ESC Cardiovascular Realities 2024

An Illustrated Atlas of Key European Statistics

ESC
European Society
of Cardiology

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An Illustrated Atlas of Key European Statistics

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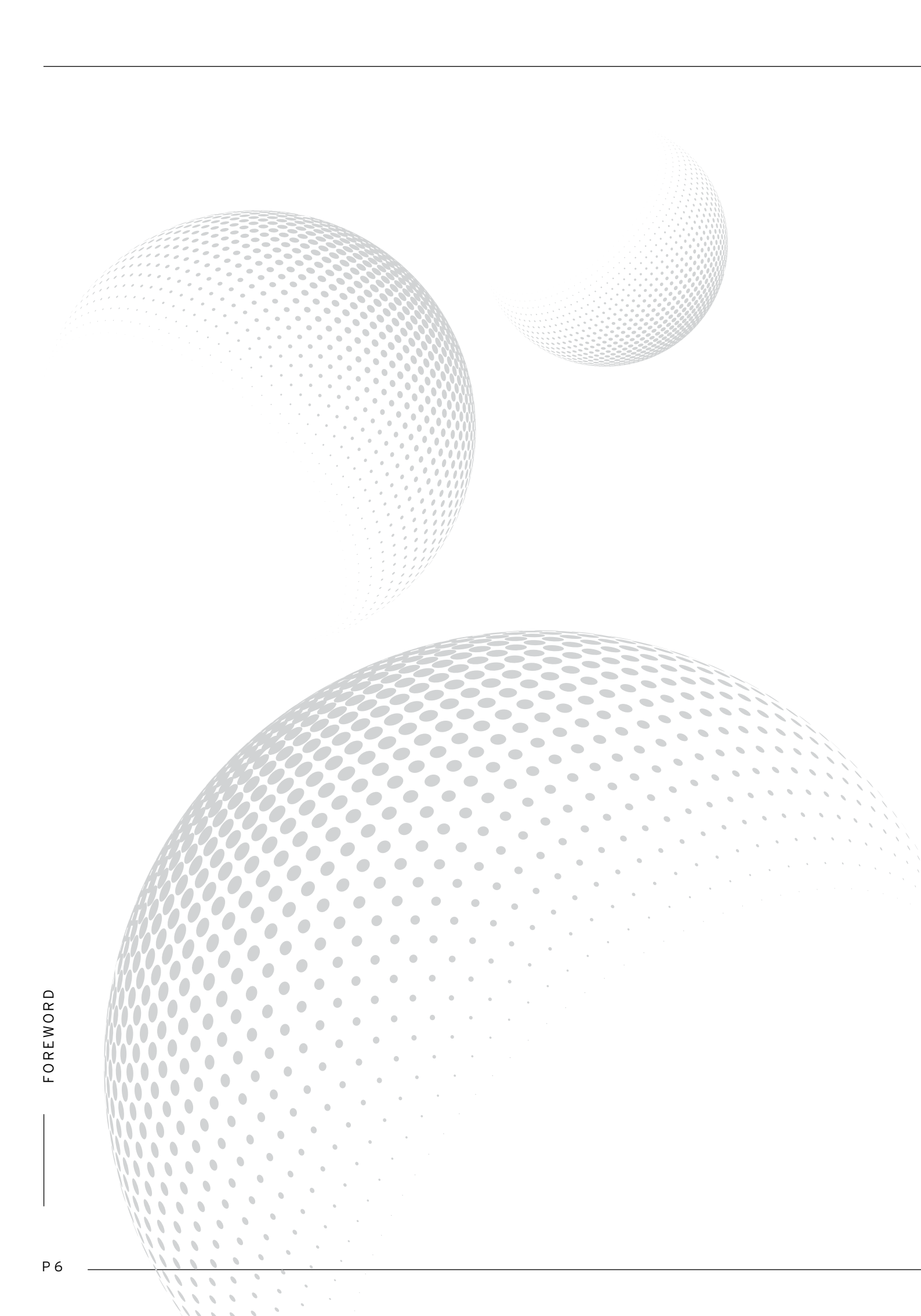


FOREWORD

Dear colleagues,

The mission of the European Society of Cardiology (ESC) is to reduce the burden of cardiovascular (CV) disease. Myocardial infarction, stroke and sudden death remain the most important causes of morbidity and mortality in European countries and the world at large. To achieve its mission, the ESC provides comprehensive education for physicians around the world, presents recent scientific findings in its congresses, journals and textbooks, provides recommendations for optimal CV care in guidelines and collects data of real world clinical practice with its registries.

An important task of the ESC is to inform on the gap between clinical practice in its member states and the recommendations of the ESC Clinical Practice Guidelines. Accessibility to modern diagnostics and therapeutics for all European citizens is a top priority for our society. To address this, real world data are essential to improve patient care along recommended standards. Indeed, without the insights into current practice that the ESC Cardiovascular Realities 2024 provide, strategies to close the gap at the local, political and European level cannot be envisaged nor implemented.

The present edition of the ESC Cardiovascular Realities 2024, a biennial report provided by our society, aspires to support not only ESC Advocacy at the European level, but also those involved in decision-making and implementation of CV care in our member states such as National Cardiac Societies, local politicians, health care specialists, journalists and key opinion leaders.

The content of the ESC Cardiovascular Realities 2024 is based on two emblematic projects of our society, the ESC Atlas of Cardiology and the Burden of Disease Project in collaboration with Oxford University. It is hoped that these unique data will help to shed light on the disparities of health care at the national or regional level throughout Europe and set the stage for further improvement of CV care to the benefit of our patients.

Closing the gap is and must be a continuing effort of a multitude of ESC volunteers and excellent staff who have a strategy, energy and professionalism to successfully continue to reduce the burden of cardiovascular disease.

Sincerely yours,
Thomas F. Lüscher, MD, FRCP, FESC
ESC President

CARDIOVASCULAR REALITIES 2024 is a publication of the European Society of Cardiology. It is based primarily on two earlier publications of the European Society of Cardiology:
(1) Timmis A. et al, "European Society of Cardiology: the 2023 Atlas of Cardiovascular Disease Statistics", Eur Heart J, 2024. doi: 10.1093/eurheartj/ehae466. Manuscript accepted for publication.
(2) Ramon Luengo-Fernandez et al, "Economic burden of cardiovascular diseases in the European Union: a population-based cost study", Eur Heart J, Volume 44, Issue 45, 1 December 2023, Pages 4752–4767, https://doi.org/10.1093/eurheartj/ehad583

DISCLAIMER: The main purpose of the ESC Atlas of Cardiology and particularly ESC Cardiovascular Realities 2024 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 member countries, 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. ESC member countries exhibit different socio-economic risk and disease prevalence dynamics hence the data contained in the present publication should be used responsibly and with caution.

DATA PRESENTATION: National CVD-related indicators are illustrated using bar charts or choropleths. Time series data are illustrated using a locally-weighted polynomial smoother (LOWESS). Box plots are used for displaying summary statistics in high-income and middle-income ESC member countries. Summary statistics for groups of countries are presented as medians.

Acknowledgements

We would like to acknowledge the National Cardiac Societies of the following ESC member countries for their contributions and help in developing national healthcare and infrastructure data: Armenia, Algeria, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lebanon, Lithuania, Luxembourg, Malta, Netherlands, Republic of North Macedonia, Norway, Poland, Portugal, Georgia, Republic of Kosovo, Moldova, Romania, Republic of San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Türkiye, Ukraine, United Kingdom, Uzbekistan.

For support in developing the ESC Atlas: Dennis Boateng, Blanca Elizondo, Ganna Momotyuk.

All the figures are based on two previous publications from European Society of Cardiology: (1) European Society of Cardiology: the 2023 Atlas of Cardiovascular Disease Statistics, European Heart Journal 2024, doi: 10.1093/eurheartj/ehae466 by Timmis A, Aboyans V, Vardas P, et al and (2) Economic burden of cardiovascular diseases in the European Union: a population-based cost study, European Heart Journal, Volume 44, Issue 45, 1 December 2023, Pages 4752–4767, https://doi.org/10.1093/eurheartj/ehad583 by Ramon Luengo-Fernandez et al. The figures (1-17) were provided by permission of Oxford University Press on behalf of the European Society of Cardiology.

This work has been enhanced by some of the more recent data from well-known organisations, such as the World Bank, the World Health Organization, the Organisation for Economic Co-operation and Development, European Environment Agency and Institute for Health Metrics and Evaluation.

TABLE OF CONTENTS

INTRODUCTION

Welcome to the 2024 biennial edition of our cardiovascular statistics booklet, brought to you by the European Society of Cardiology (ESC). This comprehensive 84-page guide aims to present the latest cardiovascular data in an accessible manner, ensuring that even complex statistics are understandable to a broad audience. Our goal is to provide insights that inform decision-making, drive improvements in cardiovascular care, and ultimately contribute to better health outcomes across Europe and beyond.

Cardiovascular disease (CVD) continues to be the leading cause of death and disability in Europe, presenting a significant public health challenge. Despite advances in medical research and healthcare, the incidence of CVD is on the rise, affecting millions of individuals and placing a substantial economic burden on healthcare systems and economies across the continent. The statistics presented in this booklet help illustrate the scale of the problem and underscore the urgent need for effective strategies in prevention and management.

In this edition, we present the latest data on incidence and prevalence of various cardiovascular disorders, including coronary artery disease, stroke, and heart failure. These disorders not only have a profound impact on individuals' quality of life but also contribute to significant healthcare costs and loss of productivity. By examining these data, we aim to highlight key trends and identify areas where interventions can be most effective.

Demographic variations play a crucial role in understanding the burden of CVD. This booklet highlights disparities across different age groups, genders, and regions within Europe and beyond. For example, we explore how age and gender influence the risk of developing CVD, and how regional differences in healthcare access and lifestyle factors contribute to varying incidence rates. Understanding these disparities is essential for developing targeted interventions that address the specific needs of different populations.

The economic burden of CVD is another critical aspect covered in this booklet. We detail the direct and indirect costs associated with CVD, including healthcare expenditure, hospitalisations, medications, and loss of productivity due to illness or premature death. The broader societal impact, including the emotional and financial strain on families and communities, is also considered. By quantifying these costs, we aim to provide a comprehensive picture of the economic impact of CVD and emphasise the importance of investing in prevention and early intervention.

The metrics we present are indispensable for the planning and implementation of cardiovascular health strategies. Accurate and up-to-date statistics enable policymakers, healthcare providers, and researchers to allocate resources efficiently, design targeted interventions, and monitor the progress of public health initiatives. This booklet provides a comprehensive overview of these essential metrics, including incidence and prevalence rates, mortality rates, and healthcare utilisation statistics. These metrics offer valuable insights that inform decision-making and help track the effectiveness of various health interventions.

As you navigate through the pages of this booklet, we hope you find the information both enlightening and practical. Our aim is to make complex data accessible and to highlight the real-world implications of these statistics. By raising awareness and enhancing our collective understanding of cardiovascular health, we can work towards reducing the burden of CVD and improving the quality of life for millions of Europeans.

In conclusion, the ESC is committed to advancing cardiovascular health through research, education, and advocacy. We believe that informed decision-making, based on accurate and comprehensive data, is key to tackling the challenges posed by CVD. This booklet is a testament to that commitment, and will serve as a valuable resource for all stakeholders involved in cardiovascular health.

Metrics are indispensable for the planning and implementation of cardiovascular health strategies. Accurate and up-to-date statistics enable policymakers, healthcare providers, and researchers to allocate resources efficiently, design targeted interventions, and monitor the progress of public health initiatives.

MESSAGES

Salient Statistics from the ESC Atlas include:

Median life expectancy across ESC member countries increased between 1970 and 2021 **from 69.1 to 76.4 years.**

The **highest birth rates** among ESC member countries are **observed in middle-income countries such as Egypt** (2.9 births per woman), **Algeria and Syrian Arab Republic.** Only **Israel** among high-income countries has comparable birth rates (2.9 births per woman).

Cardiovascular Disease represented (2021) **a cost of €630 per person**, ranging from €381 in Cyprus to €903 in Germany.

CVD is estimated to cost the EU 282 billion euros annually, with health and long-term care accounting for 155 billion euros (11% of EU health expenditure).

The proportion of the **population aged >65 years** is predicted to **exceed 30% in EU countries** by the end of the century.

The **median number of births per woman** across ESC member countries **has declined from 2.6 in** 1970 **to 1.5** in 2023.

EDITORIAL

The Atlas metrics in the era of evidence-based cardiovascular care

Panos E. Vardas
Professor of Cardiology,
University of Crete,
Greece

Over the past decades, it has become increasingly clear that the significant demands for quality and modern health care come at a cost and must be based on proper health care planning, where needs, realities, and cost-effectiveness are prioritised.

Evidence-based health care is based primarily on well-standardised data and reliable metrics, indicators capable of highlighting long-term trends, emerging new realities, and effective policies for the prevention and treatment of disorders that constitute the spectrum of cardiovascular diseases.

The strategic ESC Atlas of Cardiology project, which maps needs and compares from a cardiovascular perspective the burden of CV diseases in ESC member countries, as well as the status of health care systems, has been widely recognised as a pivotal tool for leveraging cardiovascular care. It presents the evidence of trends, disparities, gaps, and associations between fundamental variables.

In Brussels, over the past 11 years, our society has been significantly active in supporting evidence-based initiatives capable of reducing the burden of CVD in ESC member countries, but even beyond, as befits a scientific society of the size and prestige of the ESC.

Undoubtedly, advocacy is the spearhead of this effort. However, any kind of credible advocacy, presupposes in-depth knowledge of the realities of cardiovascular medicine and care, all those factors that compose the realities in ESC member countries of our society and concern one billion, one hundred sixty-four million citizens!

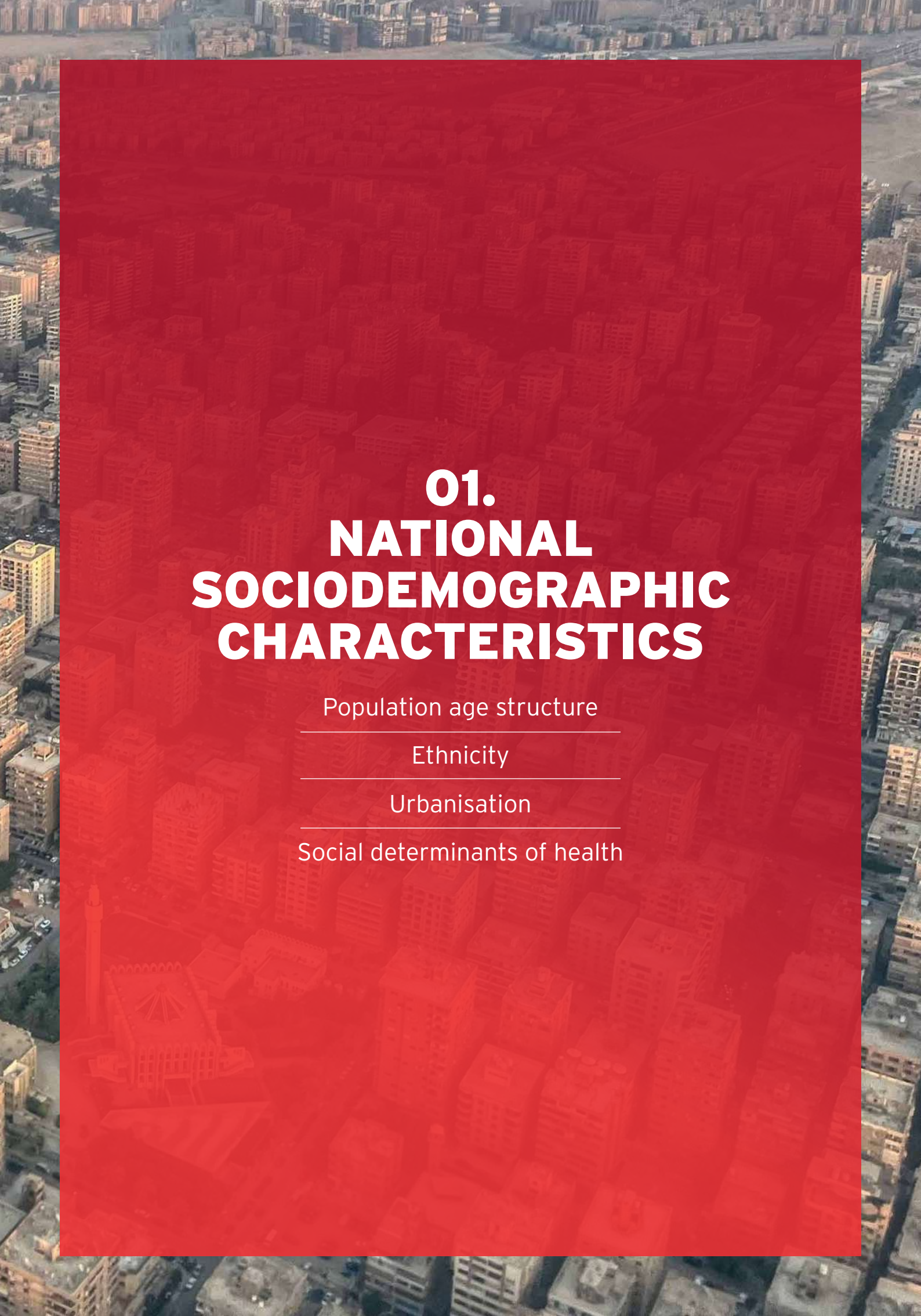
Ethical considerations compel us to prioritise improvements in prevention of CVD and conditions of care for everyone, those at significant disadvantage in enjoying the modern achievements of pharma and biotechnologies in our domain.

At the same time, our society needs to strategically study in-depth geopolitical and socio-economic conditions and examine the impacts of aging populations that are most prevalent in Western European countries.

Degenerative CVD will progressively burden morbidity, disparities, and mortality, as well as health care costs.

The ESC, through the European Heart Health Institute in Brussels where the ESC Atlas of Cardiology and Burden of CVD projects were created, needs to steadily monitor the evolving realities, needs, and conditions of CV health care and responsibly advocate to those, at the state or European Union level, who have responsibility for planning and implementing health policy.

This is what the times and our humanitarian values demand.



01. NATIONAL SOCIODEMOGRAPHIC CHARACTERISTICS

Population age structure

Ethnicity

Urbanisation

Social determinants of health

NATIONAL SOCIODEMOGRAPHIC CHARACTERISTICS

Cardiovascular diseases, resulting from the combined effects of genetic predisposition, comorbid disorders such as diabetes and dyslipidaemia, harmful lifestyles and adverse environmental conditions, have emerged over the past sixty years as a leading cause of morbidity and mortality.

The tireless efforts of a range of scientific organisations and governmental bodies, along with an important contribution from healthcare professionals, have led to reductions in CVD mortality in many ESC member countries, particularly those in Western Europe. CVD becomes progressively more common with increasing age and there is a continuing high prevalence of disease driven by the ageing populations of many ESC member countries. However, age-standardised mortality due to CVD has declined in high-income ESC member countries the last 30 years but continues to increase in many of the middle-income countries where a substantial proportion of the disease burden now resides.

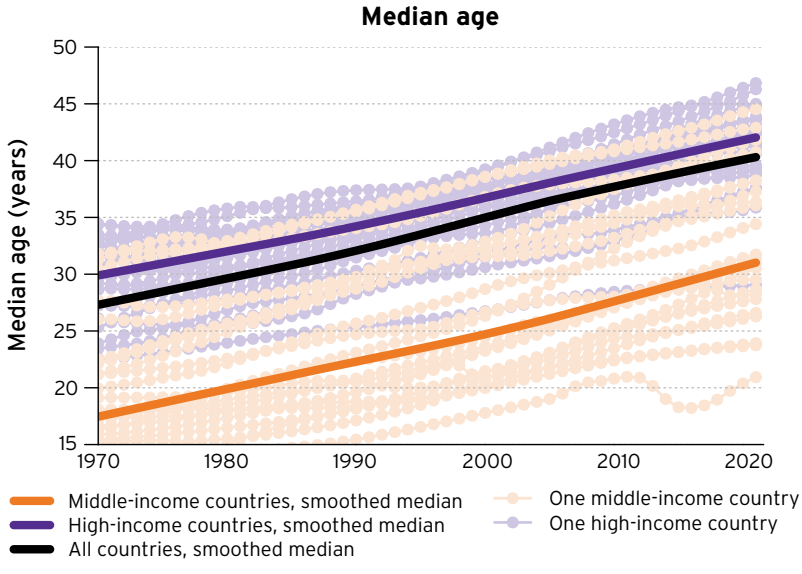
In focusing on the sociodemographic characteristics of ESC member countries, which together have a population of over 1 billion citizens, it is necessary to consider other factors in addition to ageing, including ethnicity, immigration, urbanisation and socioeconomic status, as well as environmental and climate changes, which critically influence the burden of cardiovascular diseases and levels of cardiovascular care.

a. Population age structure across ESC member countries

Ageing as a demographic phenomenon concerns all ESC member countries. It is characterised by a decrease in fertility and an increase in life expectancy. The median population age of ESC member countries increased significantly between 1970 and 2021, from 27.7 to 41.6 years (Figure 1) with the proportion of over 65s increasing from 9.1% to 18.1%. In 2021, the proportion of population aged >65 in middle-income ESC member countries was 9.6%. In high-income countries the proportion of population aged >65 was twice as high at 20.0% (Figure 2). Trends were similar in middle-income and high-income countries but median age during this period was always lower in middle-income countries, reaching 31.4 years in 2021 compared with 43.6 years in high-income countries.

It is interesting to note that with population ageing comes an increase in CVD from 40% in adults aged 40-59 years, 75% in those 60-79 years, and 86% in those over 80 years.

FIGURE 1 **Median age (years) of the population of ESC member countries (1970-2021).**

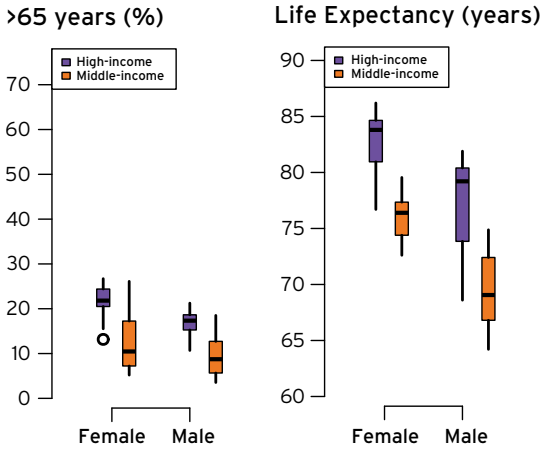


Data source: United Nations, Population Division, https://population.un.org/wpp/Download/Files/1_Indicators%20(Standard)/EXCEL_FILES/1_Population/WPP2019_POP_F05_MEDIAN_AGE.xlsx

Life expectancy

Median life expectancy across ESC member countries increased between 1970 and 2021 from 69.1 to 76.4 years. During this period, it was consistently shorter for middle-income compared with high-income countries, reaching 72.1 vs 81.2 years in 2021.

FIGURE 2 **Age distribution (>65 years) and life expectancy in ESC member countries, stratified by national income status (2021).**



Data source: World Bank, https://datatopics.worldbank.org/world-development-indicators. Data not available: Republic of San Marino.

Fertility

The median number of births per woman across ESC member countries has declined from 2.6 in 1970 to 1.5 in 2023. An average of 2.1 live births per woman is needed for each generation to exactly replace itself without international immigration. The fertility rate varies significantly among the member countries of our society, as do the trends in each country over the past decade. The highest birth rates are observed in middle-income countries such as Egypt (2.9 births per woman), Algeria, and Syrian Arab Republic with only Israel among high-income ESC member countries having comparably high rates (2.9 births per woman). In the high-income countries of the European Union birth rates are lower, ranging from 1.1 - 1.8 births per woman in Malta and France, respectively.

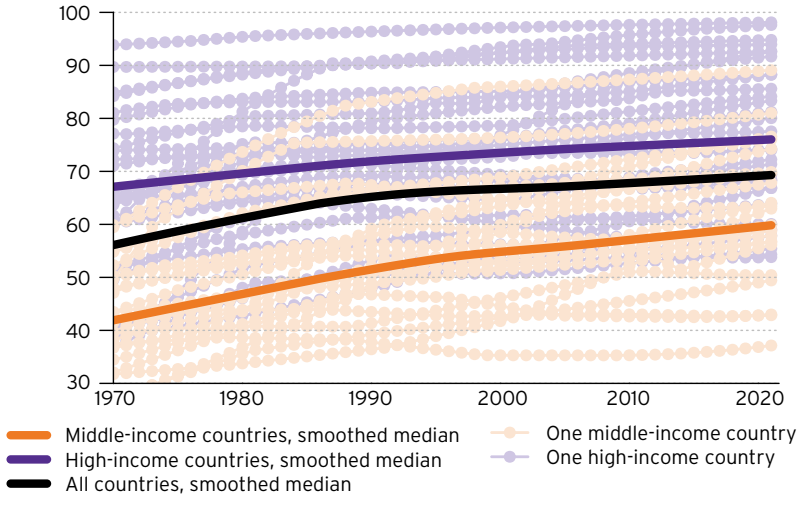
b. Ethnicity

Health inequalities among ethnic and immigrant groups have long been recognised. Available evidence suggests that migrants in Europe and North America, the two largest recipients of international immigrants from low-resource regions in the world, are at higher risk of developing CVD compared with the host population. This reality is related to pre- and post-migration factors such as socioeconomic status, cultural factors, lifestyle, psychological stress, access to healthcare, language issues, and healthcare usage. Some of these pre- and post-migration environmental factors may interact with genetic (epigenetic) and microbial factors, influencing their cardiovascular risk. Engaging migrants in population and clinical research is pivotal to bridging gaps in inequality. It must be a priority of ESC advocacy that ethnic differences in the incidence and management of CVD are identified and progressively eliminated.

c. Urbanisation

The world during the last sixty years has entered an age of urbanisation, with consequences poorly estimated. It is expected that at the end of the current century, 80% of the world population will be urbanised according to the European Investment Bank. Focusing on Europe, it is recognised that cities with a population of <250,000 citizens account for 28% of the city residents, lower than in Africa (33%), but higher than in North America (17%). Across ESC member countries the proportion of people living in urban environments increased from 52.2% in 1970 to 69.6% in 2021 as transition continued from agricultural to manufacturing and service economies (Figure 3). Urbanisation is more advanced in high-income countries where 76% of people live in urban environments compared with 61% in middle-income countries. Urban living threatens CV health due to over-crowding, air pollution, social deprivation and stress. It can also remove the autonomy of

FIGURE 3 **Proportion of population living in urban areas ESC member countries (1970-2021).**



Data source: World Bank, https://datatopics.worldbank.org/world-development-indicators. Data not available: Republic of Kosovo.

individuals to make healthy choices, with foods high in salt, sugar and fats often more cheaply and readily available than fresh fruit and vegetables. The World Heart Federation (WHF) has called for city planners to develop infrastructures to facilitate heart-healthy behaviours, stating that policies and strategies that allow individuals to adopt healthy behaviours and avoid unhealthy ones are crucial to successful urbanisation.

d. Social determinants of health

The Social Determinants of Health (SDOH), often also called socioeconomic status, are those nonmedical factors that influence health outcomes. They are the conditions in which people are born, grow, work, live, and age. According to the Center for Disease Control and Prevention (USA), the SDOH can be grouped into five domains: Economic Stability, Education Access and Quality, Health Care Access and Quality, Neighborhood and Built Environment, and Social and Community Context. People who experience conditions below average in one or more of these domains are impacted in their overall health and well-being.

TABLE 1. Sample indices of socioeconomic status

GDP PER CAPITA ($)		COMPLETED 2º EDUCATION (%)		NATIONAL UNEMPLOYMENT RATE (%)	
Middle-income	High-income	Middle-income	High-income	Middle-income	High-income
15.6K	48.3K	68.3%	77.4%	11.1%	6.2%

Data source: World Bank, https://datatopics.worldbank.org/world-development-indicators. Data not available: (A) GDP per capita - Syrian Arab Republic, (B) Completed secondary education - Republic of Kosovo, Morocco, (C) National unemployment rate - Republic of Kosovo, Republic of San Marino.

Socioeconomic status is by definition lower in middle-income ESC member countries where access to healthy life choices and high-quality healthcare is reduced compared with high-income countries.

MESSAGES

The populations in ESC countries are aging, with today **a percentage of 18.1%** consisting of people over 65 years old.

The median number of births per woman across ESC member countries has declined from 2.6 in 1970 to 1.5 in 2023.

The incidence of cardiovascular diseases and their management is significantly affected primarily by socioeconomic determinants such as **income, education, and job quality**. It is obvious that, despite the generalised needs in all member countries of our society, those 25 countries that belong to low or middle-income countries (WB, 2021) require immediate support.

It is well accepted, although not extensively documented, that there are health inequalities among ethnic and **immigrant groups**. Detailed records are needed to determine the extent of the problem.

> There is no one size that fits all. We must work country by country, region by region, community by community, to ensure the diversity of needs are addressed to support each reality.

Amina J. Mohammed
Deputy Secretary-General, UN, 2017-present

EDITORIAL

Cardiovascular Disease Prevention Amid the Challenge of Sociodemographic Change

Mika Kivimäki
Professor and Chair of Social Epidemiology, University College London, UK

The ESC Atlas of Cardiology summarises key evidence on the burden and prevention of cardiovascular diseases, which are among the leading causes of death and disability worldwide. Understanding the latest trends in incidence, prevalence, mortality, and risk factors is essential for future healthcare and health policy planning.

In recent decades, significant progress has been made in CVD prevention. The Global Burden of Disease study shows that age-standardised years of life lost to CVD in high-income countries have declined more rapidly than those for other major causes of death. In middle- and low-income countries, while the greatest progress has been made in communicable disease prevention, there have also been notable reductions in CVD-related mortality.

Despite these advancements, the number of CVD patients continues to rise, driven by population growth and demographic changes. Declining fertility rates have increased the proportion of older people, and longer life expectancies further accelerated population ageing. Additionally, the obesity pandemic, air pollution and urbanisation have contributed to the growing CVD burden.

The ESC Atlas of Cardiology indicates that approximately 70% of CVD cases are linked to 14 modifiable risk factors. Eliminating these factors could prevent or delay most CVD events. While complete elimination is ideal, interim targets should focus on reducing these factors to levels observed in populations with the lowest CVD incidence.

High socioeconomic status (SES) groups have lower levels of most modifiable CVD risk factors and can serve as benchmarks. The PURE study shows a significantly lower CVD risk among high compared to low SES individuals across countries of varying income levels: 20% in high-income countries, 37% in middle-income countries, and 55% in low-income countries. This suggests that prevention could lead to substantial health improvements globally.

Many individuals who could benefit from preventive medications like statins and antihypertensives do not receive these drugs, which is why the idea of offering a polypill to everyone aged 50 or older has been introduced. Promising pharmacological treatments for obesity, a major CVD risk factor, are also under development. Future prevention efforts should better leverage these medications and approaches. Equally crucial are more effective measures to address upstream socioeconomic and environmental risk factors. These include policies to encourage healthy eating, limit alcohol consumption, reduce tobacco use, promote physical activity, and combat climate change and air pollution.

The data summarised in the Atlas should encourage healthcare professionals and policymakers to place greater emphasis on comprehensive CVD prevention.

02. ENVIRONMENTAL RISK FACTORS

Air pollution

Noise pollution

Climate change

Chemicals and cardiovascular disease

Second-hand smoke

ENVIRONMENTAL RISK FACTORS

The environment, a surrounding complex of interacting ecosystems, exerts a fundamental influence on the quality and longevity of human life.

Among the numerous factors and conditions that constitute the environmental ecosystems, those primarily related to health burden are air pollution, noise, climate change, chemicals, and second-hand smoke.

The European Environment Agency estimates that nearly 20% of all CVD deaths are attributable to key environmental factors although there is considerable heterogeneity with a higher proportion of deaths related to environmental factors estimated in eastern and southeastern ESC member countries.

a. Air pollution

Air pollution is a major health hazard responsible for an estimated 7.6% of global deaths annually, rivaling the impact of smoking, hypertension, and physical inactivity on population health. It is caused by a mixture of harmful substances including particles and gases that are released into the atmosphere primarily from human activity. Particulate matter is further categorised according to size into coarse particles (PM10 < 10 µm in diameter), fine particles (PM2.5 < 2.5 µm in diameter), and ultrafine particles (0.1 µm in diameter). PM2.5 and nitrogen oxide are among the most frequently cited pollutants associated with development of CVD. Their inhalation leads to inflammation, vasoconstriction, and endothelial dysfunction which increases the risk of myocardial infarction, arrhythmias, and heart failure with increased cardiovascular mortality.

Air pollution reduces the mean life expectancy in Europe by an estimated 2.2 years. In developing its air pollution policy, the EU has set an annual PM2.5 exposure limit of 25µg/m^3. Only three EU member states failed to register concentrations below this rather conservative target in 2020, in contrast to the more challenging WHO target of ≤5µg/m^3 which only Estonia managed to achieve.

Air pollution is now high on the political agenda of the European Union. In October 2022, the European Commission published a proposal for a revision of the ambient air quality directive, which includes:

1. Stricter thresholds for pollution
2. Enhancing the right to clean air
3. More active penalties and compensatory possibilities for violating air quality rules
4. Strengthened rules for air quality monitoring
5. Requirements to improve air quality modelling
6. Better public information

On April 24, 2024, the European Parliament took a major step forward in addressing the key environmental and health challenges of air pollution by adopting the revised provisional EU-WHO political agreement on air quality in the EU.

b. Noise pollution

The role of noise as an environmental pollutant and its impact on health has been scrutinised since the early 20th century. The problem, especially in modern metropolitan areas, has become an increasing concern for major international and governmental health organisations such as the WHO and the EU, particularly through the European Environment Agency (EEA), that have drawn attention to the harmful effects of noise pollution.

A 2015 report from the EEA linked exposure to noise from cars, trucks, planes, and trains with nearly 1.7 million additional cases of hypertension, 80,000 additional hospital admissions, and 1,800 premature deaths from coronary artery disease and stroke in Europe each year.

The EU has set permissible noise levels in residential areas at 55 dB during the daytime and 50 dB at night. These limits are often exceeded, and noise exposure above 55 dB might affect up to 40% of the EU population. Noise induces stress and disturbs sleep, predisposing individuals to coronary heart disease (CHD), with the risk increasing by 6% for every 10 dB increase in day–night noise levels. These adverse cardiovascular consequences of noise appear to be driven by small elevations in blood pressure, triglycerides, and glycated hemoglobin that occur with exposures above 65 dB. It is estimated that a 5 dB reduction in environmental noise across the USA would reduce incident cases of hypertension and cardiovascular disease by 1.2 million and 279,000 cases per year, respectively.

c. Climate change

Climate change refers to the long-term deviation of temperature trends and weather conditions from seasonal averages. Over the past two centuries, the excessive production and emission of greenhouse gases and other air pollutants into the atmosphere have significantly contributed to climate change and global warming. The impact of climate change on cardiovascular health varies across demographic and socioeconomic subgroups but is likely more profound in vulnerable subgroups. Extreme temperature exposure, both cold and hot, has been linked to a higher risk of myocardial infarction and cardiovascular mortality in many studies. High mean annual temperatures have also been associated with elevated fasting plasma glucose levels, insulin resistance, and an increased incidence of diabetes.

d. Chemicals and cardiovascular disease

Exposure to chemicals present in the workplace or released into the environment may also increase cardiovascular risk. These include heavy metals, organic solvents, and chemical air pollutants like polycyclic aromatic hydrocarbons, benzene, and pesticides. There is also evidence of adverse effects on cardiovascular health from occupational exposures to carbon monoxide, mineral dusts, dioxins, and nitrated explosives.

e. Second-hand smoke

Second-hand smoke exposure occurs when people breathe in smoke exhaled by smokers or from burning tobacco products. The smoke contains many noxious chemicals including known carcinogens. There is no safe level of exposure to second-hand smoke; even brief exposure can cause serious health problems. According to the Centers for Disease Control and Prevention (CDC, USA) and other regulatory authorities, health problems caused by second-hand smoke in adults who do not smoke include coronary artery disease, stroke, and lung cancer, as well as adverse reproductive health effects in women. Second-hand smoke increases the risk of heart disease by ≈30%, accounting for at least 35 000 deaths annually in the United States. Additionally, second-hand smoke can cause sudden infant death syndrome (SIDS). Recognition of the harmful effects of second-hand smoke led to the widespread implementation of national smoking legislation across ESC member countries with salutary effects on the incidence of ST elevation myocardial infarction.

MESSAGES

For every 10 µg/m³ increase in PM2.5, the risk for cardiovascular death increases by nearly 2%.

The role of noise as an environmental pollutant and its impact on health are being increasingly recognised.

Adults who do not smoke and are exposed to second-hand smoke increase their risk of developing coronary artery disease by 25-30% and stroke by 20-30%.

Environmental noise is associated with an increased incidence of arterial hypertension, myocardial infarction, and stroke.

One day mankind will have to fight burden of noise as literally as plague and cholera.

Robert Koch, 1843-1910
Physician and Nobel Prize Laureate 1905

EDITORIAL
Environmental Risk Factors and Cardiovascular Disease

Thomas Münzel
Professor of Cardiology, Johannes Gutenberg University Mainz, Germany

Cardiovascular disease remains a leading cause of morbidity and mortality globally. While traditional risk factors like hypertension, diabetes, chronic smoking, and hyperlipidemia are well-known, environmental risk factors also significantly impact cardiovascular health.

Air pollution, especially fine particulate matter (PM 2.5 µm) and nitrogen dioxide, is strongly associated with increased CVD incidence and mortality. These pollutants contribute to oxidative stress, systemic inflammation, endothelial dysfunction, and atherosclerosis, leading to myocardial infarction, stroke, and heart failure. Long-term exposure to elevated air pollution levels has also been linked to a higher prevalence of hypertension and arrhythmias. Noise pollution from traffic, industry, and urban activities disrupts sleep and induces stress responses, elevating blood pressure and heart rate. This contributes to the development and exacerbation of CVD, with chronic exposure correlating with increased risks of hypertension, ischemic heart disease, arrhythmia, and stroke. Climate change, through heat waves and extreme weather events, poses additional risks to cardiovascular health. Heat stress exacerbates pre-existing cardiovascular conditions, increasing hospital admissions and mortality during extreme heat periods, particularly among patients with chronic congestive heart failure. Climate change-related alterations in air quality and vector-borne diseases may also indirectly impact cardiovascular health.

Exposure to toxic substances, including heavy metals (lead, mercury, arsenic) and persistent organic pollutants, has been implicated in CVD pathogenesis. These substances interfere with cardiovascular function through oxidative stress, endothelial damage, and dysregulation of lipid metabolism. Populations in industrial and urban areas are particularly vulnerable to these exposures. The close associations between environmental stressors and cardiovascular diseases highlight the importance of comprehensive public health strategies to mitigate these risks. Policy interventions are essential to reduce air and noise pollution, address climate change, and regulate toxic substance exposures. Increased public awareness and community-based initiatives are vital in promoting cardiovascular health.

In conclusion, environmental risk factors significantly contribute to the global burden of cardiovascular diseases. Addressing these determinants through multidisciplinary approaches involving policymakers, healthcare providers, and communities is crucial for reducing CVD prevalence and improving public health outcomes. Further research is needed to elucidate these associations' mechanisms, and develop targeted interventions.

03. LIFESTYLE AND CVD RISK

Tobacco use

Alcohol consumption

Insufficient exercise

Dietary factors

LIFESTYLE AND CVD RISK

Lifestyle factors, including diet, alcohol consumption, tobacco use, and physical inactivity are major determinants of cardiovascular risk. Healthy lifestyle habits in all age groups associate with a decreased incidence of CVD, with benefits greater in adults aged <50 years compared with older adults. This emphasises the importance of correcting unhealthy lifestyle habits, particularly among young and middle-aged persons, in order to improve cardiovascular health.

a. Tobacco use

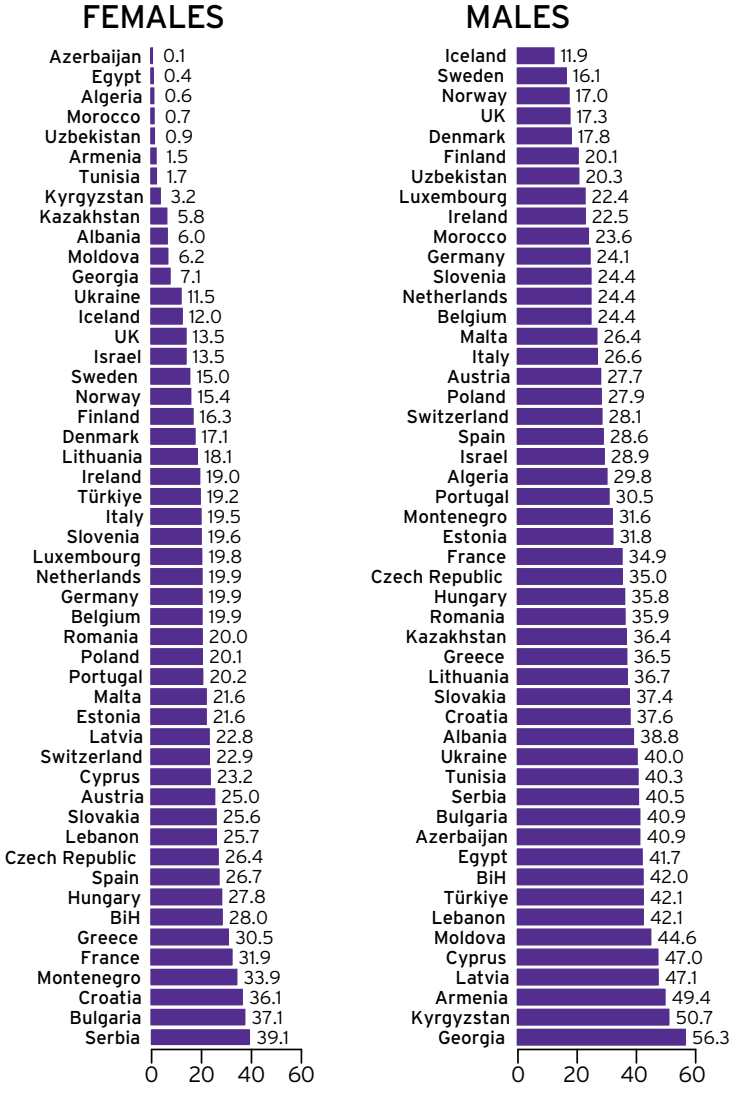
Smoking increases the risk of death from CVD by up to three times. In 2020, 25% of persons aged ≥15 years in ESC member countries were current users of tobacco products, with lower rates in females than in males (20% vs 33%). Use of tobacco products was particularly high among males in middle-income ESC member countries where 41% were smokers, with rates closer to 50% in Armenia, Georgia, and Kyrgyzstan (Figure 4). Policy measures to reduce tobacco use have been effective in reducing smoking rates across ESC member countries over the last 20 years from 34% to its current level. In Iceland only 12% of the population are now smokers, but in other countries rates are higher, with 40% of Serbian inhabitants continuing to smoke. E-cigarettes are now available as an alternative nicotine delivery system and may have a role in supporting smoking cessation. However, safety concerns persist and their increasing use among children and young adults is a worry.

b. Alcohol consumption

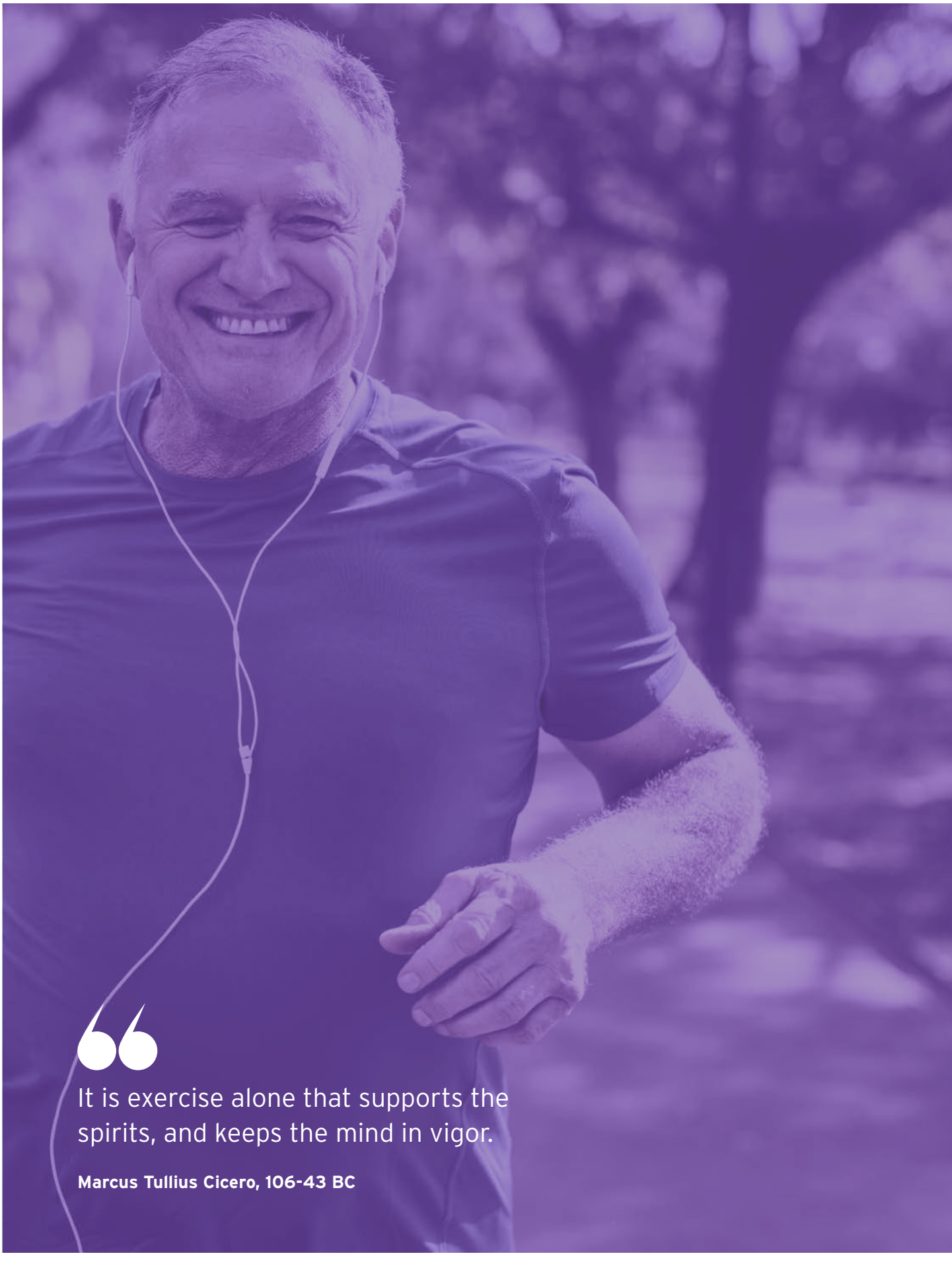
The harmful use of alcohol is particularly common in Europe where alcohol use is responsible for 240,000 to 290,000 deaths each year. In 2019, alcohol consumption per capita was 9.2 litres per year ranging from <2 L/year in Azerbaijan and Türkiye to >11 L/year in Austria, Bulgaria, Czech Republic, Estonia, France, Latvia, Lithuania and Slovenia. Consumption was over twice as high in high-income compared with middle-income ESC member countries (10.3 vs 4.4 L/year of pure alcohol). Young adults are most susceptible to the harmful effects of alcohol and current recommendations are for them to be prioritised in strategies aimed at minimising consumption. Strategies include taxation, restrictions on availability, advertising bans, public health campaigns, minimum unit pricing, regulation of digital alcohol marketing, and alcohol labelling.

> A large majority of coronary patients have unhealthy lifestyles in terms of smoking, diet and sedentary behaviour, which adversely impacts major cardiovascular risk factors.
>
> **EUROASPIRE V 2020.**

FIGURE 4 **Proportion (%) of national population aged ≥15 years who are users of tobacco (2020).**



Data source: WHO, https://www.who.int/data/gho/data/indicators/indicator-details/GHO/gho-tobacco-control-monitor-current-tobaccouse-tobaccosmoking-cigarettesmoking-agestd-tobagestdcurr. Data not available: Republic of Kosovo, Republic of San Marino, Libya, Republic of North Macedonia, Syrian Arab Republic.



It is exercise alone that supports the spirits, and keeps the mind in vigor.

Marcus Tullius Cicero, 106-43 BC

c. Insufficient exercise

Insufficient physical activity, <150 minutes of moderate physical activity or <75 minutes of vigorous physical activity per week, increases the risk of CVD. Leisure time exercise has consistently been shown to deliver dose-related improvement in CV health, reducing the incidence of CVD and mortality. During the period 1990-2019, age-standardised disability-adjusted life years (DALYs) attributable to insufficient physical activity declined by almost 50% in high-income ESC member countries but showed little change in middle-income countries.

d. Dietary factors

Diet contributes significantly to CVD mortality, with estimates indicating that across the European region, one in every five premature deaths could be prevented by an optimised diet.

- The benefits of a diet low in polyunsaturated fat but rich in vegetables, fruits, herbs, nuts, beans, and whole grains – the Mediterranean diet – has been confirmed in the PREDIMED trial in which the incidence of major CV events was reduced by 31% compared with a control diet. The Mediterranean diet is also effective for secondary prevention of CVD events.

- Associations between added sugar consumption, obesity and type 2 diabetes have long been recognised. Added sugar also shows independent association with CVD mortality. In 2020, supply of sugar and sweeteners delivered an estimated 332 kcal/capita/day across ESC member countries, ranging from <200 kcal/capita/day in Kyrgyzstan, Syrian Arab Republic and Uzbekistan to >450 kcal/capita/day in Belgium, Denmark, Malta and Poland. Recommendations are that daily intake of free sugars is reduced to less than 10% of total energy intake. A sugar reduction initiative is now being launched across Europe in a drive to reduce rates of diabetes and CVD. Policy initiatives include taxation and restrictive advertising of food products such as sugar, education in the classroom, school lunch programmes and traffic light labelling on food and drink.

- Reductions in salt intake are also recommended based on the increased risk of cardiovascular events observed when intake exceeds 5 g/day. Current guidelines recommend a sodium intake of <2.3 g/day but this low level has proved hard to achieve in population studies.

MESSAGES

In 2020, 25.4% of the persons aged ≥15 years in ESC member countries were current users of tobacco products, 20% of females and 33% of males.

In 2019, median pure alcohol consumption per capita was nearly twice as high in high-income compared with middle-income ESC member countries (10.3 vs 4.4 l/year).

Insufficient physical activity caused more DALYs per 100,000 in low-income compared with high-income ESC member countries.

Energy delivery from sugar supply in 2020 was higher in high-income countries compared with middle-income countries (345 vs 289 kcal/capita/day).

People living in the most deprived areas have the highest prevalence of smoking, being physically inactive and being classified as obese or overweight.

British Heart Foundation

EDITORIAL

Live style and cardiovascular disease: an old, well-known partnership

Marcus Flather
Professor of Medicine and Clinical Trials, Norwich Medical School, University of East Anglia, UK

This chapter summarises key lifestyle factors that contribute to excess CVD. Tobacco use increases risk of CVD and cancer, and the ESC Atlas of Cardiology data shows that 25% of adults are smoking across ESC member countries with rates greater than 50% among males in some regions. Established cardiac effects of excess alcohol consumption include cardiomyopathy, heart failure and atrial fibrillation plus higher risk of accidents and liver damage. High-income ESC member countries have among the highest rates of alcohol consumption per capita in the world with more than 11 litres of pure alcohol per year. Current recommendations for physical exercise to reduce CVD risk are for a minimum of two and a half hours of moderate exercise (brisk walking, jogging, cycling, swimming, rowing) per week. Dietary factors contributing to CVD include excess saturated fat, sugar, processed carbohydrate and salt, along with insufficient fruits, vegetables, cereals, seeds, beans, fish oils and monounsaturated fats. Direct sugar consumption from processed foods and fizzy drinks has reached an all-time high in ESC member countries and is driving an obesity crisis with all the associated complications including diabetes and increased CVD risk.

So how do we apply the ESC Atlas of Cardiology data to improving lifestyle to reduce CVD risk? Established methods to curb tobacco consumption include increasing sales tax, banning tobacco advertising and sponsorship, introducing higher age limits, and providing smoking cessation facilities. Alcohol consumption can also be reduced by increasing sales tax and limiting availability, as well as education programmes and greater availability of low alcohol products. Physical exercise can be encouraged through local and national "get fit" campaigns and the built environment can be engineered to encourage physical activity. Promoting healthy diets can only be achieved through national campaigns with the cooperation of the food industry, as well as appropriate education and regulation of unhealthy additives like fat, sugar and salt. Recent regulation of added sugar in fizzy drinks has led to reductions in consumption which is a positive sign. The elimination of smoking in ESC member countries should be given the highest priority to reduce CVD and lung cancer rates. This chapter from the ESC Cardiovascular Realities 2024 provides great hope for CVD reduction.

04. CLINICAL RISK FACTORS

Raised blood pressure

Cholesterol

Obesity

Diabetes

CLINICAL RISK FACTORS

Clinical risk factors for CVD, including hypertension, dyslipidaemia, diabetes and obesity, are often more prevalent in middle-income ESC member countries (Figure 5) where rates of CVD are higher compared with high-income countries. These risk factors are amenable to control or elimination with the potential to make a substantial reduction in incident CVD. The benefits of a comprehensive risk reduction programme involving pharmacotherapeutic and lifestyle measures to lower blood pressure, non-HDL cholesterol and other determinants of cardiovascular risk are well established.

a. Raised blood pressure

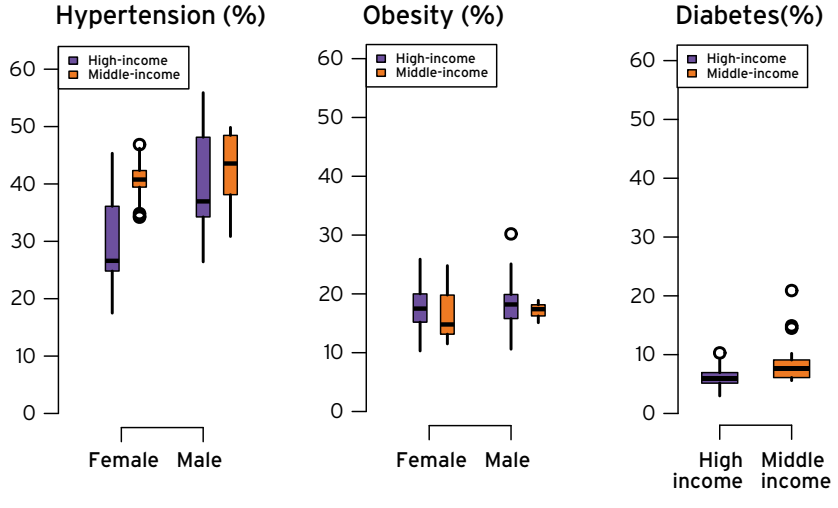
Hypertension is a leading risk factor for CVD that affected in 2019 in ESC member countries 36% of females and 41% of males. Prevalence was higher in middle-income compared with high-income countries. Considering all ESC member countries, hypertension in males exceeded 50% in Croatia, Hungary, Lithuania, Poland, and Romania. Among people with hypertension, 57% of females and 45% of males were receiving antihypertensive treatment.

During the 1990-2019 period, the median age-standardised prevalence of hypertension across all ESC member countries trended downwards in both females (40% to 36%) and males (42% to 41%). It is worth noting that despite predominant decrease, the prevalence of elevated blood pressure has increased in middle-income countries' males from 41% to 44%. During the same period, the prevalence of treated hypertension increased in both females (32% to 57%) and males (19% to 45%). In adults aged 40–89 years, systolic and diastolic blood pressure show log-linear associations with death from IHD and stroke. Lowering blood pressure by lifestyle measures and pharmacotherapy reduces cardiovascular risk.

b. Cholesterol

Non-high-density lipoprotein (non-HDL) cholesterol is a major determinant of CVD risk with median concentrations across ESC member countries in 2018, reaching 3.36 mmol/L in females and 3.53 mmol/L in males. Concentrations in high-income countries tended to be higher than in middle-income countries in

FIGURE 5 **Clinical risk factors prevalence (%): arterial hypertension, obesity and diabetes. All data in ESC member countries, stratified by national income status and gender, when available.**



Data source: (Arterial hypertension) WHO, https://ncdrisc.org/data-downloads-hypertension.html. (Obesity) WHO, http://apps.who.int/gho/data/node.main.BMIOBESITYA?lang=enhttps://ec.europa.eu/eurostat/databrowser/view/HLTH_EHIS_BM1E__custom_7112791/default/table?lang=en&page=time:2014. (Diabetes) WHO, https://data.worldbank.org/indicator/SH.STA.DIAB.ZS. Data not available: (Arterial hypertension) Republic of Kosovo, Republic of San Marino. (Obesity) Republic of Kosovo, Republic of San Marino, Albania, Algeria, Armenia, Azerbaijan, Bosnia and Herzegovina, Egypt, Republic of Georgia, Israel, Kazakhstan, Kyrgyzstan, Lebanon, Libya, Republic of North Macedonia, Moldova, Montenegro, Morocco, Switzerland, Syrian Arab Republic, Tunisia, Ukraine, Uzbekistan. (Diabetes) Republic of Kosovo.

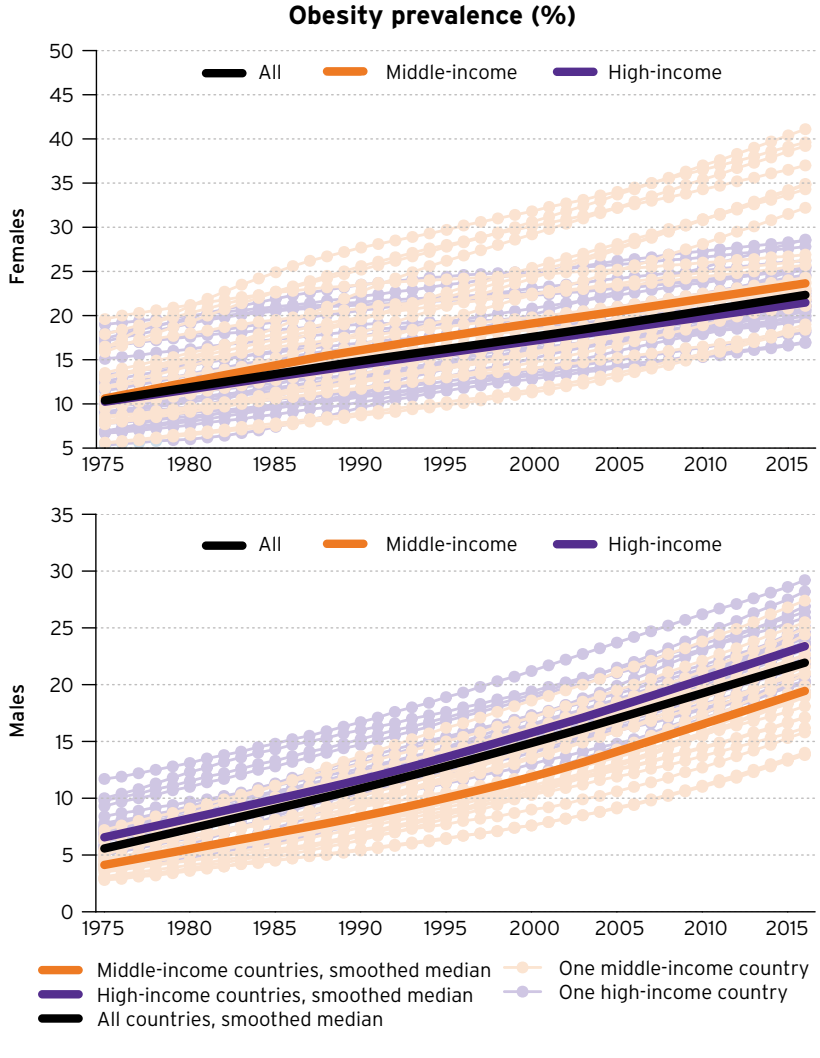
both females and males. Population measures to reduce non-HDL cholesterol have shown variable success but in high-income countries, where prevalence rates remain >50%, treatment often falls short. In the European Surveys of Cardiovascular Disease Prevention and Diabetes (EUROASPIRE) more than half of those with dyslipidaemia failed to achieve treatment targets.

Hypercholesterolaemia is commonly familial with heterozygous involvement in about 1:250 to 1:500 people causing considerable elevation of serum cholesterol concentrations (> 8.0 mmol/L) that often results in premature myocardial infarction. After diagnosis of an index case, cascade screening (lipid or genetic) of all first-degree relatives is mandatory.

c. Obesity

Overweight and obesity, defined by a body mass index (BMI) of ≥25 kg/m^2 and ≥30 kg/m^2, are linked with hypertension, dyslipidaemia, insulin resistance, coagulability, endothelial dysfunction and inflammation which together increase the risk of CVD and death. Obesity ranks 4th behind high blood pressure, dietary risks and tobacco use causing more than 13% of deaths across the European region. Rates are rising relentlessly and in 2019, 55% of people in ESC member countries were overweight and 17% obese, ranging from <15% in Bulgaria, Cyprus, Italy, France, Norway, the Netherlands, Romania, and Sweden, to >20% in Croatia, Estonia, Finland, Hungary, Iceland, Latvia, Malta, and Türkiye (Figure 6). Rates of obesity were similar in high-income and middle-income countries.

FIGURE 6 **Prevalence of obesity (BMI ≥30 kg/m^2) among females and males in ESC member countries (1975-2016).**



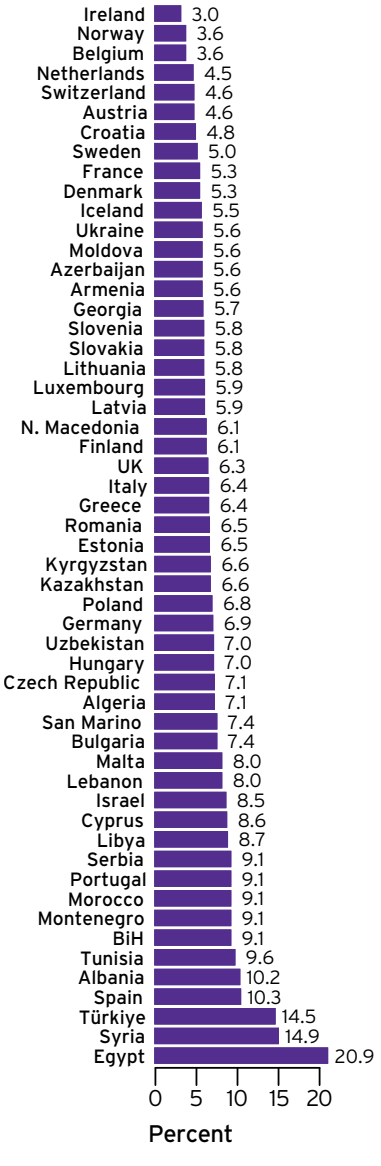
Data source: WHO, http://apps.who.int/gho/data/node.main.BMIOBESITYA?lang=en. Data not available: Republic of Kosovo.

d. Diabetes

The WHO estimates there are about 60 million people with diabetes in the European Region, or about 10.3% of men and 9.6% of women aged 25 years and over. The prevalence is increasing, particularly in low- and middle-income countries, mostly due to ageing populations, increased diagnostic testing, obesity and lifestyle factors including physical inactivity and unhealthy diet. In observational studies, having diabetes increases threefold the risk of death by CVD compared with people without diabetes, although in more contemporary studies the excess mortality is lower. Reducing trends in type 2 diabetes mortality the last 30 years have been observed in many EU countries, likely driven by improved medical management of its major complications, particularly CVD. Treating diabetes and its complications is expensive and cost the National Health Service (NHS) in the UK an estimated £14 billion in 2018, representing 10% of the annual budget for England and Wales. Public health measures should focus on primary prevention of type 2 diabetes given its significant costs, morbidity and mortality. Screening for diabetes can be cost-effective and evidence from the UK and the Netherlands confirms the efficacy of prevention programmes.

In 2021, the median prevalence of diabetes in people aged 20-79 across all ESC member countries was 6.5%, ranging from <4% in Belgium, Ireland, and Norway, to >10% in Albania, Egypt, Spain, Republic of North Macedonia and Türkiye (Figure 7).

FIGURE 7 **Age-standardised prevalence (%) of Type 1 or Type 2 diabetes among adults aged 20-79 in ESC member countries (2021).**



Data source: World Bank, https://data.worldbank.org/indicator/SH.STA.DIAB.ZS. Data not available: Republic of Kosovo.

MESSAGES

In 2019, the median age-standardised prevalence of hypertension among adults was 36% for females and 41% for males across all ESC member countries.

Systolic and diastolic blood pressure show log-linear associations with death from IHD and stroke.

In the European Surveys of Cardiovascular Disease Prevention and Diabetes (EUROASPIRE) more than half those with dyslipidaemia failed to achieve treatment targets.

In 2019, 55% of people in ESC member countries were overweight and 17% obese.

In 2021, the median prevalence of diabetes in people aged 20-79 across ESC member countries was 6.5%, lower in high-income ESC countries compared to middle-income countries (6% vs. 8%).

> Most cardiovascular disease causes and deaths can be attributed to a small number of common, modifiable risk factors.

Salim Yusuf
Professor of Medicine, McMaster University, Canada

EDITORIAL
Clinical risk factors

David A Wood
Professor of Preventive Cardiology, National University of Ireland, Galway, Republic of Ireland

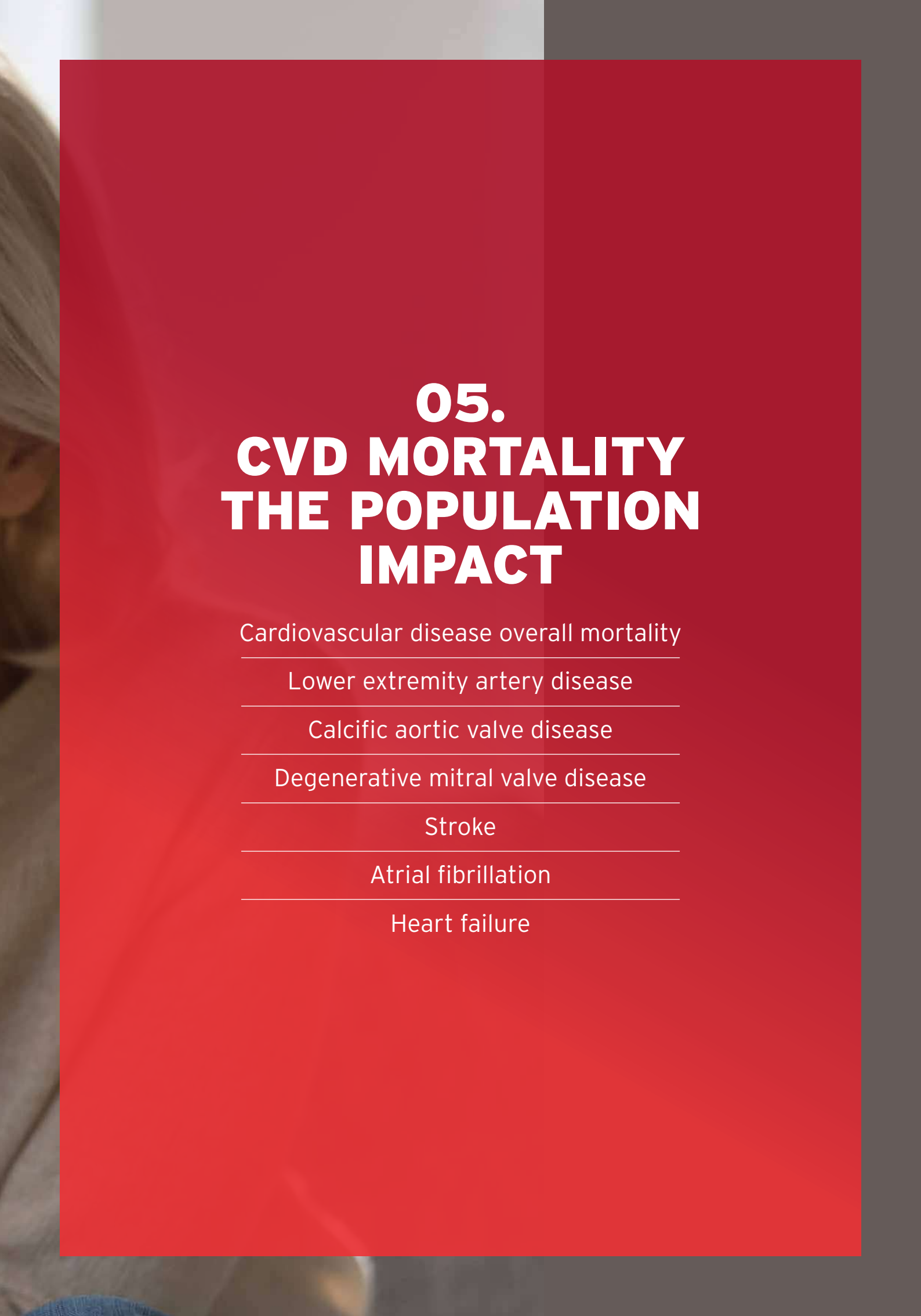
Unhealthy lifestyles lead to weight gain and over half of the European population are now overweight and almost one in two are obese. The consequences of this weight gain profoundly impact the clinical risk factors such as blood pressure, dyslipidaemia and diabetes.

Prevalence of hypertension is higher in men than women, affecting more than a third of the whole European population, but time trends show a falling prevalence in all countries with increasing treatment rates although less treatment in women in middle-income compared to high-income countries. Non-HDL cholesterol levels have fallen in high-income countries but have increased in middle-income and low-income countries and for patients with established cardiovascular disease (CVD), and those at high risk of developing CVD, the treatment of lipids to guideline standards is improving but remains inadequate despite a wealth of effective modern treatments.

Prevalence of diabetes in Europe is 6.5% although this figure conceals a wide variation between countries from less than 4% to one in ten people. Diabetes is more common in middle-income compared to high-income countries. The treatment of diabetes and obesity is being transformed with two new classes of drugs, the SGLT-2 inhibitors and the GLP-1 receptor agonists, which lower weight substantially and improve glycaemic control and, importantly, improve cardiovascular outcomes.

Although these treatments are a valuable addition to the growing therapeutic armamentarium which together substantially reduce total cardiovascular risk, they are prescribed late in adult life and don't address the growing evolution of risk factors from childhood which are associated with the development of CVD early in adult life.

Cardiovascular risk models limited to 10 years do not differentiate risk below the age of 40, when atherosclerotic disease can already be established, and what is required is a better understanding of lifetime risk to help target younger people to achieve healthier lifestyles.



05.
CVD MORTALITY THE POPULATION IMPACT

Cardiovascular disease overall mortality

Lower extremity artery disease

Calcific aortic valve disease

Degenerative mitral valve disease

Stroke

Atrial fibrillation

Heart failure

CVD MORTALITY THE POPULATION IMPACT

Cardiovascular diseases, including ischemic heart disease (IHD), stroke, heart failure, peripheral arterial disease, arrhythmias, and valvular diseases, constitute the leading cause of global mortality and significantly impact health and social care systems through premature mortality and disability. It is estimated that CVD caused approximately 19.4 million deaths worldwide in 2021, corresponding to 396 million years of life lost and another 32.5 million years lived with disability.

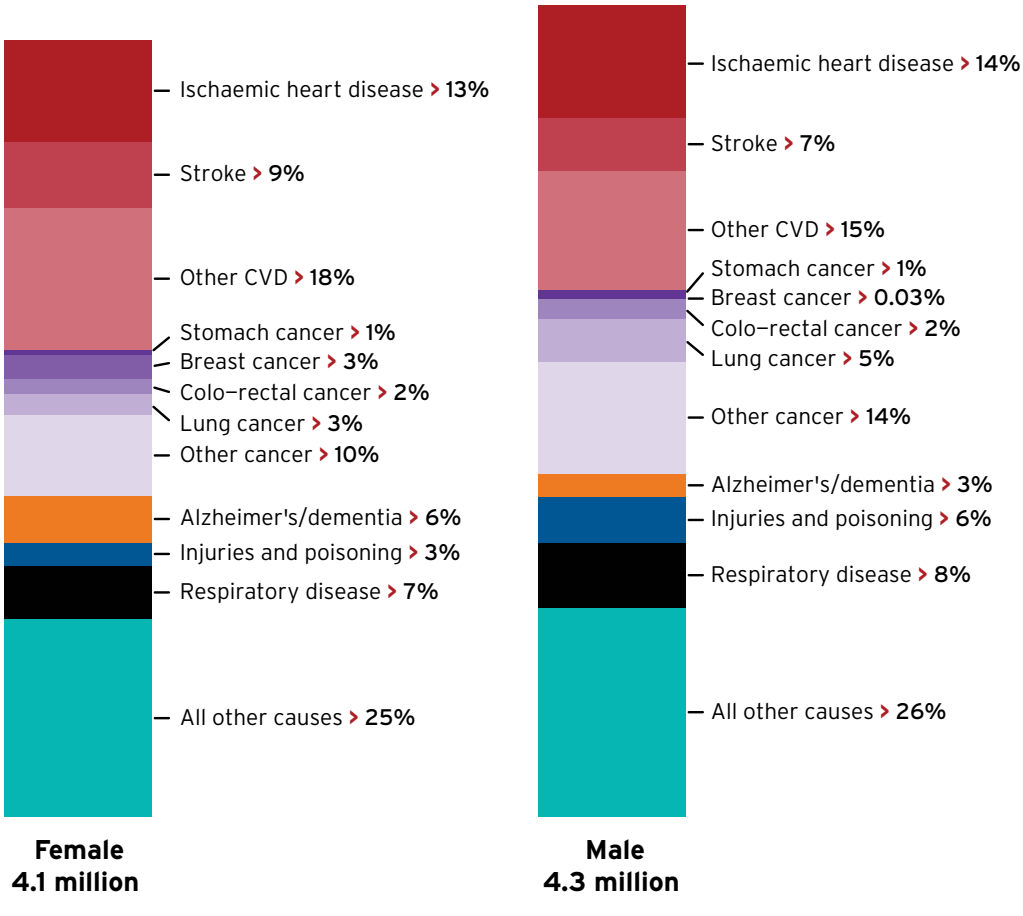
Across ESC member countries too, cardiovascular diseases remain the predominant cause of disability and premature death, causing over 37.4% of all deaths annually, equivalent to 8.5 thousand per day. However, there are significant regional disparities with the high-income countries of Western Europe benefiting from lower mortality rates compared with the middle-income ESC member countries of Eastern Europe, North Africa and Asia.

a. Cardiovascular disease overall mortality

CVD was the most common cause of death across ESC member states responsible for >1.6 million deaths in females and approximately 1.5 million in males (Figure 8). After age-standardisation, however, mortality rates per 100,000 were higher in males than females (395 vs 322) and in both sexes mortality rates were ≥2.5 times higher in middle-income compared with high-income countries (Figure 9). During the last 20 years, mortality rates have declined by >50% across high-income ESC member countries (Figure 10) but in middle-income countries declines have been much smaller for both males (11%) and females (6%) and a number of countries have seen the prevalence of CVD increase, including Azerbaijan (11%), Egypt (11%), Kyrgyzstan (8%), Libya (22%), and Syrian Arab Republic (6%) in females and Kyrgyzstan (7%), Libya (30%), and Ukraine (4%) in males. Accordingly, the estimated potential years of life lost (PYLL – a summary measure of premature mortality due to CVD) was more than 3 times higher in middle-income compared with high-income ESC member countries (7,516 vs 2,079 per 100,000).

Ischaemic heart disease (IHD) was the largest contributor to CVD mortality across ESC member states with age-standardised mortality rates (ASMRs) per 100,000 approximately half as high for females compared with males (90.8 vs 171.4). Similarly, ASMRs per 100,000 were lower in high-income than middle-income countries both for females (67.2 vs 159.9) and for males (142.9 vs 218.0).

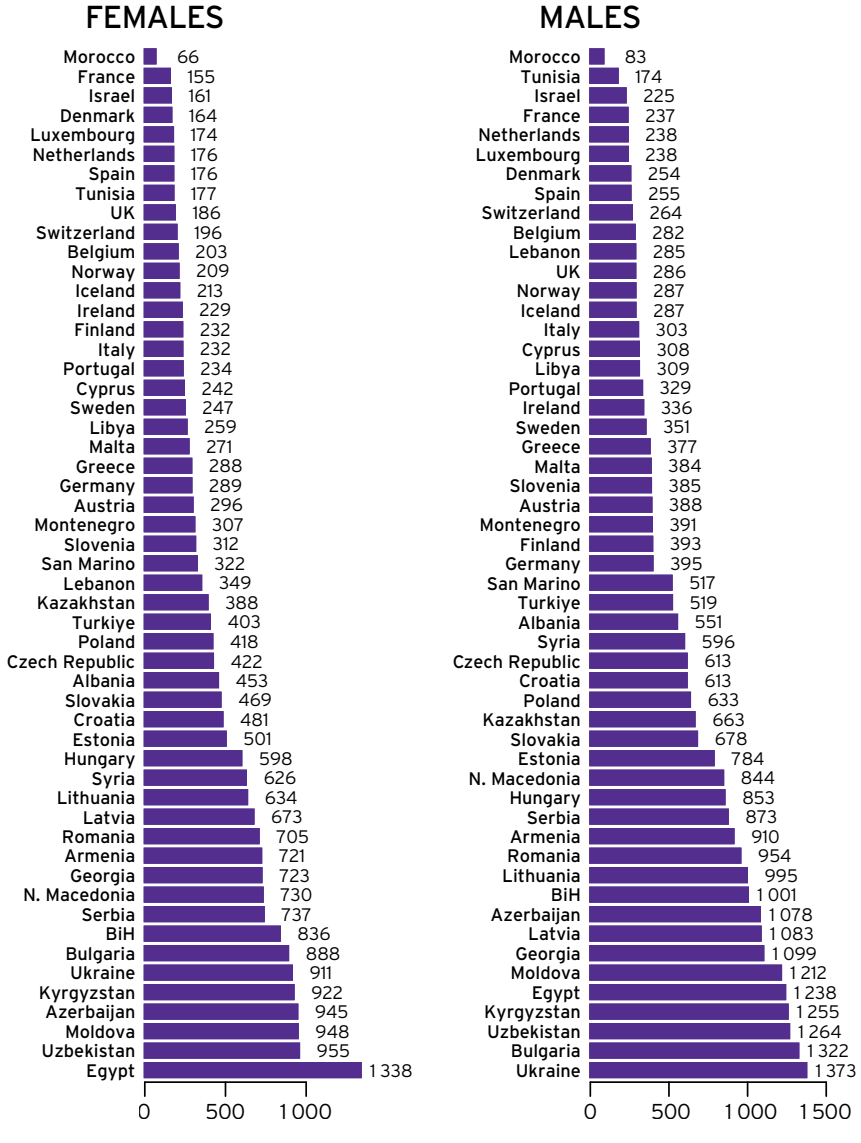
FIGURE 8 **Causes of death in ESC member countries (2021 or latest year available).**



Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Algeria, Republic of Kosovo.

(Figure 11) The highest IHD ASMRs per 100,000 in females and males were observed in Kyrgyzstan (650.7 and 835.5), Moldova (586.5 and 764.5), and Ukraine (626.4 and 963.8). Between 1990 and 2021 most high-income countries saw reductions in IHD ASMRs, but in over half of middle-income countries IHD ASMRs increased, particularly in Egypt (males 81%, females 201%), Kyrgyzstan (males 31%, females 57%), and Ukraine (males 29%, females 27%), with large increases in females also seen in Albania (56%) and Syrian Arab Republic (53%). In 2019, IHD caused 34 million PYLLs, accounting for 57% of all PYLL due to CVD (61% in males and 53% in females). Of the 34 million PYLL due to IHD, 21 million (62%) occurred in middle-income countries (61% in males and 62% in females).

FIGURE 9 **Age-standardised mortality rate per 100,000 due to CVD (2021 or latest year available).**



Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Algeria, Republic of Kosovo.

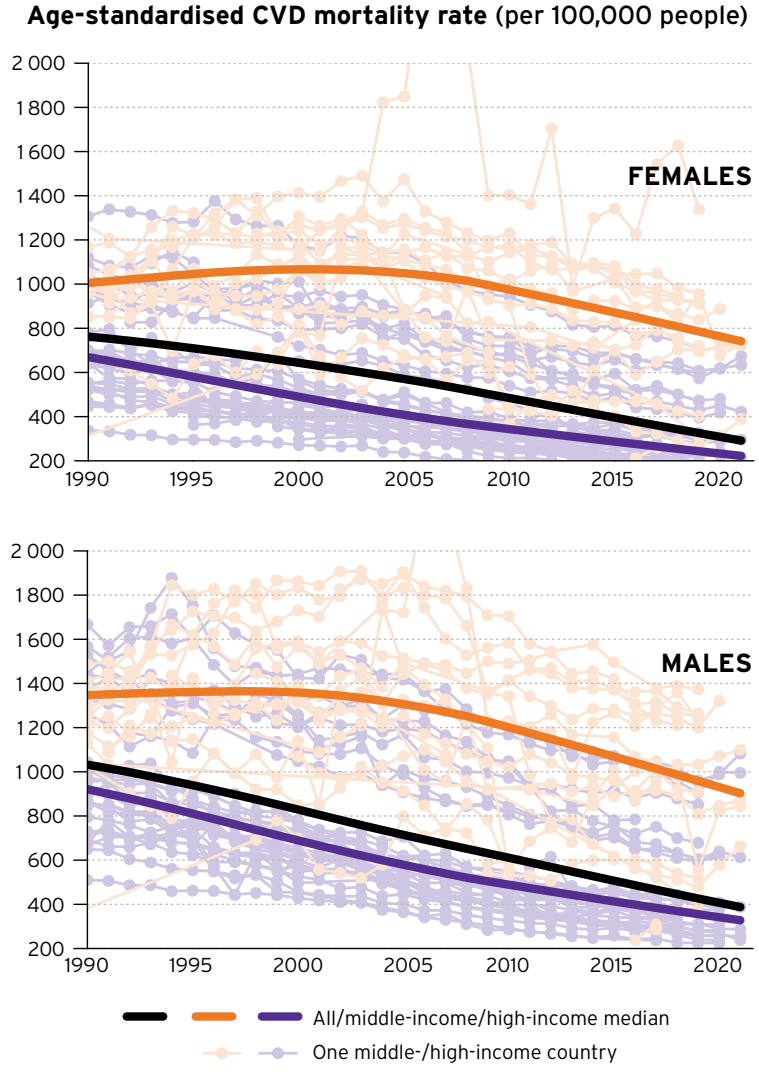
b. Lower extremity artery disease

After IHD and stroke lower extremity, artery disease is the third most prevalent form of atherosclerotic CVD. The epidemiology, however, shows important differences perhaps reflecting underdiagnosis or premature death from other causes. Thus, ASMRs per 100,000 were only 1.3 times higher in males than females while stratification by national income status revealed lower rates in middle-income compared with high-income countries in both sexes. In 2019, lower extremity artery disease (LEAD) was responsible for 0.6% of all PYLLs due to CVD across ESC member countries.

c. Calcific aortic valve disease

In high-income countries, calcific aortic valve disease (AVD) is the most prevalent heart valve disorder and affects 1.7% of the population >65 years old. Incidence rates have doubled during the last 20 years likely due to population aging. Across ESC member countries, ASMRs per 100,000 were lower in females compared with males (4.6 vs. 5.2) and in middle-income compared with high-income countries (Figure 12). In 2019, calcific AVD accounted for <1% of PYLL across ESC member countries.

FIGURE 10 **Age-standardised CVD mortality rates (ASMRs) per 100,000 people in ESC member countries (1990-2021).**

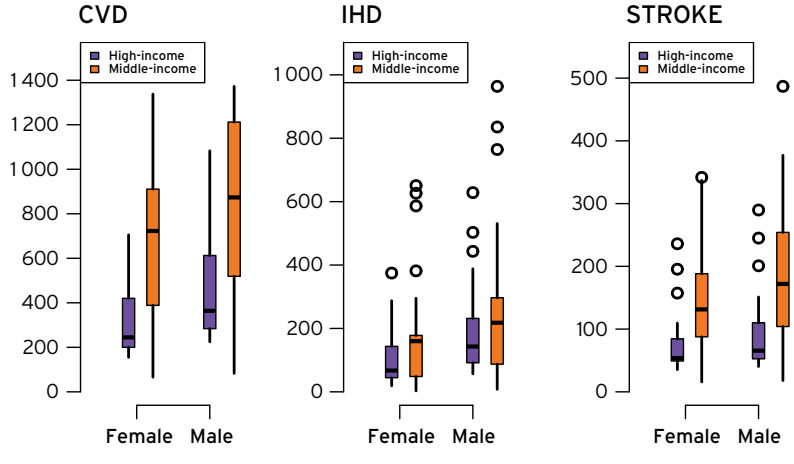


Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Algeria, Republic of Kosovo.

d. Degenerative mitral valve disease

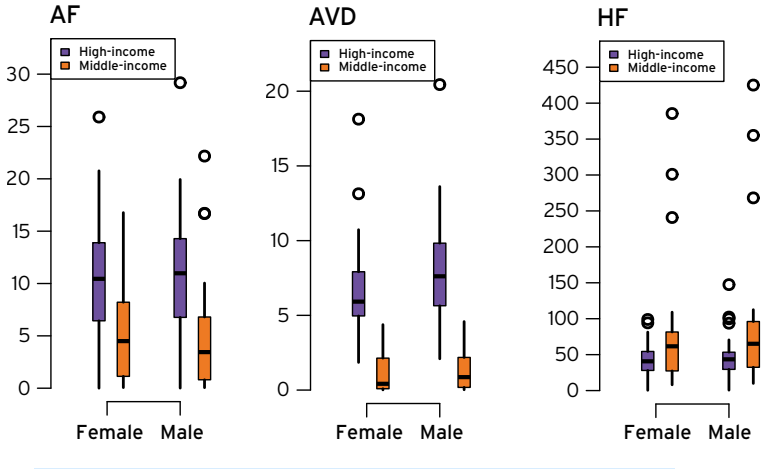
Like calcific AVD, degenerative mitral valve disease (MVD) is primarily a disease of the elderly. Incidence rates have changed little over the last 18 years. ASMRs per 100,000 for degenerative MVD were similar across ESC member countries, highest in Georgia (females 4.3, males 4.9) and lowest in Morocco (females 0.02, males 0.02). In 2019, degenerative mitral valve disease accounted for an estimated 0.2 million PYLL across ESC member countries, representing 0.3% of all PYLL due to CVD.

FIGURE 11 **ASMRs per 100,000 due to CVD, IHD and stroke in ESC member countries, stratified by sex and national income status (2021 or latest year available, median year 2019, years range 2005-2021).**



Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Algeria, Republic of Kosovo.

FIGURE 12 **ASMRs per 100,000 due to AF, AVD and HF in ESC member countries, stratified by sex and national income status (2021 or latest year available, median year 2019, years range 2000-2021).**



Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Albania, Algeria, Republic of Kosovo, Republic of San Marino, Ukraine.

e. Stroke

In 2021 or latest year available, ASMRs per 100,000 for stroke were, like IHD, higher in males than females (95.3 vs 80.3) with differences greater in middle-income compared with high-income countries for both males (172.0 vs 65.6) and females (131.4 vs 53.8) (Figure 11). The highest ASMRs above upper quartile levels for stroke occurred in 11 of 23 middle-income countries for both males and females, but in only 3 high-income countries (Latvia, Lithuania, and Romania). The number of people living with stroke in Europe is estimated to increase by almost one third by 2047, mainly because of population ageing and improved survival rates. In 2019, stroke accounted for 25% of all PYLL due to CVD in ESC member countries.

f. Atrial fibrillation

Atrial fibrillation (AF) worsens quality of life and increases cardiovascular mortality due to stroke and heart failure - with non-cardiovascular death, mainly malignancy and infection, yet more common. In 2021 or latest year available median ASMRs per 100,000 for AF were 8.3, similar for females compared with males but over twice as high in high-income compared with middle-income countries (Figure 12). AF accounted for 1.02 million PYLL (59% in females), corresponding to 1.7% of all PYLL due to CVD within ESC member countries.

g. Heart failure

As populations age so the prevalence of heart failure (HF) increases despite declines in the incidence of CVD in many western countries. Primary care data from the UK show that prognosis remains poor in patients with HF with the 5-year survival increasing only modestly from 41.0% in 2000 to 48.2% in 2012.

ESC Atlas of Cardiology data show that HF accounted for 5.8% of total deaths across ESC member countries (14.6% of CVD deaths) in females and for 4.4% of total deaths (12.5% of CVD deaths) in males. The absolute number of HF-related deaths was 27% higher in females than in males (237,000 vs. 186,000) but median estimated ASMRs per 100,000 was higher for males (47.3 vs. 43.0).

Estimated ASMRs per 100,000 for HF were higher in middle-income compared with high-income countries in both females (61.2 vs. 40.7) and males (65.1 vs. 43.5). Among middle-income countries, ASMRs were highest in Bulgaria and Egypt exceeding 300 per 100,000 in females and 350 per 100,000 in males.

MESSAGES

CVD has remained the most common cause of death in ESC member countries with over 3 million deaths in 2021 including >1.6 million deaths in females and approximately 1.5 million deaths in males.

Across ESC member countries, CVD accounted for proportionately more deaths in middle-income compared with high-income countries in both females (53% vs. 34%) and males (46% vs. 30%).

Between 1990 and 2021, age-standardised CVD mortality rates in both sexes decreased by >50% in all high-income ESC member countries but in middle-income countries the decrease was <12%.

In 2021, median age-standardised CVD mortality rates for IHD across ESC member countries were higher for males than females (171.4 vs. 90.8 per 100,000, respectively) and in both sexes were higher in middle-income compared with high-income countries.

Age-standardised CVD mortality rates for stroke in 2021 were higher for males than females (95 vs. 80 per 100,000) and more than twice as high in middle-income compared with high-income ESC member countries.

> Over three quarters of CVD deaths take place in low- and middle-income countries.
>
> **World Health Organization 2021**

EDITORIAL

CVD mortality - a significant cost for the economically disadvantaged

Nick Townsend

Professor, School for Policy Studies, University of Bristol, UK

Cardiovascular disease remains the most common cause of death within ESC member countries, accounting for more than 1.6 million deaths in females and close to 1.5 million deaths in males in one year. This is equivalent to 40% and 35% of total deaths in females and males, respectively. The proportion of all deaths attributed to CVD is higher in middle-income than in high-income countries for both sexes (females 53% vs. 34%; males 46% vs.30%), illustrating inequalities in the burden of CVD between ESC countries.

There are a smaller proportion of premature deaths (those occurring in individuals younger than 70 years of age) attributable to CVD, than for total deaths. With CVD responsible for 27% of all premature deaths in females and 31% of all premature deaths in males. Despite this, CVD still accounted for around 27 million potential years of life lost (PYLLs) in females and 33 million PYLLs in males, within ESC member countries in 2019.

Median estimates for CVD age-standardised mortality rates (ASMRs) were higher for males (395.1/100,000) than females (322.0/100,000), supporting premature mortality and PYLL data in demonstrating that despite the higher numbers of females dying from CVD, deaths in males tend to occur at younger ages. Concerningly, median CVD ASMRs in middle-income countries were more than twice as high than in high-income countries in males (873.5/100,000 vs 364.0/100,000) and three times as high in females (722.8/100,000 vs. 244.7/100,000).

Out of hospital cardiac arrest (OHCA), caused by acute myocardial infarction in about 50% of cases, remains a leading cause of death in Europe. Data on incidence, management, and outcomes from the European Registry of Cardiac Arrest (EuReCa) report an incidence of OHCA of 89 per 100,000 people per year, ranging from 53 to 166/100,000 across the 20 European countries providing OHCA data. In 32% of these countries, a response time of less than 10 minutes was achieved in urban areas, although this was longer in rural areas. Bystander cardiopulmonary resuscitation was associated with higher survival and was initiated between 13 and 82% of cases within countries. In total, 64% of patients were pronounced dead on scene, whilst of those patients transported to the hospital, survival-to-discharge was 26%.

06. CARDIOVASCULAR HEALTHCARE DELIVERY

Cardiologists

Coronary Procedures

Interventional heart valves procedures

Catheter ablation procedures and device implants

Cardiac surgery

Congenital heart disease

CARDIOVASCULAR HEALTHCARE DELIVERY

ESC countries, including the 27 that belong to the European Union, exhibit important differences in the development of programmes for prevention and treatment of cardiovascular diseases. The reasons for these differences are complex, with socio-economic factors being predominant, although cultural and gender issues, and differences in political decision making are also important.

In this chapter, we present Atlas metrics, which illustrate the differences in cardiovascular healthcare delivery among the ESC member countries. We report 2022 data describing human and capital resource statistics and cardiovascular procedures across the ESC member countries.

a. Cardiologists

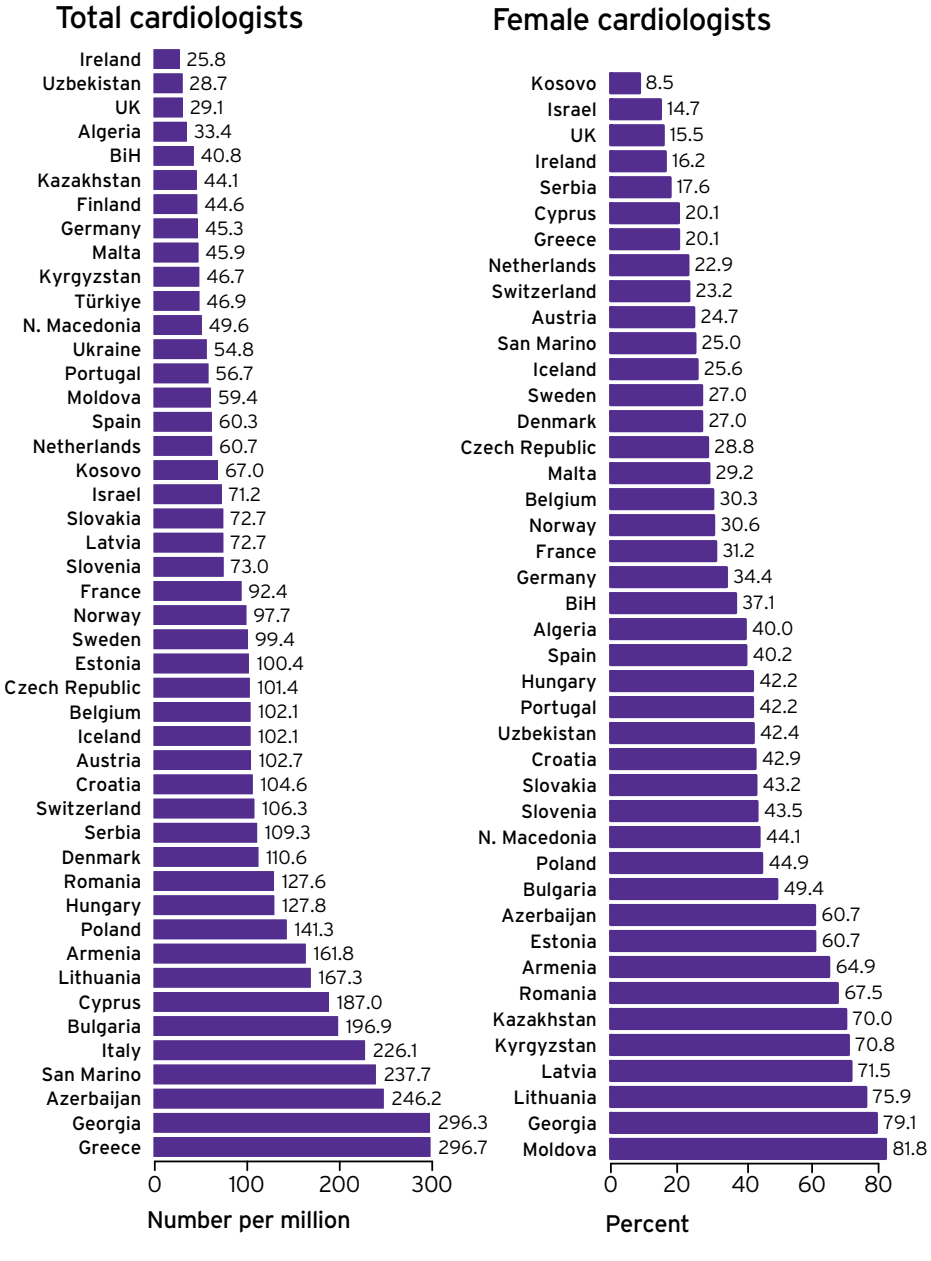
Cardiology staffing requirements to meet national needs are ill-defined and for any given country depend on an appropriate balance between the supply and demand of human resource. Major determinants of supply include recruitment rates into cardiology training programmes, the quality of the training and staff retention issues. Also important is sex and racial imbalance and there is general recognition of the need for more female and ethnically diverse cardiologists. Demand is largely determined by the burden of cardiovascular disease and the increasing development of subspecialty treatment options. These complex considerations make international workforce comparisons hard to interpret and although specialist involvement in CV care and admission to a cardiac ward can improve outcomes, there is no simple relation between the number of cardiologists working within a country and the quality of CV healthcare.

Number of cardiologists. In the 2023 survey of ESC member countries, there was a median of 95.0 cardiologists per million people, with numbers ranging from <30 per million in Ireland, Uzbekistan and the UK to >250 per million in Georgia and Greece (Figure 13).

Females in cardiology. Females comprised 38.6% of cardiologists working in ESC member countries. Under-representation of females was greatest in Republic of Kosovo and Israel where they comprised <15% of cardiologists. On the contrary, Kyrgyzstan, Latvia, Lithuania, Georgia and Moldova have a large majority of female cardiologists (>70%) (Figure 13).

FIGURE 13

(A) Cardiologists total, per million people (median year 2022, years range 2015-2023). (B) Proportion of female cardiologists (%) (median year 2022, years range 2015-2023). All data in ESC member countries.



Data source: ESC Atlas Survey. Data on file. Data not available: (A) Albania, Egypt, Lebanon, Libya, Luxembourg, Montenegro, Morocco, Syrian Arab Republic, Tunisia. (B) Albania, Egypt, Finland, Italy, Lebanon, Libya, Luxembourg, Montenegro, Morocco, Syrian Arab Republic, Tunisia, Türkiye, Ukraine.

Stratification by national income status. The median number of cardiologists per million inhabitants of middle-income ESC member countries was lower compared with high-income countries (54.8 vs 100.4). Female cardiologists comprised 49.4% of the cardiological workforce in middle-income countries compared with 30.3% in high-income countries. These averaged data, however, conceal considerable variation across ESC member countries.

Trends. The median number of cardiologists per million people has increased across biennial surveys of ESC member countries from 80.9 in the 2019 survey to 85.1 in the 2021 survey and to 95.0 in the 2023 survey. This increase has been mainly driven by the increasing number of cardiologists in high-income countries, from a median of 90.8 per million people in 2019 to 100.4 in 2023. In middle-income countries numbers have declined from a median of 61.8 per million people in 2019 to 54.8 in 2023. The gender gap, however, is narrowing, with the proportion of women increasing from 28% in 2019 to 38.6% in 2023.

b. Coronary procedures

A median of 3.0 hospitals per million people reported cardiac catheterisation facilities. In middle-income countries, this number increased from 1.8 in the 2019 survey to 3.0 in 2023, equaling high-income countries (2.8).

Across ESC member countries, a median of 3629 diagnostic coronary angiograms per million people were performed, less in middle-income countries than in high-income countries (3,086 vs. 3,773) (Figure 14). This median number fell from 4,601 in the 2019 to 3,773 in 2023, driven largely by a 30% reduction in diagnostic catheter procedures in high-income countries.

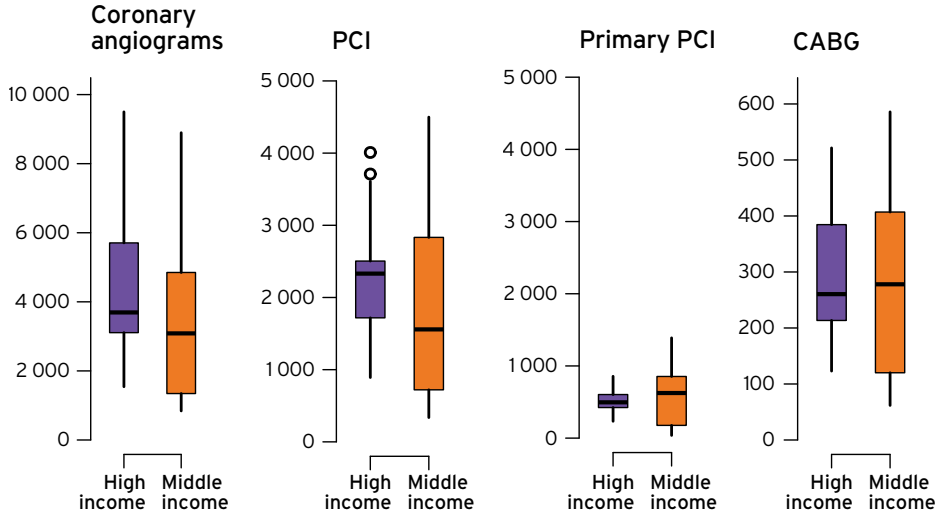
The median number of interventional cardiologists per million inhabitants was 13.1, somewhat similar between middle-income countries (10.6) and high-income countries (13.3). This median number increased in middle-income countries from 6.3 in the 2019 survey to 13.1 in 2023. In contrast, numbers in high-income countries showed a slight decrease from 15.1 in 2019 to 13.3 in 2023.

The median number of hospitals per million inhabitants of ESC member countries offering a 24 h/7-day facility for primary percutaneous coronary intervention (PCI) for acute coronary syndrome (ACS) was 2.1, similar in middle-income countries and high-income countries.

The median number of PCI procedures per million inhabitants was 2,187 across the ESC member countries, lower in middle-income countries compared with

FIGURE 14

(A) Coronary angiograms (median year 2022, years range 2021-2022). (B) Percutaneous coronary interventions (PCI) (median year 2022, years range 2021-2022). (C) Primary percutaneous coronary interventions (pPCI) (median year 2022, years range 2021-2022). (D) Coronary artery bypass graft surgery (CABG) procedures (median year 2022, years range 2020-2022). All data per million people in European Society of Cardiology member countries, stratified by national income status.



Data source: ESC Atlas Survey. Data on file. Data not available: (A) Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic. (B) Republic of Georgia, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia. (C) Belgium, Cyprus, Italy, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic. (D) Albania, Egypt, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia.

high-income countries (1,355 vs. 2,330) (Figure 14). Regarding primary PCIs for the management of ACS, the median number of procedures per million inhabitants was 498.5 across the ESC member countries, greater in middle-income countries compared with high-income countries (624.8 vs. 476.8) (Figure 14). This may reflect a greater burden of ST elevation myocardial infarction. PCI procedures showed little increase between 2019 and 2023 surveys (2,047 vs. 2,187 per million inhabitants) but a steady increase in primary PCI procedures was observed from 462.1 in 2019, to 498.5 in 2023.

c. Interventional heart valves procedures

In the 2023 survey, the median number of hospitals with catheter laboratories equipped for interventional valve procedures was 1.1 per million inhabitants across ESC member countries, lower in middle-income than high-income countries (0.59 vs. 1.24).

A median of 91.5 transcatheter aortic valve implantation (TAVI) procedures per million inhabitants were performed across all ESC member countries,

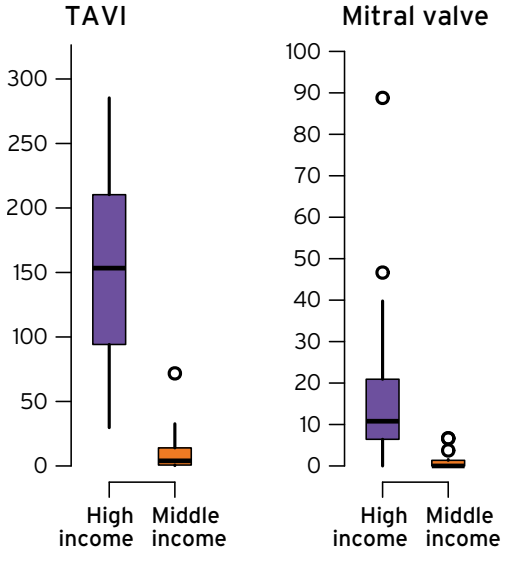
varying from <1 procedure per million people in Republic of Kosovo, Bosnia and Herzegovina, Azerbaijan Kyrgyzstan, and Uzbekistan to >200 in Denmark, Malta, Austria, Cyprus, Switzerland, Slovenia, Israel, France, and Germany.

A median of 8.5 transcatheter mitral valve procedures per million people per year were performed in ESC member countries. In several countries (Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Iceland, Republic of Kosovo, Kyrgyzstan, Moldova, San Marino and Ukraine) this activity is not yet performed.

A median of 0.5 transcatheter tricuspid valve procedures per million people were performed in the 45 ESC member countries with Switzerland and Cyprus reporting around 8 procedures per million people respectively.

Overall, procedure rates per million people in middle-income countries were strikingly lower for TAVI (4.0 vs. 153.4), transcatheter mitral valve procedures (0.0 vs. 12.3) and transcatheter tricuspid valve procedures (0.0 vs. 2.1) than in high-income countries (Figure 15).

FIGURE 15 **(A) Transcatheter aortic valve implantation (TAVI) (median year 2022, years range 2021-2023). (B) Percutaneous mitral valve interventions (median year 2022, years range 2021-2022). All data per million people in ESC member countries, stratified by national income status.**

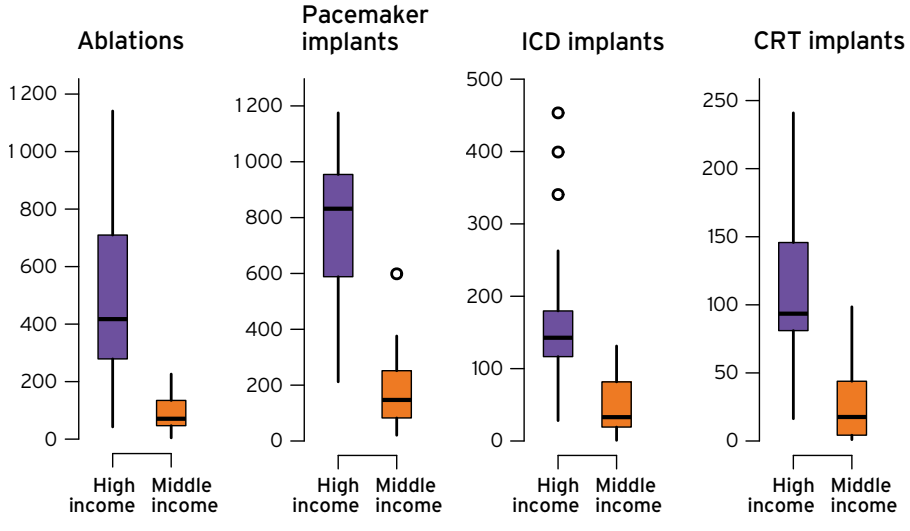


Data source: ESC Atlas Survey. Data on file. Data not available: (A) Ireland, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic. (B) Azerbaijan, Ireland, Kazakhstan, Latvia, Lebanon, Libya, Montenegro, Morocco, Republic of North Macedonia, Serbia, Syrian Arab Republic.

The median number of TAVI procedures per million increased from 25.5 in 2019 to 91.5 in 2023. This primarily reflects activity in high-income countries where numbers of TAVI procedures per million nearly matched surgical aortic valve procedures (153.4 vs. 145.2).

Procedure rates are likely to increase further as evidence for safety and efficacy becomes further available.

FIGURE 16 **(A) Ablation procedures (median year 2022, years range 2020-2022); (B) Pacemaker implantations (median year 2022, years range 2021-2022); (C) Implantable cardioverter-defibrillator implantations (median year 2022, years range 2021-2022); (D) Cardiac resynchronisation therapy implantations (median year 2022, years range 2021-2023). All data per million people in ESC member countries, stratified by national income status.**



Data source: ESC Atlas Survey. Data on file. Data not available: (A) Albania, Egypt, Ireland, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia, Türkiye. (B) Albania, Egypt, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia. (C) Albania, Egypt, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia. (D) Albania, Egypt, Lebanon, Libya, Montenegro, Morocco, the Netherlands, Syrian Arab Republic, Tunisia, Türkiye.

d. Catheter ablation procedures and device implants

The median number of cardiac electrophysiologists per million people was 4.7 across ESC countries from <1 in Uzbekistan, Azerbaijan, and Kyrgyzstan and San Marino to >10 in Belgium, Croatia, Estonia, Bulgaria, UK, Iceland and Switzerland.

There was a median of 1.5 hospitals per million people undertaking electrophysiology procedures.

A median of 279.0 ablation procedures per million inhabitants of the ESC member countries were performed for treatment of atrial fibrillation/flutter and 22.8 for ventricular tachycardia ablation.

A median of 607.3 pacemakers were implanted per million inhabitants of ESC member countries, ranging from <40 per million people in Uzbekistan to >1000 per million people in Italy, Sweden, France, Portugal, and Lithuania.

A median of 121.1 implantable cardioverter-defibrillator (ICD) implants per million inhabitants were reported, ranging from <6 per million in Kyrgyzstan and Uzbekistan to >200 in Sweden, Denmark, Italy, Belgium, the Netherlands, Czech Republic, and Germany.

A median of 81.2 cardiac resynchronisation therapy (CRT) implants per million inhabitants were reported, ranging from <2 implants per million people in Kyrgyzstan, Uzbekistan and San Marino to >150 per million in Norway, UK, Italy, Denmark, Belgium, Czech Republic and Germany.

The median number of procedures per million people was lower in middle-income countries vs. high-income countries for ablation procedures (70.9 vs. 417.4), pacemakers (147.0 vs. 831.9), ICDs (32.9 vs. 142.7) and CRT devices (17.6 vs. 88.5) (Figure 16).

Survey data across ESC member countries showed the number of ablation procedures per million people remained fairly stable from 287.1 in the 2019 to 279.0 in 2023. There was a similar pattern for the pacemaker implantations between the 2019 and 2023, but there were a small increase in the median numbers of ICD and CRT implantations per million from 100.2 to 121.1 and from 63.6 to 81.2, respectively.

e. Cardiac surgery

Coronary artery bypass graft (CABG) surgery occupies a central role in the treatment of obstructive coronary artery disease, providing significant improvement in quality of life and angina frequency. In left main and multivessel coronary artery disease, CABG can prolong life compared with medical therapy, and appears more cost-effective than PCI particularly when left ventricular function is impaired. Nevertheless, revascularisation by PCI is often preferred in contemporary practice, and data from the UK confirm that surgical case volumes have declined in recent years while PCI volumes have increased. For most patients, outcomes with PCI are comparable to those achieved with CABG but in patients with diabetes, CABG outperforms PCI and is the procedure of choice.

In the 2023 survey, the median number of cardiac surgeons per million people in ESC member countries was 7.6. Overall this number was lower in middle-income countries than in high-income countries (6.3 vs. 8.2). A median of 1.2 hospitals per million inhabitants of ESC member countries reported facilities for cardiac surgery, more in middle-income than in high-income countries (1.5 vs.

1.1). Surgical human resource and infrastructure across ESC member countries has remained relatively stable since the 2019 survey.

A median of 262.7 CABG procedures per million inhabitants were reported, similar in middle-income and high-income countries (278.0 and 260.4 respectively) (Figure 14).

In the 2023 survey the median number of hospitals reporting heart transplant programmes was 0.18 per million inhabitants. Only Croatia, Latvia, Belgium and Lithuania reported more than 0.5 hospitals per million inhabitants.

A median of 2.1 heart transplant procedures per million people were reported. Fourteen ESC member countries reported no heart transplant program, whereas only 3 countries (Czech Republic, Croatia, and Slovenia) reported >7 heart transplant procedures per million people. Heart transplant activity was considerably greater in high-income countries with a median of 3.4 procedures per million people, whereas only Bulgaria, Kazakhstan, Republic of North Macedonia and Ukraine reported transplant activity among middle-income countries.

The median rate of LVAD implants was 1.3 per million people per year. Thirteen ESC member countries reported less than 1 implant per million people, whereas only 3 countries (Slovenia, Republic of North Macedonia and Germany) reported >8 LVAD implants per million people.

f. Congenital heart disease

In the 2023 survey, 0.4 hospitals per million inhabitants reported catheter laboratory facilities for structural heart disease interventions in children, similar in middle-income and high-income countries (0.4 and 0.3 hospitals respectively). Surgical facilities for congenital heart disease were available in a median of 0.5 hospitals per million people.

A median of 29.2 percutaneous procedures and 37.9 surgical procedures for congenital heart disease were reported. The procedure rates per million people were lower in middle-income compared with high-income countries, both for percutaneous procedures (12.1 vs. 37.7) and surgical procedures (25.6 vs. 40.9).

MESSAGES

Across all ESC member countries in the 2023 survey, there was a median of 95 cardiologists per million people with almost twice as many in high-income than middle-income countries (100 vs. 55 respectively).

Between the 2019 and the 2023 surveys of ESC member countries, the number of cardiologists per million in high-income countries increased from a median of 81 to 100. In middle-income countries the numbers have declined during the same period from a median of 62 per million people to 55.

In the 2023 survey, females comprised 39% of cardiologists working in ESC member countries.

The median number of PCI procedures per million people in the 2023 survey was lower in middle-income compared with high-income countries (1,355 vs. 2,330) but the number of primary PCI procedures was greater in middle-income countries (625 vs. 477), probably reflecting a greater burden of ST elevation myocardial infarction.

In the 2023 survey, procedure rates per million people for TAVI were lower in middle-income compared with high-income countries (4 vs. 153.4), where they matched the number of surgical aortic valve replacements (153 vs. 145).

In the 2023 survey, procedure rates per million people were lower in middle-income compared with high-income countries for cardiac ablation (71 vs. 420), pacemakers (147 vs. 832), ICDs (33 vs. 143) and CRT devices (18 vs. 89).

> Of all the forms of inequality, injustice in health is the most shocking and inhumane.

Martin Luther King, 1929 –1968
Nobel Prize laureate (1964)

EDITORIAL

International cardiovascular health delivery – were are we, where do we go and where should we be going?

Hector Bueno
Professor of Cardiology, National Centre for Cardiovascular Research (CNIC), Madrid, Spain

A coordinated action to improve cardiovascular health in Europe based on an accurate analysis of the situation is needed, as this chapter presents. Major structural differences between countries and income groups are presented but important inconsistencies appear. With nearly 10-fold differences in the number of cardiologists, there are no major differences between countries in the number of interventional cardiologists or cardiac surgeons and less marked differences in cardiovascular facilities. This speaks of different models of care.

Major variations in cardiac interventions can be found - huge in cases, such a >200-fold difference in the use of TAVR or 30-50-fold in pacemaker or ICD implantations– with less striking differences in rates of PCI or cardiac surgical procedures. The country differences between hospitals performing electrophysiology procedures and their activity rates are noticeable.

Several reasons account for the variations in care delivery, so it would be an oversimplification to attribute these to economic reasons only. Country population age and prevalence of risk factors are the main drivers of needs. Healthcare models, payment models may influence activity rates, not always correlating with quality. Local policies are also important. While some health systems focus on acute hospital care, others may prioritise investments in population-based preventive policies, less visible but more cost-effective.

Readers may be tempted to find underutilisation the main finding, and this may often be correct, but the large variability observed between countries may represent underutilisation and overutilisation. It is important to keep quality in mind. Volume is relevant but appropriateness and results, i.e. procedural success and safety, life extension or quality of life becomes, are even more important.

Time trends analyses allow tracking if changes in care patterns are moving in the right direction and if regional inequities are narrowing over time. Particular attention deserves monitoring the gender gap closure in cardiovascular care internationally.

The data provided by the ESC Cardiovascular Disease Realities is a starting point to understand how cardiovascular health is delivered in ESC countries, current gaps and needs. It is a valuable tool to alleviate the lack of an official EU cardiovascular health observatory.

07. ECONOMIC BURDEN OF CARDIOVASCULAR DISEASE IN THE EUROPEAN UNION COUNTRIES

General determinants of the total cardiovascular disease economic costs

Coronary heart disease and cerebrovascular disease costs

ECONOMIC BURDEN OF CARDIOVASCULAR DISEASE IN THE EUROPEAN UNION COUNTRIES

Over the past two decades, the ESC has prioritised as its main mission to reduce the burden of cardiovascular diseases in its member countries, which constitute a diverse community with significant economic, political, and cultural differences.

In September 2023, the first part of the Burden of CV Disease project was published, covering the 27 countries of the European Union. This project was developed in collaboration between the ESC and Oxford University (Health Economics Research Center, Nuffield Department of Population Health). A publication presenting the economic cost data of CVD for all the ESC member countries is expected to be published before the end of this year.

a. General determinants of the total cardiovascular disease economic costs

Health and social costs

In 2021, cardiovascular disease accounted for approximately 10 million hospital admissions in the EU, representing 22 admissions per 1,000 population. The number of hospital admissions varied considerably between countries, ranging from 10 to 36 cases per 1,000 population.

Cardiovascular disease cost the EU health and social care systems approximately €155 billion in 2021, accounting for 11% of total healthcare expenditure in the EU. The percentage of CVD-related care expenditure varied significantly between countries, from 6% in Denmark to 19% in Hungary. The major component of CVD-related care costs was hospital care, which accounted for €79 billion, of which €30 billion (38%) was accounted for the costs of 12 CVD-related procedures. Overall, hospital care represented 51% of care costs. Costs of CVD medications accounted for €31 (20%) of care costs, followed by nursing care home institutionalisation at €15 billion.

Overall, CVD represented an annual health and social care cost of €347 per EU citizen. The amount spent on health and social care for people with CVD varied widely across the 27 countries. After adjusting for price differentials using PPP,

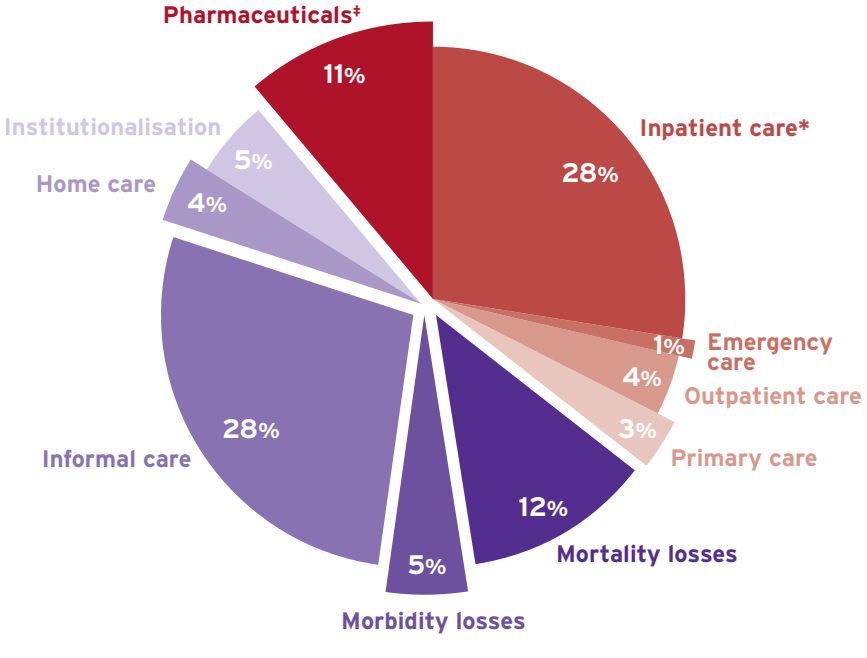
costs per person varied over three-fold between the country with the lowest costs (Croatia €154) and the one with the highest costs (Austria €505).

Informal care

A total of 7.5 billion hours of unpaid care by relatives/friends were provided to people whose care could be directly attributable to CVD, representing a cost of €79 billion across the EU. Per 1,000 population, a total of 16,700 hours were provided in the care of patients with CVD, ranging from 6,420 in Luxembourg to 31,004 in Romania.

TABLE 2

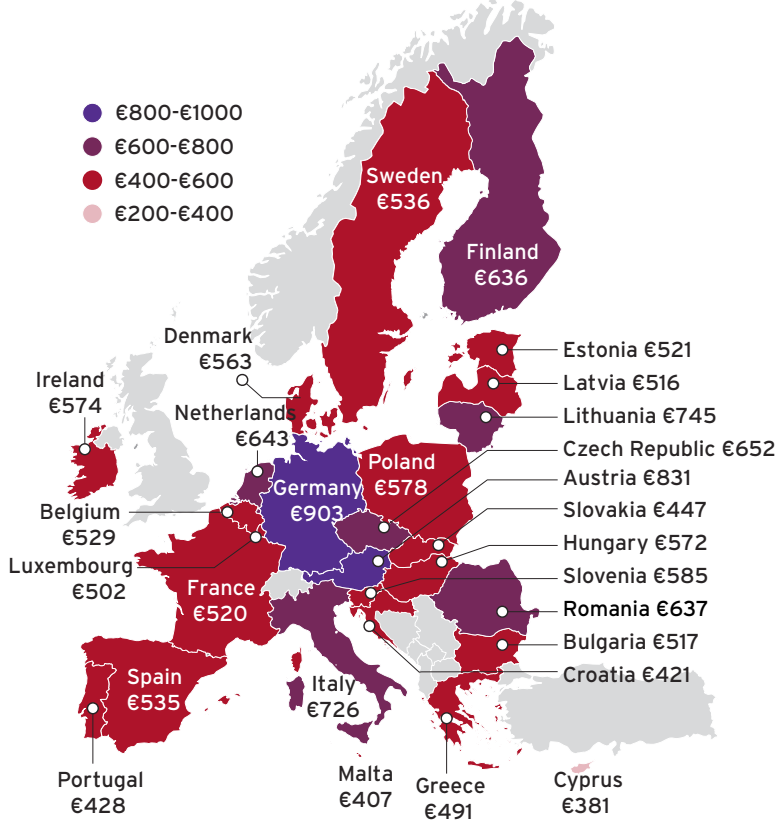
	Costs, € bn
Health care	130 (46%)
Social care	25 (9%)
Informal care	79 (28%)
Morbidity losses	15 (5%)
Mortality losses	32 (12%)
Total	**€ 282 bn**



*Including costs of in-hospital pharmaceuticals, devices and procedures
‡Only includes retail pharmaceuticals

Data source: Ramon Luengo-Fernandez, Marjan Walli-Attaei, Alastair Gray, Aleksandra Torbica, Aldo P Maggioni, Radu Huculeci, Firoozeh Bairami, Victor Aboyans, Adam D Timmis, Panos Vardas, Jose Leal, Economic burden of cardiovascular diseases in the European Union: a population-based cost study, European Heart Journal, Volume 44, Issue 45, 1 December 2023, Pages 4752–4767, https://doi.org/10.1093/eurheartj/ehad583.

FIGURE 17 **Cardiovascular disease-related total costs per capita, adjusted for price differentials.**



Data source: Ramon Luengo-Fernandez, Marjan Walli-Attaei, Alastair Gray, Aleksandra Torbica, Aldo P Maggioni, Radu Huculeci, Firoozeh Bairami, Victor Aboyans, Adam D Timmis, Panos Vardas, Jose Leal, Economic burden of cardiovascular diseases in the European Union: a population-based cost study, European Heart Journal, Volume 44, Issue 45, 1 December 2023, Pages 4752–4767, https://doi.org/10.1093/eurheartj/ehad583

Productivity losses

In 2021, there were a total of 1.7 million deaths due to CVD across the EU, representing 1.3 million working years lost. Per 1000 population, this accounted for 2.8 years of productive life lost, with the lowest number of years lost being in France and the highest in Bulgaria and Latvia. Overall, productivity losses associated with early mortality and incapacity for work were estimated at €32 billion (12% of the total) and €15 billion (5%) respectively. The cost of unpaid care by friends and relatives (informal care) was estimated at €79 billion (28%).

There were 256 million working-days lost because of CVD morbidity (i.e. 571 days per 1000 population when unadjusted), representing a cost of €30 billion. However, when adjusted using the friction period, this estimate fell to €15 billion.

Total societal costs

Overall, CVD is estimated to have cost the EU economy €282 billion in 2021. Of the total cost of CVD, 46% was due to healthcare, 9% was due to social care, 28% due to informal care, and 17% due to productivity losses (Table 2). On a per capita basis, this represented a cost of €630 per EU citizen. The economic cost of CVD varied considerably across the 27 countries in the EU after adjustment for price differentials, ranging from €381 in Cyprus to €903 in Germany (Figure 17).

b. Coronary heart disease and cerebrovascular disease costs

Coronary heart disease

Coronary heart disease cost the health and social care systems of the EU €30 billion in 2021. Per capita, this represented a cost of €67. The major component of health and social care costs was hospital care (€19 billion, 64%), followed by pharmaceutical expenditure (€4 billion, 13%). Overall, CHD was estimated to have cost the EU €77 billion in 2021: over one-quarter of the overall cost of CVD. This represented a cost of €173 per EU citizen, which after adjusting for price differentials ranged from €100 in Luxembourg to €325 in Lithuania.

Of the total cost of CHD, 37% of costs were due to healthcare, 2% to social care, 24% to productivity losses, and 37% to informal care.

Cerebrovascular disease

Cerebrovascular disease cost the health and social care systems of the EU €41 billion in 2021 (Table 2), representing a cost of €92 per citizen. The major component of health and social care costs was long-term institutionalisation (€15 billion, 36%), followed by hospital care (€13 billion, 32%) and home care (€9 billion, 23%). Overall, cerebrovascular disease was estimated to cost the EU €76 billion in 2021, which like CHD, accounted for over a quarter of the overall cost of CVD. Per capita, this equated to €169 per citizen in the EU, ranging from €66 in Malta to €267 in Austria, after adjusting for price differentials.

As a proportion of CVD costs, the contribution of cerebrovascular disease was lowest in Malta (16%) and highest in Sweden (37%). Of the total cost of cerebrovascular disease, informal care accounted for the biggest component (34%), followed by social care (32%), with health care accounting for 23% and productivity losses for the remaining 11%.

MESSAGES

Overall, CVD is estimated to have cost the EU economy €282 billion in 2021. Of the total cost of CVD, 46% was due to healthcare, 9% due to social care, 28% due to informal care, and 17% due to productivity loss.

Per capita, this represents a cost of €630 per EU citizen for the total EU burden of CVD each year.

Cardiovascular disease accounted for approximately 10 million hospital admissions in the EU, representing 22 admissions per 1,000 population.

Cardiovascular disease cost the EU health and social systems approximately €155 billion in 2021, accounting for 11% of total healthcare expenditure in the EU.

> There is an urgent need to focus on implementing existing cost effectiveness policies and interventions if the world is to meet the sustainable development goals and achieve a 30% reduction in premature mortality due to non-communicable diseases.

Global Burden of Cardiovascular Diseases and Risk Factors, 2020

EDITORIAL

Economic Burden of Cardiovascular Disease in the European Union Countries

Andrew Street
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Over the past 70 years there have been gradual and substantial reductions across countries in the death rate from cardiovascular disease (CVD), driven by improvements in detection and treatment and, particularly, by reductions in smoking. Even so CVDs, including coronary artery disease, stroke, and hypertension, represent the leading cause of mortality in the EU, accounting for nearly 45% of all deaths. Thus, despite improvements, CVD continues to put significant strain on healthcare systems and on informal carers. It also has negative economic impacts, both for individuals and countries as a whole.

It is not straightforward to quantify the total burden of CVD but carefully constructed figures are now available thanks to a collaborative effort between the European Society of Cardiology and Oxford University. The work involved gathering national-level data about the costs of health, social and informal care for people with CVD and the lost earnings due to morbidity and premature mortality. The total cost of CVD across the 27 EU countries came to €282 billion in 2021.

Direct medical costs associated with CVD include expenses for diagnoses, hospital admissions, medical procedures, and medication. Specialised treatments such as angioplasty, stent placements, and bypass surgeries are significant contributors to healthcare expenditures, as are medications for managing chronic conditions like hypertension. According to these recent estimates, the annual direct healthcare cost of CVD across the 27 EU countries amounted to €130 billion with a further €25 billion spent on long-term social care. Many of those suffering from CVD are supported by informal carers, many of whom lose the opportunity of paid work, the cost of this support amounting to €79 billion.

Premature deaths cause substantial economic damage, the consequent loss of annual earnings amounting to €32 billion. CVD-related ill-health also reduces economic output, via lower productivity, higher sickness absence and earlier retirement, costing €15 billion. Economic performance is positively related to the health of the population and reducing the burden of CVD should prove a key means to improve worker productivity.

While there has been laudable success in reducing the overall incidence of CVD, the economic burden remains high, even more so in the most socially-disadvantaged groups. Prevention policies starting early in life will be essential in lifting the burden of CVD for the most disadvantaged in our societies.

REDUCING THE BURDEN OF CARDIOVASCULAR DISEASE: A CALL TO ACTION

In the last 50 years the development and uptake of better treatments, combined with improvements in clinical settings and preventative strategies, have resulted in a significant reduction in CVD mortality across the European Region.

Despite this progress, **CVD remains a major social & economic challenge in ESC member countries:**

- CVD is the **leading cause of death**, accounting for 40% and 35% of all deaths in women and men respectively
- Tremendous inequalities in disease burden still persist between high-income and middle-income ESC member countries. Evidence suggests that most of the World Health Organization noncommunicable disease targets for 2025 are unlikely to be met in any of the countries.
- The success in reducing mortality in acute cardiac events has led to an **increasing population living with chronic cardiovascular conditions** including heart failure and structural heart disease.
- There is misperception that cardiovascular disease is limited to older people. On the contrary, CVD heavily affects people of all age groups. In fact, nearly a quarter (22%) of all premature deaths (before the age of 70) in the EU are caused by CVD which is similar to all malignant disorders.
- With the aging population **CVD prevalence is expected to increase** further and often coexist with other diseases, leading to multi-morbidity – a further challenge to CV care of the elderly. It is expected that in 2040, 155 million Europeans are aged› 65. Without decisive action starting today, the number of citizens suffering from CVD and the burden of dealing with the disease will increase dramatically for societies and for health systems alike.
- Obesity and diabetes, major **risk factors** for CVD, are becoming more prevalent.
- CVD is often triggered by other chronic conditions or their therapies including but not limited to, diabetes, hypertension, chronic kidney disease, pulmonary disease, and cancer. For example, advances in oncological treatment have led to improved cancer survival but have also increased CVD morbidity and mortality due to the **cardiotoxicity of cancer treatment.**

In addition to the loss of, and impact on, human lives, **the economic burden of CVD in the EU is evaluated at €282 billion in 2021.**

The WHO, in the recently updated Sustainable Development Agenda, has set among other goals the need to reduce by 2030 premature mortality from non-communicable diseases by one-third through prevention and treatment.

Undoubtedly, the previous goal, which primarily concerns cardiovascular premature mortality, requires appropriate planning at a national level, governmental support, and an available budget proportional to the challenge that CVDs present.

A 30% reduction in premature mortality by 2030 undoubtedly requires:

- Significant reduction in the prevalence of current tobacco use in persons aged 15+ years
- Effective reduction of individuals with arterial hypertension and high adherence of hypertensive patients to their long-term pharmaceutical therapy
- Differentiation of lifestyle, especially for the citizens of large cities, to increase their physical activity.
- Effective management of obesity, as well as diabetes.

According to the previous optimistic estimates of the WHO, a 25% reduction in cardiovascular diseases and the associated premature mortality by the year 2025 could be achieved. This now seems unattainable.

It is obvious that well-designed and systematic actions are required to achieve a substantial reduction in cardiovascular diseases in all the countries of our society.

The magnitude of the CVD burden requires corresponding attention from decision-makers so that the allocation of resources is commensurate with the size and importance of the problem.

Without a doubt, it must be highlighted that significant unmet medical needs continue to stigmatise the field of cardiovascular diseases, with a characteristic example being that of sudden cardiac death, which continues to be recognised as the leading cause of mortality worldwide.

The **ESC Atlas of Cardiology is an important tool for the development of national CVD strategies:** it should enable national policy makers to learn about how their country has performed towards achieving these targets and to identify which areas of intervention urgently need actions.

SELECTED REFERENCES PER CHAPTER

CHAPTER 1

IHME, 2020. Global Burden of Disease data set. Available from: https://gbd2019.healthdata.org/gbd-results (accessed 23 July 2024).

Demography of Europe – 2024 edition https://ec.europa.eu/eurostat/web/interactive-publications/demography-2024 (accessed on 23 July 2024)

The International Social Security Association (ISSA), Meeting the needs of an ageing population – Europe https://www.issa.int/analysis/meeting-needs-ageing-population-europe (accessed on 23 July 2024)

Mendis, S, Puska,P, Norrving, BE, World Health Organization. Global atlas on cardiovascular disease prevention and control. World Health Organization; 2011. Available from: https://apps.who.int/iris/handle/10665/44701 (accessed 23 July 2024).

Lancet T. Advancing racial and ethnic equity in health. Lancet (London, England). 2022 Dec 10;400(10368):2007.

Kramer CK, Leitão CB, Viana LV. The impact of urbanisation on the cardiometabolic health of Indigenous Brazilian peoples: a systematic review and meta-analysis, and data from the Brazilian Health registry. Lancet. 2022 Dec 10;400(10368):2074-2083.

Schultz WM, Kelli HM, Lisko JC, Varghese T, Shen J, Sandesara P, et al. Socioeconomic status and cardiovascular outcomes: challenges and interventions. Circulation. 2018 May 15;137(20):2166-78.

Marois G, Bélanger A, Lutz W. Population aging, migration, and productivity in Europe. Proc Natl Acad Sci U S A. 2020 Apr 7;117(14):7690-7695. doi: 10.1073/pnas.1918988117. Epub 2020 Mar 23.

CHAPTER 2

European Environment Agency, https://www.eea.europa.eu/en (accessed on 17 July 2024)

European Commission, EU air quality standards, https://environment.ec.europa.eu/topics/air/air-quality/eu-air-quality-standards_en (accessed on 17 July 2024)

European Parliament legislative resolution of 24 April 2024 on the proposal for a directive of the European Parliament and of the Council on Corporate Sustainability Due Diligence and amending Directive (EU) 2019/1937 (COM(2022)0071 – C9-0050/2022 – 2022/0051(COD)) https://www.europarl.europa.eu/doceo/document/TA-9-2024-0329_EN.html (accessed on 17 July 2024)

European Environment Agency, 2015 Noise report, https://www.eea.europa.eu/soer/2015/europe/noise (accessed on 17 July 2024)

Joaquin Barnoya and Stanton A. Glantz, Cardiovascular Effects of Secondhand Smoke: Nearly as Large as Smoking, Circulation, Volume 111, Number 20, https://doi.org/10.1161/CIRCULATIONAHA.104.492215

Sanjay Rajagopalan and Philip J. Landrigan, Pollution and the Heart, N Engl J Med 2021;385:1881-1892, Vol. 385 No. 20, 2021 Nov 10, doi:10.1056/NEJMra2030281

CHAPTER 3

European Commission: Eurostat https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tobacco_consumption_statistics (accessed 23 July 2024).

World Health Organization. Status report on alcohol consumption, harm and policy responses in 30 European countries 2019. World Health Organization. Regional Office for Europe; 2019. Available from: https://www.who.int/europe/publications/i/item/WHO-EURO-2019-3544-43303-60695 (accessed 23 July 2024).

OECD, Tackling Harmful Alcohol Use: Economics and Public Health Policy, OECD Publishing. 2015. Available from: http://dx.doi.org/10.1787/9789264181069-en (accessed 23 July 2024).

Estruch R, Ros E, Salas-Salvadó J, Covas MI, Corella D, Arós F, et al. Primary Prevention of cardiovascular disease with a Mediterranean diet supplemented with extra-virgin olive oil or nuts. N Engl J Med. 2018 Jun 21;378(25):e34.

Sharifi-Rad J, Rodrigues CF, Sharopov F, Docea AO, Can Karaca A, Sharifi-Rad M, et al. Diet, Lifestyle and Cardiovascular Diseases: Linking Pathophysiology to Cardioprotective Effects of Natural Bioactive Compounds. Int J Environ Res Public Health. 2020 Mar 30;17(7):2326. doi: 10.3390/ijerph17072326. PMID: 32235611; PMCID: PMC7177934.

Kornelia Kotseva, Guy De Backer, Dirk De Bacquer, Lars Rydén, Arno Hoes, Diederick Grobbee, et al., Lifestyle and impact on cardiovascular risk factor control in coronary patients across 27 countries: Results from the European Society of Cardiology ESC-EORP EUROASPIRE V registry, European Journal of Preventive Cardiology, Volume 26, Issue 8, 1 May 2019, Pages 824–835, https://doi.org/10.1177/2047487318825350

CHAPTER 4

Rapsomaniki E, Timmis A, George J, Pujades-Rodriguez M, Shah AD, Denaxas S, et al. Blood pressure and incidence of twelve cardiovascular diseases: lifetime risks, healthy life-years lost, and age-specific associations in 1·25 million people. Lancet. 2014 May 31;383(9932):1899-911.

World Health Organization. WHO European regional obesity report 2022. World Health Organization. Regional Office for Europe; 2022. Available from: https://apps.who.int/iris/handle/10665/353747 (accessed 23 July 2024).

World Obesity Federation. Global Obesity Observatory. Obesity Atlas 2023. Available from: https://data.worldobesity.org/publications/?cat=19 (accessed 23 July 2024).

De Backer G, Jankowski P, Kotseva K, Mirrakhimov E, Reiner Ž, Rydén L, et al. Management of dyslipidaemia

in patients with coronary heart disease: results from the ESC-EORP EUROASPIRE V survey in 27 countries. Atherosclerosis. 2019 Jun 1;285:135-46.

World Health Organization. Childhood obesity surveillance initiative: highlights 2015-17. https://www.euro.who.int/data/assets/pdf_file/0006/372426/WH14_COSI_factsheets_v2.pdf (accessed 23 July 2024).

World Health Organization. Europe: Diabetes. Available from: https://www.who.int/europe/health-topics/diabetes#tab=tab_1 (accessed 23 July 2024).

Diabetes UK: Cost of Diabetes. Published 15 January 2019. Updated 29 October 2023. Available from: https://www.diabetes.co.uk/cost-of-diabetes.html (accessed 23 July 2024).

CHAPTER 5

OECD Data. Potential years of life lost. Available from: https://data.oecd.org/healthstat/potential-years-of-life-lost.htm#:~:text=The%20calculation%20of%20Potential%20Years,used%20in%20OECD%20Health%20Statistics (accessed 23 July 2024).

IHME. Cardiovascular diseases – Level 2 cause. Available from: https://www.thelancet.com/pb-assets/Lancet/gbd/summaries/diseases/cardiovascular-diseases.pdf (accessed 23 July 2024).

IHME. Ischemic heart disease – Level 3 cause. Available from: https://www.thelancet.com/pb-assets/Lancet/gbd/summaries/diseases/ischaemic-heart-disease.pdf (accessed 23 July 2024).

Townsend N, Kazakiewicz D, Lucy Wright F, Timmis A, Huculeci R, Torbica A, et al. Epidemiology of cardiovascular disease in Europe. Nat Rev Cardiol. 2022 Feb;19(2): 133-43 (2022).

Timmis A, Kazakiewicz D, Townsend N, Huculeci R, Aboyans V, Vardas P. Global epidemiology of acute coronary syndromes. Nat Rev Cardiol. 2023 May:1-11.

Eurostat, Deaths due to coronary heart diseases in the EU, 28 September 2020 https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20200928-1 (accessed on 23 July 2024).

Henrik Toft Sørensen, Frederik Pagh Bredahl Kristensen - Cardiovascular diseases and health inequalities in Europe—a pressing public health challenge, The Lancet, Vol 33, 100722, October 2023, https://doi.org/10.1016/j.lanepe.2023.100722

CHAPTER 6

Dobson R, Clarke SC. Women in cardiology: narrowing the gender gap. Heart. 2022 May;108(10):757.

Maurovich-Horvat P, Bosserdt M, Kofoed KF, Rieckmann N, Benedek T, Donnelly P, et al. CT or invasive coronary angiography in stable chest pain. N Engl J Med. 2022 Apr 28;386(17):1591-602.

Costa GN, Cardoso JF, Oliveiros B, Gonçalves L, Teixeira R. Early surgical intervention versus conservative management of asymptomatic severe aortic stenosis: a systematic review and meta-analysis. Heart. 2022 Oct 5.

Anna Sonia Petronio, Piera Capranzano, MD; Emanuele Barbato3,4, MD, PhD; Nicolo Piazza, Andreas Baumbach, Michael Haude, Stephan Windecker - Current status of transcatheter valve therapy in Europe: results from an EAPCI survey https://eurointervention.pcronline.com/article/current-status-of-transcatheter-valve-therapy-in-europe-results-from-an-eapci-survey

Tanja Rudolph, Clare Appleby, Victoria Delgado, Helene Eltchaninoff, Catherine Gebhard, Christian Hengstenberg, et al., Patterns of Aortic Valve Replacement in Europe: Adoption by Age. Cardiology 18 December 2023; 148 (6): 547–555. https://doi.org/10.1159/000533633

Vassilikos VP, Pagourelias ED, Laroche C, Blomström-Lundqvist C, Kautzner J, Maggioni AP, et al., AFA LT registry investigators group. Impact of centre volume on atrial fibrillation ablation outcomes in Europe: a report from the ESC EHRA EORP Atrial Fibrillation Ablation Long-Term (AFA LT) Registry. Europace. 2021 Jan 27;23(1):49-58. doi: 10.1093/europace/euaa236.

CHAPTER 7

OECD. Expenditure by disease, age and gender-focus on health spending. 2016. Available from: https://www.oecd.org/health/Expenditure-by-disease-age-and-gender-FOCUS-April2016.pdf (accesssed 23 July 2024).

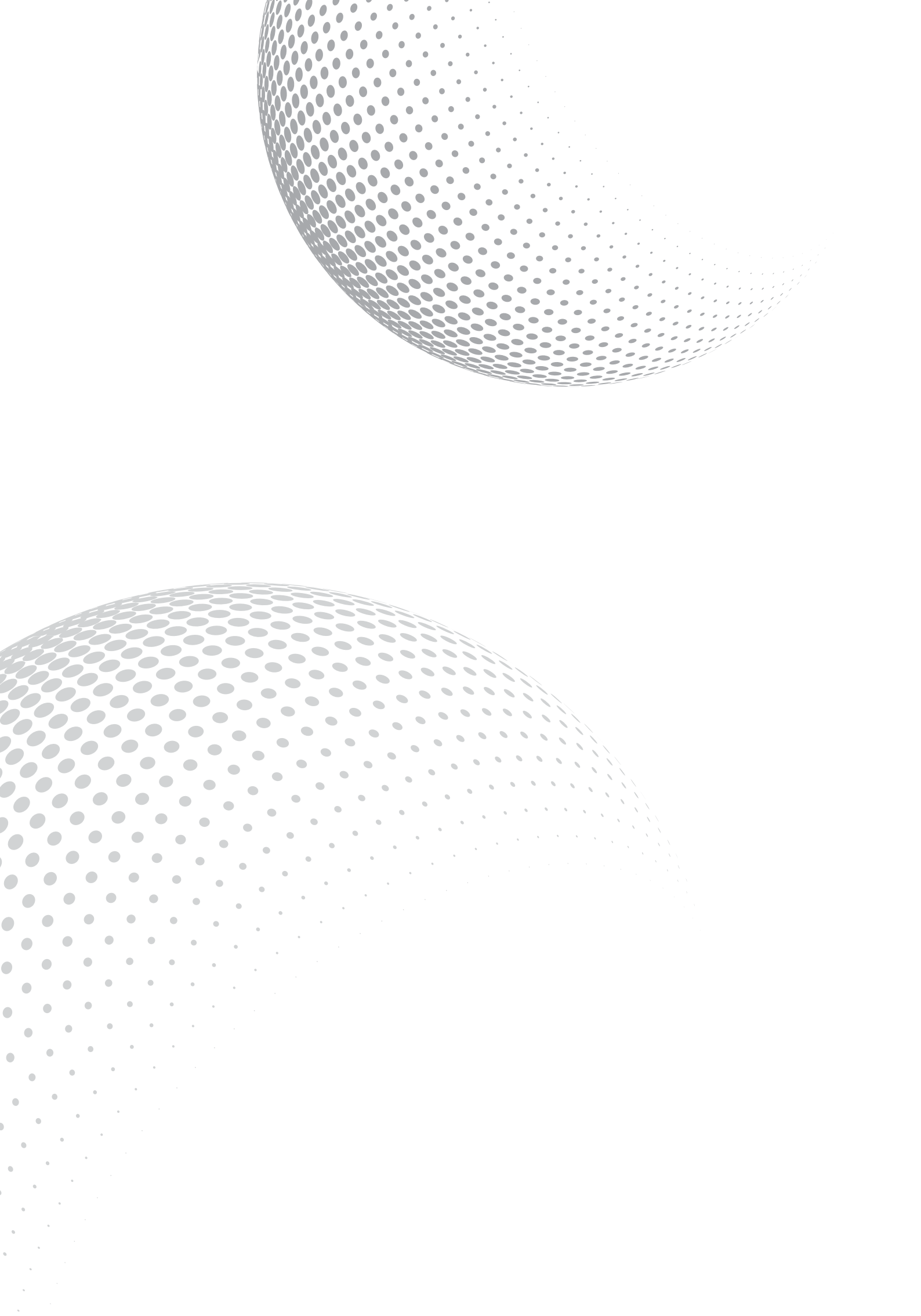
Eurostat. HEDIC: Health expenditures by diseases and conditions. 2016. Available from: https://ec.europa.eu/eurostat/web/products-statistical-working-papers/-/ks-tc-16-008 (accessed 23 July 2024).

Luengo-Fernandez R, Walli-Attaei M, Gray A, Torbica A, Maggioni AP, Huculeci R, et al. Economic burden of cardiovascular diseases in the European Union: a population-based cost study. Eur Heart J. 2023 Dec 1:44(45):4752-67. https://doi.org/10.1093/eurheartj/ehad583

Luengo-Fernandez R, Little M, Gray A, Torbica A, Maggioni AP, Huculeci R, et al. Cardiovascular disease burden due to productivity losses in European Society of Cardiology countries. Eur Heart J Qual Care Clin Outcomes . 2023; Available from: http://dx.doi.org/10.1093/ehjqcco/qcad031

Kazi Dhruv S., et al. Forecasting the Economic Burden of Cardiovascular Disease and Stroke in the United States Through 2050: A Presidential Advisory From the American Heart Association. Circulation, 2024. https://doi.org/10.1161/CIR.0000000000001258

Cardiovascular Disease, A Costly Burden for America, American Heart Association, https://www.heart.org/-/media/Files/About-Us/Policy-Research/Fact-Sheets/Public-Health-Advocacy-and-Research/CVD-A-Costly-Burden-for-America-Projections-Through-2035.pdf



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ESC Cardiovascular Realities 2024

An Illustrated Atlas of Key European Statistics

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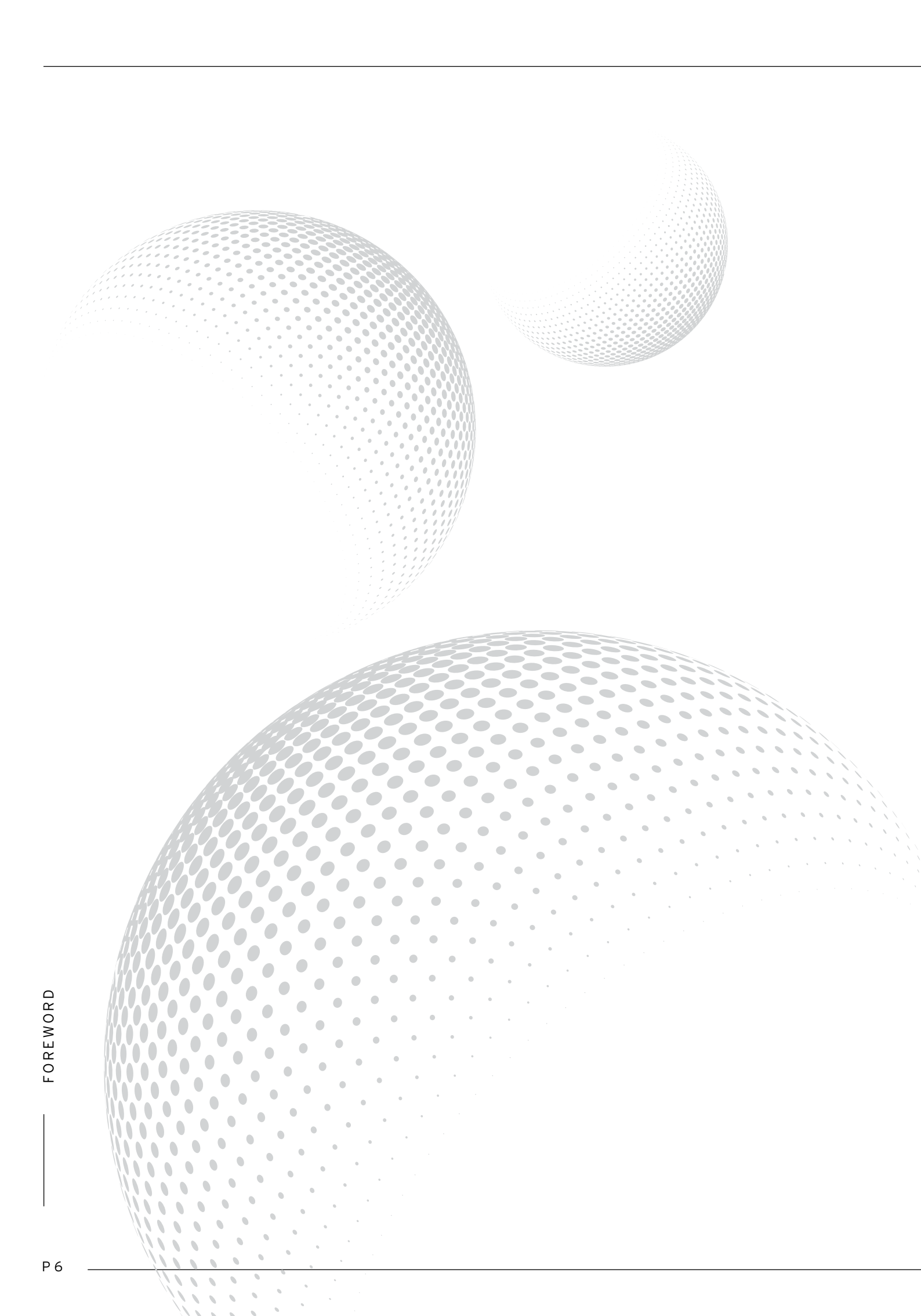

FOREWORD

Dear colleagues,

The mission of the European Society of Cardiology (ESC) is to reduce the burden of cardiovascular (CV) disease. Myocardial infarction, stroke and sudden death remain the most important causes of morbidity and mortality in European countries and the world at large. To achieve its mission, the ESC provides comprehensive education for physicians around the world, presents recent scientific findings in its congresses, journals and textbooks, provides recommendations for optimal CV care in guidelines and collects data of real world clinical practice with its registries.

An important task of the ESC is to inform on the gap between clinical practice in its member states and the recommendations of the ESC Clinical Practice Guidelines. Accessibility to modern diagnostics and therapeutics for all European citizens is a top priority for our society. To address this, real world data are essential to improve patient care along recommended standards. Indeed, without the insights into current practice that the ESC Cardiovascular Realities 2024 provide, strategies to close the gap at the local, political and European level cannot be envisaged nor implemented.

The present edition of the ESC Cardiovascular Realities 2024, a biennial report provided by our society, aspires to support not only ESC Advocacy at the European level, but also those involved in decision-making and implementation of CV care in our member states such as National Cardiac Societies, local politicians, health care specialists, journalists and key opinion leaders.

The content of the ESC Cardiovascular Realities 2024 is based on two emblematic projects of our society, the ESC Atlas of Cardiology and the Burden of Disease Project in collaboration with Oxford University. It is hoped that these unique data will help to shed light on the disparities of health care at the national or regional level throughout Europe and set the stage for further improvement of CV care to the benefit of our patients.

Closing the gap is and must be a continuing effort of a multitude of ESC volunteers and excellent staff who have a strategy, energy and professionalism to successfully continue to reduce the burden of cardiovascular disease.

Sincerely yours,
Thomas F. Lüscher, MD, FRCP, FESC
ESC President

CARDIOVASCULAR REALITIES 2024 is a publication of the European Society of Cardiology. It is based primarily on two earlier publications of the European Society of Cardiology:
(1) Timmis A. et al, "European Society of Cardiology: the 2023 Atlas of Cardiovascular Disease Statistics", Eur Heart J, 2024. doi: 10.1093/eurheartj/ehae466. Manuscript accepted for publication.
(2) Ramon Luengo-Fernandez et al, "Economic burden of cardiovascular diseases in the European Union: a population-based cost study", Eur Heart J, Volume 44, Issue 45, 1 December 2023, Pages 4752–4767, https://doi.org/10.1093/eurheartj/ehad583

DISCLAIMER: The main purpose of the ESC Atlas of Cardiology and particularly ESC Cardiovascular Realities 2024 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 member countries, 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. ESC member countries exhibit different socio-economic risk and disease prevalence dynamics hence the data contained in the present publication should be used responsibly and with caution.

DATA PRESENTATION: National CVD-related indicators are illustrated using bar charts or choropleths. Time series data are illustrated using a locally-weighted polynomial smoother (LOWESS). Box plots are used for displaying summary statistics in high-income and middle-income ESC member countries. Summary statistics for groups of countries are presented as medians.

Acknowledgements

We would like to acknowledge the National Cardiac Societies of the following ESC member countries for their contributions and help in developing national healthcare and infrastructure data: Armenia, Algeria, Austria, Azerbaijan, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Kazakhstan, Kyrgyzstan, Latvia, Lebanon, Lithuania, Luxembourg, Malta, Netherlands, Republic of North Macedonia, Norway, Poland, Portugal, Georgia, Republic of Kosovo, Moldova, Romania, Republic of San Marino, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Tunisia, Türkiye, Ukraine, United Kingdom, Uzbekistan.

For support in developing the ESC Atlas: Dennis Boateng, Blanca Elizondo, Ganna Momotyuk.

All the figures are based on two previous publications from European Society of Cardiology: (1) European Society of Cardiology: the 2023 Atlas of Cardiovascular Disease Statistics, European Heart Journal 2024, doi: 10.1093/eurheartj/ehae466 by Timmis A, Aboyans V, Vardas P, et al and (2) Economic burden of cardiovascular diseases in the European Union: a population-based cost study, European Heart Journal, Volume 44, Issue 45, 1 December 2023, Pages 4752–4767, https://doi.org/10.1093/eurheartj/ehad583 by Ramon Luengo-Fernandez et al. The figures (1-17) were provided by permission of Oxford University Press on behalf of the European Society of Cardiology.

This work has been enhanced by some of the more recent data from well-known organisations, such as the World Bank, the World Health Organization, the Organisation for Economic Co-operation and Development, European Environment Agency and Institute for Health Metrics and Evaluation.

TABLE OF CONTENTS

INTRODUCTION

Welcome to the 2024 biennial edition of our cardiovascular statistics booklet, brought to you by the European Society of Cardiology (ESC). This comprehensive 84-page guide aims to present the latest cardiovascular data in an accessible manner, ensuring that even complex statistics are understandable to a broad audience. Our goal is to provide insights that inform decision-making, drive improvements in cardiovascular care, and ultimately contribute to better health outcomes across Europe and beyond.

Cardiovascular disease (CVD) continues to be the leading cause of death and disability in Europe, presenting a significant public health challenge. Despite advances in medical research and healthcare, the incidence of CVD is on the rise, affecting millions of individuals and placing a substantial economic burden on healthcare systems and economies across the continent. The statistics presented in this booklet help illustrate the scale of the problem and underscore the urgent need for effective strategies in prevention and management.

In this edition, we present the latest data on incidence and prevalence of various cardiovascular disorders, including coronary artery disease, stroke, and heart failure. These disorders not only have a profound impact on individuals' quality of life but also contribute to significant healthcare costs and loss of productivity. By examining these data, we aim to highlight key trends and identify areas where interventions can be most effective.

Demographic variations play a crucial role in understanding the burden of CVD. This booklet highlights disparities across different age groups, genders, and regions within Europe and beyond. For example, we explore how age and gender influence the risk of developing CVD, and how regional differences in healthcare access and lifestyle factors contribute to varying incidence rates. Understanding these disparities is essential for developing targeted interventions that address the specific needs of different populations.

The economic burden of CVD is another critical aspect covered in this booklet. We detail the direct and indirect costs associated with CVD, including healthcare expenditure, hospitalisations, medications, and loss of productivity due to illness or premature death. The broader societal impact, including the emotional and financial strain on families and communities, is also considered. By quantifying these costs, we aim to provide a comprehensive picture of the economic impact of CVD and emphasise the importance of investing in prevention and early intervention.

The metrics we present are indispensable for the planning and implementation of cardiovascular health strategies. Accurate and up-to-date statistics enable policymakers, healthcare providers, and researchers to allocate resources efficiently, design targeted interventions, and monitor the progress of public health initiatives. This booklet provides a comprehensive overview of these essential metrics, including incidence and prevalence rates, mortality rates, and healthcare utilisation statistics. These metrics offer valuable insights that inform decision-making and help track the effectiveness of various health interventions.

As you navigate through the pages of this booklet, we hope you find the information both enlightening and practical. Our aim is to make complex data accessible and to highlight the real-world implications of these statistics. By raising awareness and enhancing our collective understanding of cardiovascular health, we can work towards reducing the burden of CVD and improving the quality of life for millions of Europeans.

In conclusion, the ESC is committed to advancing cardiovascular health through research, education, and advocacy. We believe that informed decision-making, based on accurate and comprehensive data, is key to tackling the challenges posed by CVD. This booklet is a testament to that commitment, and will serve as a valuable resource for all stakeholders involved in cardiovascular health.

Metrics are indispensable for the planning and implementation of cardiovascular health strategies. Accurate and up-to-date statistics enable policymakers, healthcare providers, and researchers to allocate resources efficiently, design targeted interventions, and monitor the progress of public health initiatives.

MESSAGES

Salient Statistics from the ESC Atlas include:

Median life expectancy across ESC member countries increased between 1970 and 2021 **from 69.1 to 76.4 years.**

The **highest birth rates** among ESC member countries are **observed in middle-income countries such as Egypt** (2.9 births per woman), **Algeria and Syrian Arab Republic.** Only **Israel** among high-income countries has comparable birth rates (2.9 births per woman).

Cardiovascular Disease represented (2021) **a cost of €630 per person**, ranging from €381 in Cyprus to €903 in Germany.

CVD is estimated to cost the EU 282 billion euros annually, with health and long-term care accounting for 155 billion euros (11% of EU health expenditure).

The proportion of the **population aged >65 years** is predicted to **exceed 30% in EU countries** by the end of the century.

The **median number of births per woman** across ESC member countries **has declined from 2.6 in** 1970 **to 1.5** in 2023.

EDITORIAL

The Atlas metrics in the era of evidence-based cardiovascular care

Panos E. Vardas
Professor of Cardiology,
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Greece

Over the past decades, it has become increasingly clear that the significant demands for quality and modern health care come at a cost and must be based on proper health care planning, where needs, realities, and cost-effectiveness are prioritised.

Evidence-based health care is based primarily on well-standardised data and reliable metrics, indicators capable of highlighting long-term trends, emerging new realities, and effective policies for the prevention and treatment of disorders that constitute the spectrum of cardiovascular diseases.

The strategic ESC Atlas of Cardiology project, which maps needs and compares from a cardiovascular perspective the burden of CV diseases in ESC member countries, as well as the status of health care systems, has been widely recognised as a pivotal tool for leveraging cardiovascular care. It presents the evidence of trends, disparities, gaps, and associations between fundamental variables.

In Brussels, over the past 11 years, our society has been significantly active in supporting evidence-based initiatives capable of reducing the burden of CVD in ESC member countries, but even beyond, as befits a scientific society of the size and prestige of the ESC.

Undoubtedly, advocacy is the spearhead of this effort. However, any kind of credible advocacy, presupposes in-depth knowledge of the realities of cardiovascular medicine and care, all those factors that compose the realities in ESC member countries of our society and concern one billion, one hundred sixty-four million citizens!

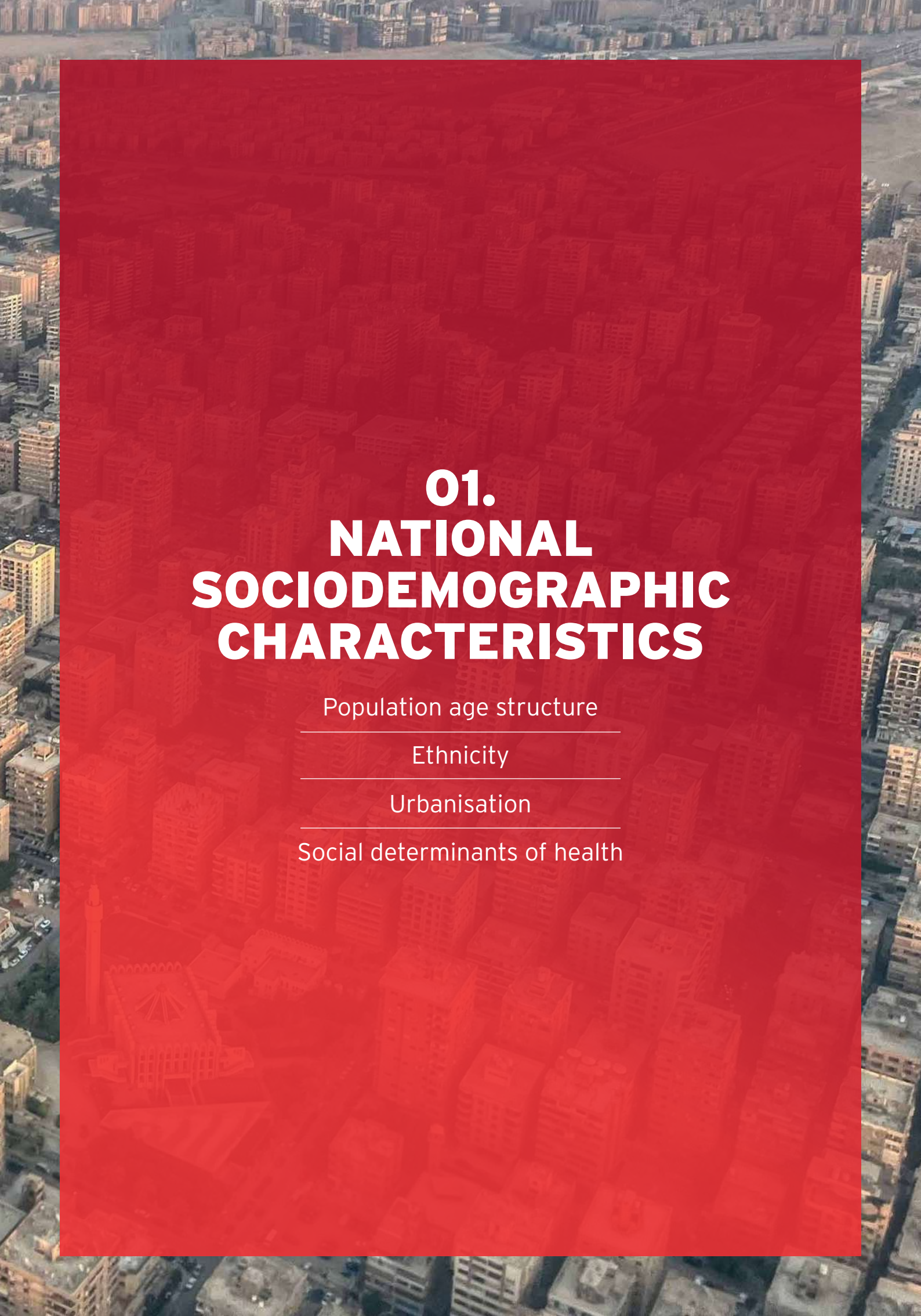
Ethical considerations compel us to prioritise improvements in prevention of CVD and conditions of care for everyone, those at significant disadvantage in enjoying the modern achievements of pharma and biotechnologies in our domain.

At the same time, our society needs to strategically study in-depth geopolitical and socio-economic conditions and examine the impacts of aging populations that are most prevalent in Western European countries.

Degenerative CVD will progressively burden morbidity, disparities, and mortality, as well as health care costs.

The ESC, through the European Heart Health Institute in Brussels where the ESC Atlas of Cardiology and Burden of CVD projects were created, needs to steadily monitor the evolving realities, needs, and conditions of CV health care and responsibly advocate to those, at the state or European Union level, who have responsibility for planning and implementing health policy.

This is what the times and our humanitarian values demand.



01. NATIONAL SOCIODEMOGRAPHIC CHARACTERISTICS

Population age structure

Ethnicity

Urbanisation

Social determinants of health

NATIONAL SOCIODEMOGRAPHIC CHARACTERISTICS

Cardiovascular diseases, resulting from the combined effects of genetic predisposition, comorbid disorders such as diabetes and dyslipidaemia, harmful lifestyles and adverse environmental conditions, have emerged over the past sixty years as a leading cause of morbidity and mortality.

The tireless efforts of a range of scientific organisations and governmental bodies, along with an important contribution from healthcare professionals, have led to reductions in CVD mortality in many ESC member countries, particularly those in Western Europe. CVD becomes progressively more common with increasing age and there is a continuing high prevalence of disease driven by the ageing populations of many ESC member countries. However, age-standardised mortality due to CVD has declined in high-income ESC member countries the last 30 years but continues to increase in many of the middle-income countries where a substantial proportion of the disease burden now resides.

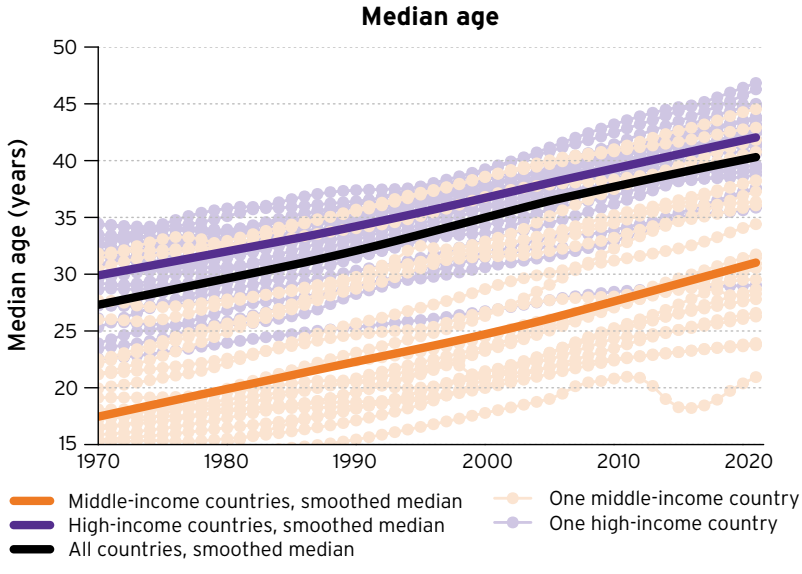
In focusing on the sociodemographic characteristics of ESC member countries, which together have a population of over 1 billion citizens, it is necessary to consider other factors in addition to ageing, including ethnicity, immigration, urbanisation and socioeconomic status, as well as environmental and climate changes, which critically influence the burden of cardiovascular diseases and levels of cardiovascular care.

a. Population age structure across ESC member countries

Ageing as a demographic phenomenon concerns all ESC member countries. It is characterised by a decrease in fertility and an increase in life expectancy. The median population age of ESC member countries increased significantly between 1970 and 2021, from 27.7 to 41.6 years (Figure 1) with the proportion of over 65s increasing from 9.1% to 18.1%. In 2021, the proportion of population aged >65 in middle-income ESC member countries was 9.6%. In high-income countries the proportion of population aged >65 was twice as high at 20.0% (Figure 2). Trends were similar in middle-income and high-income countries but median age during this period was always lower in middle-income countries, reaching 31.4 years in 2021 compared with 43.6 years in high-income countries.

It is interesting to note that with population ageing comes an increase in CVD from 40% in adults aged 40-59 years, 75% in those 60-79 years, and 86% in those over 80 years.

FIGURE 1 **Median age (years) of the population of ESC member countries (1970-2021).**

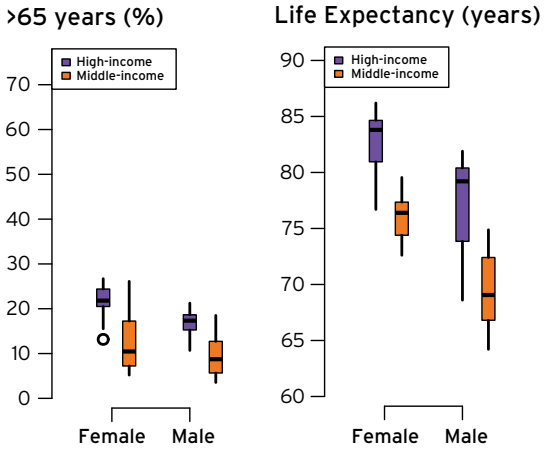


Data source: United Nations, Population Division, https://population.un.org/wpp/Download/Files/1_Indicators%20(Standard)/EXCEL_FILES/1_Population/WPP2019_POP_F05_MEDIAN_AGE.xlsx

Life expectancy

Median life expectancy across ESC member countries increased between 1970 and 2021 from 69.1 to 76.4 years. During this period, it was consistently shorter for middle-income compared with high-income countries, reaching 72.1 vs 81.2 years in 2021.

FIGURE 2 **Age distribution (>65 years) and life expectancy in ESC member countries, stratified by national income status (2021).**



Data source: World Bank, https://datatopics.worldbank.org/world-development-indicators. Data not available: Republic of San Marino.

Fertility

The median number of births per woman across ESC member countries has declined from 2.6 in 1970 to 1.5 in 2023. An average of 2.1 live births per woman is needed for each generation to exactly replace itself without international immigration. The fertility rate varies significantly among the member countries of our society, as do the trends in each country over the past decade. The highest birth rates are observed in middle-income countries such as Egypt (2.9 births per woman), Algeria, and Syrian Arab Republic with only Israel among high-income ESC member countries having comparably high rates (2.9 births per woman). In the high-income countries of the European Union birth rates are lower, ranging from 1.1 - 1.8 births per woman in Malta and France, respectively.

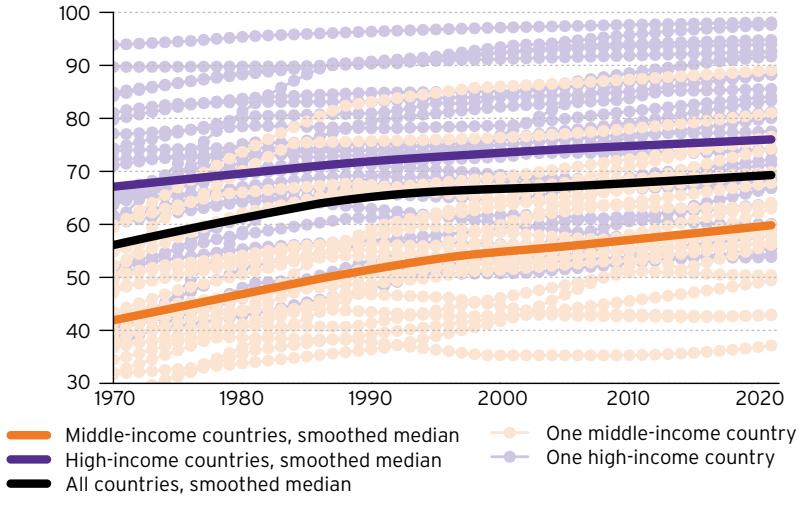
b. Ethnicity

Health inequalities among ethnic and immigrant groups have long been recognised. Available evidence suggests that migrants in Europe and North America, the two largest recipients of international immigrants from low-resource regions in the world, are at higher risk of developing CVD compared with the host population. This reality is related to pre- and post-migration factors such as socioeconomic status, cultural factors, lifestyle, psychological stress, access to healthcare, language issues, and healthcare usage. Some of these pre- and post-migration environmental factors may interact with genetic (epigenetic) and microbial factors, influencing their cardiovascular risk. Engaging migrants in population and clinical research is pivotal to bridging gaps in inequality. It must be a priority of ESC advocacy that ethnic differences in the incidence and management of CVD are identified and progressively eliminated.

c. Urbanisation

The world during the last sixty years has entered an age of urbanisation, with consequences poorly estimated. It is expected that at the end of the current century, 80% of the world population will be urbanised according to the European Investment Bank. Focusing on Europe, it is recognised that cities with a population of <250,000 citizens account for 28% of the city residents, lower than in Africa (33%), but higher than in North America (17%). Across ESC member countries the proportion of people living in urban environments increased from 52.2% in 1970 to 69.6% in 2021 as transition continued from agricultural to manufacturing and service economies (Figure 3). Urbanisation is more advanced in high-income countries where 76% of people live in urban environments compared with 61% in middle-income countries. Urban living threatens CV health due to over-crowding, air pollution, social deprivation and stress. It can also remove the autonomy of

FIGURE 3 **Proportion of population living in urban areas ESC member countries (1970-2021).**



Data source: World Bank, https://datatopics.worldbank.org/world-development-indicators. Data not available: Republic of Kosovo.

individuals to make healthy choices, with foods high in salt, sugar and fats often more cheaply and readily available than fresh fruit and vegetables. The World Heart Federation (WHF) has called for city planners to develop infrastructures to facilitate heart-healthy behaviours, stating that policies and strategies that allow individuals to adopt healthy behaviours and avoid unhealthy ones are crucial to successful urbanisation.

d. Social determinants of health

The Social Determinants of Health (SDOH), often also called socioeconomic status, are those nonmedical factors that influence health outcomes. They are the conditions in which people are born, grow, work, live, and age. According to the Center for Disease Control and Prevention (USA), the SDOH can be grouped into five domains: Economic Stability, Education Access and Quality, Health Care Access and Quality, Neighborhood and Built Environment, and Social and Community Context. People who experience conditions below average in one or more of these domains are impacted in their overall health and well-being.

TABLE 1. Sample indices of socioeconomic status

GDP PER CAPITA ($)		COMPLETED 2º EDUCATION (%)		NATIONAL UNEMPLOYMENT RATE (%)	
Middle-income	High-income	Middle-income	High-income	Middle-income	High-income
15.6K	48.3K	68.3%	77.4%	11.1%	6.2%

Data source: World Bank, https://datatopics.worldbank.org/world-development-indicators. Data not available: (A) GDP per capita - Syrian Arab Republic, (B) Completed secondary education - Republic of Kosovo, Morocco, (C) National unemployment rate - Republic of Kosovo, Republic of San Marino.

Socioeconomic status is by definition lower in middle-income ESC member countries where access to healthy life choices and high-quality healthcare is reduced compared with high-income countries.

MESSAGES

The populations in ESC countries are aging, with today **a percentage of 18.1%** consisting of people over 65 years old.

The median number of births per woman across ESC member countries has declined from 2.6 in 1970 to 1.5 in 2023.

The incidence of cardiovascular diseases and their management is significantly affected primarily by socioeconomic determinants such as **income, education, and job quality**. It is obvious that, despite the generalised needs in all member countries of our society, those 25 countries that belong to low or middle-income countries (WB, 2021) require immediate support.

It is well accepted, although not extensively documented, that there are health inequalities among ethnic and **immigrant groups**. Detailed records are needed to determine the extent of the problem.

> There is no one size that fits all. We must work country by country, region by region, community by community, to ensure the diversity of needs are addressed to support each reality.

Amina J. Mohammed
Deputy Secretary-General, UN, 2017-present

EDITORIAL

Cardiovascular Disease Prevention Amid the Challenge of Sociodemographic Change

Mika Kivimäki
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The ESC Atlas of Cardiology summarises key evidence on the burden and prevention of cardiovascular diseases, which are among the leading causes of death and disability worldwide. Understanding the latest trends in incidence, prevalence, mortality, and risk factors is essential for future healthcare and health policy planning.

In recent decades, significant progress has been made in CVD prevention. The Global Burden of Disease study shows that age-standardised years of life lost to CVD in high-income countries have declined more rapidly than those for other major causes of death. In middle- and low-income countries, while the greatest progress has been made in communicable disease prevention, there have also been notable reductions in CVD-related mortality.

Despite these advancements, the number of CVD patients continues to rise, driven by population growth and demographic changes. Declining fertility rates have increased the proportion of older people, and longer life expectancies further accelerated population ageing. Additionally, the obesity pandemic, air pollution and urbanisation have contributed to the growing CVD burden.

The ESC Atlas of Cardiology indicates that approximately 70% of CVD cases are linked to 14 modifiable risk factors. Eliminating these factors could prevent or delay most CVD events. While complete elimination is ideal, interim targets should focus on reducing these factors to levels observed in populations with the lowest CVD incidence.

High socioeconomic status (SES) groups have lower levels of most modifiable CVD risk factors and can serve as benchmarks. The PURE study shows a significantly lower CVD risk among high compared to low SES individuals across countries of varying income levels: 20% in high-income countries, 37% in middle-income countries, and 55% in low-income countries. This suggests that prevention could lead to substantial health improvements globally.

Many individuals who could benefit from preventive medications like statins and antihypertensives do not receive these drugs, which is why the idea of offering a polypill to everyone aged 50 or older has been introduced. Promising pharmacological treatments for obesity, a major CVD risk factor, are also under development. Future prevention efforts should better leverage these medications and approaches. Equally crucial are more effective measures to address upstream socioeconomic and environmental risk factors. These include policies to encourage healthy eating, limit alcohol consumption, reduce tobacco use, promote physical activity, and combat climate change and air pollution.

The data summarised in the Atlas should encourage healthcare professionals and policymakers to place greater emphasis on comprehensive CVD prevention.

02. ENVIRONMENTAL RISK FACTORS

Air pollution

Noise pollution

Climate change

Chemicals and cardiovascular disease

Second-hand smoke

ENVIRONMENTAL RISK FACTORS

The environment, a surrounding complex of interacting ecosystems, exerts a fundamental influence on the quality and longevity of human life.

Among the numerous factors and conditions that constitute the environmental ecosystems, those primarily related to health burden are air pollution, noise, climate change, chemicals, and second-hand smoke.

The European Environment Agency estimates that nearly 20% of all CVD deaths are attributable to key environmental factors although there is considerable heterogeneity with a higher proportion of deaths related to environmental factors estimated in eastern and southeastern ESC member countries.

a. Air pollution

Air pollution is a major health hazard responsible for an estimated 7.6% of global deaths annually, rivaling the impact of smoking, hypertension, and physical inactivity on population health. It is caused by a mixture of harmful substances including particles and gases that are released into the atmosphere primarily from human activity. Particulate matter is further categorised according to size into coarse particles (PM10 < 10 µm in diameter), fine particles (PM2.5 < 2.5 µm in diameter), and ultrafine particles (0.1 µm in diameter). PM2.5 and nitrogen oxide are among the most frequently cited pollutants associated with development of CVD. Their inhalation leads to inflammation, vasoconstriction, and endothelial dysfunction which increases the risk of myocardial infarction, arrhythmias, and heart failure with increased cardiovascular mortality.

Air pollution reduces the mean life expectancy in Europe by an estimated 2.2 years. In developing its air pollution policy, the EU has set an annual PM2.5 exposure limit of 25µg/m^3. Only three EU member states failed to register concentrations below this rather conservative target in 2020, in contrast to the more challenging WHO target of ≤5µg/m^3 which only Estonia managed to achieve.

Air pollution is now high on the political agenda of the European Union. In October 2022, the European Commission published a proposal for a revision of the ambient air quality directive, which includes:

1. Stricter thresholds for pollution
2. Enhancing the right to clean air
3. More active penalties and compensatory possibilities for violating air quality rules
4. Strengthened rules for air quality monitoring
5. Requirements to improve air quality modelling
6. Better public information

On April 24, 2024, the European Parliament took a major step forward in addressing the key environmental and health challenges of air pollution by adopting the revised provisional EU-WHO political agreement on air quality in the EU.

b. Noise pollution

The role of noise as an environmental pollutant and its impact on health has been scrutinised since the early 20th century. The problem, especially in modern metropolitan areas, has become an increasing concern for major international and governmental health organisations such as the WHO and the EU, particularly through the European Environment Agency (EEA), that have drawn attention to the harmful effects of noise pollution.

A 2015 report from the EEA linked exposure to noise from cars, trucks, planes, and trains with nearly 1.7 million additional cases of hypertension, 80,000 additional hospital admissions, and 1,800 premature deaths from coronary artery disease and stroke in Europe each year.

The EU has set permissible noise levels in residential areas at 55 dB during the daytime and 50 dB at night. These limits are often exceeded, and noise exposure above 55 dB might affect up to 40% of the EU population. Noise induces stress and disturbs sleep, predisposing individuals to coronary heart disease (CHD), with the risk increasing by 6% for every 10 dB increase in day–night noise levels. These adverse cardiovascular consequences of noise appear to be driven by small elevations in blood pressure, triglycerides, and glycated hemoglobin that occur with exposures above 65 dB. It is estimated that a 5 dB reduction in environmental noise across the USA would reduce incident cases of hypertension and cardiovascular disease by 1.2 million and 279,000 cases per year, respectively.

c. Climate change

Climate change refers to the long-term deviation of temperature trends and weather conditions from seasonal averages. Over the past two centuries, the excessive production and emission of greenhouse gases and other air pollutants into the atmosphere have significantly contributed to climate change and global warming. The impact of climate change on cardiovascular health varies across demographic and socioeconomic subgroups but is likely more profound in vulnerable subgroups. Extreme temperature exposure, both cold and hot, has been linked to a higher risk of myocardial infarction and cardiovascular mortality in many studies. High mean annual temperatures have also been associated with elevated fasting plasma glucose levels, insulin resistance, and an increased incidence of diabetes.

d. Chemicals and cardiovascular disease

Exposure to chemicals present in the workplace or released into the environment may also increase cardiovascular risk. These include heavy metals, organic solvents, and chemical air pollutants like polycyclic aromatic hydrocarbons, benzene, and pesticides. There is also evidence of adverse effects on cardiovascular health from occupational exposures to carbon monoxide, mineral dusts, dioxins, and nitrated explosives.

e. Second-hand smoke

Second-hand smoke exposure occurs when people breathe in smoke exhaled by smokers or from burning tobacco products. The smoke contains many noxious chemicals including known carcinogens. There is no safe level of exposure to second-hand smoke; even brief exposure can cause serious health problems. According to the Centers for Disease Control and Prevention (CDC, USA) and other regulatory authorities, health problems caused by second-hand smoke in adults who do not smoke include coronary artery disease, stroke, and lung cancer, as well as adverse reproductive health effects in women. Second-hand smoke increases the risk of heart disease by ≈30%, accounting for at least 35 000 deaths annually in the United States. Additionally, second-hand smoke can cause sudden infant death syndrome (SIDS). Recognition of the harmful effects of second-hand smoke led to the widespread implementation of national smoking legislation across ESC member countries with salutary effects on the incidence of ST elevation myocardial infarction.

MESSAGES

For every 10 µg/m³ increase in PM2.5, the risk for cardiovascular death increases by nearly 2%.

The role of noise as an environmental pollutant and its impact on health are being increasingly recognised.

Adults who do not smoke and are exposed to second-hand smoke increase their risk of developing coronary artery disease by 25-30% and stroke by 20-30%.

Environmental noise is associated with an increased incidence of arterial hypertension, myocardial infarction, and stroke.

One day mankind will have to fight burden of noise as literally as plague and cholera.

Robert Koch, 1843-1910
Physician and Nobel Prize Laureate 1905

EDITORIAL
Environmental Risk Factors and Cardiovascular Disease

Thomas Münzel
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Cardiovascular disease remains a leading cause of morbidity and mortality globally. While traditional risk factors like hypertension, diabetes, chronic smoking, and hyperlipidemia are well-known, environmental risk factors also significantly impact cardiovascular health.

Air pollution, especially fine particulate matter (PM 2.5 µm) and nitrogen dioxide, is strongly associated with increased CVD incidence and mortality. These pollutants contribute to oxidative stress, systemic inflammation, endothelial dysfunction, and atherosclerosis, leading to myocardial infarction, stroke, and heart failure. Long-term exposure to elevated air pollution levels has also been linked to a higher prevalence of hypertension and arrhythmias. Noise pollution from traffic, industry, and urban activities disrupts sleep and induces stress responses, elevating blood pressure and heart rate. This contributes to the development and exacerbation of CVD, with chronic exposure correlating with increased risks of hypertension, ischemic heart disease, arrhythmia, and stroke. Climate change, through heat waves and extreme weather events, poses additional risks to cardiovascular health. Heat stress exacerbates pre-existing cardiovascular conditions, increasing hospital admissions and mortality during extreme heat periods, particularly among patients with chronic congestive heart failure. Climate change-related alterations in air quality and vector-borne diseases may also indirectly impact cardiovascular health.

Exposure to toxic substances, including heavy metals (lead, mercury, arsenic) and persistent organic pollutants, has been implicated in CVD pathogenesis. These substances interfere with cardiovascular function through oxidative stress, endothelial damage, and dysregulation of lipid metabolism. Populations in industrial and urban areas are particularly vulnerable to these exposures. The close associations between environmental stressors and cardiovascular diseases highlight the importance of comprehensive public health strategies to mitigate these risks. Policy interventions are essential to reduce air and noise pollution, address climate change, and regulate toxic substance exposures. Increased public awareness and community-based initiatives are vital in promoting cardiovascular health.

In conclusion, environmental risk factors significantly contribute to the global burden of cardiovascular diseases. Addressing these determinants through multidisciplinary approaches involving policymakers, healthcare providers, and communities is crucial for reducing CVD prevalence and improving public health outcomes. Further research is needed to elucidate these associations' mechanisms, and develop targeted interventions.

03. LIFESTYLE AND CVD RISK

Tobacco use

Alcohol consumption

Insufficient exercise

Dietary factors

LIFESTYLE AND CVD RISK

Lifestyle factors, including diet, alcohol consumption, tobacco use, and physical inactivity are major determinants of cardiovascular risk. Healthy lifestyle habits in all age groups associate with a decreased incidence of CVD, with benefits greater in adults aged <50 years compared with older adults. This emphasises the importance of correcting unhealthy lifestyle habits, particularly among young and middle-aged persons, in order to improve cardiovascular health.

a. Tobacco use

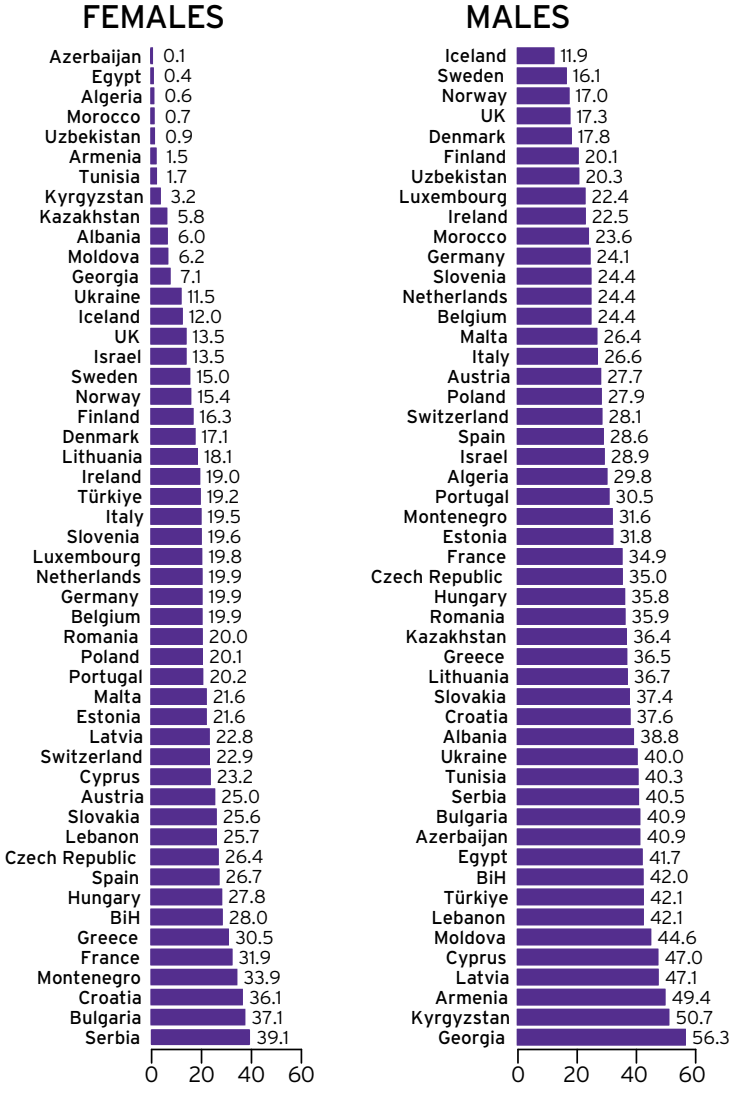
Smoking increases the risk of death from CVD by up to three times. In 2020, 25% of persons aged ≥15 years in ESC member countries were current users of tobacco products, with lower rates in females than in males (20% vs 33%). Use of tobacco products was particularly high among males in middle-income ESC member countries where 41% were smokers, with rates closer to 50% in Armenia, Georgia, and Kyrgyzstan (Figure 4). Policy measures to reduce tobacco use have been effective in reducing smoking rates across ESC member countries over the last 20 years from 34% to its current level. In Iceland only 12% of the population are now smokers, but in other countries rates are higher, with 40% of Serbian inhabitants continuing to smoke. E-cigarettes are now available as an alternative nicotine delivery system and may have a role in supporting smoking cessation. However, safety concerns persist and their increasing use among children and young adults is a worry.

b. Alcohol consumption

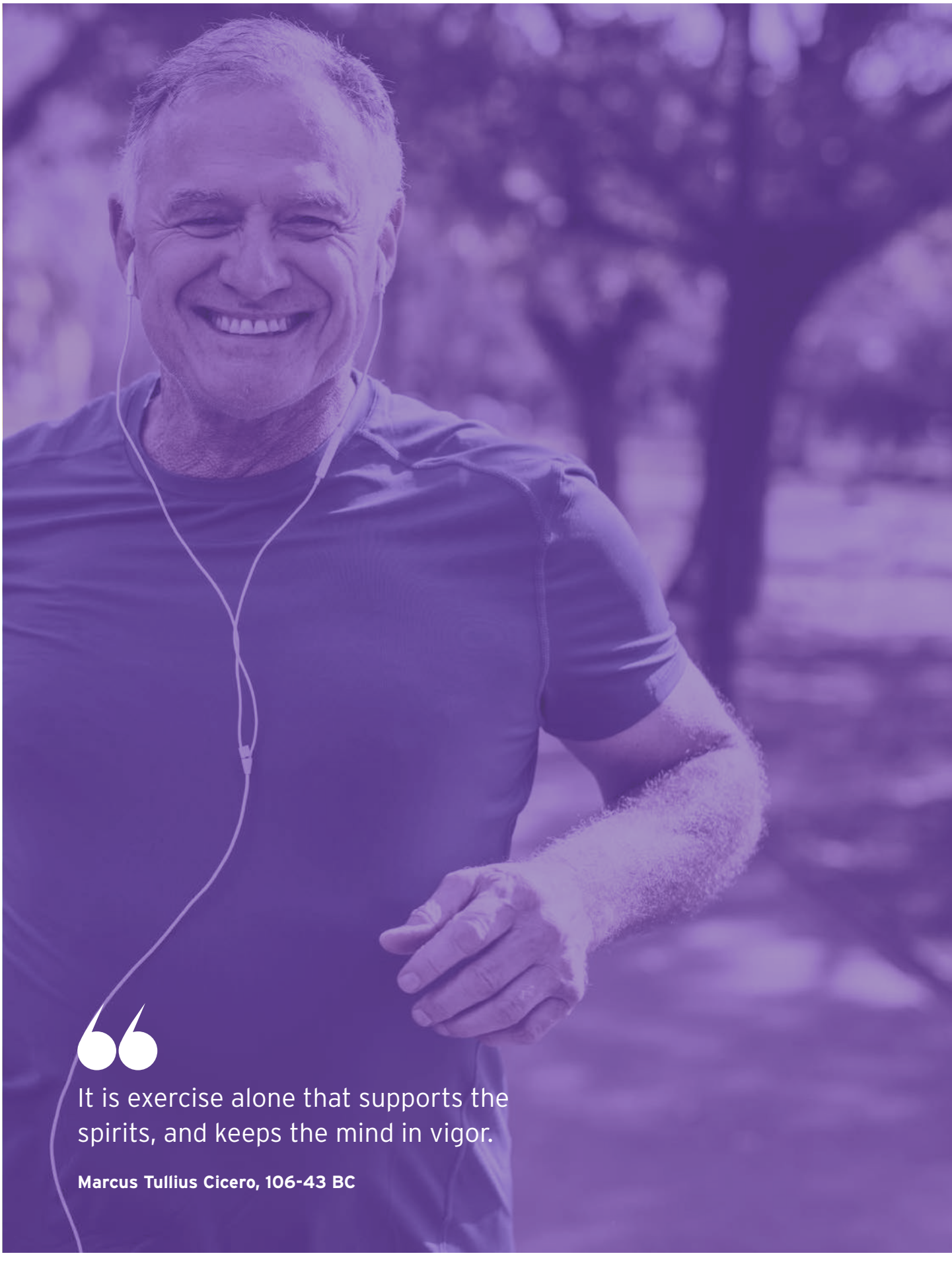
The harmful use of alcohol is particularly common in Europe where alcohol use is responsible for 240,000 to 290,000 deaths each year. In 2019, alcohol consumption per capita was 9.2 litres per year ranging from <2 L/year in Azerbaijan and Türkiye to >11 L/year in Austria, Bulgaria, Czech Republic, Estonia, France, Latvia, Lithuania and Slovenia. Consumption was over twice as high in high-income compared with middle-income ESC member countries (10.3 vs 4.4 L/year of pure alcohol). Young adults are most susceptible to the harmful effects of alcohol and current recommendations are for them to be prioritised in strategies aimed at minimising consumption. Strategies include taxation, restrictions on availability, advertising bans, public health campaigns, minimum unit pricing, regulation of digital alcohol marketing, and alcohol labelling.

> A large majority of coronary patients have unhealthy lifestyles in terms of smoking, diet and sedentary behaviour, which adversely impacts major cardiovascular risk factors.
>
> **EUROASPIRE V 2020.**

FIGURE 4 **Proportion (%) of national population aged ≥15 years who are users of tobacco (2020).**



Data source: WHO, https://www.who.int/data/gho/data/indicators/indicator-details/GHO/gho-tobacco-control-monitor-current-tobaccouse-tobaccosmoking-cigarettesmoking-agestd-tobagestdcurr. Data not available: Republic of Kosovo, Republic of San Marino, Libya, Republic of North Macedonia, Syrian Arab Republic.



It is exercise alone that supports the spirits, and keeps the mind in vigor.

Marcus Tullius Cicero, 106-43 BC

c. Insufficient exercise

Insufficient physical activity, <150 minutes of moderate physical activity or <75 minutes of vigorous physical activity per week, increases the risk of CVD. Leisure time exercise has consistently been shown to deliver dose-related improvement in CV health, reducing the incidence of CVD and mortality. During the period 1990-2019, age-standardised disability-adjusted life years (DALYs) attributable to insufficient physical activity declined by almost 50% in high-income ESC member countries but showed little change in middle-income countries.

d. Dietary factors

Diet contributes significantly to CVD mortality, with estimates indicating that across the European region, one in every five premature deaths could be prevented by an optimised diet.

- The benefits of a diet low in polyunsaturated fat but rich in vegetables, fruits, herbs, nuts, beans, and whole grains – the Mediterranean diet – has been confirmed in the PREDIMED trial in which the incidence of major CV events was reduced by 31% compared with a control diet. The Mediterranean diet is also effective for secondary prevention of CVD events.

- Associations between added sugar consumption, obesity and type 2 diabetes have long been recognised. Added sugar also shows independent association with CVD mortality. In 2020, supply of sugar and sweeteners delivered an estimated 332 kcal/capita/day across ESC member countries, ranging from <200 kcal/capita/day in Kyrgyzstan, Syrian Arab Republic and Uzbekistan to >450 kcal/capita/day in Belgium, Denmark, Malta and Poland. Recommendations are that daily intake of free sugars is reduced to less than 10% of total energy intake. A sugar reduction initiative is now being launched across Europe in a drive to reduce rates of diabetes and CVD. Policy initiatives include taxation and restrictive advertising of food products such as sugar, education in the classroom, school lunch programmes and traffic light labelling on food and drink.

- Reductions in salt intake are also recommended based on the increased risk of cardiovascular events observed when intake exceeds 5 g/day. Current guidelines recommend a sodium intake of <2.3 g/day but this low level has proved hard to achieve in population studies.

MESSAGES

In 2020, 25.4% of the persons aged ≥15 years in ESC member countries were current users of tobacco products, 20% of females and 33% of males.

In 2019, median pure alcohol consumption per capita was nearly twice as high in high-income compared with middle-income ESC member countries (10.3 vs 4.4 l/year).

Insufficient physical activity caused more DALYs per 100,000 in low-income compared with high-income ESC member countries.

Energy delivery from sugar supply in 2020 was higher in high-income countries compared with middle-income countries (345 vs 289 kcal/capita/day).

People living in the most deprived areas have the highest prevalence of smoking, being physically inactive and being classified as obese or overweight.

British Heart Foundation

EDITORIAL

Live style and cardiovascular disease: an old, well-known partnership

Marcus Flather
Professor of Medicine and Clinical Trials, Norwich Medical School, University of East Anglia, UK

This chapter summarises key lifestyle factors that contribute to excess CVD. Tobacco use increases risk of CVD and cancer, and the ESC Atlas of Cardiology data shows that 25% of adults are smoking across ESC member countries with rates greater than 50% among males in some regions. Established cardiac effects of excess alcohol consumption include cardiomyopathy, heart failure and atrial fibrillation plus higher risk of accidents and liver damage. High-income ESC member countries have among the highest rates of alcohol consumption per capita in the world with more than 11 litres of pure alcohol per year. Current recommendations for physical exercise to reduce CVD risk are for a minimum of two and a half hours of moderate exercise (brisk walking, jogging, cycling, swimming, rowing) per week. Dietary factors contributing to CVD include excess saturated fat, sugar, processed carbohydrate and salt, along with insufficient fruits, vegetables, cereals, seeds, beans, fish oils and monounsaturated fats. Direct sugar consumption from processed foods and fizzy drinks has reached an all-time high in ESC member countries and is driving an obesity crisis with all the associated complications including diabetes and increased CVD risk.

So how do we apply the ESC Atlas of Cardiology data to improving lifestyle to reduce CVD risk? Established methods to curb tobacco consumption include increasing sales tax, banning tobacco advertising and sponsorship, introducing higher age limits, and providing smoking cessation facilities. Alcohol consumption can also be reduced by increasing sales tax and limiting availability, as well as education programmes and greater availability of low alcohol products. Physical exercise can be encouraged through local and national "get fit" campaigns and the built environment can be engineered to encourage physical activity. Promoting healthy diets can only be achieved through national campaigns with the cooperation of the food industry, as well as appropriate education and regulation of unhealthy additives like fat, sugar and salt. Recent regulation of added sugar in fizzy drinks has led to reductions in consumption which is a positive sign. The elimination of smoking in ESC member countries should be given the highest priority to reduce CVD and lung cancer rates. This chapter from the ESC Cardiovascular Realities 2024 provides great hope for CVD reduction.

04. CLINICAL RISK FACTORS

Raised blood pressure

Cholesterol

Obesity

Diabetes

CLINICAL RISK FACTORS

Clinical risk factors for CVD, including hypertension, dyslipidaemia, diabetes and obesity, are often more prevalent in middle-income ESC member countries (Figure 5) where rates of CVD are higher compared with high-income countries. These risk factors are amenable to control or elimination with the potential to make a substantial reduction in incident CVD. The benefits of a comprehensive risk reduction programme involving pharmacotherapeutic and lifestyle measures to lower blood pressure, non-HDL cholesterol and other determinants of cardiovascular risk are well established.

a. Raised blood pressure

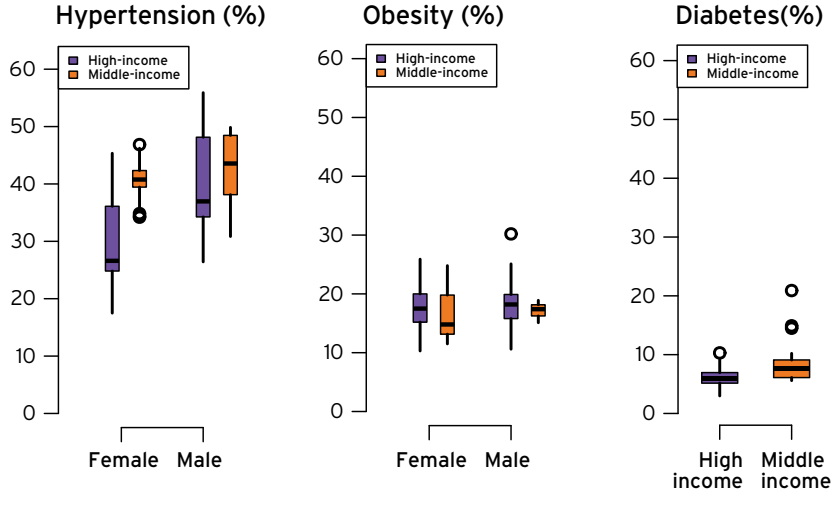
Hypertension is a leading risk factor for CVD that affected in 2019 in ESC member countries 36% of females and 41% of males. Prevalence was higher in middle-income compared with high-income countries. Considering all ESC member countries, hypertension in males exceeded 50% in Croatia, Hungary, Lithuania, Poland, and Romania. Among people with hypertension, 57% of females and 45% of males were receiving antihypertensive treatment.

During the 1990-2019 period, the median age-standardised prevalence of hypertension across all ESC member countries trended downwards in both females (40% to 36%) and males (42% to 41%). It is worth noting that despite predominant decrease, the prevalence of elevated blood pressure has increased in middle-income countries' males from 41% to 44%. During the same period, the prevalence of treated hypertension increased in both females (32% to 57%) and males (19% to 45%). In adults aged 40–89 years, systolic and diastolic blood pressure show log-linear associations with death from IHD and stroke. Lowering blood pressure by lifestyle measures and pharmacotherapy reduces cardiovascular risk.

b. Cholesterol

Non-high-density lipoprotein (non-HDL) cholesterol is a major determinant of CVD risk with median concentrations across ESC member countries in 2018, reaching 3.36 mmol/L in females and 3.53 mmol/L in males. Concentrations in high-income countries tended to be higher than in middle-income countries in

FIGURE 5 **Clinical risk factors prevalence (%): arterial hypertension, obesity and diabetes. All data in ESC member countries, stratified by national income status and gender, when available.**



Data source: (Arterial hypertension) WHO, https://ncdrisc.org/data-downloads-hypertension.html. (Obesity) WHO, http://apps.who.int/gho/data/node.main.BMIOBESITYA?lang=enhttps://ec.europa.eu/eurostat/databrowser/view/HLTH_EHIS_BM1E__custom_7112791/default/table?lang=en&page=time:2014. (Diabetes) WHO, https://data.worldbank.org/indicator/SH.STA.DIAB.ZS. Data not available: (Arterial hypertension) Republic of Kosovo, Republic of San Marino. (Obesity) Republic of Kosovo, Republic of San Marino, Albania, Algeria, Armenia, Azerbaijan, Bosnia and Herzegovina, Egypt, Republic of Georgia, Israel, Kazakhstan, Kyrgyzstan, Lebanon, Libya, Republic of North Macedonia, Moldova, Montenegro, Morocco, Switzerland, Syrian Arab Republic, Tunisia, Ukraine, Uzbekistan. (Diabetes) Republic of Kosovo.

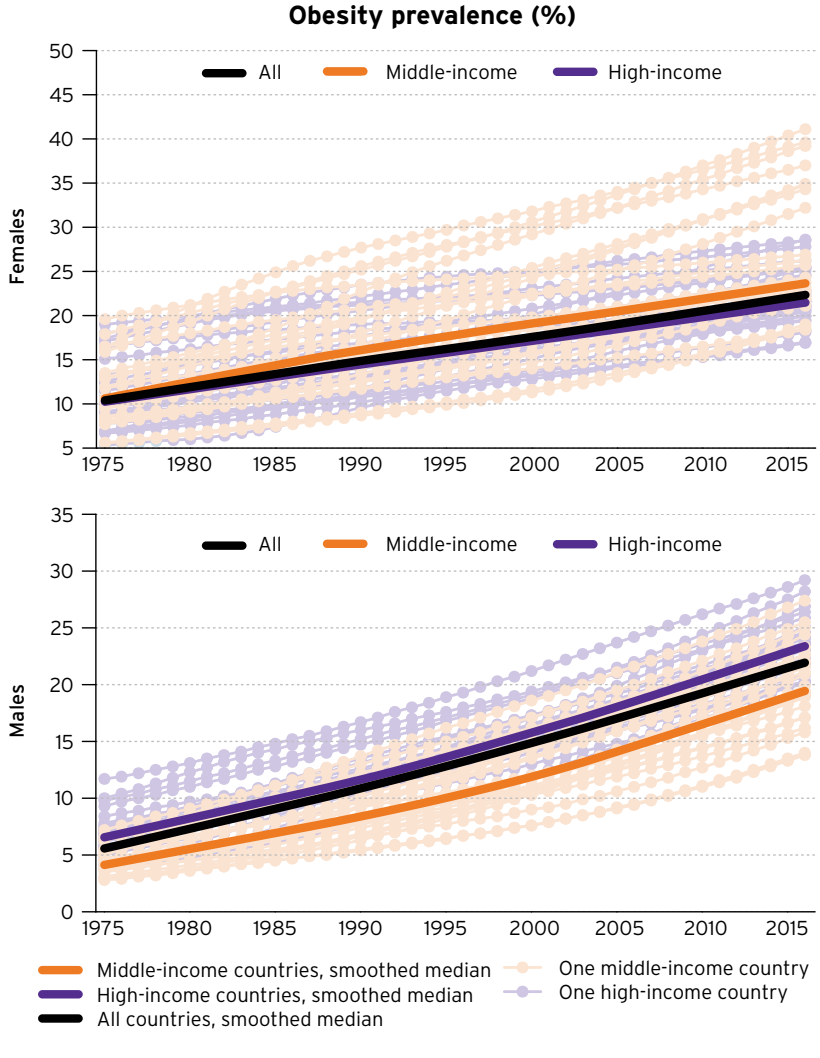
both females and males. Population measures to reduce non-HDL cholesterol have shown variable success but in high-income countries, where prevalence rates remain >50%, treatment often falls short. In the European Surveys of Cardiovascular Disease Prevention and Diabetes (EUROASPIRE) more than half of those with dyslipidaemia failed to achieve treatment targets.

Hypercholesterolaemia is commonly familial with heterozygous involvement in about 1:250 to 1:500 people causing considerable elevation of serum cholesterol concentrations (> 8.0 mmol/L) that often results in premature myocardial infarction. After diagnosis of an index case, cascade screening (lipid or genetic) of all first-degree relatives is mandatory.

c. Obesity

Overweight and obesity, defined by a body mass index (BMI) of ≥25 kg/m^2 and ≥30 kg/m^2, are linked with hypertension, dyslipidaemia, insulin resistance, coagulability, endothelial dysfunction and inflammation which together increase the risk of CVD and death. Obesity ranks 4th behind high blood pressure, dietary risks and tobacco use causing more than 13% of deaths across the European region. Rates are rising relentlessly and in 2019, 55% of people in ESC member countries were overweight and 17% obese, ranging from <15% in Bulgaria, Cyprus, Italy, France, Norway, the Netherlands, Romania, and Sweden, to >20% in Croatia, Estonia, Finland, Hungary, Iceland, Latvia, Malta, and Türkiye (Figure 6). Rates of obesity were similar in high-income and middle-income countries.

FIGURE 6 **Prevalence of obesity (BMI ≥30 kg/m^2) among females and males in ESC member countries (1975-2016).**



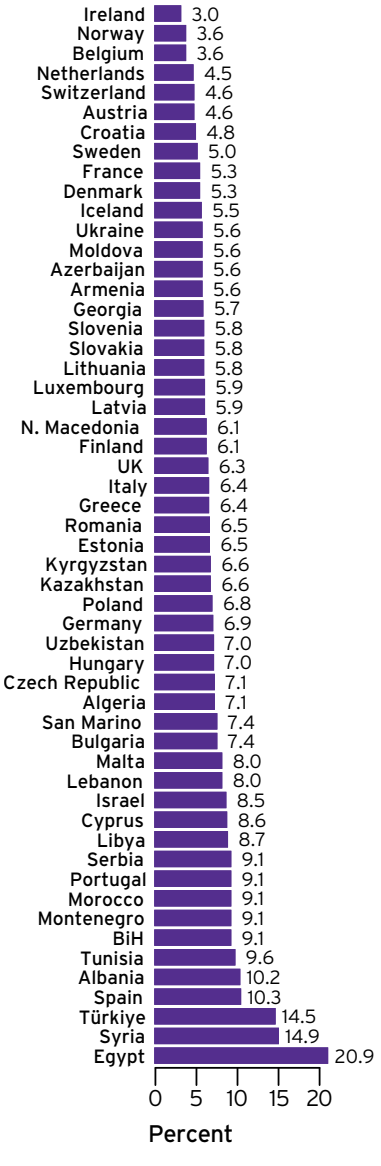
Data source: WHO, http://apps.who.int/gho/data/node.main.BMIOBESITYA?lang=en. Data not available: Republic of Kosovo.

d. Diabetes

The WHO estimates there are about 60 million people with diabetes in the European Region, or about 10.3% of men and 9.6% of women aged 25 years and over. The prevalence is increasing, particularly in low- and middle-income countries, mostly due to ageing populations, increased diagnostic testing, obesity and lifestyle factors including physical inactivity and unhealthy diet. In observational studies, having diabetes increases threefold the risk of death by CVD compared with people without diabetes, although in more contemporary studies the excess mortality is lower. Reducing trends in type 2 diabetes mortality the last 30 years have been observed in many EU countries, likely driven by improved medical management of its major complications, particularly CVD. Treating diabetes and its complications is expensive and cost the National Health Service (NHS) in the UK an estimated £14 billion in 2018, representing 10% of the annual budget for England and Wales. Public health measures should focus on primary prevention of type 2 diabetes given its significant costs, morbidity and mortality. Screening for diabetes can be cost-effective and evidence from the UK and the Netherlands confirms the efficacy of prevention programmes.

In 2021, the median prevalence of diabetes in people aged 20-79 across all ESC member countries was 6.5%, ranging from <4% in Belgium, Ireland, and Norway, to >10% in Albania, Egypt, Spain, Republic of North Macedonia and Türkiye (Figure 7).

FIGURE 7 **Age-standardised prevalence (%) of Type 1 or Type 2 diabetes among adults aged 20-79 in ESC member countries (2021).**



Data source: World Bank, https://data.worldbank.org/indicator/SH.STA.DIAB.ZS. Data not available: Republic of Kosovo.

MESSAGES

In 2019, the median age-standardised prevalence of hypertension among adults was 36% for females and 41% for males across all ESC member countries.

Systolic and diastolic blood pressure show log-linear associations with death from IHD and stroke.

In the European Surveys of Cardiovascular Disease Prevention and Diabetes (EUROASPIRE) more than half those with dyslipidaemia failed to achieve treatment targets.

In 2019, 55% of people in ESC member countries were overweight and 17% obese.

In 2021, the median prevalence of diabetes in people aged 20-79 across ESC member countries was 6.5%, lower in high-income ESC countries compared to middle-income countries (6% vs. 8%).

> Most cardiovascular disease causes and deaths can be attributed to a small number of common, modifiable risk factors.

Salim Yusuf
Professor of Medicine, McMaster University, Canada

EDITORIAL
Clinical risk factors

David A Wood
Professor of Preventive Cardiology, National University of Ireland, Galway, Republic of Ireland

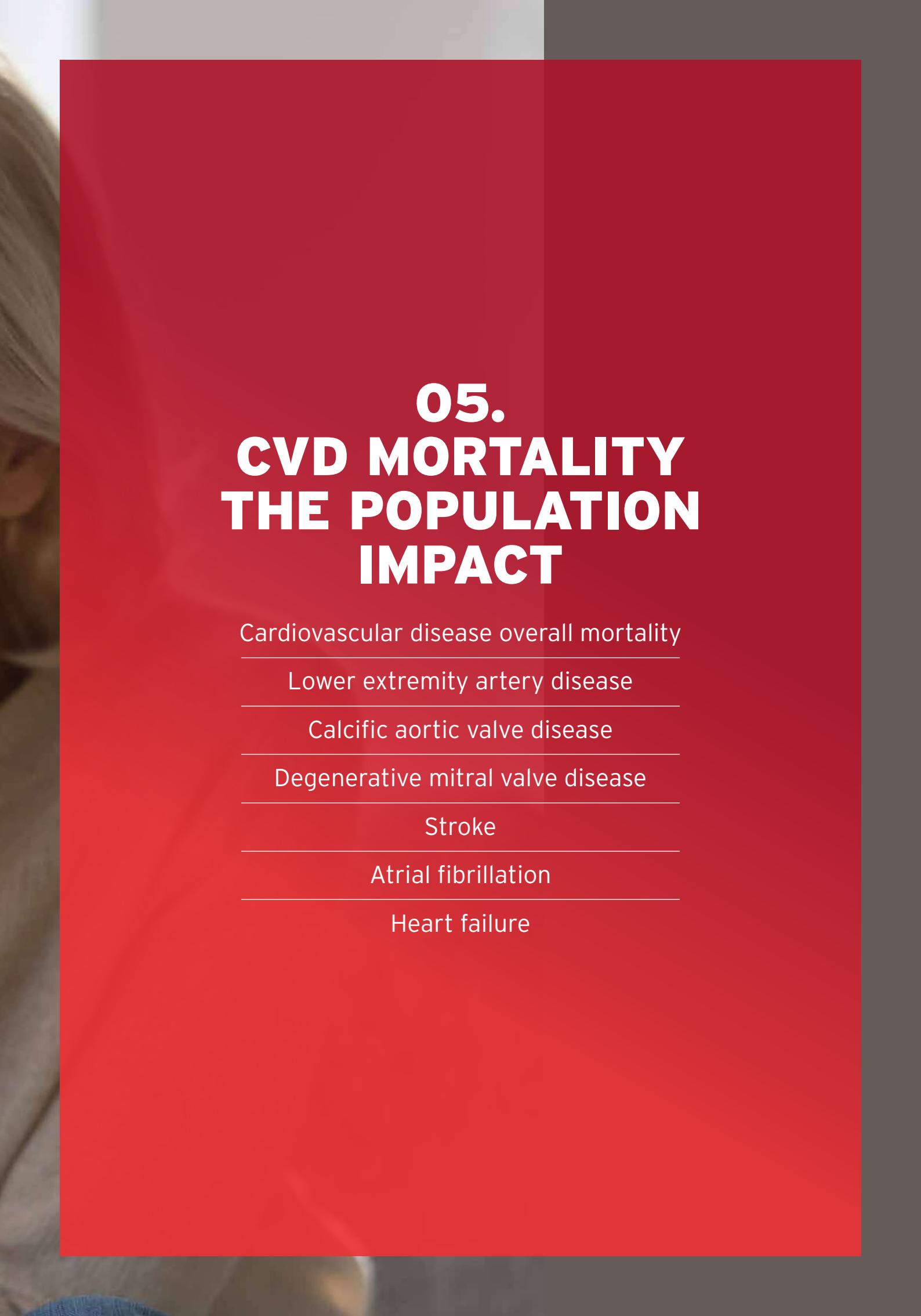
Unhealthy lifestyles lead to weight gain and over half of the European population are now overweight and almost one in two are obese. The consequences of this weight gain profoundly impact the clinical risk factors such as blood pressure, dyslipidaemia and diabetes.

Prevalence of hypertension is higher in men than women, affecting more than a third of the whole European population, but time trends show a falling prevalence in all countries with increasing treatment rates although less treatment in women in middle-income compared to high-income countries. Non-HDL cholesterol levels have fallen in high-income countries but have increased in middle-income and low-income countries and for patients with established cardiovascular disease (CVD), and those at high risk of developing CVD, the treatment of lipids to guideline standards is improving but remains inadequate despite a wealth of effective modern treatments.

Prevalence of diabetes in Europe is 6.5% although this figure conceals a wide variation between countries from less than 4% to one in ten people. Diabetes is more common in middle-income compared to high-income countries. The treatment of diabetes and obesity is being transformed with two new classes of drugs, the SGLT-2 inhibitors and the GLP-1 receptor agonists, which lower weight substantially and improve glycaemic control and, importantly, improve cardiovascular outcomes.

Although these treatments are a valuable addition to the growing therapeutic armamentarium which together substantially reduce total cardiovascular risk, they are prescribed late in adult life and don't address the growing evolution of risk factors from childhood which are associated with the development of CVD early in adult life.

Cardiovascular risk models limited to 10 years do not differentiate risk below the age of 40, when atherosclerotic disease can already be established, and what is required is a better understanding of lifetime risk to help target younger people to achieve healthier lifestyles.



05.
CVD MORTALITY THE POPULATION IMPACT

Cardiovascular disease overall mortality

Lower extremity artery disease

Calcific aortic valve disease

Degenerative mitral valve disease

Stroke

Atrial fibrillation

Heart failure

CVD MORTALITY THE POPULATION IMPACT

Cardiovascular diseases, including ischemic heart disease (IHD), stroke, heart failure, peripheral arterial disease, arrhythmias, and valvular diseases, constitute the leading cause of global mortality and significantly impact health and social care systems through premature mortality and disability. It is estimated that CVD caused approximately 19.4 million deaths worldwide in 2021, corresponding to 396 million years of life lost and another 32.5 million years lived with disability.

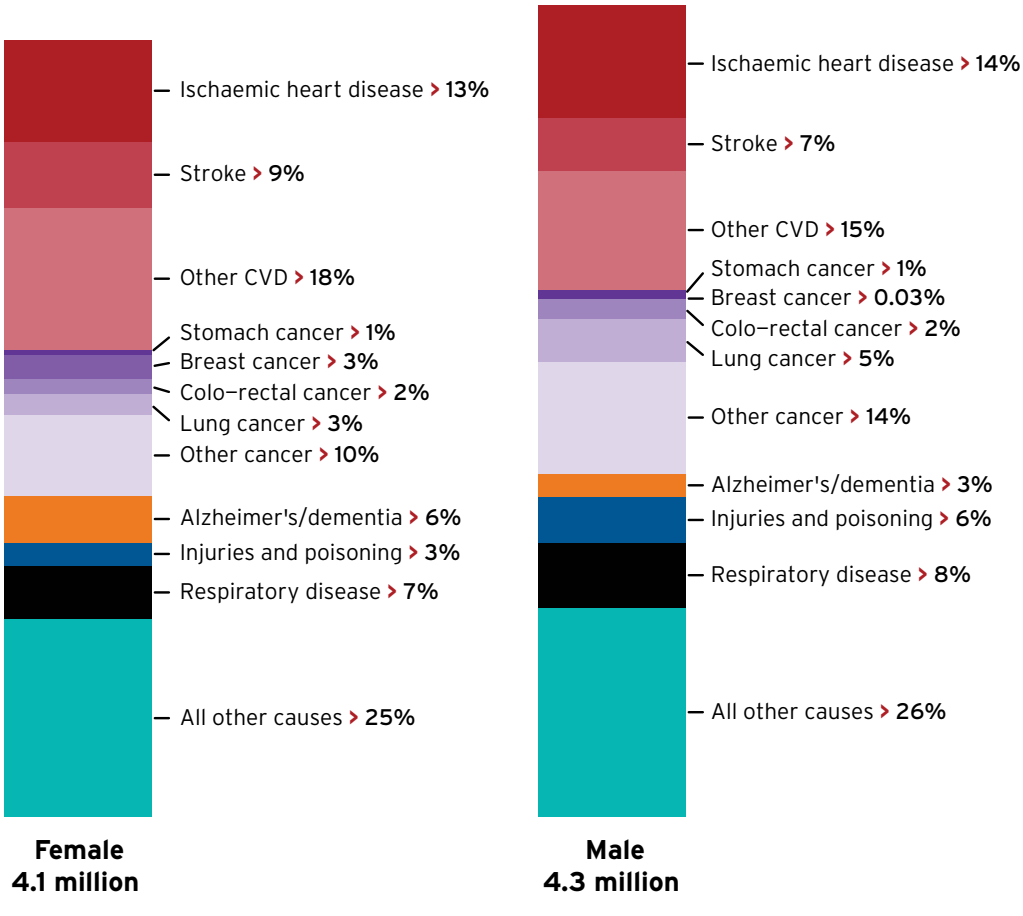
Across ESC member countries too, cardiovascular diseases remain the predominant cause of disability and premature death, causing over 37.4% of all deaths annually, equivalent to 8.5 thousand per day. However, there are significant regional disparities with the high-income countries of Western Europe benefiting from lower mortality rates compared with the middle-income ESC member countries of Eastern Europe, North Africa and Asia.

a. Cardiovascular disease overall mortality

CVD was the most common cause of death across ESC member states responsible for >1.6 million deaths in females and approximately 1.5 million in males (Figure 8). After age-standardisation, however, mortality rates per 100,000 were higher in males than females (395 vs 322) and in both sexes mortality rates were ≥2.5 times higher in middle-income compared with high-income countries (Figure 9). During the last 20 years, mortality rates have declined by >50% across high-income ESC member countries (Figure 10) but in middle-income countries declines have been much smaller for both males (11%) and females (6%) and a number of countries have seen the prevalence of CVD increase, including Azerbaijan (11%), Egypt (11%), Kyrgyzstan (8%), Libya (22%), and Syrian Arab Republic (6%) in females and Kyrgyzstan (7%), Libya (30%), and Ukraine (4%) in males. Accordingly, the estimated potential years of life lost (PYLL – a summary measure of premature mortality due to CVD) was more than 3 times higher in middle-income compared with high-income ESC member countries (7,516 vs 2,079 per 100,000).

Ischaemic heart disease (IHD) was the largest contributor to CVD mortality across ESC member states with age-standardised mortality rates (ASMRs) per 100,000 approximately half as high for females compared with males (90.8 vs 171.4). Similarly, ASMRs per 100,000 were lower in high-income than middle-income countries both for females (67.2 vs 159.9) and for males (142.9 vs 218.0).

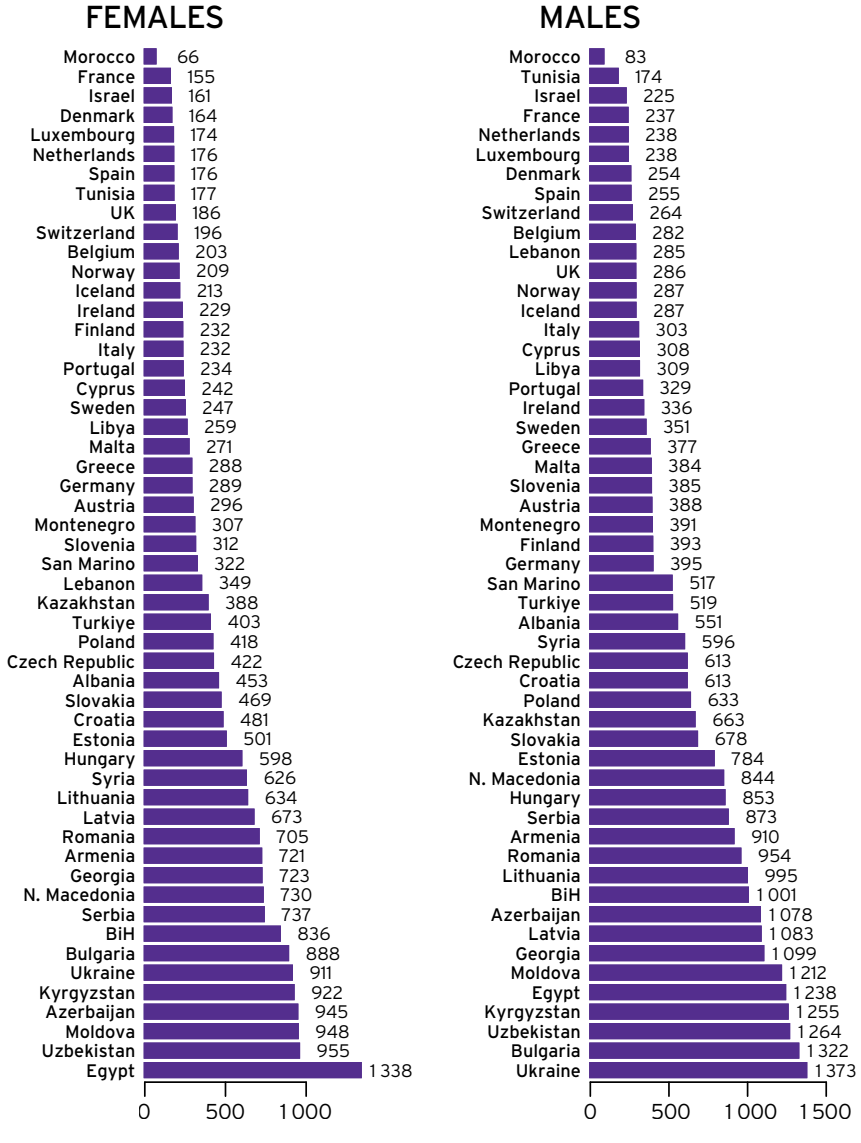
FIGURE 8 **Causes of death in ESC member countries (2021 or latest year available).**



Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Algeria, Republic of Kosovo.

(Figure 11) The highest IHD ASMRs per 100,000 in females and males were observed in Kyrgyzstan (650.7 and 835.5), Moldova (586.5 and 764.5), and Ukraine (626.4 and 963.8). Between 1990 and 2021 most high-income countries saw reductions in IHD ASMRs, but in over half of middle-income countries IHD ASMRs increased, particularly in Egypt (males 81%, females 201%), Kyrgyzstan (males 31%, females 57%), and Ukraine (males 29%, females 27%), with large increases in females also seen in Albania (56%) and Syrian Arab Republic (53%). In 2019, IHD caused 34 million PYLLs, accounting for 57% of all PYLL due to CVD (61% in males and 53% in females). Of the 34 million PYLL due to IHD, 21 million (62%) occurred in middle-income countries (61% in males and 62% in females).

FIGURE 9 **Age-standardised mortality rate per 100,000 due to CVD (2021 or latest year available).**



Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Algeria, Republic of Kosovo.

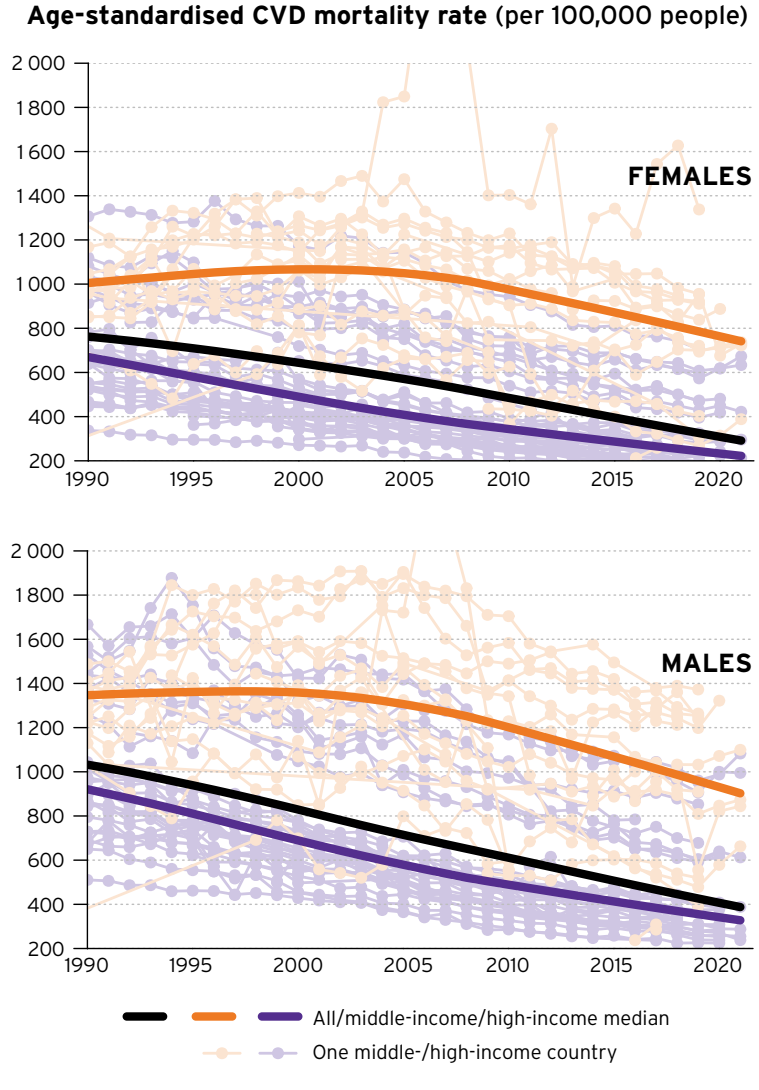
b. Lower extremity artery disease

After IHD and stroke lower extremity, artery disease is the third most prevalent form of atherosclerotic CVD. The epidemiology, however, shows important differences perhaps reflecting underdiagnosis or premature death from other causes. Thus, ASMRs per 100,000 were only 1.3 times higher in males than females while stratification by national income status revealed lower rates in middle-income compared with high-income countries in both sexes. In 2019, lower extremity artery disease (LEAD) was responsible for 0.6% of all PYLLs due to CVD across ESC member countries.

c. Calcific aortic valve disease

In high-income countries, calcific aortic valve disease (AVD) is the most prevalent heart valve disorder and affects 1.7% of the population >65 years old. Incidence rates have doubled during the last 20 years likely due to population aging. Across ESC member countries, ASMRs per 100,000 were lower in females compared with males (4.6 vs. 5.2) and in middle-income compared with high-income countries (Figure 12). In 2019, calcific AVD accounted for <1% of PYLL across ESC member countries.

FIGURE 10 **Age-standardised CVD mortality rates (ASMRs) per 100,000 people in ESC member countries (1990-2021).**

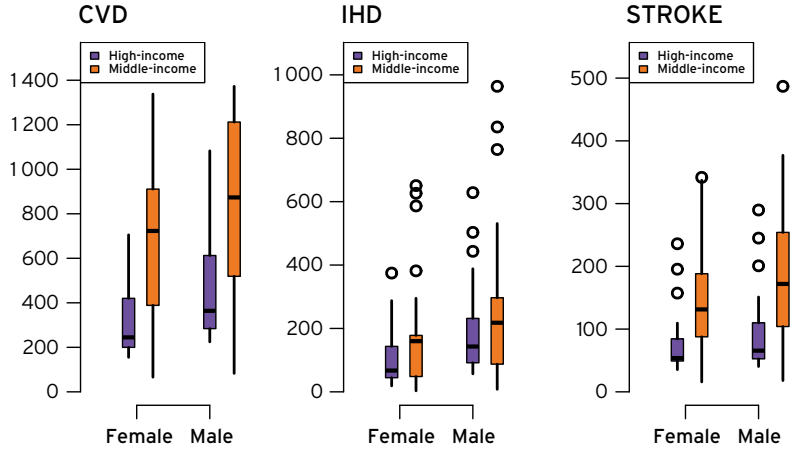


Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Algeria, Republic of Kosovo.

d. Degenerative mitral valve disease

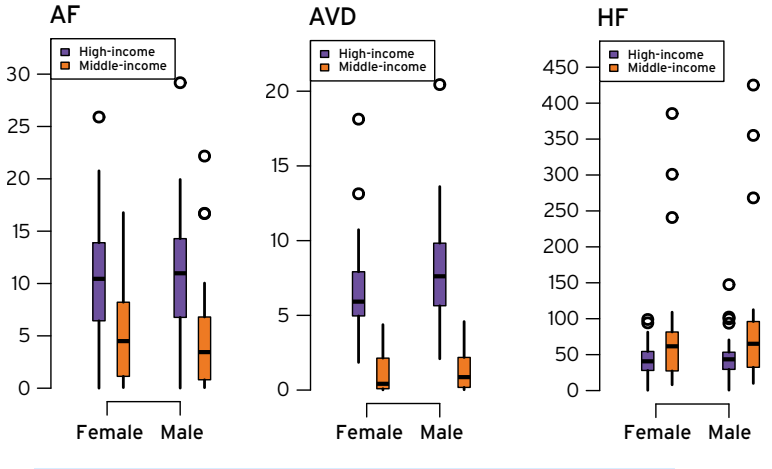
Like calcific AVD, degenerative mitral valve disease (MVD) is primarily a disease of the elderly. Incidence rates have changed little over the last 18 years. ASMRs per 100,000 for degenerative MVD were similar across ESC member countries, highest in Georgia (females 4.3, males 4.9) and lowest in Morocco (females 0.02, males 0.02). In 2019, degenerative mitral valve disease accounted for an estimated 0.2 million PYLL across ESC member countries, representing 0.3% of all PYLL due to CVD.

FIGURE 11 **ASMRs per 100,000 due to CVD, IHD and stroke in ESC member countries, stratified by sex and national income status (2021 or latest year available, median year 2019, years range 2005-2021).**



Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Algeria, Republic of Kosovo.

FIGURE 12 **ASMRs per 100,000 due to AF, AVD and HF in ESC member countries, stratified by sex and national income status (2021 or latest year available, median year 2019, years range 2000-2021).**



Data source: WHO, https://www.who.int/data/data-collection-tools/who-mortality-database. Data not available: Albania, Algeria, Republic of Kosovo, Republic of San Marino, Ukraine.

e. Stroke

In 2021 or latest year available, ASMRs per 100,000 for stroke were, like IHD, higher in males than females (95.3 vs 80.3) with differences greater in middle-income compared with high-income countries for both males (172.0 vs 65.6) and females (131.4 vs 53.8) (Figure 11). The highest ASMRs above upper quartile levels for stroke occurred in 11 of 23 middle-income countries for both males and females, but in only 3 high-income countries (Latvia, Lithuania, and Romania). The number of people living with stroke in Europe is estimated to increase by almost one third by 2047, mainly because of population ageing and improved survival rates. In 2019, stroke accounted for 25% of all PYLL due to CVD in ESC member countries.

f. Atrial fibrillation

Atrial fibrillation (AF) worsens quality of life and increases cardiovascular mortality due to stroke and heart failure - with non-cardiovascular death, mainly malignancy and infection, yet more common. In 2021 or latest year available median ASMRs per 100,000 for AF were 8.3, similar for females compared with males but over twice as high in high-income compared with middle-income countries (Figure 12). AF accounted for 1.02 million PYLL (59% in females), corresponding to 1.7% of all PYLL due to CVD within ESC member countries.

g. Heart failure

As populations age so the prevalence of heart failure (HF) increases despite declines in the incidence of CVD in many western countries. Primary care data from the UK show that prognosis remains poor in patients with HF with the 5-year survival increasing only modestly from 41.0% in 2000 to 48.2% in 2012.

ESC Atlas of Cardiology data show that HF accounted for 5.8% of total deaths across ESC member countries (14.6% of CVD deaths) in females and for 4.4% of total deaths (12.5% of CVD deaths) in males. The absolute number of HF-related deaths was 27% higher in females than in males (237,000 vs. 186,000) but median estimated ASMRs per 100,000 was higher for males (47.3 vs. 43.0).

Estimated ASMRs per 100,000 for HF were higher in middle-income compared with high-income countries in both females (61.2 vs. 40.7) and males (65.1 vs. 43.5). Among middle-income countries, ASMRs were highest in Bulgaria and Egypt exceeding 300 per 100,000 in females and 350 per 100,000 in males.

MESSAGES

CVD has remained the most common cause of death in ESC member countries with over 3 million deaths in 2021 including >1.6 million deaths in females and approximately 1.5 million deaths in males.

Across ESC member countries, CVD accounted for proportionately more deaths in middle-income compared with high-income countries in both females (53% vs. 34%) and males (46% vs. 30%).

Between 1990 and 2021, age-standardised CVD mortality rates in both sexes decreased by >50% in all high-income ESC member countries but in middle-income countries the decrease was <12%.

In 2021, median age-standardised CVD mortality rates for IHD across ESC member countries were higher for males than females (171.4 vs. 90.8 per 100,000, respectively) and in both sexes were higher in middle-income compared with high-income countries.

Age-standardised CVD mortality rates for stroke in 2021 were higher for males than females (95 vs. 80 per 100,000) and more than twice as high in middle-income compared with high-income ESC member countries.

> Over three quarters of CVD deaths take place in low- and middle-income countries.
>
> **World Health Organization 2021**

EDITORIAL

CVD mortality - a significant cost for the economically disadvantaged

Nick Townsend

Professor, School for Policy Studies, University of Bristol, UK

Cardiovascular disease remains the most common cause of death within ESC member countries, accounting for more than 1.6 million deaths in females and close to 1.5 million deaths in males in one year. This is equivalent to 40% and 35% of total deaths in females and males, respectively. The proportion of all deaths attributed to CVD is higher in middle-income than in high-income countries for both sexes (females 53% vs. 34%; males 46% vs.30%), illustrating inequalities in the burden of CVD between ESC countries.

There are a smaller proportion of premature deaths (those occurring in individuals younger than 70 years of age) attributable to CVD, than for total deaths. With CVD responsible for 27% of all premature deaths in females and 31% of all premature deaths in males. Despite this, CVD still accounted for around 27 million potential years of life lost (PYLLs) in females and 33 million PYLLs in males, within ESC member countries in 2019.

Median estimates for CVD age-standardised mortality rates (ASMRs) were higher for males (395.1/100,000) than females (322.0/100,000), supporting premature mortality and PYLL data in demonstrating that despite the higher numbers of females dying from CVD, deaths in males tend to occur at younger ages. Concerningly, median CVD ASMRs in middle-income countries were more than twice as high than in high-income countries in males (873.5/100,000 vs 364.0/100,000) and three times as high in females (722.8/100,000 vs. 244.7/100,000).

Out of hospital cardiac arrest (OHCA), caused by acute myocardial infarction in about 50% of cases, remains a leading cause of death in Europe. Data on incidence, management, and outcomes from the European Registry of Cardiac Arrest (EuReCa) report an incidence of OHCA of 89 per 100,000 people per year, ranging from 53 to 166/100,000 across the 20 European countries providing OHCA data. In 32% of these countries, a response time of less than 10 minutes was achieved in urban areas, although this was longer in rural areas. Bystander cardiopulmonary resuscitation was associated with higher survival and was initiated between 13 and 82% of cases within countries. In total, 64% of patients were pronounced dead on scene, whilst of those patients transported to the hospital, survival-to-discharge was 26%.

06. CARDIOVASCULAR HEALTHCARE DELIVERY

Cardiologists

Coronary Procedures

Interventional heart valves procedures

Catheter ablation procedures and device implants

Cardiac surgery

Congenital heart disease

CARDIOVASCULAR HEALTHCARE DELIVERY

ESC countries, including the 27 that belong to the European Union, exhibit important differences in the development of programmes for prevention and treatment of cardiovascular diseases. The reasons for these differences are complex, with socio-economic factors being predominant, although cultural and gender issues, and differences in political decision making are also important.

In this chapter, we present Atlas metrics, which illustrate the differences in cardiovascular healthcare delivery among the ESC member countries. We report 2022 data describing human and capital resource statistics and cardiovascular procedures across the ESC member countries.

a. Cardiologists

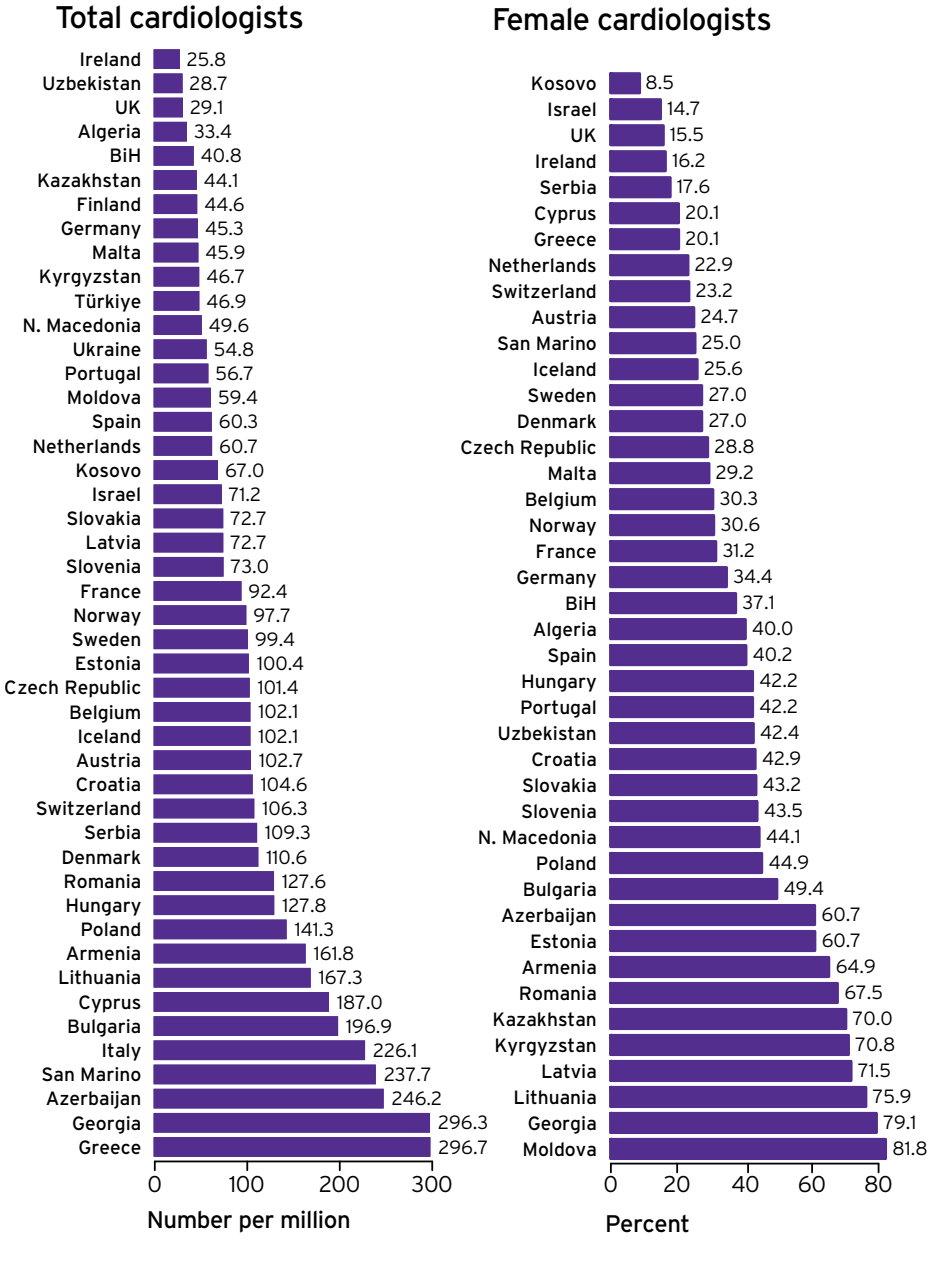
Cardiology staffing requirements to meet national needs are ill-defined and for any given country depend on an appropriate balance between the supply and demand of human resource. Major determinants of supply include recruitment rates into cardiology training programmes, the quality of the training and staff retention issues. Also important is sex and racial imbalance and there is general recognition of the need for more female and ethnically diverse cardiologists. Demand is largely determined by the burden of cardiovascular disease and the increasing development of subspecialty treatment options. These complex considerations make international workforce comparisons hard to interpret and although specialist involvement in CV care and admission to a cardiac ward can improve outcomes, there is no simple relation between the number of cardiologists working within a country and the quality of CV healthcare.

Number of cardiologists. In the 2023 survey of ESC member countries, there was a median of 95.0 cardiologists per million people, with numbers ranging from <30 per million in Ireland, Uzbekistan and the UK to >250 per million in Georgia and Greece (Figure 13).

Females in cardiology. Females comprised 38.6% of cardiologists working in ESC member countries. Under-representation of females was greatest in Republic of Kosovo and Israel where they comprised <15% of cardiologists. On the contrary, Kyrgyzstan, Latvia, Lithuania, Georgia and Moldova have a large majority of female cardiologists (>70%) (Figure 13).

FIGURE 13

(A) Cardiologists total, per million people (median year 2022, years range 2015-2023). (B) Proportion of female cardiologists (%) (median year 2022, years range 2015-2023). All data in ESC member countries.



Data source: ESC Atlas Survey. Data on file. Data not available: (A) Albania, Egypt, Lebanon, Libya, Luxembourg, Montenegro, Morocco, Syrian Arab Republic, Tunisia. (B) Albania, Egypt, Finland, Italy, Lebanon, Libya, Luxembourg, Montenegro, Morocco, Syrian Arab Republic, Tunisia, Türkiye, Ukraine.

Stratification by national income status. The median number of cardiologists per million inhabitants of middle-income ESC member countries was lower compared with high-income countries (54.8 vs 100.4). Female cardiologists comprised 49.4% of the cardiological workforce in middle-income countries compared with 30.3% in high-income countries. These averaged data, however, conceal considerable variation across ESC member countries.

Trends. The median number of cardiologists per million people has increased across biennial surveys of ESC member countries from 80.9 in the 2019 survey to 85.1 in the 2021 survey and to 95.0 in the 2023 survey. This increase has been mainly driven by the increasing number of cardiologists in high-income countries, from a median of 90.8 per million people in 2019 to 100.4 in 2023. In middle-income countries numbers have declined from a median of 61.8 per million people in 2019 to 54.8 in 2023. The gender gap, however, is narrowing, with the proportion of women increasing from 28% in 2019 to 38.6% in 2023.

b. Coronary procedures

A median of 3.0 hospitals per million people reported cardiac catheterisation facilities. In middle-income countries, this number increased from 1.8 in the 2019 survey to 3.0 in 2023, equaling high-income countries (2.8).

Across ESC member countries, a median of 3629 diagnostic coronary angiograms per million people were performed, less in middle-income countries than in high-income countries (3,086 vs. 3,773) (Figure 14). This median number fell from 4,601 in the 2019 to 3,773 in 2023, driven largely by a 30% reduction in diagnostic catheter procedures in high-income countries.

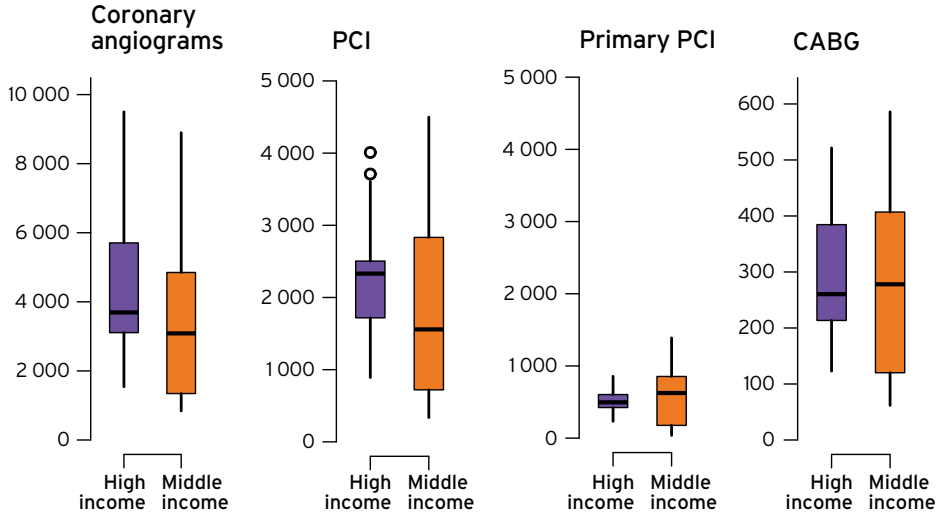
The median number of interventional cardiologists per million inhabitants was 13.1, somewhat similar between middle-income countries (10.6) and high-income countries (13.3). This median number increased in middle-income countries from 6.3 in the 2019 survey to 13.1 in 2023. In contrast, numbers in high-income countries showed a slight decrease from 15.1 in 2019 to 13.3 in 2023.

The median number of hospitals per million inhabitants of ESC member countries offering a 24 h/7-day facility for primary percutaneous coronary intervention (PCI) for acute coronary syndrome (ACS) was 2.1, similar in middle-income countries and high-income countries.

The median number of PCI procedures per million inhabitants was 2,187 across the ESC member countries, lower in middle-income countries compared with

FIGURE 14

(A) Coronary angiograms (median year 2022, years range 2021-2022). (B) Percutaneous coronary interventions (PCI) (median year 2022, years range 2021-2022). (C) Primary percutaneous coronary interventions (pPCI) (median year 2022, years range 2021-2022). (D) Coronary artery bypass graft surgery (CABG) procedures (median year 2022, years range 2020-2022). All data per million people in European Society of Cardiology member countries, stratified by national income status.



Data source: ESC Atlas Survey. Data on file. Data not available: (A) Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic. (B) Republic of Georgia, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia. (C) Belgium, Cyprus, Italy, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic. (D) Albania, Egypt, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia.

high-income countries (1,355 vs. 2,330) (Figure 14). Regarding primary PCIs for the management of ACS, the median number of procedures per million inhabitants was 498.5 across the ESC member countries, greater in middle-income countries compared with high-income countries (624.8 vs. 476.8) (Figure 14). This may reflect a greater burden of ST elevation myocardial infarction. PCI procedures showed little increase between 2019 and 2023 surveys (2,047 vs. 2,187 per million inhabitants) but a steady increase in primary PCI procedures was observed from 462.1 in 2019, to 498.5 in 2023.

c. Interventional heart valves procedures

In the 2023 survey, the median number of hospitals with catheter laboratories equipped for interventional valve procedures was 1.1 per million inhabitants across ESC member countries, lower in middle-income than high-income countries (0.59 vs. 1.24).

A median of 91.5 transcatheter aortic valve implantation (TAVI) procedures per million inhabitants were performed across all ESC member countries,

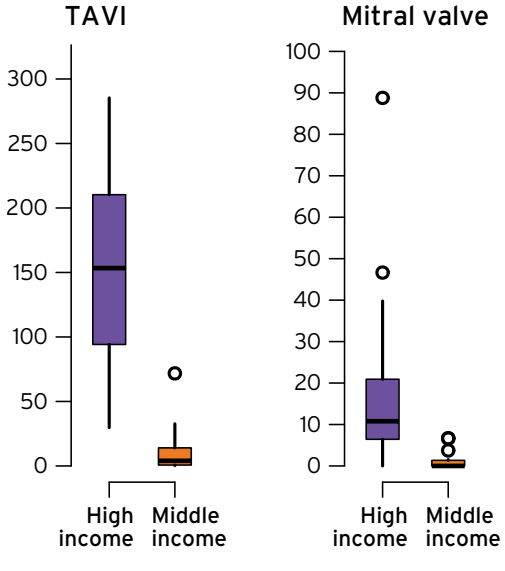
varying from <1 procedure per million people in Republic of Kosovo, Bosnia and Herzegovina, Azerbaijan Kyrgyzstan, and Uzbekistan to >200 in Denmark, Malta, Austria, Cyprus, Switzerland, Slovenia, Israel, France, and Germany.

A median of 8.5 transcatheter mitral valve procedures per million people per year were performed in ESC member countries. In several countries (Albania, Armenia, Azerbaijan, Bosnia and Herzegovina, Georgia, Iceland, Republic of Kosovo, Kyrgyzstan, Moldova, San Marino and Ukraine) this activity is not yet performed.

A median of 0.5 transcatheter tricuspid valve procedures per million people were performed in the 45 ESC member countries with Switzerland and Cyprus reporting around 8 procedures per million people respectively.

Overall, procedure rates per million people in middle-income countries were strikingly lower for TAVI (4.0 vs. 153.4), transcatheter mitral valve procedures (0.0 vs. 12.3) and transcatheter tricuspid valve procedures (0.0 vs. 2.1) than in high-income countries (Figure 15).

FIGURE 15 **(A) Transcatheter aortic valve implantation (TAVI) (median year 2022, years range 2021-2023). (B) Percutaneous mitral valve interventions (median year 2022, years range 2021-2022). All data per million people in ESC member countries, stratified by national income status.**

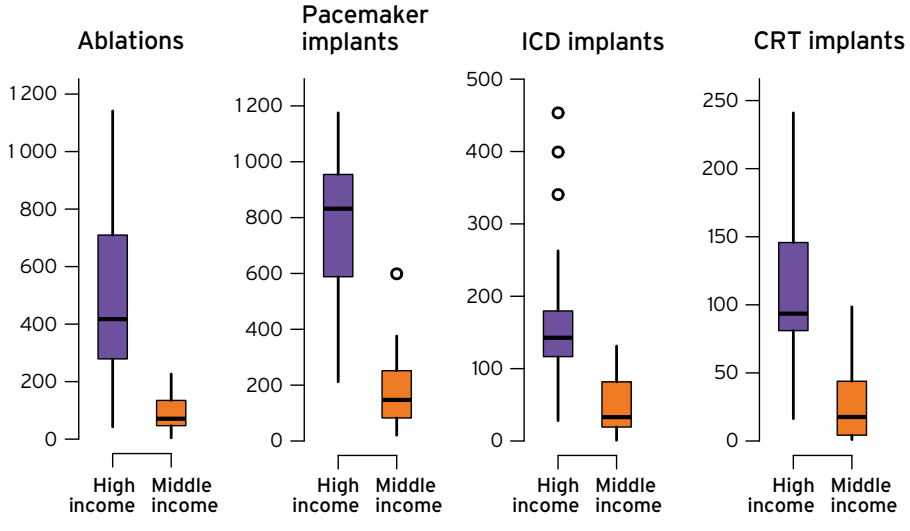


Data source: ESC Atlas Survey. Data on file. Data not available: (A) Ireland, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic. (B) Azerbaijan, Ireland, Kazakhstan, Latvia, Lebanon, Libya, Montenegro, Morocco, Republic of North Macedonia, Serbia, Syrian Arab Republic.

The median number of TAVI procedures per million increased from 25.5 in 2019 to 91.5 in 2023. This primarily reflects activity in high-income countries where numbers of TAVI procedures per million nearly matched surgical aortic valve procedures (153.4 vs. 145.2).

Procedure rates are likely to increase further as evidence for safety and efficacy becomes further available.

FIGURE 16 **(A) Ablation procedures (median year 2022, years range 2020-2022); (B) Pacemaker implantations (median year 2022, years range 2021-2022); (C) Implantable cardioverter-defibrillator implantations (median year 2022, years range 2021-2022); (D) Cardiac resynchronisation therapy implantations (median year 2022, years range 2021-2023). All data per million people in ESC member countries, stratified by national income status.**



Data source: ESC Atlas Survey. Data on file. Data not available: (A) Albania, Egypt, Ireland, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia, Türkiye. (B) Albania, Egypt, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia. (C) Albania, Egypt, Lebanon, Libya, Montenegro, Morocco, Syrian Arab Republic, Tunisia. (D) Albania, Egypt, Lebanon, Libya, Montenegro, Morocco, the Netherlands, Syrian Arab Republic, Tunisia, Türkiye.

d. Catheter ablation procedures and device implants

The median number of cardiac electrophysiologists per million people was 4.7 across ESC countries from <1 in Uzbekistan, Azerbaijan, and Kyrgyzstan and San Marino to >10 in Belgium, Croatia, Estonia, Bulgaria, UK, Iceland and Switzerland.

There was a median of 1.5 hospitals per million people undertaking electrophysiology procedures.

A median of 279.0 ablation procedures per million inhabitants of the ESC member countries were performed for treatment of atrial fibrillation/flutter and 22.8 for ventricular tachycardia ablation.

A median of 607.3 pacemakers were implanted per million inhabitants of ESC member countries, ranging from <40 per million people in Uzbekistan to >1000 per million people in Italy, Sweden, France, Portugal, and Lithuania.

A median of 121.1 implantable cardioverter-defibrillator (ICD) implants per million inhabitants were reported, ranging from <6 per million in Kyrgyzstan and Uzbekistan to >200 in Sweden, Denmark, Italy, Belgium, the Netherlands, Czech Republic, and Germany.

A median of 81.2 cardiac resynchronisation therapy (CRT) implants per million inhabitants were reported, ranging from <2 implants per million people in Kyrgyzstan, Uzbekistan and San Marino to >150 per million in Norway, UK, Italy, Denmark, Belgium, Czech Republic and Germany.

The median number of procedures per million people was lower in middle-income countries vs. high-income countries for ablation procedures (70.9 vs. 417.4), pacemakers (147.0 vs. 831.9), ICDs (32.9 vs. 142.7) and CRT devices (17.6 vs. 88.5) (Figure 16).

Survey data across ESC member countries showed the number of ablation procedures per million people remained fairly stable from 287.1 in the 2019 to 279.0 in 2023. There was a similar pattern for the pacemaker implantations between the 2019 and 2023, but there were a small increase in the median numbers of ICD and CRT implantations per million from 100.2 to 121.1 and from 63.6 to 81.2, respectively.

e. Cardiac surgery

Coronary artery bypass graft (CABG) surgery occupies a central role in the treatment of obstructive coronary artery disease, providing significant improvement in quality of life and angina frequency. In left main and multivessel coronary artery disease, CABG can prolong life compared with medical therapy, and appears more cost-effective than PCI particularly when left ventricular function is impaired. Nevertheless, revascularisation by PCI is often preferred in contemporary practice, and data from the UK confirm that surgical case volumes have declined in recent years while PCI volumes have increased. For most patients, outcomes with PCI are comparable to those achieved with CABG but in patients with diabetes, CABG outperforms PCI and is the procedure of choice.

In the 2023 survey, the median number of cardiac surgeons per million people in ESC member countries was 7.6. Overall this number was lower in middle-income countries than in high-income countries (6.3 vs. 8.2). A median of 1.2 hospitals per million inhabitants of ESC member countries reported facilities for cardiac surgery, more in middle-income than in high-income countries (1.5 vs.

1.1). Surgical human resource and infrastructure across ESC member countries has remained relatively stable since the 2019 survey.

A median of 262.7 CABG procedures per million inhabitants were reported, similar in middle-income and high-income countries (278.0 and 260.4 respectively) (Figure 14).

In the 2023 survey the median number of hospitals reporting heart transplant programmes was 0.18 per million inhabitants. Only Croatia, Latvia, Belgium and Lithuania reported more than 0.5 hospitals per million inhabitants.

A median of 2.1 heart transplant procedures per million people were reported. Fourteen ESC member countries reported no heart transplant program, whereas only 3 countries (Czech Republic, Croatia, and Slovenia) reported >7 heart transplant procedures per million people. Heart transplant activity was considerably greater in high-income countries with a median of 3.4 procedures per million people, whereas only Bulgaria, Kazakhstan, Republic of North Macedonia and Ukraine reported transplant activity among middle-income countries.

The median rate of LVAD implants was 1.3 per million people per year. Thirteen ESC member countries reported less than 1 implant per million people, whereas only 3 countries (Slovenia, Republic of North Macedonia and Germany) reported >8 LVAD implants per million people.

f. Congenital heart disease

In the 2023 survey, 0.4 hospitals per million inhabitants reported catheter laboratory facilities for structural heart disease interventions in children, similar in middle-income and high-income countries (0.4 and 0.3 hospitals respectively). Surgical facilities for congenital heart disease were available in a median of 0.5 hospitals per million people.

A median of 29.2 percutaneous procedures and 37.9 surgical procedures for congenital heart disease were reported. The procedure rates per million people were lower in middle-income compared with high-income countries, both for percutaneous procedures (12.1 vs. 37.7) and surgical procedures (25.6 vs. 40.9).

MESSAGES

Across all ESC member countries in the 2023 survey, there was a median of 95 cardiologists per million people with almost twice as many in high-income than middle-income countries (100 vs. 55 respectively).

Between the 2019 and the 2023 surveys of ESC member countries, the number of cardiologists per million in high-income countries increased from a median of 81 to 100. In middle-income countries the numbers have declined during the same period from a median of 62 per million people to 55.

In the 2023 survey, females comprised 39% of cardiologists working in ESC member countries.

The median number of PCI procedures per million people in the 2023 survey was lower in middle-income compared with high-income countries (1,355 vs. 2,330) but the number of primary PCI procedures was greater in middle-income countries (625 vs. 477), probably reflecting a greater burden of ST elevation myocardial infarction.

In the 2023 survey, procedure rates per million people for TAVI were lower in middle-income compared with high-income countries (4 vs. 153.4), where they matched the number of surgical aortic valve replacements (153 vs. 145).

In the 2023 survey, procedure rates per million people were lower in middle-income compared with high-income countries for cardiac ablation (71 vs. 420), pacemakers (147 vs. 832), ICDs (33 vs. 143) and CRT devices (18 vs. 89).

> Of all the forms of inequality, injustice in health is the most shocking and inhumane.

Martin Luther King, 1929 –1968
Nobel Prize laureate (1964)

EDITORIAL

International cardiovascular health delivery – where are we, where do we go and where should we be going?

Hector Bueno
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A coordinated action to improve cardiovascular health in Europe based on an accurate analysis of the situation is needed, as this chapter presents. Major structural differences between countries and income groups are presented but important inconsistencies appear. With nearly 10-fold differences in the number of cardiologists, there are no major differences between countries in the number of interventional cardiologists or cardiac surgeons and less marked differences in cardiovascular facilities. This speaks of different models of care.

Major variations in cardiac interventions can be found - huge in cases, such a >200-fold difference in the use of TAVR or 30-50-fold in pacemaker or ICD implantations– with less striking differences in rates of PCI or cardiac surgical procedures. The country differences between hospitals performing electrophysiology procedures and their activity rates are noticeable.

Several reasons account for the variations in care delivery, so it would be an oversimplification to attribute these to economic reasons only. Country population age and prevalence of risk factors are the main drivers of needs. Healthcare models, payment models may influence activity rates, not always correlating with quality. Local policies are also important. While some health systems focus on acute hospital care, others may prioritise investments in population-based preventive policies, less visible but more cost-effective.

Readers may be tempted to find underutilisation the main finding, and this may often be correct, but the large variability observed between countries may represent underutilisation and overutilisation. It is important to keep quality in mind. Volume is relevant but appropriateness and results, i.e. procedural success and safety, life extension or quality of life becomes, are even more important.

Time trends analyses allow tracking if changes in care patterns are moving in the right direction and if regional inequities are narrowing over time. Particular attention deserves monitoring the gender gap closure in cardiovascular care internationally.

The data provided by the ESC Cardiovascular Disease Realities is a starting point to understand how cardiovascular health is delivered in ESC countries, current gaps and needs. It is a valuable tool to alleviate the lack of an official EU cardiovascular health observatory.

07. ECONOMIC BURDEN OF CARDIOVASCULAR DISEASE IN THE EUROPEAN UNION COUNTRIES

General determinants of the total cardiovascular disease economic costs

Coronary heart disease and cerebrovascular disease costs

ECONOMIC BURDEN OF CARDIOVASCULAR DISEASE IN THE EUROPEAN UNION COUNTRIES

Over the past two decades, the ESC has prioritised as its main mission to reduce the burden of cardiovascular diseases in its member countries, which constitute a diverse community with significant economic, political, and cultural differences.

In September 2023, the first part of the Burden of CV Disease project was published, covering the 27 countries of the European Union. This project was developed in collaboration between the ESC and Oxford University (Health Economics Research Center, Nuffield Department of Population Health). A publication presenting the economic cost data of CVD for all the ESC member countries is expected to be published before the end of this year.

a. General determinants of the total cardiovascular disease economic costs

Health and social costs

In 2021, cardiovascular disease accounted for approximately 10 million hospital admissions in the EU, representing 22 admissions per 1,000 population. The number of hospital admissions varied considerably between countries, ranging from 10 to 36 cases per 1,000 population.

Cardiovascular disease cost the EU health and social care systems approximately €155 billion in 2021, accounting for 11% of total healthcare expenditure in the EU. The percentage of CVD-related care expenditure varied significantly between countries, from 6% in Denmark to 19% in Hungary. The major component of CVD-related care costs was hospital care, which accounted for €79 billion, of which €30 billion (38%) was accounted for the costs of 12 CVD-related procedures. Overall, hospital care represented 51% of care costs. Costs of CVD medications accounted for €31 (20%) of care costs, followed by nursing care home institutionalisation at €15 billion.

Overall, CVD represented an annual health and social care cost of €347 per EU citizen. The amount spent on health and social care for people with CVD varied widely across the 27 countries. After adjusting for price differentials using PPP,

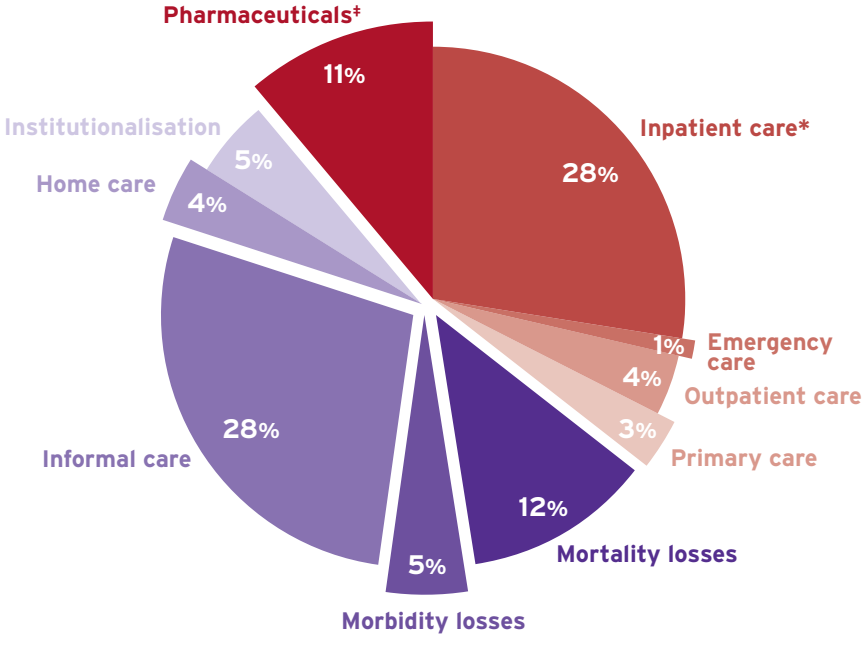
costs per person varied over three-fold between the country with the lowest costs (Croatia €154) and the one with the highest costs (Austria €505).

Informal care

A total of 7.5 billion hours of unpaid care by relatives/friends were provided to people whose care could be directly attributable to CVD, representing a cost of €79 billion across the EU. Per 1,000 population, a total of 16,700 hours were provided in the care of patients with CVD, ranging from 6,420 in Luxembourg to 31,004 in Romania.

TABLE 2

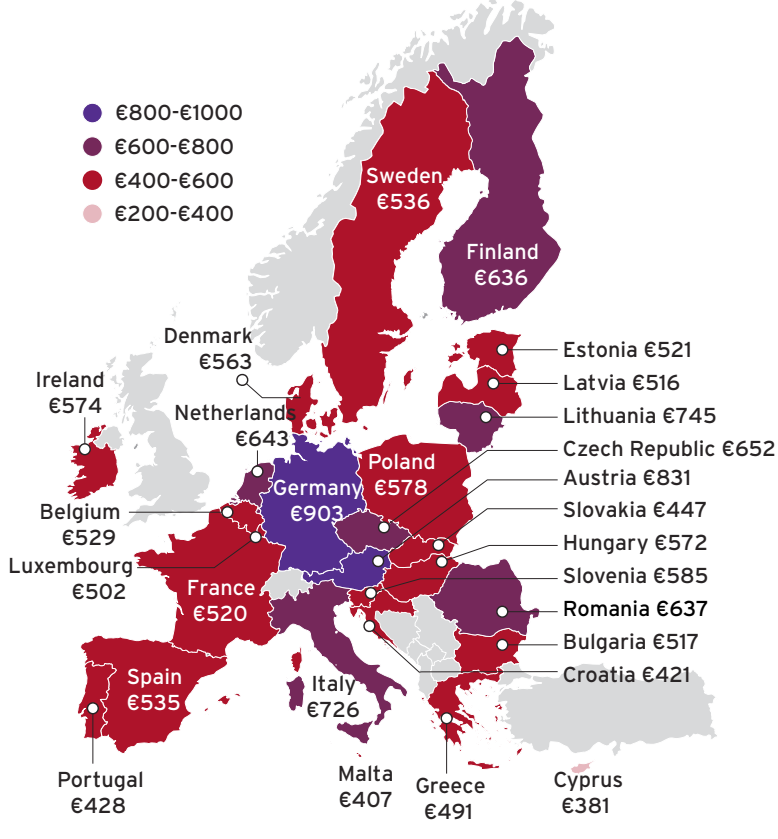
	Costs, € bn
Health care	130 (46%)
Social care	25 (9%)
Informal care	79 (28%)
Morbidity losses	15 (5%)
Mortality losses	32 (12%)
Total	**€ 282 bn**



*Including costs of in-hospital pharmaceuticals, devices and procedures
‡Only includes retail pharmaceuticals

Data source: Ramon Luengo-Fernandez, Marjan Walli-Attaei, Alastair Gray, Aleksandra Torbica, Aldo P Maggioni, Radu Huculeci, Firoozeh Bairami, Victor Aboyans, Adam D Timmis, Panos Vardas, Jose Leal, Economic burden of cardiovascular diseases in the European Union: a population-based cost study, European Heart Journal, Volume 44, Issue 45, 1 December 2023, Pages 4752–4767, https://doi.org/10.1093/eurheartj/ehad583.

FIGURE 17 **Cardiovascular disease-related total costs per capita, adjusted for price differentials.**



Data source: Ramon Luengo-Fernandez, Marjan Walli-Attaei, Alastair Gray, Aleksandra Torbica, Aldo P Maggioni, Radu Huculeci, Firoozeh Bairami, Victor Aboyans, Adam D Timmis, Panos Vardas, Jose Leal, Economic burden of cardiovascular diseases in the European Union: a population-based cost study, European Heart Journal, Volume 44, Issue 45, 1 December 2023, Pages 4752–4767, https://doi.org/10.1093/eurheartj/ehad583

Productivity losses

In 2021, there were a total of 1.7 million deaths due to CVD across the EU, representing 1.3 million working years lost. Per 1000 population, this accounted for 2.8 years of productive life lost, with the lowest number of years lost being in France and the highest in Bulgaria and Latvia. Overall, productivity losses associated with early mortality and incapacity for work were estimated at €32 billion (12% of the total) and €15 billion (5%) respectively. The cost of unpaid care by friends and relatives (informal care) was estimated at €79 billion (28%).

There were 256 million working-days lost because of CVD morbidity (i.e. 571 days per 1000 population when unadjusted), representing a cost of €30 billion. However, when adjusted using the friction period, this estimate fell to €15 billion.

Total societal costs

Overall, CVD is estimated to have cost the EU economy €282 billion in 2021. Of the total cost of CVD, 46% was due to healthcare, 9% was due to social care, 28% due to informal care, and 17% due to productivity losses (Table 2). On a per capita basis, this represented a cost of €630 per EU citizen. The economic cost of CVD varied considerably across the 27 countries in the EU after adjustment for price differentials, ranging from €381 in Cyprus to €903 in Germany (Figure 17).

b. Coronary heart disease and cerebrovascular disease costs

Coronary heart disease

Coronary heart disease cost the health and social care systems of the EU €30 billion in 2021. Per capita, this represented a cost of €67. The major component of health and social care costs was hospital care (€19 billion, 64%), followed by pharmaceutical expenditure (€4 billion, 13%). Overall, CHD was estimated to have cost the EU €77 billion in 2021: over one-quarter of the overall cost of CVD. This represented a cost of €173 per EU citizen, which after adjusting for price differentials ranged from €100 in Luxembourg to €325 in Lithuania.

Of the total cost of CHD, 37% of costs were due to healthcare, 2% to social care, 24% to productivity losses, and 37% to informal care.

Cerebrovascular disease

Cerebrovascular disease cost the health and social care systems of the EU €41 billion in 2021 (Table 2), representing a cost of €92 per citizen. The major component of health and social care costs was long-term institutionalisation (€15 billion, 36%), followed by hospital care (€13 billion, 32%) and home care (€9 billion, 23%). Overall, cerebrovascular disease was estimated to cost the EU €76 billion in 2021, which like CHD, accounted for over a quarter of the overall cost of CVD. Per capita, this equated to €169 per citizen in the EU, ranging from €66 in Malta to €267 in Austria, after adjusting for price differentials.

As a proportion of CVD costs, the contribution of cerebrovascular disease was lowest in Malta (16%) and highest in Sweden (37%). Of the total cost of cerebrovascular disease, informal care accounted for the biggest component (34%), followed by social care (32%), with health care accounting for 23% and productivity losses for the remaining 11%.

MESSAGES

Overall, CVD is estimated to have cost the EU economy €282 billion in 2021. Of the total cost of CVD, 46% was due to healthcare, 9% due to social care, 28% due to informal care, and 17% due to productivity loss.

Per capita, this represents a cost of €630 per EU citizen for the total EU burden of CVD each year.

Cardiovascular disease accounted for approximately 10 million hospital admissions in the EU, representing 22 admissions per 1,000 population.

Cardiovascular disease cost the EU health and social systems approximately €155 billion in 2021, accounting for 11% of total healthcare expenditure in the EU.

> There is an urgent need to focus on implementing existing cost effectiveness policies and interventions if the world is to meet the sustainable development goals and achieve a 30% reduction in premature mortality due to non-communicable diseases.

Global Burden of Cardiovascular Diseases and Risk Factors, 2020

EDITORIAL

Economic Burden of Cardiovascular Disease in the European Union Countries

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Over the past 70 years there have been gradual and substantial reductions across countries in the death rate from cardiovascular disease (CVD), driven by improvements in detection and treatment and, particularly, by reductions in smoking. Even so CVDs, including coronary artery disease, stroke, and hypertension, represent the leading cause of mortality in the EU, accounting for nearly 45% of all deaths. Thus, despite improvements, CVD continues to put significant strain on healthcare systems and on informal carers. It also has negative economic impacts, both for individuals and countries as a whole.

It is not straightforward to quantify the total burden of CVD but carefully constructed figures are now available thanks to a collaborative effort between the European Society of Cardiology and Oxford University. The work involved gathering national-level data about the costs of health, social and informal care for people with CVD and the lost earnings due to morbidity and premature mortality. The total cost of CVD across the 27 EU countries came to €282 billion in 2021.

Direct medical costs associated with CVD include expenses for diagnoses, hospital admissions, medical procedures, and medication. Specialised treatments such as angioplasty, stent placements, and bypass surgeries are significant contributors to healthcare expenditures, as are medications for managing chronic conditions like hypertension. According to these recent estimates, the annual direct healthcare cost of CVD across the 27 EU countries amounted to €130 billion with a further €25 billion spent on long-term social care. Many of those suffering from CVD are supported by informal carers, many of whom lose the opportunity of paid work, the cost of this support amounting to €79 billion.

Premature deaths cause substantial economic damage, the consequent loss of annual earnings amounting to €32 billion. CVD-related ill-health also reduces economic output, via lower productivity, higher sickness absence and earlier retirement, costing €15 billion. Economic performance is positively related to the health of the population and reducing the burden of CVD should prove a key means to improve worker productivity.

While there has been laudable success in reducing the overall incidence of CVD, the economic burden remains high, even more so in the most socially-disadvantaged groups. Prevention policies starting early in life will be essential in lifting the burden of CVD for the most disadvantaged in our societies.

REDUCING THE BURDEN OF CARDIOVASCULAR DISEASE: A CALL TO ACTION

In the last 50 years the development and uptake of better treatments, combined with improvements in clinical settings and preventative strategies, have resulted in a significant reduction in CVD mortality across the European Region.

Despite this progress, **CVD remains a major social & economic challenge in ESC member countries:**

- CVD is the **leading cause of death**, accounting for 40% and 35% of all deaths in women and men respectively
- Tremendous inequalities in disease burden still persist between high-income and middle-income ESC member countries. Evidence suggests that most of the World Health Organization noncommunicable disease targets for 2025 are unlikely to be met in any of the countries.
- The success in reducing mortality in acute cardiac events has led to an **increasing population living with chronic cardiovascular conditions** including heart failure and structural heart disease.
- There is misperception that cardiovascular disease is limited to older people. On the contrary, CVD heavily affects people of all age groups. In fact, nearly a quarter (22%) of all premature deaths (before the age of 70) in the EU are caused by CVD which is similar to all malignant disorders.
- With the aging population **CVD prevalence is expected to increase** further and often coexist with other diseases, leading to multi-morbidity – a further challenge to CV care of the elderly. It is expected that in 2040, 155 million Europeans are aged› 65. Without decisive action starting today, the number of citizens suffering from CVD and the burden of dealing with the disease will increase dramatically for societies and for health systems alike.
- Obesity and diabetes, major **risk factors** for CVD, are becoming more prevalent.
- CVD is often triggered by other chronic conditions or their therapies including but not limited to, diabetes, hypertension, chronic kidney disease, pulmonary disease, and cancer. For example, advances in oncological treatment have led to improved cancer survival but have also increased CVD morbidity and mortality due to the **cardiotoxicity of cancer treatment.**

In addition to the loss of, and impact on, human lives, **the economic burden of CVD in the EU is evaluated at €282 billion in 2021.**

The WHO, in the recently updated Sustainable Development Agenda, has set among other goals the need to reduce by 2030 premature mortality from non-communicable diseases by one-third through prevention and treatment.

Undoubtedly, the previous goal, which primarily concerns cardiovascular premature mortality, requires appropriate planning at a national level, governmental support, and an available budget proportional to the challenge that CVDs present.

A 30% reduction in premature mortality by 2030 undoubtedly requires:

- Significant reduction in the prevalence of current tobacco use in persons aged 15+ years
- Effective reduction of individuals with arterial hypertension and high adherence of hypertensive patients to their long-term pharmaceutical therapy
- Differentiation of lifestyle, especially for the citizens of large cities, to increase their physical activity.
- Effective management of obesity, as well as diabetes.

According to the previous optimistic estimates of the WHO, a 25% reduction in cardiovascular diseases and the associated premature mortality by the year 2025 could be achieved. This now seems unattainable.

It is obvious that well-designed and systematic actions are required to achieve a substantial reduction in cardiovascular diseases in all the countries of our society.

The magnitude of the CVD burden requires corresponding attention from decision-makers so that the allocation of resources is commensurate with the size and importance of the problem.

Without a doubt, it must be highlighted that significant unmet medical needs continue to stigmatise the field of cardiovascular diseases, with a characteristic example being that of sudden cardiac death, which continues to be recognised as the leading cause of mortality worldwide.

The **ESC Atlas of Cardiology is an important tool for the development of national CVD strategies:** it should enable national policy makers to learn about how their country has performed towards achieving these targets and to identify which areas of intervention urgently need actions.

SELECTED REFERENCES PER CHAPTER

CHAPTER 1

IHME, 2020. Global Burden of Disease data set. Available from: https://gbd2019.healthdata.org/gbd-results (accessed 23 July 2024).

Demography of Europe – 2024 edition https://ec.europa.eu/eurostat/web/interactive-publications/demography-2024 (accessed on 23 July 2024)

The International Social Security Association (ISSA), Meeting the needs of an ageing population – Europe https://www.issa.int/analysis/meeting-needs-ageing-population-europe (accessed on 23 July 2024)

Mendis, S, Puska,P, Norrving, BE, World Health Organization. Global atlas on cardiovascular disease prevention and control. World Health Organization; 2011. Available from: https://apps.who.int/iris/handle/10665/44701 (accessed 23 July 2024).

Lancet T. Advancing racial and ethnic equity in health. Lancet (London, England). 2022 Dec 10;400(10368):2007.

Kramer CK, Leitão CB, Viana LV. The impact of urbanisation on the cardiometabolic health of Indigenous Brazilian peoples: a systematic review and meta-analysis, and data from the Brazilian Health registry. Lancet. 2022 Dec 10;400(10368):2074-2083.

Schultz WM, Kelli HM, Lisko JC, Varghese T, Shen J, Sandesara P, et al. Socioeconomic status and cardiovascular outcomes: challenges and interventions. Circulation. 2018 May 15;137(20):2166-78.

Marois G, Bélanger A, Lutz W. Population aging, migration, and productivity in Europe. Proc Natl Acad Sci U S A. 2020 Apr 7;117(14):7690-7695. doi: 10.1073/pnas.1918988117. Epub 2020 Mar 23.

CHAPTER 2

European Environment Agency, https://www.eea.europa.eu/en (accessed on 17 July 2024)

European Commission, EU air quality standards, https://environment.ec.europa.eu/topics/air/air-quality/eu-air-quality-standards_en (accessed on 17 July 2024)

European Parliament legislative resolution of 24 April 2024 on the proposal for a directive of the European Parliament and of the Council on Corporate Sustainability Due Diligence and amending Directive (EU) 2019/1937 (COM(2022)0071 – C9-0050/2022 – 2022/0051(COD)) https://www.europarl.europa.eu/doceo/document/TA-9-2024-0329_EN.html (accessed on 17 July 2024)

European Environment Agency, 2015 Noise report, https://www.eea.europa.eu/soer/2015/europe/noise (accessed on 17 July 2024)

Joaquin Barnoya and Stanton A. Glantz, Cardiovascular Effects of Secondhand Smoke: Nearly as Large as Smoking, Circulation, Volume 111, Number 20, https://doi.org/10.1161/CIRCULATIONAHA.104.492215

Sanjay Rajagopalan and Philip J. Landrigan, Pollution and the Heart, N Engl J Med 2021;385:1881-1892, Vol. 385 No. 20, 2021 Nov 10, doi:10.1056/NEJMra2030281

CHAPTER 3

European Commission: Eurostat https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Tobacco_consumption_statistics (accessed 23 July 2024).

World Health Organization. Status report on alcohol consumption, harm and policy responses in 30 European countries 2019. World Health Organization. Regional Office for Europe; 2019. Available from: https://www.who.int/europe/publications/i/item/WHO-EURO-2019-3544-43303-60695 (accessed 23 July 2024).

OECD, Tackling Harmful Alcohol Use: Economics and Public Health Policy, OECD Publishing. 2015. Available from: http://dx.doi.org/10.1787/9789264181069-en (accessed 23 July 2024).

Estruch R, Ros E, Salas-Salvadó J, Covas MI, Corella D, Arós F, et al. Primary Prevention of cardiovascular disease with a Mediterranean diet supplemented with extra-virgin olive oil or nuts. N Engl J Med. 2018 Jun 21;378(25):e34.

Sharifi-Rad J, Rodrigues CF, Sharopov F, Docea AO, Can Karaca A, Sharifi-Rad M, et al. Diet, Lifestyle and Cardiovascular Diseases: Linking Pathophysiology to Cardioprotective Effects of Natural Bioactive Compounds. Int J Environ Res Public Health. 2020 Mar 30;17(7):2326. doi: 10.3390/ijerph17072326. PMID: 32235611; PMCID: PMC7177934.

Kornelia Kotseva, Guy De Backer, Dirk De Bacquer, Lars Rydén, Arno Hoes, Diederick Grobbee, et al., Lifestyle and impact on cardiovascular risk factor control in coronary patients across 27 countries: Results from the European Society of Cardiology ESC-EORP EUROASPIRE V registry, European Journal of Preventive Cardiology, Volume 26, Issue 8, 1 May 2019, Pages 824–835, https://doi.org/10.1177/2047487318825350

CHAPTER 4

Rapsomaniki E, Timmis A, George J, Pujades-Rodriguez M, Shah AD, Denaxas S, et al. Blood pressure and incidence of twelve cardiovascular diseases: lifetime risks, healthy life-years lost, and age-specific associations in 1·25 million people. Lancet. 2014 May 31;383(9932):1899-911.

World Health Organization. WHO European regional obesity report 2022. World Health Organization. Regional Office for Europe; 2022. Available from: https://apps.who.int/iris/handle/10665/353747 (accessed 23 July 2024).

World Obesity Federation. Global Obesity Observatory. Obesity Atlas 2023. Available from: https://data.worldobesity.org/publications/?cat=19 (accessed 23 July 2024).

De Backer G, Jankowski P, Kotseva K, Mirrakhimov E, Reiner Ž, Rydén L, et al. Management of dyslipidaemia

in patients with coronary heart disease: results from the ESC-EORP EUROASPIRE V survey in 27 countries. Atherosclerosis. 2019 Jun 1;285:135-46.

World Health Organization. Childhood obesity surveillance initiative: highlights 2015-17. https://www.euro.who.int/data/assets/pdf_file/0006/372426/WH14_COSI_factsheets_v2.pdf (accessed 23 July 2024).

World Health Organization. Europe: Diabetes. Available from: https://www.who.int/europe/health-topics/diabetes#tab=tab_1 (accessed 23 July 2024).

Diabetes UK: Cost of Diabetes. Published 15 January 2019. Updated 29 October 2023. Available from: https://www.diabetes.co.uk/cost-of-diabetes.html (accessed 23 July 2024).

CHAPTER 5

OECD Data. Potential years of life lost. Available from: https://data.oecd.org/healthstat/potential-years-of-life-lost.htm#:~:text=The%20calculation%20of%20Potential%20Years,used%20in%20OECD%20Health%20Statistics (accessed 23 July 2024).

IHME. Cardiovascular diseases – Level 2 cause. Available from: https://www.thelancet.com/pb-assets/Lancet/gbd/summaries/diseases/cardiovascular-diseases.pdf (accessed 23 July 2024).

IHME. Ischemic heart disease – Level 3 cause. Available from: https://www.thelancet.com/pb-assets/Lancet/gbd/summaries/diseases/ischaemic-heart-disease.pdf (accessed 23 July 2024).

Townsend N, Kazakiewicz D, Lucy Wright F, Timmis A, Huculeci R, Torbica A, et al. Epidemiology of cardiovascular disease in Europe. Nat Rev Cardiol. 2022 Feb;19(2): 133-43 (2022).

Timmis A, Kazakiewicz D, Townsend N, Huculeci R, Aboyans V, Vardas P. Global epidemiology of acute coronary syndromes. Nat Rev Cardiol. 2023 May:1-11.

Eurostat, Deaths due to coronary heart diseases in the EU, 28 September 2020 https://ec.europa.eu/eurostat/web/products-eurostat-news/-/edn-20200928-1 (accessed on 23 July 2024).

Henrik Toft Sørensen, Frederik Pagh Bredahl Kristensen - Cardiovascular diseases and health inequalities in Europe—a pressing public health challenge, The Lancet, Vol 33, 100722, October 2023, https://doi.org/10.1016/j.lanepe.2023.100722

CHAPTER 6

Dobson R, Clarke SC. Women in cardiology: narrowing the gender gap. Heart. 2022 May;108(10):757.

Maurovich-Horvat P, Bosserdt M, Kofoed KF, Rieckmann N, Benedek T, Donnelly P, et al. CT or invasive coronary angiography in stable chest pain. N Engl J Med. 2022 Apr 28;386(17):1591-602.

Costa GN, Cardoso JF, Oliveiros B, Gonçalves L, Teixeira R. Early surgical intervention versus conservative management of asymptomatic severe aortic stenosis: a systematic review and meta-analysis. Heart. 2022 Oct 5.

Anna Sonia Petronio, Piera Capranzano, MD; Emanuele Barbato3,4, MD, PhD; Nicolo Piazza, Andreas Baumbach, Michael Haude, Stephan Windecker - Current status of transcatheter valve therapy in Europe: results from an EAPCI survey https://eurointervention.pcronline.com/article/current-status-of-transcatheter-valve-therapy-in-europe-results-from-an-eapci-survey

Tanja Rudolph, Clare Appleby, Victoria Delgado, Helene Eltchaninoff, Catherine Gebhard, Christian Hengstenberg, et al., Patterns of Aortic Valve Replacement in Europe: Adoption by Age. Cardiology 18 December 2023; 148 (6): 547–555. https://doi.org/10.1159/000533633

Vassilikos VP, Pagourelias ED, Laroche C, Blomström-Lundqvist C, Kautzner J, Maggioni AP, et al., AFA LT registry investigators group. Impact of centre volume on atrial fibrillation ablation outcomes in Europe: a report from the ESC EHRA EORP Atrial Fibrillation Ablation Long-Term (AFA LT) Registry. Europace. 2021 Jan 27;23(1):49-58. doi: 10.1093/europace/euaa236.

CHAPTER 7

OECD. Expenditure by disease, age and gender-focus on health spending. 2016. Available from: https://www.oecd.org/health/Expenditure-by-disease-age-and-gender-FOCUS-April2016.pdf (accesssed 23 July 2024).

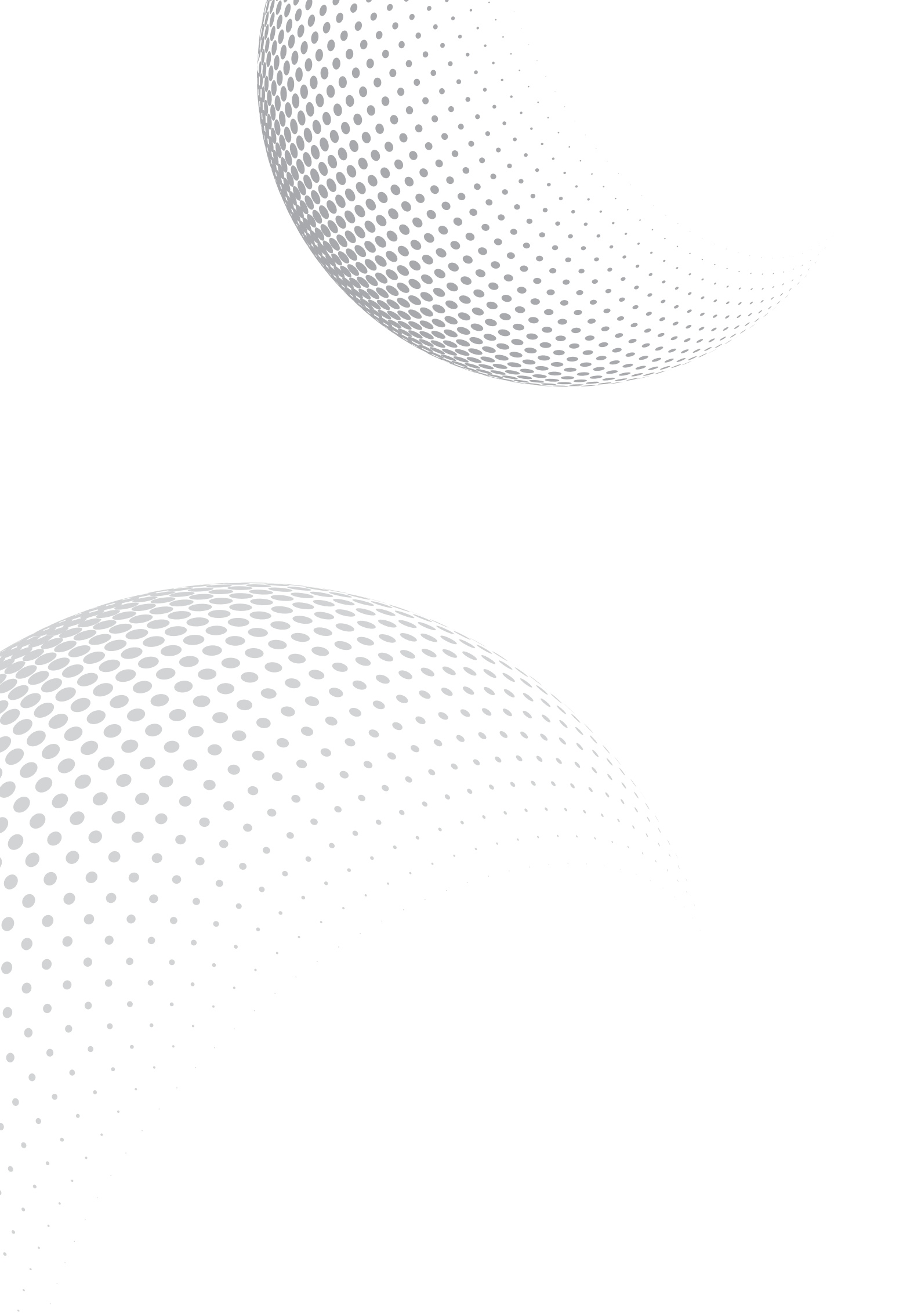
Eurostat. HEDIC: Health expenditures by diseases and conditions. 2016. Available from: https://ec.europa.eu/eurostat/web/products-statistical-working-papers/-/ks-tc-16-008 (accessed 23 July 2024).

Luengo-Fernandez R, Walli-Attaei M, Gray A, Torbica A, Maggioni AP, Huculeci R, et al. Economic burden of cardiovascular diseases in the European Union: a population-based cost study. Eur Heart J. 2023 Dec 1:44(45):4752-67. https://doi.org/10.1093/eurheartj/ehad583

Luengo-Fernandez R, Little M, Gray A, Torbica A, Maggioni AP, Huculeci R, et al. Cardiovascular disease burden due to productivity losses in European Society of Cardiology countries. Eur Heart J Qual Care Clin Outcomes . 2023; Available from: http://dx.doi.org/10.1093/ehjqcco/qcad031

Kazi Dhruv S., et al. Forecasting the Economic Burden of Cardiovascular Disease and Stroke in the United States Through 2050: A Presidential Advisory From the American Heart Association. Circulation, 2024. https://doi.org/10.1161/CIR.0000000000001258

Cardiovascular Disease, A Costly Burden for America, American Heart Association, https://www.heart.org/-/media/Files/About-Us/Policy-Research/Fact-Sheets/Public-Health-Advocacy-and-Research/CVD-A-Costly-Burden-for-America-Projections-Through-2035.pdf



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