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How can we Improve Secondary Prevention of Cardiovascular Disease?

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Abbreviations

ASCVD	Atherosclerotic cardiovascular disease
CKD	Chronic kidney disease
CVD	Cardiovascular disease
CVH	Cardiovascular health
DALY	Disability-adjusted life year
EACH	European Alliance for Cardiovascular Health
EASD	European Association for the Study of Diabetes
EHN	European Heart Network
ESC	European Society of Cardiology
GP	General Practitioner
HbA1c	Glycated haemoglobin
HDL-C	High-density lipoprotein cholesterol
INI	Own-initiative Report
KPI	Key performance indicator
LDL-C	Low-density lipoprotein cholesterol
LLT	Lipid lowering therapy
MEP	Member of the European Parliament
NCDs	Non-communicable diseases
P4P	Pay for performance
QOF	Quality and Outcomes Framework

Glossary

Atherosclerotic cardiovascular disease

Caused by a build-up of cholesterol plaque in arteries. It is responsible for acute coronary syndrome, peripheral arterial disease and events such as heart attack and stroke.

Hyperlipidaemia

An elevation of blood lipids. Variations include: hypercholesterolaemia (high levels of low-density lipoprotein cholesterol (LDL-C)); hypertriglyceridaemia (raised levels of triglycerides); high lipoprotein (a); and familial dyslipidaemias (genetic disorders resulting in abnormal lipid levels).

Hypertension

Raised pressure in blood vessels. Stage one hypertension is defined as 130-139/80-89 mmHG, although definitions vary. Normal blood pressure is considered to be 120/80.

Hyperglycaemia

Mainly affecting people with diabetes, it is defined as blood HbA1c (glycated haemoglobin) levels greater than 6.5% or ~48mmol/L more precisely.

Primordial cardiovascular prevention

Precedes primary prevention and focuses on risk factor prevention. Primordial prevention of hypertension consists of strategies to maintain blood pressure in a normal range and prevent development of elevated blood pressure or hypertension for example by preventing and reducing childhood obesity, avoiding excessive salt consumption, and removing barriers to physical activity and healthy sleep throughout childhood.

Primary cardiovascular prevention

Interventions to prevent a cardiovascular event from ever occurring, for example, via the adoption of a healthy diet and lifestyle and / or as needed pharmacological treatments, including statins and blood pressure lowering medications.

Secondary cardiovascular prevention

Any strategy aimed at reducing the probability of a recurrent cardiovascular event in patients with known atherosclerotic cardiovascular disease.

Tertiary cardiovascular prevention

Focuses on avoiding further complications aiming to achieve a better quality of life for those living with cardiovascular disease.

Executive summary

Rationale

The last two decades have seen improvements in cardiovascular disease (CVD)-related mortality, but there is recent evidence of plateauing, or even increases, in mortality rates. This suggests that future improvements are only likely to be gained through improving prevention of atherosclerotic events such as heart attack or stroke. This together with an increase in lifestyle related CV risk factors such as obesity and diabetes are contributing to current trends. There are well known relationships between CVD and a number of risk factors, including high cholesterol (hyperlipidaemia), high blood pressure (hypertension), high blood glucose (hyperglycaemia), unhealthy diet, obesity, alcohol overconsumption, smoking and physical inactivity. The reversible nature of these risk factors provides a huge opportunity to prevent CVD events by improving risk factor treatment and promoting the adoption of a healthy lifestyle. Medical guidelines for both the primary and secondary prevention of CVD recommend specific treatment targets for these risk factors, but there are decades of evidence that these targets are insufficiently achieved across most countries and health systems. Optimising primary and secondary prevention could significantly improve European CV health (CVH) with subsequent positive effects on individual and population health outcomes, healthcare systems and economies. This project identifies the benefits available, in terms of fatal CV events avoided, by optimising secondary prevention in those with established atherosclerotic cardiovascular disease (ASCVD) in seven European countries, including Denmark, France, Germany, Italy, Poland, Spain and the United Kingdom. We focused on hypertension, hyperlipidaemia, diabetes and tobacco smoking. Results guide policy discussions and interventions to improve cardiovascular health and reduce the burden of CVD in the EU.

Results

Enhancing secondary prevention in France, Germany, Italy, Spain, Denmark, Poland and the UK could prevent 67,170 fatal cardiovascular (CV) events (heart attack and stroke) per year. This equates to 671,700 avoided fatal CV events over the next ten years via improved management of hypertension, hyperlipidaemia and diabetes. Encouraging 70% of patients with CVD who smoke to quit could prevent an additional 27,189 fatal CV events per year (271,890 over the next ten years). Considering roughly 1.8 million deaths in 2019 in the seven countries were thought to be due to ASCVD, the prevention of almost 95 thousand (94,359) fatal CV events represents a 5% improvement per year. Across ten years this could mean the prevention of nearly a million deaths (943,590).

Recommendations

In order to realise the reductions in fatal CV events identified here, we must prioritise and optimise secondary prevention as much as possible across the European region. We make a number of recommendations for both individual EU Member States and the wider EU region to pursue for the optimisation of secondary CVD prevention, although many are also relevant for the primary prevention of CVD.

1. Joint diabetes and heart health checks performed in the primary care setting by a general practitioner (GP), nurse or healthcare assistant, in community pharmacies or even in workplace settings, with linkage and data sharing built in, to ensure access is as streamlined as possible and that continuity of care is prioritised. There is a requirement to standardise this offering across the EU to ensure early diagnosis of CVD and effective intervention throughout the region.
2. Development of a European Cardiovascular Health Plan. EU-level political motivation is required to bring the European Alliance for Cardiovascular Health (EACH) blueprint for EU action on CVD into fruition. Robust action by policy makers at the EU level has the potential to significantly reduce fundamental health inequalities and address societal barriers that exist due to fragile health systems across Europe.
3. All 27 Member States to develop, implement and fund national CVH plans to ensure everyone in the EU has access to CVD-related healthcare and that inequalities seen in prevention and treatment are reduced across the EU. National goals and targets must be co-created to ensure standardisation whilst reflecting national context and culture to allow for the nuances that individual country's populations and health systems will require.
4. Establish equitable access to prevention across the EU by ensuring that all countries follow harmonized treatment guidelines to enable as many patients as possible to reach quantifiable targets for lifestyle, blood pressure, cholesterol and glucose levels.
5. Enhance streamlined, standardised and consistent data collection across the EU to allow for more accurate estimations of the power of optimised secondary prevention at the population level and enhanced determination of cost-benefits.
6. Design healthcare system incentives via key performance indicators and pay-for-performance schemes to act as behavioural change enablers for both physicians and patients. The aim is to increase the proportion of patients reaching lifestyle and treatment targets for CVD risk factors like hyperlipidaemia, hypertension and diabetes.
7. Encourage the provision of effective, comprehensive, multidisciplinary, dedicated CVD rehabilitation programmes (using specialised nurses and allied professionals), incorporated into national CVD plans alongside, at the EU level, the development of a consistent definition of an effective cardiac and stroke rehabilitation programme.
8. Build quantifiable health literacy programs to increase adherence via the development of effective health promotion and preventive strategies to address individual behaviours and to ensure individuals have the power and knowledge required to facilitate healthier life choices to reduce the prevalence of CVD risk factors and CVD. Improved health literacy would allow citizens to benefit from better 'self-care', would encourage increased adherence to medication and reduce the prevalence of CVD risk factors.

Conclusions

The benefits of avoided fatal CV events are vast for individuals, the population, country health systems, country economies and the EU economy as a whole. To drive change, and optimise secondary CVD prevention, targeted action is required at both the EU level and at the Member State level. European policy makers must drive the current momentum in order to reduce the burden of CVD moving forward for all those living in the EU.

Higher spending does not always improve health, but making the right investments at the right time can.

World Health Organization, 2017

1. Background

Cardiovascular disease (CVD) is responsible for almost four million deaths (1) and a third of premature deaths in Europe[1] each year. It causes the majority of morbidity and mortality in the region (2) and around 50 million people are thought to be living with CVD in the EU (3). There is a significant financial burden associated with CVD – recent estimates put the figure at €282 billion per year, with roughly half due to health care costs, a quarter due to productivity losses and a fifth due to informal care of those with CVD (4). In the UK, CVD has been shown to cost the economy as much as 6% of the NHS budget (5), while in Germany, it is estimated to be responsible for 13% of total health expenditure (6).

While the last two decades have seen improvements in CVD-related mortality (7), there is recent evidence of plateauing, or even increases, in mortality rates in those with atherosclerotic CVD (ASCVD)[2] (1). This suggests that future improvements are only likely to be gained through improving prevention of atherosclerotic events such as heart attack or stroke. This together with an increase in lifestyle related CV risk factors such as obesity and diabetes are contributing to current trends. We must also not ignore the COVID-19 pandemic, which had an enormous impact on people with CVD. This ranged from issues of accessing care, as well as the specific effect of the infection on heart health and CVD complications, and the impact of pre-existing CVD conditions on COVID-19 severity and mortality (8).

There are well known relationships between a number of risk factors and cardiovascular events. High cholesterol (hyperlipidaemia), high blood pressure (hypertension), high blood glucose (hyperglycaemia), obesity, physical inactivity and smoking are currently the primary, reversible risk factors (9)[3]. Whilst we must not forget the impact of broader non-modifiable and modifiable risk factors, like age[4], genetics and living conditions, the reversible nature of these lifestyle and biological risk factors like high blood pressure and high cholesterol provides a huge opportunity to prevent events related to ASCVD, like heart attacks and strokes, by improving risk factor treatment and promoting the adoption of a healthy lifestyle. Whilst professional medical guidelines for both the primary and secondary prevention of CVD recommend specific treatment targets for these risk factors, there is evidence that these are not usually achieved across different countries and health systems (11–16). Studies like EUROASPIRE show a wide gap between the cardiovascular prevention guidelines and their implementation in everyday clinical practice with poor lifestyle management and inadequate control of medical risk factors in patients with CVD in Europe (17,18).

Optimising primary and secondary prevention could significantly improve European CV health with subsequent positive effects on individual and population health outcomes, healthcare systems and economies. The optimal way to reduce CVD at the population level is via primordial prevention, to stop the development of the risk factors of CV disease such as high blood pressure, high cholesterol levels, diabetes and obesity by tackling unhealthy lifestyle behaviours such as smoking, limited exercise, unhealthy diet and high alcohol consumption. For those that require treatments beyond

[1] Relates to deaths in people under the age of 70.
[2] Atherosclerosis is the build-up of fats and cholesterol on the artery walls in the form of a plaque. Plaques narrow arteries, blocking blood flow and they can burst, leading to a blood clot.
[3] Despite its known links with CVD risk (10), we were unable to represent obesity in the current analysis. Reasons for this are explored further in the limitations section (2.2).
[4] Whist age in and of itself is not a risk factor it is the increased years of exposure, years of inertia and years of missed opportunity that come with increasing age that contribute to risk.

lifestyle, increasing adherence to treatment helps achieve risk factor control in the primary prevention setting. Once CVD has begun to develop, secondary prevention plays a vital role. Detecting and treating CVD as quickly and early and as aggressively as possible will slow, or even stop, the deleterious progress and reduce the impact on the patient, avoiding and/or reducing complications such as heart attacks or strokes. Secondary CVD prevention is therefore described as a 'strategy aimed at reducing the probability of a recurrent cardiovascular event in those with known CVD' (19). It centres around effectively managing unhealthy lifestyles with more aggressive control of risk factors to make up for lost years and more advanced disease through more stringent control of blood pressure, cholesterol and uncontrolled blood sugar alongside the encouragement of smoking cessation and exercise. Pharmacological products can also be used to, for example, reduce the ability of blood clot formation, lower blood glucose and slow plaque progression. Whilst proven secondary prevention models have been shown to reduce cardiovascular mortality by 58% (20), there is a wealth of evidence that effective secondary prevention is lacking across Europe.

Aims and Objectives

In the context of the above, this project aims to identify the benefits available, in terms of fatal CV events averted, by optimising secondary prevention in patients with established ASCVD.

The impact of improved secondary prevention and risk factor reduction will be determined on a population basis in seven European countries including Denmark, France, Germany, Italy, Poland, Spain and the United Kingdom. This will guide the development of a number of policy recommendations and interventions.

Section 2 briefly describes the methodology employed, **section 3** describes links between CVD and four main risk factors, **section 4** summarises the results, describing the benefits of improving secondary prevention, **section 5** describes the policy implications and **section 6** outlines a number of recommendations for the improvement of secondary prevention.

RESEARCH QUESTIONS

1. What is the impact of improved secondary prevention in patients with pre-existing cardiovascular disease?
2. How many fatal CV events can be averted in seven country populations by reducing risk factors including raised blood pressure levels, raised cholesterol levels, raised blood glucose levels and smoking?
3. Is European cardiovascular data sufficient to determine the impact of improved risk factor control?
4. How can the EU and EU Member States improve secondary CVD prevention for their populations?

2. Methodology

2.1 Modelling Process

A brief, targeted literature review identified two key papers and methodological approaches that were utilised in the modelling process. To estimate the benefits of better management of ASCVD risk factors, we adopted and modified an analytical framework developed by Farley et al. (2010) (21). The survival of three subpopulations was estimated: 1) people with ASCVD risk factors not receiving preventative treatment; 2) people with ASCVD risk factors receiving preventative treatment; 3) and people without ASCVD risk factors, and combined to determine the total survival for a country.

Survival is estimated from the estimated survival probability identified using the SMART-REACH model. This estimates life expectancy without fatal cardiovascular events (heart attacks or strokes) for individuals with coronary, cerebrovascular, and/or peripheral artery disease and was developed using data from patient cohorts in Western Europe and North America (22). We analysed the number of fatal CV events that were avoided by improving treatment coverage[5] from an assumed baseline of 43% (23) to 70% (i.e., the proportion of patients achieving risk factor target levels increases from 43% to 70%), in line with studies looking at the benefit of increasing treatment coverage of secondary preventative medication[6] (24). We also modelled gains at 90% coverage (i.e., the proportion of patients achieving risk factor target levels increases from 43% to 90%). Whilst this level of treatment coverage may be outside current treatment targets, it still provides valuable information on the benefits of further improving secondary prevention.

Six EU Member States, including Denmark, France, Germany, Italy, Poland and Spain, plus the United Kingdom, were included in the study. Countries were chosen to ensure a cross-section of European countries as well as the existence of available data. Annex 1 contains background information on all countries of choice.

2.1 Data Sources

We identified data on the prevalence of risk factors in the CVD population in the countries of interest from peer-reviewed and grey literature. We used large scale, observational studies in ASCVD populations which use standardised protocols, are geographically diverse and include comprehensive patient histories and clinical examination. They are widely accepted as rigorous, and representative of ASCVD population characteristics (17,18,25–29).

2.2 Limitations

The model used takes advantage of the most robust clinical risk model for European ASCVD populations. It was derived in this way because this is, to our knowledge, the first estimation of the impact of improving risk factors in the European population and this method is a necessary iteration on existing high-quality research.

Our approach was limited by the parameters used in SMART-REACH and available data. As such, we modelled the impact of improving treatment coverage in hyperlipidaemia, hypertension, diabetes

[5] Treatment coverage as we define it is a product of compliance / adherence to medication and, importantly, all other factors that contribute to improvements in the value of a risk factor.
[6] In this case treatment coverage is defined as adherence.

and tobacco use. Restrictions in the modelling process meant that the baseline blood pressure utilised was 140 mmHG. We were unable to model the effect of further blood pressure reductions due to the functional relationship between systolic BP and risk status that is encoded by the SMART-REACH dataset and the risk model derived from it. Given recent evidence that describes this relationship (without interdependencies to other risk factors), further risk reductions and life year- / CVD event gains / reductions might be expected. Similarly, the model incorporated cholesterol as total cholesterol, even though there may not be a specific clinical guideline threshold for total cholesterol levels.

Obesity was not represented in the analysis performed in this report, despite the known links with CVD risk (10,29), because it is not included in the SMART-REACH model on which the analysis used here is based. Future studies and reports on the benefits of secondary CVD prevention should include obesity in any modelling due to the known links to CVD risk. Numerous studies have shown that weight loss results in significant improvements in cardiometabolic risk factors and can lead to clinically relevant reductions in blood pressure and glucose regulation, particularly in those at highest risk (30,31).

Finally, diabetes is represented in a binary manner in the model so analysis was limited to assessing differences in survival between diabetic and non-diabetic patients. This might deviate from prevailing national clinical guidelines and clinical reality but is fundamental to the mathematical model used. It is the product of historical data collection / cohort studies, and the extensive research work conducted to derive risk models using these existing datasets. The SMART-REACH score has been clinically validated over several years and has shown excellent predictive performance.

3. Understanding the Impact of Risk Factors

Before discussing the results of our analysis, it is important to briefly explore the relationship between CVD and the four primary risk factors analysed in the modelling process.

3.1 Hyperlipidaemia

The links between high low-density lipoprotein (bad) cholesterol (LDL-C)[7] and ASCVD have been well established. About 8% of the burden of CVD (32) and almost a third of CVD-related morbidity and mortality in Europe (33) is due to uncontrolled cholesterol.

The prevalence of elevated/uncontrolled cholesterol levels is over 50% in Europe (9). Therefore, reducing cholesterol levels, particularly that of 'bad' LDL-C, is crucial to reducing the risk of CVD in both primary and secondary prevention. Due to the cumulative nature of the risk, there is significant benefit to reducing LDL-C values as early as possible via a combination of lifestyle and diet improvements (i.e. a healthier diet and weight management) and medication to reduce LDL-C levels (34). Evidence consistently confirms the link between reduced LDL-C levels and CV events, such as heart attacks and strokes. Each 1 mmol/L reduction in LDL-C safely reduces the annual rate of heart attack, revascularisation and ischaemic stroke by just over a fifth as well as a reduction in all-cause mortality of 10% (35). Whilst these links are well understood, over 90% of adults do not know their LDL-C levels (36), and only 20% of high and very high-risk patients achieved 2019 ESC/EAS LDL-C target levels which are <1.4 mmol/l (55 mg/dl) for very high risk patients or <1.8 mmol/l (70 mg/dl) for high risk patients (34). Issues with treatment practice may be at play – the majority of lipid lowering therapy (LLT) in use is statin-based monotherapy and, whilst combination therapy has increased over recent years, on average in the EU5, only 24% of patients experience combination LLT (13). There is also the impact of adherence to treatment to consider. Patients experiencing side effects as a result of statin use were more likely to terminate statin use and were over three-times more likely to miss the cholesterol target than those without side-effects (37). Optimising LLT with novel therapies enhancing effectiveness and adherence would prevent around 12,000 CVD events each year in a population of 500,000 (38).

3.2 Hypertension

Elevated blood pressure (BP), recognised as the primary global risk factor for CVD (9), affects more than a fifth of the EU population (39). It gradually damages blood vessel walls, the heart and other organs, increases the risk of coronary artery disease, heart failure, cerebrovascular disease, lower extremity arterial disease, chronic kidney disease, and atrial fibrillation (40). It is responsible for about 12.8% of all deaths globally and 3.7% of DALYs (41). Treating hypertension includes lifestyle changes, reducing alcohol consumption and pharmacotherapy (42). Regular monitoring and adherence[8] to treatment is critical for the successful management of raised BP. When management is successful, a 10mmHg reduction in systolic BP significantly reduces the risk of major CVD events,

[7] LDL-C is considered the 'bad' cholesterol as it contributes to the fatty build-ups found in arteries in those with atherosclerosis. The 'good' cholesterol, HDL, carries LDL-C away from arteries to the liver where it is broken down and eliminated from the body.

[8] A level of good adherence needed for a pharmacological treatment to be effective is widely recognized to be around 80% of the prescribed therapy (43).

coronary heart disease, stroke, heart failure, and all-cause mortality by 20%, 17%, 27%, 28%, and 13%, respectively (44). Similarly, recent research has shown that a 5mmHg reduction of systolic BP reduces the risk of major cardiovascular events by around 10%, regardless of previous diagnoses of CVD (45).

ESC guidelines recommend systolic BP under 140mmHg in all patients as the first step toward prevention goals. If tolerated, a further reduction below 130mmHg is recommended as the second step in some groups (40). Clinical research in high-risk patients has shown that the lowest BP possible is not necessarily the best target, as a systolic below 120mmHG has been associated with an increased risk of negative outcomes (46,47).

There is evidence of insufficient achievement of therapeutic goals for raised blood pressure in Europe. In Western Europe, whilst 70% of people with elevated BP are diagnosed, only 60% are on treatment, and only 40% achieve control. In Central and Eastern Europe, only half of hypertensive individuals are treated, and one in five achieves control (2). Increasing the rate of adherence to antihypertensives to 70% in Italy, Germany, France, Spain and England would save healthcare systems about €332 million, which can be translated to 82,235 fewer cardiovascular events (24). This underlines the consequences of hypertension on health outcomes and highlights the need to improve adherence to antihypertensive therapy, which has the potential to reduce the number of cardiovascular events and associated healthcare costs.

3.3 Diabetes

Diabetes is one of the most common chronic health conditions in Europe, and together with CVDs is a leading cause of death (48,49). In 2015, 415 million adults aged 20 to 79 worldwide were living with diabetes, and the International Diabetes Federation expects this figure to reach 642 million by 2040 (50). Approximately 7% of the European population is living with diabetes, although about 1 in 3 adults has not yet been diagnosed or is not treated sufficiently (48,49). Diabetes and CVD are interlinked and are frequently seen together as comorbidities. The high blood glucose levels, characteristic of diabetes, can harm the nerves and blood vessels within the cardiovascular system, contributing to the increased risk of high blood pressure and high cholesterol levels (51). As a result, CVDs are the major cause of morbidity and mortality in people living with diabetes (52,53). Lowering raised blood glucose levels would generally decrease the occurrence of CVD-related complications and increase life expectancy. Diabetes is also a major risk factor for developing chronic kidney disease (CKD). The combination of diabetes, as well as impaired glucose tolerance, with these cardio-renal comorbidities enhances the risk for CV events, CV mortality and all-cause mortality.

Lifestyle modifications targeting weight management, glycaemic control, blood pressure regulation, and lipid profile optimisation could prolong life expectancy by up to three years in patients with type 2 diabetes mellitus (51). Whilst guidelines specifying the importance of not only glucose-lowering drugs but also BP control, statins, and antiplatelet therapy for CVD patients with diabetes have been developed by the ESC (54) and the European Association for the Study of Diabetes (EASD), most high-risk patients do not reach treatment targets in primary care settings (55) and there is significant space for improvement in treatment.

3.4 Tobacco Use

The widespread use of tobacco is one of the biggest challenges for global public health. More than one fifth of the global population used tobacco in 2020 (56), accounting for approximately 700,000 deaths every year in the EU (57). Smoking prevalence varies significantly across Europe with rates

as low as 6% in Sweden and as high as 29% in Bulgaria (58). It is responsible for half of preventable deaths in smokers, with half of these attributed to ASCVD (40). The chemicals released during smoking damage the lining of arteries, increase the risk of blood clots, reduce the oxygen-carrying capacity of red blood cells, and increase both blood pressure and heart rate (59). As a result, the risk of CVD in individuals under 50 who smoke tobacco is five times higher than that in non-smokers (40). People who quit smoking have a significantly lower risk of stroke and myocardial infarction compared to sustained smokers and those who reduced smoking rather than quitting (60). Therefore, increasing the proportion who quit smoking should be the aim for all governments using a combination of tobacco control policies, including a plain packaging policy to reduce the appeal of smoking (57) and excise duties. Smoking restrictions can significantly impact the incidence of acute coronary events with a 15% reduction in emergency admissions for heart attack being recorded in France one year after the implementation of a public ban on smoking (61). Ultimately, smoking cessation is a vital component in the prevention of CVD – both primary and secondary – and public health policies that discourage smoking initiation and support smoking cessation are necessary to reduce the burden of CVD on population health.

4. Benefits of Improving Secondary Prevention

Our research showed that enhancing secondary prevention by increasing the proportion of patients achieving risk factor targets from 43% to 70% in France, Germany, Italy, Spain, Denmark, Poland and the UK could prevent 67,170 fatal CV events (heart attack and stroke) per year (Table 1). This equates to 671,700 avoided events over the next ten years via improved management of hypertension, hyperlipidaemia and diabetes, which contributed to 1.5%, 10% and 59% of the avoided fatal events respectively. Encouraging 70% of patients with CVD who smoke to quit could prevent an additional 27,189 fatal events per year (29% of the avoided fatal events). Roughly half of the 3.7 million deaths in the seven countries in 2019 (33) are thought to be due to ASCVD (62). Therefore, preventing almost 95,000 fatal CV events per year (94,359) represents a 5% improvement per year. Across ten years this could equate to almost a million prevented deaths (943,590).

It is important to note the potential impact of hypertension control versus that seen in work done by, for example, the Global Cardiovascular Risk Consortium study in which hypertension, the leading risk factor for CVD, was identified as having the greatest potential for prevention (63). There are a number of reasons for this variation including differences in study design, the modelling methodology used in this report, and primarily the fact that The Global Cardiovascular Risk Consortium looked at cardiovascular prevention in general, rather than the impact of secondary CVD prevention on which this report is based.

Clinically, the relationship between blood pressure reduction and decreased risk of CVD is established (44,45); the contribution of blood pressure control to survival probability requires further exploration. Our analysis assumes the four risk factors operate independently of each other so we cannot study the dynamics of the relationships between treating one risk factor and the production of (potential) benefits to other risk factors. This mirrors the clinical evidence, for which the interactions between patients (phenotypes) and multiple treatments (combination of therapies) and their precise effects on survival are understood poorly. Further research in real-life conditions could support the demonstration of survival benefits in polymedicated patients with one or more risk factors and factor in the impact of behavioural patterns, such as adherence to lifestyle recommendations and personalised treatment and their persistence over time in different patient subgroups.

Table 1: Number of fatal CV events avoided, per year, due to improving secondary prevention and increasing treatment coverage from 43% to 70%

Total Number of Fatal CV Events Avoided (per year)	Hyperlipidaemia	Hypertension	Diabetes	Tobacco Use	Total Across 4 Risk Factors	Total excl. Tobacco Use
Denmark	174	20	593	425	1212	787
France	1901	215	8551	3917	14,584	10,667
Germany	2955	339	14,845	7194	25,333	18,139
Italy	2036	353	12,334	6421	21,144	14,723
Poland	1158	133	5257	2821	9369	6548
Spain	713	162	6155	2363	9393	7030
UK	717	226	8333	4048	13,324	9276
Total Across all 7 Countries	9654	1448	56,068	27,189	**94,359**	**67,170**
Potential impact across 10 years					**943,590**	
Proportion of avoided events due to risk factor (based on 'Total across all 7 countries')	10%	1.5%	59%	29%	--	--
Total excl. UK (i.e. 6 EU countries)	8937	1222	47,735	23,141	**81,035**	**57,894**

Analysing the impact of increasing the proportion of patients achieving risk factor targets from 43% to 90% allowed us to evaluate the benefit of improving secondary prevention even further. Across the seven countries, a total of 116,921 fatal CV events could be avoided (per year) by improving hyperlipidaemia, hypertension and diabetes treatment. Encouraging even more smokers with CVD to quit could prevent an additional 47,326 fatal CV events per year. Whilst 90% treatment coverage may be outside current treatment targets, it still provides valuable information on the benefits of further improving secondary prevention. Section 5 discusses the policy implications of these findings.

5. Policy Implications

Our analysis has highlighted that tens of thousands of fatal CV events could be prevented across the seven countries by increasing the proportion of patients with pre-existing CVD that achieve risk factor targets. What are the implications of these findings?

The fact that many CVD risk factors – including high blood pressure, high cholesterol, high blood glucose levels and smoking - can be reduced via lifestyle and/or medical interventions means that many cases of CVD are preventable. Whilst treatment is effective, diagnosis delays have a downstream effect on treatment initiation which has an obvious impact on the burden of CVD, both at the individual and population level. In England alone, over 13 million adults have hypertension but 40% are not diagnosed (64). Globally, this figure is slightly higher at 46% (65). We know that it is particularly important to diagnose and treat people with CVD as early as possible to prevent complications – the beneficial impacts of cholesterol lowering treatment, for example, are not fixed but increase steadily with longer durations of treatment (66). Therefore, investment in prevention, and early detection should be a key government focus. The best 'vehicle' for early detection is likely to be cardiovascular health checks, run in a primary care setting. The relationship between CVD and diabetes, including shared risk factors and the propensity to occur simultaneously, means that joint health checks, based on common risk factors for both diseases (for example, obesity, high blood pressure, smoking, high blood cholesterol and high blood glucose) would be an easily implementable and cost-effective method to identify people at risk of developing CVD. People with type 2 diabetes are two- to four-times more likely to develop CVD. Having both diabetes and CVD, particularly at a younger age, has a major impact on prognosis. It is therefore vital to both screen patients for CVD and for diabetes.

There is evidence of inadequate secondary prevention and disease management following diagnosis across Europe. In people with hypertension, optimal treatment in England could prevent 14,000 strokes and almost ten thousand heart attacks over three years, saving a combined £270 million (67). In wider Europe, where post-stroke lifestyle management programmes to manage and reduce risk factors are only available in half of countries (68), policies for the secondary prevention of heart attack and stroke are lacking (69). There are also issues related to 'adherence' which can affect the progression of CVD. Specifically, adherence to medicines to prevent or reduce risk factors like high blood pressure and high cholesterol (14,24), as well as adherence to the clinical guidelines which determine treatment processes and treatment targets (70,71). Improving adherence to the current scientific treatment guidelines would accelerate the delivery of innovative solutions to patients.

Secondary prevention is obviously preferable to tertiary prevention – the action of improving a person's quality of life and reducing the symptoms and the severity of disease – due to the minimal costs involved (72) and the fact that the smaller interventions characteristic of secondary prevention, such as medication and lifestyle changes, cause minimal disruption to a patient's lifestyle. Unfortunately, ineffective post-event rehabilitation can mean that tertiary prevention is the only option. Almost half of coronary events occur in people with existing coronary heart disease (73) and almost a third of strokes are 'repeat events' (74). As time goes on, the risk of subsequent CV events only increases. There is therefore a need to initiate specialised secondary prevention programmes to achieve better long-term outcomes without escalation to tertiary preventive treatment. Specialised secondary prevention programmes are both cost-effective and cost-saving, reducing both mortality and costs associated with recurrent hospitalisation.

5.1 Impact on the Economic Burden

Determining the costs saved, and value gained, due to optimised secondary prevention is out of the scope of this project, but it is obvious that any reduction in the number of fatal cardiovascular events experienced by a country will reduce the burden of CVD and have a considerable, positive, impact on the economy, as well as the financial sustainability of the health system. In 2021, the economic burden of CVDs in the EU was estimated at €282 billion, including health and long-term care costs (€155 billion), productivity losses (€48 billion), and informal care costs (€79 billion) (4). The per capita level costs were in the region of €630, although there is significant variation across countries. Health and social care costs related to CVD represent, on average, 11% of EU-health expenditure and 2% of the EU GDP (4). The overall estimated economic burden of CVD is even more striking if compared to the direct and indirect economic burden of other highly prevalent diseases in Europe. The economic burden of cancer across the EU has been predicted to be around €126 billion, almost half that of CVD (4).

Critically, a large proportion of the economic burden of CVDs in Europe could be directly or indirectly reduced. For example, over and above the obvious health impact, improving the adherence rate of antihypertensive therapy by 70% could save €332 million in direct healthcare costs over a 10-year period in Italy, Germany, Spain, France and England (24). In the US, simulation studies have estimated that a 100% increase in adherence could save $72 billion in healthcare costs over 10 years and prevent 8.5 million events over the same period (75).

Societal interventions aimed at enhancing the prevention of CVD are highly cost-effective for healthcare systems. Investments in interventions targeting stroke, myocardial infarction, diabetes, and other cardiovascular diseases yield, on average, a societal return of $10 for every $1 invested (76). Furthermore, proven secondary prevention models have been shown to reduce cardiovascular mortality by around 58%. They can therefore be exceedingly valuable in saving future health system and societal costs (77).

5.2 Scenario Analysis for the 27 EU Member States

In all likelihood, an even larger impact is to be made from the improvement of secondary prevention across Europe than that identified here. Whilst our data does not allow us to definitively determine the number of avoided fatal CV events as a result of better secondary prevention across the whole of the EU, we can make comment on the potential cross-EU impact based on the potential for 81,035 averted fatal CV events per year with improved secondary prevention of the four risk factors in the six EU study countries of interest here – Denmark, France, Germany, Italy, Poland and Spain. The combined population within these six countries equates to roughly two thirds of the total population of the EU27. If we take a ‘standardised’ approach to scaling up, ignoring briefly the impact of, for example the propensity for reduced risk factor prevalence in countries like Norway and Sweden, or the reduced access to healthcare and CVD related interventions that might be experienced by CVD patients in Eastern European and the Balkan states (1,78), we could predict that 1,215,525 fatal CV events would be avoided over the next ten years across the EU with improved secondary prevention of the four risk factors (hyperlipidaemia, hypertension, diabetes and smoking).

Obviously, there is huge variation within the EU in terms of access to treatment, effective healthcare, rehabilitation following primary CVD events and risk factor prevalence and as such, the predicted number of avoided fatal CV events is not necessarily representative of the realistic impact of improved secondary prevention. Nonetheless, it may be useful to draw attention to the size of the potential impact across the EU. Specifically, it adds weight to calls for a European Cardiovascular Health Plan (79), similar to Europe’s Beating Cancer Plan that was published by the European

Commission in 2022 (80). In the case of cancer, the political push to reduce the impact of the disease has been evident for a number of years, but, despite the morbidity and mortality associated with CVD, the political strategy and leadership required to tackle it lags behind that of oncology - perhaps a representation of the lifestyle-related risk factors being seen as a matter for individual responsibility. CVD is very often perceived as a 'lifestyle' disease, related to modifiable risk factors, for which the individuals themselves are to blame. The issue is much more complex and requires population-level policy interventions and a shift in mindset. Several CV risk factors are also risk factors for certain cancers, and yet perceptions of cancer and cancer treatment are viewed very differently by policy makers.

However, momentum is now building in the EU for the need to address CVD. In December 2021, the European Commission published the "Healthier Together EU Non-Communicable Diseases Initiative", promoting a coordinated approach to the prevention and care of NCDs. It advised EU countries on the implementation of effective policies and actions to reduce disease burden - among other NCDs, CVD was included in the guidance document, with specific recommendations for prevention of the disease and early detection of risk factors (81). Moreover, in 2023, the SANT public health sub-committee of the European Parliament started working on an Own-initiative (INI) Report on NCDs, which triggered a number of Members of the European Parliament (MEPs) to call for the need for a European cardiovascular health strategy (82).

It is becoming clear that the EU needs a comprehensive CVD plan. The formation of the European Alliance for Cardiovascular Health (EACH), comprised of 17 organisations in the European CVD space (83), has been instrumental in elevating this need and coordinated advocacy efforts have also led to CVD now being included in the programme of the current Presidency of the Council of the European Union trio (Spain-Belgium-Hungary) for the first time in the 30-year history of the EU (84). However, as implementation will happen at the national level, national plans need to be launched across the Member States to ensure equitable access to high levels of prevention and care across the region. Spain and Poland have already introduced a comprehensive cardiovascular health strategy (85,86), while the Czech Republic (87), Bulgaria, Estonia, Croatia, Latvia and Romania are currently working on their own. Plans would include specific treatment goals as well as the reduction of mortality targets, the establishment of targeted screening policies and the promotion of innovative access schemes to ensure access to effective medicines (88). Aligning goals and key performance indicators for each national plan across the region would be vital in order to ensure health equity across the 27 Member States. Country governments should be encouraged by the analysis included here. The reductions in the number of fatal CV events that could be seen by improving secondary prevention give an indication of the power of national CVD plans. Whilst prevalence figures used in this analysis are entirely unique to the countries studied here, it is likely that similar levels of improvement will be seen in countries across the EU, despite variations in risk factor prevalence figures.

6. Recommendations to Improve Secondary Prevention

In order to realise the reduction in fatal events identified within this report, secondary prevention must be optimised as much as possible across the European region. The WHO recommends that effective reduction in mortality related to CVD must be based on 1). Surveillance, i.e., mapping and monitoring the epidemic of CVDs effectively; 2). Prevention, i.e., reducing exposure to risk factors as much as possible; and 3). Management, i.e., equitable health care for patients with CVD (89). Aligning with this, we make a number of recommendations for both individual EU Member States and the wider EU region to pursue for the optimisation of secondary CVD prevention, although many are also relevant for the primary prevention of CVD.

Before considering these recommendations, it is first worth noting that, alongside the specific points below, all EU Member State governments need to ensure that, as the burden of NCDs increases due to the epidemiological transition process, their healthcare systems have a shift in mindset from a reactive system, focused on acute care, to a proactive system focused on prevention.

1. Joint diabetes and heart health checks

Combined, diabetes and CVD cost in the region of €386 billion per year (4,90). The two conditions are intrinsically linked, sharing multiple risk factors. Furthermore, people with diabetes are up to three times more likely to have CVD than people without (91). There is consensus among the CVD and diabetes communities that the development of inexpensive targeted joint cardiovascular and diabetes health checks, performed in a primary care setting, would be a cost-effective way to improve early diagnosis of both diseases (48) and should be a target for all EU Member States. An effective health check would measure the main causal and modifiable risk factors for both conditions – LDL-C, blood pressure, smoking status, BMI and glycated haemoglobin (HbA1c) level. It would also involve effective linkage and data sharing with secondary care settings to prevent the development of health silos which could limit continuity of care. Some countries have health checks in place already. For example, the NHS Health Check in the UK, set up in 2009 targets people aged between 40 and 74 years old without pre-existing conditions. It utilises simple measurements of blood pressure, weight/body mass index (BMI) and cholesterol to calculate total and lifetime CVD risk. It is performed in the primary care setting by a general practitioner (GP), nurse or healthcare assistant, in community pharmacies or even in workplace settings to ensure access is as streamlined as possible (92). There is a requirement to standardise this offering across the EU to ensure early diagnosis and intervention throughout the region.

Key action point: Ensure health checks include calculations on total and lifetime CVD risk to allow people to increase familiarity with both CVD risk and their personal blood pressure and cholesterol levels.

2. Development of a European Cardiovascular Health Plan

In 2022, EACH published a ground-breaking blueprint for EU action on CVD (93), having seen the precedent set by the European Beating Cancer Plan and the benefits of the singular, highly efficient approach at the heart of the plan. The proposed plan focuses on five pillars of action – 1) primary prevention; 2) secondary prevention; 3) early intervention and treatment; 4) rehabilitation and 5)

improved quality of life for survivors with the aim of reducing premature and preventable CVD-related deaths in Europe by one third by 2030 (93). The political push to make this plan a reality is now required across the EU, something that has been missing to date for CVD, despite the associated morbidity, mortality and financial impact at the heart of CVD effects across the region (4). Robust action by policy makers at the EU level has the potential to significantly reduce fundamental health inequalities and address societal barriers that exist due to fragile health systems across Europe. Specific components recommended for the EU CVH plan are outlined in Table 2. These incorporate steps required to both *improve clinical outcomes* and *improve the quality of care* in secondary prevention.

3. All 27 Member States to develop, implement and fund national CVH plans

As most of the EU Member States do not have a dedicated CVH plan, or have outdated CVH strategies, there are significant inequalities in national prevention policies throughout the EU (94). This impacts access to CVD related healthcare across the EU and leads to inequalities seen in prevention and treatment (95). A key component of any European plan to tackle CVD is the development of comprehensive national plans for CVD with a focus on secondary prevention. Without this, any EU-wide plan for action on CVD will be unsuccessful. National goals should be co-created to ensure standardisation whilst reflecting national context and culture to allow for the nuances that individual country's populations, health systems and economies will require. Plans must incorporate the development of tools and dashboards to help healthcare workers and patients visualise risks to cardiovascular health and benefits related to risk factor reduction.

Furthermore, each country should have plans in place to detect people at risk of developing CVD as well as those at elevated risk of progressing to severe cardiac events. Any plan must complement those already existing in the country related to, for example, stroke, diabetes and oncology, due to the interconnected relationship between NCDs. Improving European data collection possibilities for CVD (see recommendation 5) will allow Member States to more accurately quantify the potential benefits of improved national plans. Specific components recommended for national CVH plans are outlined in Table 2. These incorporate steps required to both *improve clinical outcomes* and *improve the quality of care* in secondary prevention.

Table 2: Key components recommended for European and national cardiovascular health plans to improve secondary prevention

Expected outcome	Recommended Component	Relevant for EU CVH plan	Relevant for National CVH plans
Improving clinical outcomes in secondary prevention	Train healthcare practitioners to support patients reaching target BP, LDL-C and HbA1c levels for hypertension, hyperlipidaemia, diabetes as per medical guidelines		✓
	Implement treatment protocols, tailored to specific patient groups, as per medical guidelines	✓	✓
	Implement biomarker follow-up/appropriate lab tests as per medical guidelines	✓	✓

	Implement harmonized medication adherence metrics across EU to close the gap between efficacy in clinical trials and real-life effectiveness in CVD management	✓	✓
Improving quality of care in secondary prevention	Improve coordination between GP and specialists through multidisciplinary decision-making and patient referral to outpatient care in specialized CV care centers		✓
	Improve transition from hospital to outpatient care via implementation of discharge protocols, referent physician/nurse/pharmacist follow-up and patient education		✓
	Develop EU Quality and Outcomes Frameworks	✓	✓
	Define key performance indicators and incentives for healthcare practitioners to implement and monitor achievement of target clinical outcomes for BP, LDL-C and HbA1c as per medical guidelines	✓	✓
	Set up dedicated funding programs for CV Health	✓	✓

4. Ensure equitable access to prevention across the EU

Whilst evidence shows reductions in inequalities across Europe over the last decade (96), there are still instances of disparities in care and outcomes. For example, there are discrepancies between Eastern and Western Europe in terms of CVD burden (2), with Eastern Europe facing higher negative consequences than richer countries in the west. The impact of changing political regimes, leading to health reform, and socially patterned increased levels of alcohol consumption may play a role here, Similarly, the war in Ukraine is likely to impact BP and lipid control, due to supply chain issues and problems accessing medical help, affecting CVD burden (97).

There are also 'within-country' disparities related to CVD outcomes. For example, in the UK, premature death rates from CVD in the most deprived 10% of the population are almost twice as high as rates in the least deprived 10% (92). Education also has an impact on disease burden - people with the lowest levels of education are more than twice as likely to have diabetes than people with the highest level of education across EU countries (81).

There is significant evidence of gaps and inequalities in the secondary prevention of CVD (17,18). Perhaps because, as mentioned previously, country health systems may still be focusing on managing acute symptoms, rather than prioritising the initiation of secondary prevention. Specifically, in Spain, death rates for cardiac events are doubled in regions missing specialist treatment units (98) and, across the EU, less than a third of stroke patients have treatment in a specialist stroke unit (99) due to countries like France and Spain not meeting the recommended target of three stroke units per one million inhabitants (100).

Whilst access to cost-effective antihypertensives and LLT is not likely to be a problem across the EU, variations in clinical approach may limit the effectiveness with which blood pressure and lipid levels are reduced. The majority of LLT used in Europe is statin-based monotherapy with only 10% being combination therapy (13). All countries should be following harmonised treatment guidelines and ensuring that as many patients as possible reach targets for blood pressure, cholesterol and

glucose levels. The EU should set targets for each Member State to follow related to, for example, the target number of specialist stroke and cardiac care centres per 100,000 population to ensure that everyone who needs it has access to high-quality, specialist care and that they can receive the secondary prevention medication needed to reduce the impact of hypertension, hyperlipidaemia and diabetes.

Many of the other recommendations suggested here will work towards reducing inequalities across the region; for example, national CVH plans (recommendation 3) will help countries and regions overcome inequalities. Similarly, harmonised data collection across the EU (recommendation 5) will allow continuous monitoring and the evaluation of progress in individual countries, as well as allowing countries to identify and effectively address inequalities.

Key action point: Improve referral pathways for patients in prevention programmes and ensure that cost-effectiveness is considered in all settings so that the economic benefits of improved prevention can be recognised.

5. Enhance EU-wide data collection

There is space for enhanced data collection amongst the CVD population to counteract current holes and fragmentation in existing data availability. A lack of comprehensive data and publicly funded registries impedes government understanding of gaps and opportunities in both secondary prevention of CVD but also primary prevention, and the impact of enhanced post-acute CVD event rehabilitation (69). Streamlined, standardised and consistent data collection across the EU, including information on, for example, the prevalence of CVD risk factors amongst the CVD population would allow for more accurate estimations of the power of optimised secondary prevention at the population level and enhanced determination of cost-benefits. Whilst this ties in with European ambitions to create a shared health space to allow direct comparison between centers and countries, there is a requirement to intensify and catalyse the incorporation of CVD based data. Some progress in this area has been made, for example the EuroHeart registry which offers a common IT and dataset infrastructure (101). The project is still in the consolidation phase but it aims to expand the EuroHeart network to at least fifteen countries (102).

Key action point: Collect standardised national and harmonized cross-EU data over time to audit the implementation of CVD prevention guidelines, to change behaviour and to set priorities.

6. Design the right healthcare system incentives in primary care to achieve effective CVD management

There is evidence that patients with hyperlipidaemia, hypertension and diabetes are not meeting medical society treatment guideline goals (2,13,55) which has obvious implications on the development of CVD and the risk of recurrent CV events. Healthcare service incentives are critical for altering clinical practice and ensuring that as many patients as possible are reaching treatment targets for the CVD risk factors. Investing in quality of care through the development of key performance indicators (KPIs) and quality metrics for CVD plus pay-for-performance (P4P) schemes in primary care are critical system enablers for behavioural change in both physicians and patients. The development and utilisation of effective referral pathways could also be encouraged via incentivisation. Building effective partnerships between GPs and CVD specialists would help ensure that those who have previously had a CV event are not ‘lost to follow-up’.

Existing examples of P4P schemes include the Quality and Outcomes Framework (QOF), introduced in England in 2004 as a voluntary annual reward and incentive program. The scheme remunerates GP practices for the achievement of predetermined targets across 76 indicators, including blood pressure measurement, treatment with statins and cardiovascular disease risk assessment (103). Research on the impact of QOF has shown that hospital admission and death rates due to chronic heart disease are lower in GP practices which better meet evidence-based quality targets related to CVD and risk factor management (104), although evidence has been mixed (105). What is important is that the development of any new financial incentive will require careful calibration. Incentives must align with pre-existing professional values and must be challenging whilst also attainable. Similarly, any payment must be substantial enough to encourage high quality care without affecting clinical practice.

Key action point: Develop key performance indicators and incentives that align with professional values in individual countries and are challenging but also attainable.

7. Encourage provision of effective rehabilitation programmes

One of the most crucial parts of post-event (heart attack, stroke or heart failure) management is rehabilitation. Effective rehabilitation programmes prevent recurrence and improve recovery, capacity and survivor well-being. In fact, proven vascular risk management and rehabilitation models have been shown to reduce heart attacks by almost a third, strokes by almost two-thirds (20) and hospitalisation by up to 30% (106).

Access to rehabilitation programmes varies significantly across Europe, alongside variations of what constitutes a rehabilitation program (99) and less than 50% of cardiac patients are referred to rehabilitation programmes (18,107). The 'ideal' programme includes counselling, lifestyle management (smoking cessation, healthy diet, increasing physical activity, weight management), medical treatment and psychological support alongside occupational, physical, speech and language therapy (93), but more often than not, rehabilitation programmes do not encompass these components (99).

Reduced access to effective rehabilitation programmes has resulting implications on cost – the cost of healthcare following a heart attack or stroke is high and often grows with repeated events (69) – and the burden of CVD (99). There is now a need to incorporate dedicated, effective CVD rehabilitation programmes in national CVD plans. These do not necessarily need to involve physician participation but could be run by specialist nurses and allied professionals. At the EU level, a consistent definition of what constitutes an effective cardiac and stroke rehabilitation programme will enable Member States to work towards the development of efficient rehabilitation services for their CVD populations, which will reduce the further burden and additional cost associated with repeated CVD events.

Key action point: Ensure that rehabilitation programmes include all aspects of lifestyle and medial risk factor management and that they can be run by specialist nurses and other allied professionals without the need for physician involvement.

8. Build health literacy programs to increase adherence

Health literacy, the knowledge and competence to access, understand, appraise, and apply health information for health judgment, is an important aspect of the social determinants of health. It has proven links with health outcomes as well as resource utilisation (108) and there is evidence of limited health literacy related to CVD (109). For instance, in a survey of 12,000 European adults over

the age of 25, only just over half believed that cholesterol affected heart health. A quarter also incorrectly believed that cholesterol level was only problematic when there were signs or symptoms of high LDL-C levels (36). Low levels of health literacy have also been found to be a risk factor for carotid artery plaques, suggesting an inverse relationship between health literacy and CVD risk (110). In addition, reduced health literacy can play a role in reduced adherence to medication, which has a knock-on effect on the effectiveness of medication (111). In the CVD context, this has an impact on risk factor management and the prevalence of CVD events like heart attacks and strokes.

Building effective health promotion and quantifiable preventive strategies to address individual behaviours and to ensure individuals have the power and knowledge required to facilitate healthier life choices could reduce the prevalence of CVD risk factors and CVD. In fact, health promotion strategies can reduce the prevalence of NCDs by as much as 70% (81). National campaigns, backed by scientific societies and developed by national advocacy groups could be used to increase the conversation around CVD risk factors and the importance of prevention and early diagnosis. In the UK, the 'Know your Numbers' campaign, initiated by Blood Pressure UK in 2000 (112), serves as a useful example.

Amplifying the messaging around CVD and related risk factors and improving health literacy would allow citizens to benefit from better 'self-care', would encourage increased adherence to medication and reduce the prevalence of CVD risk factors.

Key action point: Raising public awareness of this silent disease and ensuring health promotion strategies incorporate information on the benefits of improved cardiovascular health and reduced risk factors such as enhanced vigour and a longer life expectancy.

6.1 Conclusions

The prevention of fatal CV events has obvious benefits for patients, country health systems, country economies and the EU economy as a whole. To realise the potential improvements outlined in this report, targeted action is proposed at both the EU and Member State level. At the EU level there is a requirement to drive the development of a European Cardiovascular Health Plan and enhanced EU-wide data collection. At the Member State level, there is a need to ensure that all 27 Member States consider diabetes and heart health a political priority and co-design, within the full ecosystem of stakeholders, well-funded national CV Health plans. These plans need to be supported by dedicated investments, KPIs and financial incentive schemes which will lead to equitable access to primary and secondary CVD prevention and innovative treatments across the EU and within countries. There must also be focus on building health literacy levels amongst populations with healthcare access challenges and standardising access to effective post-CV event rehabilitation programmes.

European policy makers, together with industry players, the medical professional societies and the patient CVD community must enter into public private partnerships to pull knowledge and resources to drive impact at the local and EU level in order to create a generational decline in CVD. Future studies on the benefits of secondary CVD prevention should build on this research with new data and modelling, broadened to include additional cardiometabolic risk factors like obesity and alcohol consumption.

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Annex I. Country Background

Six EU Member States, including Denmark, France, Germany, Italy, Poland and Spain, plus the United Kingdom were included in the study. Countries were chosen to ensure a cross-section of Europe as well as the existence of relevant data. We outline below the impact of CVD in the seven countries of interest.

Denmark

CVDs are the second leading cause of death in Denmark responsible for a quarter of all deaths, only slightly lower than that of cancer which causes just under a third of deaths. CVD-related healthcare costs are estimated to be €2.0 billion, of which indirect healthcare costs (informal care, productivity losses due to morbidity and mortality) represent the main component at 54% (4,57,113). The burden of CVD has not markedly decreased over the last 30 years – the prevalence of people with CVD per 100,000 population fell from 11,578 in 1990 to 10,670 in 2019. However, mortality significantly decreased over the same period of time – in 1990, 522 deaths per 100,000 people were related to CVD, while in 2019 this figure stood at 264 deaths per 100,000 people. Hypertension plays a major role as a risk factor – one fifth of the population suffers from hypertension. Diabetes affects just under ten per cent of the population whilst 17% of adults are reported to be smokers.

Various prevention programs have been implemented to tackle the associated risk factors in Denmark: dedicated prevention programs related to obesity reduction, physical activity, and tobacco and alcohol consumption have been introduced and a national target has been set for tobacco use. A plan to reduce CVD burden is included in the national prevention plan, which is reported to be utilized as a guideline in at least 50% of health facilities. Furthermore, CVD multidisciplinary care teams are implemented in the Danish health system as part of CVD care and management practices (114).

France

As in Denmark, CVD is the second most common cause of death in France. CVD prevalence is approximately 10.9%, with around 630,635 new cases of CVD emerging annually. The economic cost associated with CVD is substantial, burdening the French healthcare system with €24.30 billion (4). The prevalence of hypertension is 22% whilst a similar proportion is considered obese[9]. Almost five per cent have diabetes and a quarter of adults smoke daily. Mean total cholesterol levels have been declining since 1990 reaching 5.034 mmol/L in men and 5.112 mmol/L in women in 2018 (115).

France has recognised the significance of CVD as a public health concern, which is reflected by government efforts to combat it. More specifically, CVD is part of the national health strategy, in addition to a dedicated programme introduced in 2019 (115). The objective of this programme is to produce indicators for monitoring cardiovascular pathologies and strokes, and to record their evolution (116). In addition, a number of prevention programmes have been introduced to tackle tobacco consumption, alcohol consumption and obesity, and to provide recommendations concerning physical activity (115).

[9] Age-standardised; BMI ≥ 30

Germany

CVD is the leading cause of death in the country, followed by cancer and respiratory diseases. The prevalence stands at 12.8%, with more than one million new cases of CVD emerging annually. The financial impact of CVD in the healthcare system is €44 billion, with total costs to the economy, including informal care and productivity losses, reaching €83 billion (4). One in five Germans has hypertension, one in ten has diabetes, one in five is obese and a similar proportion smoke. As in other countries, data covering the period 1990 to 2018 show that mean total cholesterol levels have been decreasing over time in both genders. Mean total cholesterol was 4.816 mmol/L in men and 4.991 mmol/L in women in 2018 (117).

To combat the impact of CVD on public health, the government has included CVD as part of the national action plan to prevent non-communicable diseases. However, this does not include targets set within a particular timeframe (117,118). A national CVD strategy for secondary prevention is currently in development (117,119). Lastly, prevention programmes targeting associated risk factors have been introduced. Such programmes are related to tobacco use, alcohol consumption, obesity reduction and physical activity, with a national target also set for sodium intake (117).

Italy

CVDs are the main cause of death (36%) both for males and females in Italy. CVD prevalence is estimated at 16.5%, with an annual CVD incidence of 0.30% out of all causes. The financial impact of CVD in the healthcare system is €23 billion, with total costs to the economy, including informal care and productivity losses, reaching €38 billion (4).

Risk factor prevalence values are similar to other European countries. A fifth of the population has hypertension, 19.9% are obese and 5% are diabetic. The majority of the population does not get sufficient physical activity (57%). Furthermore, 20% of adults are smokers, with a slightly higher prevalence across teenagers (22%). Average consumption of alcohol stands at 7.9L per capita per year. Only 73% of patients reach LDL-C goals when receiving lipid-lowering treatments for primary or secondary prevention (120,121).

Despite not having developed a dedicated plan to address CVD burden (122), the Italian government included in its National Prevention Plan a program to reduce the burden of the disease and defined a set of national targets related to physical activity, air pollution, alcohol and tobacco consumption (94).

Poland

CVDs represent the most common cause of death in Poland – 48% of deaths are caused by CVD. Consequently, the estimated healthcare cost of CVD is high at €6.1billion (4). CVD burden over time represents an increasingly relevant challenge for Poland. In 1990, there was a CVD rate of 7,942 cases per 100,000 population, while in 2019 there were 11,027 people with CVD per 100,000 population. Despite the increased prevalence of CVD, mortality over time decreased, falling from 514 deaths per 100,000 population in 1990 to 455 deaths in 2019 (121,123).

Risk factor prevalence values are higher than those in Italy, France, Denmark and Germany. Hypertension affects 28% of the population whilst just under 30% are physically inactive and just under a quarter of the population are obese. A similar proportion smoke while just over 5% has diabetes. As in other countries, total cholesterol levels over time have fallen slightly. In 1990, men reported a mean total cholesterol level of 5.293 mmol/L, while women reported 5.338 mmol/L in the same year. In 2018, men and women respectively reported a mean total cholesterol level of 4.969 mmol/L and 4.856 mmol/L (120).

Poland has recently introduced a comprehensive cardiovascular health strategy. The National Program for Cardiovascular Diseases is a multi-year program for 2022-2032 which introduces comprehensive changes focused on reduce morbidity and mortality due to CVD (86).

Spain

CVD is the most common cause of death in the overall population, followed by cancer and respiratory diseases. The prevalence of CVD in the country was estimated at 10.4% in 2019, while there were 457,183 new CVD cases in the same year. CVD costs the Spanish economy €23.96 billion, with 56% being attributable to health and social care costs (4). One-fifth of the population has hypertension, 6.9% have diabetes, 23.8% are obese, and 22% of adults smoke. CVD is part of the national prevention plan, while the government recently published the Cardiovascular Health Strategy, a dedicated programme that sets specific goals to improve the CVD health of the Spanish population (85). However, there is lack of specific time-bound targets within this plan (124). In addition, dedicated prevention programmes have been introduced, focusing on tobacco, alcohol and obesity prevention, as well as the promotion of physical activity.

United Kingdom

CVD is the second most common cause of death in the country, causing a quarter of all deaths per year. CVD prevalence is estimated at 10.3%, while the incidence of CVD was 642,508 in 2019. The economic burden of CVD in the UK is substantial, estimated at €26.67 billion in 2015. Direct healthcare costs accounted for 46.3% of the total healthcare costs in the same year (125).

In England, 1 in 4 adults has high blood pressure, of whom half are not diagnosed or not on treatment (126) and approximately half of the adult population in England has cholesterol levels above recommended guidelines (126). A large proportion of the population is considered obese (27.8%) whilst 3.9% are diabetic and 17% of adults are smokers. The UK government is making efforts to address CVD prevalence and reduce its burden by including it in the national prevention plan and setting specific time-bound CVD targets within this plan (116). Moreover, prevention programmes have been implemented, focusing on risk factors such as tobacco and alcohol use, obesity, and inadequate physical activity. Indeed, national targets have been set for physical inactivity, sodium intake, tobacco use, and obesity. Lastly, a guideline for the diagnosis and management of hypertension has been published by the National Institute for Health and Care Excellence (NICE) (125).