tobacco smoking and calorie consumption, but the unavailability of facilities for contemporary investigation and interventional management of CVD also merits consideration [1, 43]. Procedure and device costs are considerable and challenge the delivery of guideline-recommended cardiovascular care in many middle income and developing countries [37, 44]. This is reflected in substantial inequalities in the resources available for invasive management of cardiovascular disease that the Atlas data for 2016 highlight in documenting national interventional facilities and cardiovascular procedure rates. In this review, we examine these data and the inequalities between different ESC member countries as they associate with national prosperity and impact on the delivery of healthcare.

5.1 Cardiovascular Specialists

Data from the USA show that the specialist to population ratio at county or state level bears little relation to health outcomes [45, 46]. Indeed, while US specialist numbers are high, there is no evidence that increasing them further will do anything other than increase healthcare costs. Whether the same applies across ESC member countries - where healthcare systems are often very different – is unknown. The ESC Atlas and its data on cardiac staffing, facilities and outcomes provides an opportunity to start examining this question.

5.1.1 Cardiologists and Diagnostic Angiography – ESC Atlas

Data: Interventional cardiology infrastructure and procedures, per million people; Data source: ESC Atlas of Cardiology.
Completeness: Europe 34/39; Non-European former Russian Republics 5/9; E Med & N Africa 2/8; Year of data: 2014

- **Infrastructure** The number of cardiologists per million people averaged 86.3 (median 72.8) across the 41 ESC member countries that contributed data, ranging from <30 in Ireland and Turkey to >250 in Republic of Georgia and Greece. (Table S26, Figure 41).

- **Service Delivery** Coronary angiographic workload as reflected by the number of coronary angiograms per million people per year averaged 4,122 across ESC member countries ranging from 244 in Kyrgyzstan to 9,117 in Austria (Table S26).
- **Stratification by National Income Status** The number of cardiologists was similar in high income compared with middle income member countries, averaging 86.3 and 86.1 per million people in 2014 or the most recent available year. (Table S26, Figure 42). The numbers of coronary angiograms, however, were higher in high income compared with middle income countries, averaging 4,916 vs 2,412 per million people per year (Table S26, Figure 43). Outliers among the middle income countries were Turkey and Bulgaria where more coronary angiograms were performed than in many high income countries.

5.1.2 Intervention, PCI and Transcatheter Valve Replacement – ESC Atlas

Data: Interventional cardiology infrastructure and procedures, per million people; Data source: ESC Atlas of Cardiology.
Completeness: Europe 34/39; Non-European former Russian Republics 5/9; E Med & N Africa 2/8; Year of data: 2014

- **Infrastructure** The number of interventional cardiologists per million people averaged 11.8 across the 33 ESC member countries that contributed data, ranging from ≤3 in Republic of Moldova, Kyrgyzstan and Azerbaijan to >27 in Estonia and Austria (Table S26, Figure 44). As the number of interventional cardiologists increased across ESC member countries so did the number of coronary interventional centres, peaking in Bulgaria and Germany where, for every million people, there were 6.6 and 6.0 interventional centres respectively, while in Kyrgyzstan there was a total of just 0.7 per million people (Table S26, Figure 45). The number of centres undertaking transcatheter valve replacements showed similar variation among the 34 ESC member countries that provided data, ranging from none in Albania, Republic of Moldova and Ukraine to >2 per million people in Belgium, Iceland and Malta.
- **Service Delivery** Germany recorded the most coronary interventional procedures with 3,975 PCIs and 1,452 primary PCIs per million people. At the other end of the distribution was Kyrgyzstan undertaking 82 PCIs and 27 primary PCIs per million people (Table S26, Figure 46).

- **Stratification by National Income Status** The number of interventional cardiologists in high income countries averaged 14.7 per million people compared with 7.4 per million people in middle income countries. Interventional centres in high income countries numbered 3.0 per million people compared with 2.5 per million people in middle income countries (Table S26, Figures 47,48). Associated with these infrastructure differences was the performance of over twice as many PCIs (2,160 vs. 1,051) and 40% more primary PCIs (527 vs. 375) per million people in high income compared with middle income countries, although again Turkey and Bulgaria were outliers in performing more PCIs per million people (2,709 and 3,603) than many high income countries. (Table S26, Figures 49, 50). Transcatheter valve replacement infrastructure was also better developed in high income ESC member countries where there were more than five times as many specialist centres per million people equipped to undertake these procedures compared with middle income countries (1.1 vs. 0.2 centres) (Table S26, Figure 51).

5.1.3 Electrophysiology, Devices and Ablations – ESC Atlas

Data: Interventional cardiology infrastructure and procedures, per million people; Data source: ESC Atlas of Cardiology.
Completeness: Europe 34/39; Non-European former Russian Republics 5/9; E Med & N Africa 2/8; Year of data: 2014

- **Infrastructure** The number of electrophysiologists per million people averaged 5.0 across the 26 member countries for which data were available, ranging from <1 in Azerbaijan, Bosnia and Herzegovina, and Romania to >10 in Czech Republic, Greece, Poland and Sweden (Table S27, Figure 52).
- **Service Delivery** As the number of electrophysiologists per million people increased across ESC member countries so did the number of electrophysiological centres (Table S27, Figures 53-55), device implantations and procedures (Table S27, Figures 56-59). Pacemaker implantation per million people peaked at >1,000, in France, Italy and Sweden while implantable cardioverter defibrillator (ICD) implantation peaked at >300 per million people in Czech Republic and Germany. At the other end of the distribution with <25 pacemaker implanations per million people were Azerbaijan, Bosnia and Herzegovina and Kyrgyzstan while Albania, Algeria, Morocco, Republic of Kosovo, Republic of Moldova and Ukraine implanted <2 ICDs per million people. Ablation procedures showed huge variation across

ESC member countries, ranging from <10 per million in Albania, Algeria, Kyrgyzstan, and Morocco to >600 per million in Denmark, Germany and Switzerland (Table S27, Figures 56-59).

- **Stratification by National Income Status** The number of electrophysiologists per million people in high income ESC member countries averaged 6.5 compared with 1.5 in middle income countries, with a similar differential for pacemaker (742 vs. 153), ICD (147 vs. 19), CRT-D (64 vs. 6) and CRT-P (30 vs. 7) implantation rates per million people (Table S27, Figures 60-62). It was the high income ESC member countries where the most ablation procedures were performed, with an average five-fold higher rate compared with middle income countries (341 vs. 60 procedures per million (Table S27, Figure 63).

5.1.4 Cardiac Surgery – ESC Atlas

Table 5.3 Cardiac surgery infrastructure and procedures, per million people, 2015 or latest year, Data source: ESC Atlas of Cardiology. Completeness: Europe 34/39; Non-European former Russian Republics 6/9; E Med & N Africa 1/8. Year of data: 2015

- **Infrastructure** The number of cardiac surgeons per million people averaged 10.3 across the 36 member states that provided data, ranging from ≤4 in, Azerbaijan, Kyrgyzstan, Romania, TFYR Macedonia and to >20 in Finland, Greece and Sweden. Similar differences in the number of cardiac surgical centres per million people were recorded, ranging from ≤0.5 in Azerbaijan, Kyrgyzstan and Ukraine to >2.5 in Belgium, Cyprus, Iceland and Turkey (Table S28, Figures 64, 65).
- **Service Delivery** Coronary bypass operations averaged 362 per million across the ESC member countries that provided data, ranging from <60 in Kyrgyzstan and Republic of Moldova to >600 in Iceland, Lithuania, Netherlands and Turkey (Table S28, Figure 66).
- **Stratification by National Income Status** The number of cardiac surgeons per million people in high income ESC member countries averaged 11.7 compared with 7.3 in middle income countries. Although the number of cardiac surgical centres was similar (1.4 vs. 1.2 per million people) an average of over 35% more coronary bypass operations were performed across high income compared with middle income ESC member countries (396 vs. 291 per million people) (Table S28, Figure 67-69). Heart transplant procedures were performed almost exclusively in high income ESC member countries where an average of 3.8 per

million people underwent transplantation compared with just 0.1 per million people in low income countries (Table S28, Figure 70).

5.2 Commentary

In the absence of any evidence about what comprises optimal specialist provision, it is perhaps inevitable that countries will make their own choices as to how many cardiologists and cardiac surgeons they require. These choices are affected, at least in part, by national prosperity with a tendency towards greater specialist provision in high income compared with middle income ESC member countries. The importance of financial muscle for cardiovascular healthcare delivery is further emphasised by the other measures of cardiological and surgical activity documented in the Atlas all of which incur variable, often considerable, expense that tests resources available for healthcare in many middle income countries. Accordingly, it tends to be the more prosperous ESC member countries where rates of costly health technologies such as cardiac catheterization and coronary bypass surgery, and the number of specialist centres required to deliver them, are greatest. The Atlas confirms that these same ESC member countries where facilities for contemporary treatment of coronary disease are best developed are often those in which declines in coronary mortality have been most pronounced.

The paradox of greater cardiological provision in those countries where need is manifestly less emphasises the inequalities that, together with hypertension and smoking, must contribute to the continued imbalance in CVD mortality between high income and middle income ESC member countries. However, the Atlas also makes clear that economic resources are not the only driver for delivery of equitable cardiovascular healthcare, some middle income ESC member countries reporting rates for interventional procedures and device implantations that match or exceed rates in wealthier high income member countries. Analyses of electrophysiological activity recorded in the European Heart Rhythm Association (EHRA) White book [47] have come to similar conclusions confirming that inequitable cardiovascular healthcare is not an inevitable consequence of limited economic resource. The failure of some middle income member countries In Eastern Europe to offer reperfusion therapy to a large proportion of patients presenting with ST elevation myocardial infarction [48, 49] demands action by policy makers to reorganize service delivery by prioritizing initiatives of proven value in other healthcare settings. Examples include the development of primary PCI networks which in Poland have been associated with substantial reductions in mortality of patients with ST-segment elevation myocardial infarction [50] while promoting an invasive strategy in non-ST-segment elevation myocardial infarction which has had similar benefits in the UK [51]. A complex mix of societal, life-style and treatment factors interact to drive coronary mortality and all need to be taken account of in organising national service provision.

6. CARDIOVASCULAR DISEASE MORTALITY

Epidemiological transition has occurred at different rates across ESC member countries during the last 50-100 years as infectious disease has given way to non-communicable diseases including CVD and cancer that are now the major causes of death. The epidemiology continues to evolve with age-adjusted cardiovascular mortality now in steep decline in most of the high income countries of Western Europe with a similar but delayed pattern emerging in a number of countries further east. Whether the epidemics of obesity and type 2 diabetes currently afflicting populations across Europe will halt further declines in CVD mortality remains to be seen but at present myocardial infarction and stroke continue to dominate among causes of death. Recognition that these potentially lethal cardiovascular disorders are largely preventable provides grounds for optimism that the encouraging mortality trends in the high income countries of Western Europe will continue to spread eastwards as inequalities in prevention and treatment diminish. Monitoring of these mortality trends and definition of the inequalities between ESC member countries is a key function of the Atlas that is now having a central role in benchmarking the ESC's progress towards achieving its ambitious mission "to reduce the burden of cardiovascular disease" not only in its member countries but also in nation states around the world.

6.1 CVD Mortality

Data: Total numbers of deaths by cause, male, latest available year; WHO Mortality Database http://apps.who.int/healthinfo/statistics/mortality/whodpms/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8. Year of data: 2009-2014

In the high income countries of Western Europe, the annual number of deaths from CVD declined between 1990 and 2013, but globally deaths increased by 41% despite a 39% decrease in age-specific death rates. This increase was driven by a 55% increase in mortality due to the aging of populations and a 25% increase due to population growth [52]. The data are a reminder that CVD will remain a global threat as the world population grows and ages.

- **National Statistics** The latest available data show that CVD accounted for over 3.8 million deaths each year, or 45% of all deaths across ESC member countries. IHD was the leading cause, responsible for 1.7 million deaths (20% of all deaths) with stroke responsible for 970,391 deaths (11% of all deaths). After CVD, cancer was the next most common cause of death accounting for 1.9 million cases or 23% of all deaths (Table 29 a,b, Figures 71a,b).

- **Stratification by Sex** Using the latest available data, the number of deaths due to CVD in ESC member countries was higher in women (2.1 million) than in men (1.7 million). CVD also accounted for a larger proportion of all deaths in women (49%) compared with men (40%). This sex difference was driven largely by a greater number of women dying from stroke and 'other CVDs' (all CVD deaths excluding deaths from IHD and stroke). There were around 575,000 stroke deaths (13% of all deaths) in women, compared with 396,000 (9%) in men, and 658,000 'other CVD' deaths (15%) in women compared with 516,000 (12%) in men. By contrast, IHD mortality in women (~854,000 deaths, 20%) and men (~836,000 deaths, 19%) were more comparable. Cancer, the second most common cause of death across Europe, was responsible for just under 1.1 million deaths (25%) in men and just over 850,000 deaths (20%) in women.
- **Stratification by National Income Status** The CVD mortality burden was typically higher in middle income compared with high income ESC member countries (Figure 72). For instance, the proportion of total deaths due to CVD ranged from 25% in Israel to 75% in Ukraine among women and from 23% in France to 60% in Bulgaria among men (Tables 29a, b). However, among men in Israel and 11 high income countries (Belgium, Denmark, France, Italy, Luxembourg, the Netherlands, Norway, Portugal, Slovenia, Spain and the UK) cancer was the more common cause of death. In women, there were only two countries (Israel and Denmark), where the number of cancer deaths exceeded deaths from CVD.

6.2 Premature CVD Mortality

Data: Number of deaths under 75 years by cause, sex; Data source: WHO Mortality Database http://apps.who.int/healthinfo/statistics/mortality/whodpms/.. Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: latest available from 2009-2004

Number of deaths under 65 years by cause, sex, latest available year; Data source: WHO Mortality Database http://apps.who.int/healthinfo/statistics/mortality/whodpms/.. Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: latest available from 2009-2004

Premature deaths are of interest since many are deemed to be preventable through reduced exposure to behavioural risk factors plus timely and effective treatment. There is no standard definition, with what counts as 'premature' varying for different countries according to average life expectancy at birth. Here we employ two definitions of premature mortality to reflect the range of life expectancies across Europe: deaths before the age of 75 years and deaths before the age of 65 years.

- **National Statistics** Although around 65% of all CVD deaths in the member countries of the ESC occurred in individuals over 75 years, ~1.3 million people under 75, and ~ 635,000 under 65, died each year from CVD. This makes CVD the leading cause of premature death, responsible for 35% of deaths under 75 years and 29% of deaths under 65 years, compared with 29% (1.1 million) and 27% (607,000), respectively, from cancer. (Tables S30a,b S31a,b Figures 73a,b Figures 74a,b).
- **Stratification by Age and Sex** In contrast to deaths at all ages, fewer women than men died prematurely from CVD in the member countries of the ESC.
  - **Age <75 years** Across ESC member countries, CVD was the most common cause of premature death among men <75 years, but in women the numbers of deaths from CVD (~457,000) and cancer (~453,000) were similar. CVD caused just over half as many deaths in women compared with men (~457,000 vs. ~834,000), although the proportion of deaths caused by CVD (34%) was the same in both sexes. In both sexes, IHD was the leading single cause, responsible for ~205,000 deaths (16%) in women and ~435,000 deaths (18%) in men. Stroke was the second most common cause of death (~132,000 deaths, 10%) in women and the third most common in men (~176,000 deaths, 7%) after IHD and lung cancer (Tables S30a, b).
  - **Age <65 years** Across ESC member countries, CVD was the most common cause of premature death among men <65 years, but in women cancer was more common being responsible for around 35% more deaths. CVD caused fewer deaths in women compared with men (~176,000 vs. ~458,000). IHD was the most common single cause, accounting for ~72,000 deaths (10%) in women and ~239,000 deaths (16%) in men. Stroke, joint with breast cancer, was the second most common cause of death in women (~48,000, 7%), and the third most common in men (~86,000 6%), after IHD and lung cancer (Tables S31a,b).
- **Stratification by National Income Status** It has been the high income ESC member countries where cancer has begun to take over from CVD as the leading

cause of premature death. In Polish women aged <75 years, for example, cancer caused around 60% more deaths than CVD, while in Croatian men it caused around 20% more deaths than CVD. In people <65 years, cancer was yet more common and in a majority of ESC member countries, particularly high income countries, caused more premature deaths than CVD (Tables S30a, b, S31a, b, Figures 75,76).

6.3 Potential Years of Life Lost to CVD

Data: Potential years of life lost (PYLL) by cause, by sex, latest available year; Data source: European WHO Mortality Database http://apps.who.int/healthinfo/statistics/mortality/whodpms/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8; Year of data: latest between 2007-2014

The potential years of life lost (PYLL) provides another measure of premature mortality and is calculated by summing up deaths occurring at each age and multiplying this by the number of remaining years to live up to a selected age limit (75 years for the data presented here). In this way, PYLL adds greater weight to the deaths occurring at younger ages.

- CVD makes a considerable yet variable contribution to PYLL in the member countries of the ESC. Among men, latest available data (2007-2014) showed that CVD accounted for between 11% of PYLL in France and 39% of PYLL in Bulgaria. Among women, the contribution ranged from 7% in Iceland, Israel and Luxembourg to 33% in Bulgaria. The contribution of CVD to PYLL is lower in high income than middle income countries both for women (13% vs. 23%) and for men (20% vs. 27%) (Table S32).

6.4 CVD Mortality Rates

Data: Age-standardised mortality rates (deaths per 100,000) from IHD, all ages, by sex, 1980 to 2014; Data source: European WHO Mortality Database http://apps.who.int/healthinfo/statistics/mortality/whodpms/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8. Year of data: latest 2007-2014

Data: Age-standardised death rates (Deaths per 100,000) from stroke, all ages, by sex, 1980 to 2014: European WHO Mortality Database http://apps.who.int/healthinfo/statistics/mortality/whodpms/; Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8.; Year of data: latest 2007-2014

Age-standardisation adjusts crude mortality rates to remove the influence of different population age structures, and hence allows more meaningful comparisons to be made between countries and over time[18].

- **National Statistics Stratified by Sex** The average age-standardised mortality rates for IHD across ESC member countries (using data from 2014) were 241 per 100,000 in women and 384 per 100,000 in men. Using the latest available data, the countries with the highest rates were Belarus, Kyrgyzstan, Republic of Moldova, Russian Federation and Ukraine with rates of >500 for women and >800 for men . At the other end of the spectrum with the lowest rates were France, Luxembourg, the Netherlands, Portugal and Spain where rates were <60 in women and <120 in men per 100,000 people (Table S33). Age-standardised stroke mortality (latest available data 2014), averaged across ESC member countries, was similar between women and men (133 and 173 per 100,000 people). For individual countries, rates ranged from <55 per 100,000 women and ≤60 per 100,000 men in France, Israel, Luxembourg and Switzerland (as well as women in Spain) to >300 per 100,000 people for both sexes in Bulgaria, Kyrgyzstan, Russian Federation and TFYR Macedonia (also men in Republic of Moldova) (Table S34). Trends for IHD and stroke were similar among people below 65 years of age (Table S35,36).
- **Temporal Changes by National Income Status** Paired prevalence data for IHD mortality in 1985 and 2010-2014 (most recent estimate) were available for 38 ESC member countries. During that period, the average age-standardised mortality declined from 374 to 209 deaths per 100 000 in women and from 586 to 339 deaths per 100 000 in men (Table S37, Figures 77a,b). All of the 27 high income countries for which paired data were available recorded a decline in mortality, averaging 286 to 129 deaths per 100 000 in women and 508 to 227 deaths per 100 000 in men. In middle income countries, the average mortality also declined during this period in both women (591 to 405 deaths per 100 000) and men (779 to 614 deaths per 100 000). At a national level, however, the pattern was inconsistent and while many countries showed variable reductions in mortality, it increased in Kyrgyzstan and Bosnia and Herzegovina in both women and men and also in men from Ukraine (Table

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[18] It should be noted that the mortality rates presented here are standardised for population age structure only. Differences between countries and over time in migration and other aspects of population composition may still confound comparisons.

S37). There have been similar trends in age-standardised stroke mortality, with steady declines occurring since the 1980s in most high income ESC member countries and more recent declines in middle income countries (Table S34). Trends in premature (<65 years) IHD and stroke mortality have also been similar, with consistent declines in the high income member countries of the ESC, and more volatile trends in middle income countries.

6.5 CVD Mortality and National Economic Measures

Data: Data: Age-standardised mortality rates (deaths per 100,000) from IHD/Stroke, and GDP per capita in US$ (PPP); Data source: European WHO Mortality Database http://apps.who.int/healthinfo/statistics/mortality/whodpms/ and World Bank (WB) (http://data.worldbank.org/indicator); Completeness: Europe 37/39; Non-European former Russian Republics 9/9; E Med & N Africa 1/8. Year of data: latest between 2007-2014

- **Mortality and Gross Domestic Product** Across all ESC member countries there was a negative association between age-standardised CVD mortality rates and gross domestic product (GDP) per capita adjusted for purchasing power parity (PPP)[19]. For example, Luxembourg, which has the highest per capita GDP in Europe, had the seventh lowest IHD death rate among men, while the third highest IHD death rate in men was found in Kyrgyzstan, the poorest European country (Figure 78). There were exceptions: Russian Federation in particular stood out as a country with a relatively high IHD death rate (790 deaths/100 000) for its level of economic development (GDP per capita US$ 25,636). In general, the negative relationship was clear and was consistent for women and men and for premature (<65 years) as well as total death rates.
- **Mortality and Total Health Expenditure** The total health expenditure per capita is a more health service specific economic indicator than GDP but like GDP showed a negative association with age-standardised CVD mortality rates across ESC member countries. Data for men in Figure 78 show that high spending countries like Switzerland, Norway and Luxembourg enjoy IHD mortality rates among the lowest in Europe, while Kyrgyzstan, which spent least on health of any ESC member country, had the third highest IHD mortality rate (Figure 79). The negative association was consistent for men and women and for premature (<65 years) as well as total death rates (not shown). However, this relationship was not

[19]. Various factors are likely to underlie the associations in section 6.5, and we make no attempt here to infer possible causal pathways.

uniform across the continent. For example, in Russian Federation the death rate from stroke in men was more than four times that in Estonia despite similar total health expenditure (US$ 1423 and $1453 per capita respectively).

- **Mortality and Relative Health Expenditure** The association between cardiovascular disease mortality rates and total health expenditure as a proportion of GDP was also negative, but was noticeably weaker than that with GDP per capita or with total health expenditure per capita. For a given proportion of GDP spent on health, European country death rates from IHD and stroke varied widely. Kyrgyzstan and Cyprus both spent approximately 7% of GDP on health, yet of all European countries Kyrgyzstan had the highest death rate from stroke in women <65 years and Cyprus had the joint second lowest. Similar weak, negative associations with health expenditure were seen for all cause and IHD mortality in men (not shown).

6.6 Commentary

The statistics recorded within the Atlas suggest that the steep declines in CVD mortality across high income European countries during the last 50 years are now beginning to become established in many middle income countries. However, huge inequalities persist with CVD accounting for >50% of all deaths in many middle income countries compared with <30% in the high income countries of Western Europe. Declines in CVD mortality have been driven largely by reductions in the numbers of people presenting with myocardial infarction and stroke, with health gains, particularly in the more prosperous countries of Western Europe, tending to offset the effects of population ageing and growth [52]. The erosion of these health gains by the obesity epidemic and type 2 diabetes, however, is a tragedy waiting to happen and already there are concerns about plateauing of cardiovascular mortality rates in younger adults [53].

The Atlas data confirm that more women than men – and a greater proportion of women than men – are dying from CVD. Indeed, while CVD remains the most common cause of death across all ESC member countries, cancer has now overtaken CVD as the most common cause of death among men in a number of high income ESC member countries. The same is true for women aged <65 years for whom cancer is now the most common cause of death in countries across Europe. In these younger women, however, deaths from CVD continue to dwarf deaths from breast cancer. Most of these CVD deaths in young women are preventable through modification of risk factors [20], prompting recent comment that “if the effort put into the detection of breast cancer could be matched in protecting young women against CVD, particularly AMI and stroke, many more lives would probably be saved“ [7].

Analysis of age-standardised mortality rates for IHD confirms the inequalities between high and middle income ESC member countries. These are not trivial with rates in Ukrainian men and women, for example, respectively 14 and 23 times greater than in France. Importantly, the data begin to show evidence of consistent declines in mortality rates across nearly all of the middle income member countries of the ESC since the start of the new millennium. These encouraging trends need reinforcement by policy initiatives such as smoking legislation and programmes to tackle hypertension and dyslipidaemia that have been successfully applied in many countries and have probably contributed as much, if not more, to declining CVD mortality, as the development of specialist treatments and interventions in patients with established disease[1].

Associations in the Atlas between national CVD mortality rates and economic measures are not unexpected and must reflect, at least in part, the socioeconomic gradients in disease incidence and mortality that others have reported [54, 55]. However, the Atlas also suggests that economic resources are not the only driver of health outcomes, as exemplified by Russian Federation where the death rate for stroke is more than four times the rate in Estonia despite similar per capita health expenditure. It needs emphasizing that inequitable health outcomes are not an inevitable consequence of limited economic resource.

Disclaimer: The main purpose of the Atlas is to map the status of the ESC member countries from a cardiovascular point of view. Such data can be useful to provide a broad profile and to identify inequalities and disparities between middle income and high income ESC countries, in order to draw attention to the need for investing more resources into proper implementation of guidelines and into increasing the standards of CVD care. Although sources of data are clearly referenced throughout the report, the summaries, interpretations, and conclusions are those of the authors. The ESC Atlas comprises national level data coming from a variety of different sources that have been processed using different methods such that data quality is variable. ESC countries exhibit different socioeconomic, risk and and disease prevalence dynamics and hence the data contained in the present publication should be used responsibly and with caution.

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