Epidemiology of cardiovascular disease in Europe

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Abstract | This Review presents data describing the health burden of cardiovascular disease (CVD) within and across the WHO European Region. CVD remains the most common cause of death in the region. Deaths from CVD in those under the age of 70 years, commonly referred to as premature, are a particular concern, with more than 60 million Potential Years of Life Lost (PYLLs) to CVD within Europe annually. Although more females than males die from CVD, age standardised rates of both mortality and morbidity are higher in males, with these difference in rates greatest in those aged less than 70 years. Large inequalities for all measures of mortality, morbidity and treatment can be found between countries across the continent and must be a focus for improving health. It is also apparent that there are large differences between countries in the data available. The development and implementation of

evidence-based preventive and treatment approaches must be supported in all countries by consistent surveillance and monitoring, such that we can quantify the health burden of CVD, as well as target interventions and provide impetus for action across Europe.

Introduction

Cardiovascular disease (CVD) remains the most common cause of death worldwide, with the Global Burden of Disease (GBD) study estimating that 17.8 million deaths occurred due to CVD globally in 2017[1]. This demonstrated a 21% increase in the number of people dying from CVD in the decade leading up to 2017, with ischaemic heart disease (IHD) and stroke accounting for close to 50% and 35% of these CVD deaths, respectively. However, over the same period, age standardised deaths rates for CVD decreased by around 10%[1].

Similarly, in Europe, despite large declines in age standardised deaths for CVD[2–9], IHD[10] and stroke[11] in recent decades across Europe, CVD remains the most common cause of death in the region[4,6,7]. Previous publications have reported that CVD kills close to 4 million people in Europe every year, around 44% of all deaths, with IHD accounting for 44% of these CVD deaths and stroke 25%[2–4,7,8].

Disparities are found across the continent, with large differences in current age standardised and crude mortality rates for CVD between countries[2–8]. In general, both metrics are lower in the more affluent countries, with a number of high income countries in Europe now experiencing a greater number of deaths from cancer than CVD, most commonly in men, but also in women[4,7]. This NCD mortality transition has been caused by large decreases in CVD mortality over recent decades, compared with much smaller reductions in cancer mortality over the same time period[12].

The burden of CVD does not come solely from the deaths caused by it. CVD morbidity and associated disability are important considerations in the epidemiology of the disease, with large variations in incidence and prevalence found across the European continent[2–9]. Overall, the number of people who have CVD has increased within Europe. Between 1990 and 2015, most European countries reported an increase in incident CVD, which is most likely to be due to an ageing population and increases in population size, as age standardised rates for both incidence and prevalence have decreased[4–7].

Continued surveillance and monitoring of CVD within the European region is crucial if we are to build on and scale up effective CVD prevention and treatment approaches. Such epidemiological data may help to understand the distribution of the burden from CVDs, thereby allowing future trends to be identified and interventions to be targeted, as well as providing impetus for action across the continent[13–16].

In this Review, we present a series of data related to the mortality, morbidity, and treatment of CVD throughout Europe. These data, collated by central sources, are drawn from the European Society of Cardiology (ESC) Atlas that is compiled and regularly updated by the European Heart Agency, Brussels, Belgium[17] to provide country-level CVD epidemiological data for the 57 ESC member states[5,6]. Within this article we focus on the 53 WHO European defined countries, comparing between countries and sub-regions. We also include health treatment data, including length of hospital stay, case fatality and hospital admissions, that have not been included in previous Atlas publications.

Definitions and data sources

Cardiovascular diseases

Throughout this Review, we present data for all CVD with a focus on the two most common forms: IHD and stroke. The following ICD codes have been used for collating data in this

Review: CVD (ICD-10 codes I00-I99; ICD-9 codes 390.0-459.9; ICD-8 codes 3900-4589) IHD (ICD-10 codes I20-I25; ICD-9 and ICD-8 codes 4100-4149) stroke (ICD-10 codes I60-I69; ICD-9 and ICD-8 codes 4300-4380). Where data were collated by an external organisation, further details are available from that source.

Europe

There are a number of definitions for 'Europe'. In this review, we follow the 53 member states of the World Health Organization's (WHO's) European Region[18]. Aggregated data are also presented for different geographical sub-regions for countries within Europe, using the United Nations (UN) sub-regional classification. The 53 member states of the WHO European Region can be found in the following UN sub-regional classifications: Western Asia, Central Asia, Northern Europe, Western Europe, Southern Europe and Eastern Europe[4,19].

ESC Atlas of Cardiology

Data were provided by the ESC Atlas of Cardiology that contains more than 100 variables relating to human and capital infrastructure and major cardiovascular interventions and services for ESC member countries[17,20,21]. The Atlas is maintained by the ESC Health Policy Unit in Brussels to be used for promoting evidence-based health policy and practice in cardiology for ESC countries[17,20,21]. These data were expanded to include all 53 WHO European region countries, although quality and coverage of data varies by topic.

Mortality data

Mortality data come from the WHO mortality database, which collates data reported by national authorities based on their vital registration systems[22–24]. All analyses, interpretations, and conclusions are those of the authors, not the WHO, which is responsible only for the provision of the original information.

From these primary data, mortality rates are calculated using country-level data on population size as denominators, taken from the same database. Age standardised rates are computed using the direct method[25] with the 2013 European Standard Population (ESP) to control for cross-national differences in population age structures. The 2013 ESP was developed as an update to the 1976 ESP by the European Commission for the EU27 and European Free Trade Association countries, to reflect better the age structure of the current European population[26]. Age standardised rates can only be calculated where data on the absolute number of an outcome and the population are available in comparable age-specific aggregates. Where rates are presented for the 'most recent year', this relates to the most recent data for which both mortality and population data were available.

Premature mortality statistics also come from the WHO mortality database and identify deaths under the age of 70 years as premature, to align with WHO targets[13,27,28]. Given that CVD risk increases with age we expect such ageing-associated diseases to increase[29]. However, deaths at younger ages are an important measure because they are considered avoidable and represent a metric of unfulfilled life[13,14,30]. Such premature mortality data are supported by estimates of Potential Years of Life Lost (PYLLs) provided by the Global Burden of Disease (GBD) study, conducted by the Institute for Health Metrics and Evaluation (IHME), University of Washington, USA[31]. PYLL is a summary measure of premature mortality, taking into account the age at which an individual died and relating it to their life expectancy, thereby giving greater weight to deaths at younger age and lower weight to deaths at older age[32,33].

Morbidity data

Estimates of CVD incidence and prevalence come from the GBD study. The estimates are derived in the GBD study using modelling software and data from health surveys, prospective cohorts, health system administrative data, and registries[1,34]. The GBD study also provides estimates of disability-adjusted life years (DALYs). One DALY is equivalent to 1 year of healthy life lost and is a composite measure of years of life lost due to death from a condition and years lived with disability due to a condition[35,36]. Age standardized rates provided by the GBD study are based on the GBD world population age standard[1].

Hospital treatment data

Hospital discharge data on CVD, IHD and stroke were drawn from the WHO European Region's Health for All Database. These data were in turn sourced from the national registries of each country and provide an indication of the burden of CVD on health services within European countries. Data on the average length of stay (ALOS) in hospital for myocardial infarction, stroke and heart failure, are provided by the Organization for Economic Co-operation and Development (OECD), for those European countries which are also part of the OECD. ALOS is generally measured by dividing the total number of hospital days stayed by all patients during a year by the number of cause-specific admissions or discharges[37]. The OECD also presents 30-day case-fatality rate as a proportion of people aged 45 years and over who die within 30 days following admission to hospital for myocardial infarction, and ischaemic stroke (IS) which represents around 85% of all cases of cerebrovascular disease[38,39] age-sex standardised to the 2010 OECD population.

Data presentation

Data presentation in this Review is descriptive, illustrated by tables and charts produced by the ESC Atlas Publication Committee. No attempt is made to attach statistical significance to temporal trends or to differences observed in stratified analyses and there is no assumption of causation when associations are identified. Medians of country-level data are presented, with box plots used to depict differences between groups. Temporal changes are presented where available, using locally weighted polynomial smoother (LOWESS)[40].

Data availability and coverage

Mortality data taken from the WHO mortality database differ between countries in coverage. With no data available for Monaco, mortality data were obtained for 52 countries. The most recent year of data was 2017 for seven (13%) countries, 2016 for 24 (46%) countries, and 2015 for 11 (21%) countries. There were three countries in which the most recent year of mortality data came from 2010 or before: Albania (2010), Montenegro (2009) and Azerbaijan (2007). Mortality rates that require population data from the same year, showed a similar patter, although for six countries rates calculated using population and mortality data were older that the most recent year of mortality data: France (rates one year older than most recent mortality data), Spain (one year older), Switzerland (three years older), San Marino (10 years older), Tajikistan (12 years older), and Turkmenistan (17 years older).

It was possible to obtain mortality trend data from 1979 for 11 (21%) countries. For 13 (26%) countries the earliest year of available data came from 1990 onwards, with no data available from before the year 2000 for four of these: Uzbekistan (oldest year of data available = 2004), Turkey (2009), Andorra (2011), and Tajikistan (2016). Of the possible 38 years of mortality data, between 1979 and 2017, only seven countries provided data for every year: Austria, Belgium, Greece, Israel, Luxembourg, Netherlands, and Romania. A further seven countries provided 37 years of data, all of which were from Northern, Southern or Western Europe. Ten countries (19%) provided less than half the data points, with three of these providing less than 10 years of data: Turkey (8 years of data), Andorra (n = 5), and

Tajikistan (n = 1). Data on Potential Years of Life Lost (PYLLs), along with morbidity data, modelled by the GBD, provided greater coverage, with estimates calculated for 2017 for all countries except for San Marino and Monaco. Trend data for these GDB estimates were available for all data points between 1990 and 2017 for all other countries.

Much greater variation was found within hospital treatment data with 10 of 53 (19%) countries providing data on CVD hospital discharges from 2016 or 2017, whilst for 21 (40%) countries the most recent data preceded 2010. OECD data on Average Length of Hospital Stay (ALOS) and case fatality were only available for OECD countries, covering less than 30 (57%) of the European Region Member States. There was wide variation in years of data available between these OECD members.

Mortality from CVD in Europe

Data on the current mortality burden of CVD in Europe, including number of deaths, premature mortality, age standardised and crude rates, along with measures on potential years of life lost can be found in Supplementary Table 1.

Number of deaths

Using the most recent data available, CVD caused just over 3.8 million deaths per year across Europe, accounting for more than 2 million deaths in females and just under 1.76 million deaths in males. This corresponded to 39% of total deaths in males and 46% of total deaths in females. In comparison, cancer, the second most common cause of death in Europe, accounted for 24% of all deaths in males and 20% in females. Equally, within individual countries, the median percentage of total deaths that CVD caused was greater for females (47%) than males (38%).

Of the CVD deaths, IHD was the most common, accounting for 47% of all CVD deaths in males and 40% of all CVD deaths in females. Similar numbers of males (n = 819,104) and females (n = 813,191) died of IHD, whereas more than five hundred thousand females died from stroke, compared to less than four hundred thousand males.

The median percentage of CVD deaths was greater than the median percentage of deaths caused by cancer for both sexes (female median = 47% vs 22% for CVD and cancer respectively, male median = 37.5% vs 27%). There were 15 countries (28%) in which more males died of cancer than CVD and six countries (11%) in which this was the case for females (Figure 1).

Countries within the Eastern European sub-region had the highest median percentage of all deaths that were due to CVD in both males (48%) and females (57%). It was also one of the only two sub-regions, along with Central Asia, in which no country had a greater number of deaths from cancer than CVD in either sex. Countries in Western European had the lowest median percentage of all deaths due to CVD in males (29%), whilst for females it was Northern European countries (33%) although this was similar to that found in Western Europe (34%).

Premature mortality

CVD accounted for more than 900,000 premature deaths (those in individuals aged less than 70 years), with more than twice as many males dying from CVD before the age of 70 years than females. CVD accounted for close to one-third (32%) of all premature deaths in males and 28% of all premature deaths in females. This compared to 25% of premature deaths in males due to cancer and 36% in females. Stroke accounted for a greater proportion of premature CVD deaths in females (27%) than in males (20%), although IHD accounted for around half of all CVD deaths in males (51%) compared to 42% in females.

Median proportions of premature deaths caused were similar between CVD (30%) and cancer (31%) for males, although for females they were greater for cancer (median = 44%) than CVD (median = 24%). In 24 (46%) countries, CVD caused fewer deaths in males under the age of 70 than cancer; this was the case for 35 countries (67%) in females.

Median proportions of all deaths due to CVD, in those under 70 years, were greatest in countries in Central Asia (male median = 35%, female median = 35%) and Eastern Europe (male median = 36%, female median = 34%). Central Asia was also the only sub-region in which no country had more premature deaths due to cancer than CVD. Western Europe had the lowest proportion of all premature deaths due to CVD in both males (median = 19%) and females (median = 14%). It was also the only sub-region in which all countries had more premature deaths from cancer than CVD in males. Cancer also caused more premature deaths than CVD amongst females in both Western and Southern European regions (Figure 2).

Age Standardised Mortality Rates

CVD mortality rates, age standardised to the 2013 European Standard Population (ASMRs), were higher in males (median = 551/100,000) in Europe than females (median = 441/100,000), with a greater difference in ASMRs for IHD (males median = 203/100,000; females median = 113/100,000; relative difference = 80%) than for stroke (males median = 118/100,000; females median = 105/100,000; relative difference = 12%).

Median ASMRs were greater in males than females in all European regions, with the highest median CVD ASMRs found in Central Asian countries for both sexes (male median = 1,305/100,000, female median = 967/100,000). The lowest ASMRs were found within the Western European countries for both males (median = 324/100,000) and females (median = 234/100,000) (Figure 3).

ASMR trends for CVD have shown a decrease from 1995 to 2015 in most countries, with relative decreases similar between males and females for total CVD, IHD and stroke (Supplementary Figures 1-3). Although data for a very small number of countries suggest there may have been some plateauing of decreasing trends in CVD, these are also in countries with a smaller number of time point data and less consistent mortality reporting. Eastern European and Central Asian countries have poorer coverage of mortality statistics over time (Supplementary Table 2). They have also demonstrated the smallest reductions and, consequently, the worst median ASMRs for CVD, IHD and stroke for both sexes.

Crude mortality rates

Crude mortality rates for CVD within Europe in all ages are similar for females (median = 344/100,000) and males (median = 324/100,000). However, males had two times higher median crude rates (110/100,000) than females (54/100,000) in those under 70 years of age.

Crude CVD mortality rates were highest in Eastern European countries for both sexes for all ages (male median = 633/100,000, female median = 673/100,000) and those aged below 70 years (male median = 253/100,000, female median = 119/100,000). They were lowest in Western European countries for all ages in males (median = 243/100,000) but lowest in Western Asian countries amongst females (median = 268/100,000). They were lowest in Western Europe for those under 70 years of age in both males (median = 52/100,000) and females (median = 25/100,000).

As with ASMRs, consistent decreases in crude death rates for CVD for all ages have been seen across the WHO European Region between 1979 and 2017. Decreases were similar between the sexes. Western European countries have shown the most consistent decreases in crude rates during this period, whereas Eastern European countries have experienced the smallest change (Supplementary Table 3). These decreases have also been seen in crude mortality rates in those under 70 years of age, with greater absolute decreases in males but greater relative decreases in females. Western, Northern and Southern European countries have shown the greatest relative decreases over this time, although Western and Southern countries started with lower crude rates, such that their absolute decreases may not have been as great as other regions (Figure 4; Supplementary Table 4).

Potential Years of Life Lost

In total, there were 60 million PYLLs to CVD within the European region in the most recent year of data. The 34.5 million PYLLs to CVD in males was the equivalent of 34% of all PYLLs in males, whilst the 25.7 million CVD PYLLs in females accounted for 38% of all PYLLs.

Individual countries showed a median percentage of all PYLLs that were caused by CVD in males of 33%, for females this was 35%. This compares to a median percentage of PYLLs lost to cancer of just over 30% in both. In 21 countries (41%) a greater number of PYLLs were lost to cancer than CVD amongst females and there were 18 countries (35%) in which this was the case for males.

The highest proportion of PYLLs lost to CVD was found within Eastern European countries in both sexes (male median = 38%, female median = 48%) with the lowest in Western European countries (male median = 25%, female median = 24%). The Western European region was the only one in which no country lost more PYLLs to CVD than cancer in both sexes. In contrast there were no countries in Central Asia or Eastern Europe that lost more PYLLs to cancer than CVD for either sex (Supplementary Table 1).

Morbidity from CVD in Europe

Incidence

Overall in Europe, for the most recent year reported (2017), age standardised incidence rates (ASIRs) for total CVD, calculated using GBD estimates, were higher in males (median = 1325/100,000) than females (median = 1029/100,000). Higher median rates were also found in men for IHD (male median = 223/100,000, female median = 120/100,000) and stroke (male median = 150/100,000, female median = 126/100,000). Central Asia reported the lowest total CVD ASIRs for both sexes (male median = 1006/100,000, female median = 837/100,000), whilst the highest total CVD ASIRs were found in Western Europe for both sexes (male median = 1463/100,000, female median = 1130/100,000) (Figure 5). Eastern European countries showed the highest ASIRs in both sexes for both IHD (Male median = 290/100,000, Female median = 164/100,000) and stroke (male median = 204/100,000, female median = 163/100,000). Southern European countries demonstrated the lowest ASIRs for IHD (male median = 198/100,000, female median = 97/100,000) and Western European countries the lowest for stroke (male median = 109/100,000, female median = 93/100,000). Notably, there have been consistent decreases in ASIRs for both IHD and stroke for both sexes across European countries between 1990 and 2017 (Supplementary Table 5).

Prevalence

Median age standardised rates for prevalence (ASPRs), across the continent for 2017, were higher in males than females for total CVD (male median = 7,077/100,000, female median = 6,026/100,000) and IHD (male median = 2,528/100,000, female median = 1,752/100,000) but were similar between the sexes for stroke (male median = 1,187/100,000, female median = 1,188/100,000). Total CVD ASPRs were highest in Eastern Europe for both males (median = 7,847/100,000) and females (median = 6,564/100,000). They were lowest in Central Asia for males (median = 6,976/100,000) and Northern Europe for females (median = 5,561/100,000) (Supplementary Figure 4). IHD ASPRs were lowest in Western Europe for both sexes (male median = 1,982/100,000, female median = 945/100,000) as were stroke ASPRs (male median = 1,014/100,000, female median = 875/100,000). ASPRs for were highest in Eastern Europe in both sexes for both IHD (male median = 3,123/100,000, female median = 2,185/100,000) and stroke (male median = 1,699/100,000, female median = 1,500/100,000). As with incidence, consistent decreases in ASPRs for total CVD, IHD and stroke have been seen across Europe between 1990 and 2017 (Supplementary Table 6).

Disability Adjusted Life Years (DALYs)

Total CVD median Age Standardised Disability Adjusted Life Years (ASDALYs) were substantially higher in males (5,205/100,000), in the most recent year of data (2017), than females (2,844/100,000). IHD ASDALYs were more than twice as high in males (2,927/100,000) than females (1,249/100,000) and were also higher in males for stroke (male median = 1,139/100,00, female median = 810/100,000). Median ASDALYs were lowest in Western European countries for total CVD (male median = 2,563/100,000, female median = 1,513/100,000), IHD (male median = 1,242/100,000, female median = 520/100,000) and stroke (male median = 552/100,000, female median = 451/100,000). They were highest in Central Asian countries for all conditions in both sexes (total CVD median male = 11,786/100,000, female = 6,567; IHD median male = 6,399/100,000, female = 3,617/100,000; stroke median male = 3,277/100,000; female = 2,180/100,000) (Supplementary Table 7).

Age standardised DALYs (ASDALYs) for total CVD have also fallen between 1990 and 2017. As with mortality, although Western, Southern and Northern European countries started with lower ASDALYs, they also experienced more consistent decreases. Central Asian counties, in comparison, experienced later decreases in ASDALYs, for both sexes, in total CVD, CHD and stroke, over this period of time (Supplementary Figures 5-7).

Hospital treatment

Between 1970 and 2017, the number of, and crude rates for, hospital discharges, for CVD, IHD and stroke have increased across the WHO European region. However, trends in Northern and Western Europe demonstrate some recent plateauing (Figure 6; Supplementary Table 8). OECD data for 28 countries, show that the average length of stay (ALOS) in hospital following admission for CVD has also decreased since 2000. For example, the median ALOS for AMI decreased from around 10 days to less than a week between 2000 and 2017. There have been less consistent decreases in ALOS for stroke, with patients still spending around two weeks in hospital. There is greater variation between regions in the median ALOS for heart failure and stroke than for myocardial infarction (Supplementary Figure 8, Supplementary Table 9).

Case fatality rates, also from OECD data, are greater for haemorrhagic stroke (male median = 23.2%, female median = 24.4%; country n = 26) than for both ischemic stroke (male median = 7.9%, female median = 9.0%; country n = 26) and myocardial infarction (male median = 6.6%, female median = 7.0%; country n = 27). Although trend data are presented for only a limited number of countries, where they are available consistent decreases have been seen in case fatality for all conditions, in both sexes, with these relative decreases greatest for myocardial infarction and lowest for haemorrhagic stroke (Supplementary Table 10).

Discussion

Epidemiological surveillance is central to addressing the substantial burden of CVD both across the European region and within individual countries[41–44]. This Review highlights large heterogeneity between countries in the CVD data available. In particular, there was a paucity of information about CVD morbidity, with this Review using modelled estimates from the Global Burden of Disease study. Initiatives are therefore required to standardise and enable data collection within Europe in order to overcome this gap, essential for providing robust evidence to policy makers.

Mortality data demonstrate that CVD remains the most common cause of death within the European region. It is apparent, however, that CVD mortality continues to decrease once adjusted for population size and age. Along with large between country and sub-regional inequalities in CVD mortality, differences in the burden of CVD in Europe are also found between males and females. Although more women than men die from CVD in the region, higher age standardised mortality rates and deaths in those aged under 70 years demonstrate that CVD remains a greater burden amongst men in all countries. This is highlighted through premature mortality statistics indicating that although CVD is the most common cause of premature death in men, more women die prematurely from cancer than CVD.

Similarly, morbidity estimates, including DALYs, show a greater burden in men than women with large differences also found between countries in all morbidity measures. Some differences in mortality and morbidity may be due to diversities in treatment options found across the continent. High incidence rates for CVD in Western and Northern European sub-regions, along with comparatively low mortality rates, could be due to better diagnosis and treatment in these countries. Further work should be done to explain these sub-regional and country differences, particularly in relation to heterogeneity in cardiological specialist provision, hospital facilities, and healthcare delivery[6].

Estimates for the total number of deaths in Europe are consistently lower in this Review than reported in previous publications[3,7,8]. In addition, the 15 countries in which more males died of cancer than CVD and the six countries in which this was the case for females reported in the current paper, compares to the 12 countries for males and two countries for females, reported in a similar paper on CVD epidemiology in Europe that used data from 2014 and before[7]. It is beyond the scope of this Review to undertake in-depth statistical analysis. We focus on presenting and discussing summary statistics that do not infer causality. This means that although we describe trends, along with differences between countries and sub-regions, we do not try to attach statistical significance to them. Earlier papers using joinpoint analysis to analyse trends in both IHD[10] and stroke[11] have reported similar overall decreases in age-standardised rates, as presented here. However, both papers have identified some evidence in plateauing of trends in individual countries, when considering disease sub-types in stroke[11] and examining trends by sex[10]. Larger publications have also included measures for behavioural and physiological risk factors, we do not do so here, although we acknowledge that they are an important focus in the prevention and treatment of CVD in all countries and regions[2,4–6]. These include previous reports from the Atlas publication committee[5,6] covering all 57 Member States of the ESC, rather than the 53 countries in the European Union.

Limitations

Throughout this review, we focus on between-country rather than within-country inequalities, despite strong evidence that the later exist within many European countries[45–56]. All data presented in this Review were compiled from major data sources including the WHO, OECD and GBD, rather than collecting from individual countries, in order to be consistent and comparable between countries and across Europe. These data were chosen to achieve the highest possible coverage of the European region, data quality and most recent data. The sources we utilised are generally updated through routine and administrative mechanisms, relying on individual countries to provide the data they collate. For example, data included in this publication from the WHO Mortality Database are as submitted by individual countries to the WHO. No adjustments have been made to account for potential bias in reporting. As a result, the quality of mortality data likely varies between countries, depending on the functioning of vital registration systems. Even for countries with strong vital registration systems, however, regional patterns of clinical diagnosis may limit inter-country comparability.

Similarly, in order to provide time trend data of a reasonable length, in this paper up to 48 years for some measures, we must incorporate data that span the use of several versions of the ICD. This means that definitions of some conditions may have changed over time. The use of relatively broad disease categories, for which the implications of coding changes are small, may help alleviate some concern over this. Although variability between countries in coding practices at any one time, or over the course of the trend data, may occur.

Reporting deaths, including a record of cause, is often a mandatory part of a country's vital statistics system, with it required by most national health authorities[57]. This means that although quality of this reporting may vary between countries, good coverage in mortality statistics across Europe can be assumed. This is not the case for morbidity data, with the aggregation of incidence and prevalence data from national statistics being rare in the majority of European countries. For this reason, we used GBD country-level point estimates of CVD morbidity. The accuracy of modelled estimates is heavily dependent on the original data used, which can be a concern when recent data have not been collected or data are incomplete[58,59]. Modelled estimates are, therefore, open to concerns regarding accuracy when describing the national level of CVD burden and may change as more recent data become available[60]. Despite recent critique in terms of methodology, culture, and qualitative differences, in addition to a lack of homogeneity in access to resources[61], GBD estimates remain the best available option, in the absence of consistent and systematic collection of CVD morbidity data across the continent.

The development of sustainable national surveillance systems for CVD morbidity, within individual countries, would be key in understanding disease occurrence across the continent and in informing context relevant approaches to prevent and control CVD. In order to establish contemporary surveillance systems for CVD health outcomes and treatment, countries could consider repurposing electronic health records (HER) routinely collected through health information systems (HIS)[62]. Such approaches could learn from, and build on, the success of the WHO Multinational MONItoring of Trends and Determinants in CArdiovascular Disease (MONICA) Project that remains the most comprehensive approach to understanding better disease etiology, incidence and trends at the population level[63–65]. Set up in response to calls for more population-based disease surveillance, due to the epidemic proportions of CHD experienced in western countries after World War II, the objective of the MONICA Project was to measure trends in cardiovascular mortality and morbidity and to assess the extent to which these trends related to changes in risk factor levels and/or medical care, measured at the same time in defined communities in different countries across 38 populations in 21 countries worldwide[63–65].

Lastly, within this paper we present data on the epidemiology of CVD within the WHO European region. Although these data highlight the variation across the region in CVD mortality, morbidity and treatment, we make no attempt to analyse the reasons behind these variations, due to the complexity in their determination. Previous publications have found that a combination of treatment and prevention efforts have played a crucial role in decreasing the burden of CVD within some European countries[66–69]. Similarly, studies have reported large variations in the prevalence of key CVD behavioural risk factors and healthcare delivery, across Europe[4–6,70]. Simple analyses have also demonstrated that less affluent countries, as defined by GDP per capita, along with those with lower health care expenditure, tend to have a higher burden from CVD, as defined by mortality[6]. Alongside this, further research has considered the role of wider determinants, including such risk factors as air pollution[71,72], that may link to CVD outcomes. These findings point to the complexity in the multifaceted determination of CVD and its risk factors, highlighting the challenge faced in trying to account for all these factors when unravelling the inequalities in CVD burden found across Europe.

Conclusions

The data presented in this Review shed light on the significant burden of CVD across 53 countries in the WHO European Region. While CVD continues to have a major impact on health in the European region, important diversities exist across the continent. This observation supports calls to reduce the burden from CVD and lessen inequalities through the implementation of targeted evidence-based treatment and preventive approaches across all countries in the region. A prerequisite for the achievement of this goal is to provide a consistent, comprehensive and reliable estimates of the actual burden of CVD across and within countries of the European region.

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Competing interests

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Key points

- Cardiovascular disease (CVD) remains the most common cause of death in the European region.
- More than 60 million Potential Years of Life are Lost (PYLLs) to CVD within Europe annually.
- More females than males die from CVD within Europe.
- Age standardised rates of both mortality and morbidity are higher in males than females.
- In 15 of the 53 European region countries, more males died of cancer than CVD, with this the case for females in six countries.
- Large inequalities in country level mortality, morbidity, and treatment outcomes along with data coverage can be found across the continent.