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Strategic Plan for Cardiovascular Health in Portugal – Portuguese Society of Cardiology (PESCP-SPC)

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PII: S0870-2551(24)00329-9

DOI: https://doi.org/doi:10.1016/j.repc.2024.11.006

Reference: REPC 2393

To appear in: *Revista Portuguesa de Cardiologia*

Received Date: 13 November 2024

Accepted Date: 19 November 2024

Please cite this article as: Cabral S, Gavina C, Almeida M, Sousa A, Rita Francisco A, Infante Oliveira E, Domingues K, Moura Branco L, Monteiro S, Alegria S, Baptista R, Pereira H, Strategic Plan for Cardiovascular Health in Portugal – Portuguese Society of Cardiology (PESCP-SPC), *Revista Portuguesa de Cardiologia* (2024), doi: https://doi.org/10.1016/j.repc.2024.11.006

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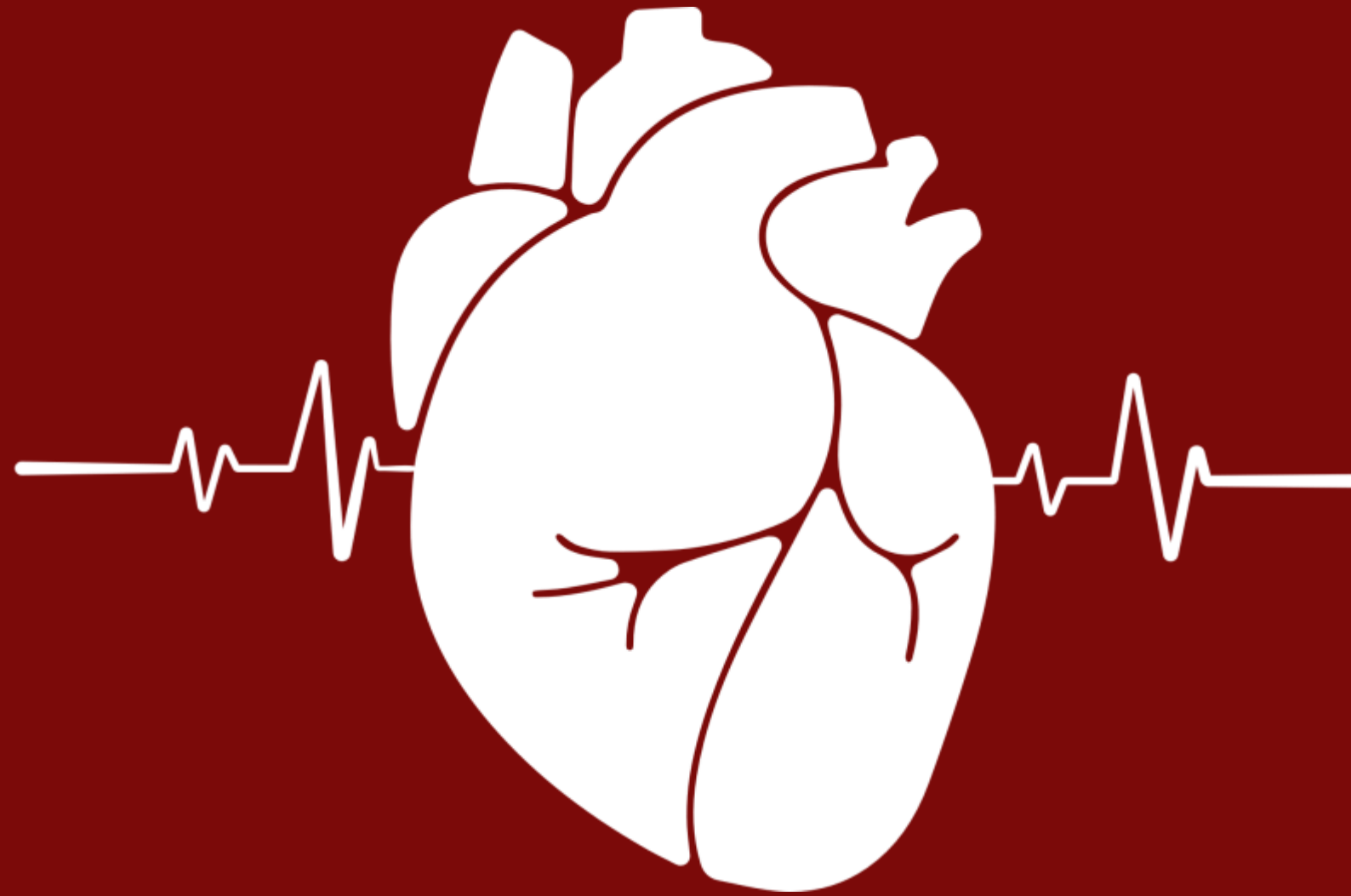
Sociedade Portuguesa de CARDIOLOGIA

Strategic Plan for Cardiovascular Health in Portugal – Portuguese Society of Cardiology (PESCP - SPC)

2024

Coordination: Portuguese Society of Cardiology Board



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Strategic Plan for Cardiovascular Health in Portugal − Portuguese Society of Cardiology (PESCP-SPC)

Plano Estratégico para a Saúde Cardiovascular em Portugal – Sociedade Portuguesa de Cardiologia (PESC-SPC)

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Resumo

O **Plano Estratégico para a Saúde Cardiovascular em Portugal** é um projeto da Sociedade Portuguesa de Cardiologia alinhado com o movimento propulsionado pela Sociedade Europeia de Cardiologia e pela *World Heart Federation* para a elaboração de planos nacionais, à escala e no contexto cultural e socio-económico locais, focados na abordagem da saúde cardiovascular. O objetivo alargado é impulsionar e contribuir para a melhoria contínua e sustentada da saúde cardiovascular da população portuguesa. A metodologia envolvida passou pela identificação dos principais desafios e oportunidades a enfrentar no médio prazo, nomear e destacar áreas de intervenção prioritária e propor linhas estratégicas de intervenção. Este artigo define a conceptualização do projeto e traça as linhas

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orientadoras para as propostas de atuação a ser elaboradas por grupos designados de peritos e que serão objeto de divulgação subsequente.

PALAVRAS-CHAVE:

Saúde Cardiovascular | Sociedade Portuguesa de Cardiologia | Plano Estratégico

Abstract

The **Strategic Plan for Cardiovascular Health in Portugal** is an initiative of the Portuguese Society of Cardiology, aligned with efforts by the European Society of Cardiology and the World Heart Federation to develop national plans, at a local level within the cultural and socio-economic contexts, focused on cardiovascular health. The overarching goal is to promote and ensure the continuous and sustained improvement of cardiovascular health in the Portuguese population.

The methodology identified key challenges and opportunities for the medium term, highlighted priority areas for intervention, and proposed strategic lines of action. This article outlines the project's design and establishes a guiding framework for the proposed actions, which will be drawn up by designated expert groups and communicated subsequently.

Keywords: Cardiovascular Health | Portuguese Society of Cardiology | Strategic Plan

Journal Pre-proof

Journal Pre-proof

Table of contents

Journal Pre-proof

Journal Pre-proof

List of Tables

List of Figures

List of Abbreviations and Acronyms

AI	Artificial intelligence
AF	Atrial fibrillation
APAPE	Portuguese Association of Arrhythmology, Pacing, and Electrophysiology.
BMI	Body mass index
CHD	Coronary artery disease
CNCDC	National Center for Cardiological Data Collection
CT	Computed tomography

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CVD	Cardiovascular disease
CHF	Chronic heart failure
DGS	General Directorate of Health
EACH	European Alliance for Cardiovascular Health
EHN	European Heart Network
EMA	European Medicines Agency
EU	European Union
ESC	European Society of Cardiology
GDP	Gross domestic product
GDPR	General Data Protection Regulation
HF	Heart failure
MCDT	Complementary diagnostic and therapeutic tests
NCD	Non-communicable diseases
NIS	National Institute of Statistics
NHS	National Health Service
P-EAM	Post-acute myocardial infarction
PESCP	Strategic Plan for Cardiovascular Health in Portugal
SPC	Portuguese Society of Cardiology
SCD	Sudden cardiac death
SPMS	Shared Services of the Ministry of Health
TAVI	Transcatheter aortic valve implantation
TMRG	Guaranteed maximum response times
WHO	World Health Organization

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Preamble

The Portuguese Society of Cardiology (SPC), leveraging its extensive expertise and technical-scientific knowledge, proposes the creation of a strategic plan for cardiovascular diseases (CVDs) in Portugal. This initiative reflects the SPCs commitment to improving cardiovascular health in the country. Achieving this goal requires a coordinated strategy grounded in a multidisciplinary, multidimensional, and integrated approach, where all stakeholders join forces in a cohesive effort.

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The goal is to ensure that the health system's pathway remains person-centered, adopting a holistic rather than segmented approach. This strategy aims to ensure disease prevention, provide universal access to the highest quality cardiovascular care, uphold principles of inclusion and equity, and facilitate access to appropriate rehabilitation to mitigate complications once the disease has occurred.

This document outlines the SPC's vision, identifying priority areas for short- and medium-term interventions from a practical perspective, in alignment with its European partners.

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1. INTRODUCTION

Cardiovascular diseases (CVDs) encompass a diverse range of conditions that affect the heart, brain vessels, and peripheral vessels. These diseases impact individuals across all age groups and stem from a combination of genetic, infectious, behavioral, environmental, and social factors. Many of these diseases are preventable through the promotion of healthy lifestyles and early medical intervention. As the leading cause of preventable death in Portugal, CVDs are a concern for everyone, irrespective of age.

While CVDs are not exclusive to older adults, it is well established that both their risk and prevalence increase with age. In older age groups, these diseases often come with a significant burden of comorbidities and increased complexity, requiring various levels of care that typically involve transdisciplinary and multidisciplinary approaches. This reality, combined with the demographic changes in Portugal's population, is placing mounting pressure on the healthcare system and economy – a trend anticipated to escalate in the coming decades.[1,2] In 2016, it is noteworthy that the costs related to atherosclerotic CVD were estimated to account for 1% of the gross domestic product (GDP) and 11% of overall health spending.[3]

Over the past 30 years, global age-adjusted cardiovascular mortality and premature mortality (occurring before age 70) have declined significantly, by approximately 31% and 50%, respectively, since 1990. This progress stems from technological and scientific advancements, the implementation of primary prevention strategies, and improved access to medical care in both acute and chronic settings. Despite this, CVDs remain the leading cause of global mortality, with an uneven distribution linked to the income level from each geographic region. In Portugal, this pattern aligns with the broader European trend, with CVDs responsible for about 50% of premature deaths from non-communicable diseases (NCDs).[4,5]

In 2013, the World Health Organization established a goal to achieve a 25% reduction in mortality from NCDs by 2025. This target was further reinforced in 2015 by the United Nations through the 2030 Agenda for Sustainable Development, which aims for a 30% reduction in NCD mortality by 2030.[6–8] The European Commission, through the Healthier Together – EU Non-Communicable Diseases Initiative, has also identified CVDs as a priority. This initiative provides Member States with a platform that includes legal and funding tools essential for a successful approach.[9] At the end of 2023, the Report on Non-Communicable Diseases and the European Parliament's Resolution Proposal encouraged Member States to develop, implement, and monitor national plans and strategies regarding NCDs, particularly for those that are most common and have the highest mortality and morbidity rates, including CVDs.[10]

In Portugal, the National Health Plan 2030 establishes as one of its objectives for the decade: "To work toward the elimination of all preventable and premature deaths, particularly those related to cancer and brain-cardiovascular diseases", considering the latter as a problem of "high magnitude and one of the health needs".[11] Unfortunately, the slowdown in the reduction of cardiovascular mortality will make it difficult, or even impossible, to achieve these goals in Portugal, highlighting the importance of a

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continuous and dedicated effort in this area. This should encompass research, technical-scientific investment, health literacy, as well as the organization, allocation of resources, and funding of healthcare services.[8]

In parallel with other diseases, such as cancer, European-wide movements and supra- and multinational initiatives have emerged. They highlight that CVDs are currently the greatest health challenge in Europe. These initiatives call for the development of structured plans focused on addressing CVDs from a broader geographical perspective at the continental scale. In 2007, the European Heart Network and the European Society of Cardiology (ESC) were pioneers in launching the European Heart Health Charter, which was revised in 2023.[12] The European Alliance for Cardiovascular Health, a consortium comprising 15 European organizations and two global organizations, proposed a comprehensive plan at the European level in 2022. This plan emphasizes the importance and necessity of developing national strategies tailored to local realities and cultural contexts.[13]

Some countries have already implemented their national plans, including Spain, Poland, the Czech Republic, Croatia, Germany, and Romania. The SPC, an institutional member and founder of the ESC, believes it would be beneficial for Portugal to develop and implement a **Strategic Plan for Cardiovascular Health** that is harmonized and aligned with other European initiatives. This plan should run in parallel with the Priority Health Programs of the Directorate-General for Health (DGS), which have already been established nationally, without detracting from them.

2. PURPOSE

This Strategic Plan for Cardiovascular Health in Portugal aims to drive the continuous and sustained improvement of cardiovascular health among the Portuguese population. To achieve this mission, the SPC has established a broad scope, medium-term plan with the following phases:

1. Diagnosis of the national epidemiological reality and recognition of needs;
2. Identification of priority intervention areas;
3. Listing of the necessary and appropriate measures to achieve the goals;
4. Developing the plan for implementing the identified measures.

To be implemented, the plan must adhere to the following guiding principles: rational and efficient distribution of human, organizational, economic and financial, and technical resources, resulting in gains in efficiency, equity, access, and resilience of the cardiovascular care health system.

Motto: For a better heart, for everyone.

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Value Framework

a) Commitment to ethical principles and best practices;

b) Responsibility;

c) Integrity;

d) Comprehensive and integrated vision of the different dimensions of cardiovascular health, grounded in scientific evidence and the principles of humanism;

e) Constant dedication to adding value in health, with a forward-thinking, innovative perspective and a creative approach to solutions;

f) Multidisciplinarity as a paradigm of action;

g) Prioritization of the patient's centrality in the decision-making process and improvement of quality in the provision of health care;

h) Equity in access to timely health care.

3. Characterization of Cardiovascular Health in Portugal

Epidemiological Characterization of Cardiovascular Disease

Cardiovascular health in Portugal is a crucial area for study and intervention due to its significant impact on the population's morbidity and mortality. CVDs remain one of the leading causes of death both nationally and across Europe, contributing significantly to premature mortality. In 2020, diseases of the circulatory system accounted for 27.4% of all deaths in Portugal, a percentage lower than the European Union (EU) average, which is a positive sign. However, there has been a slowdown in the reduction of this mortality rate over the past two decades (see Figure 1).[14,15]

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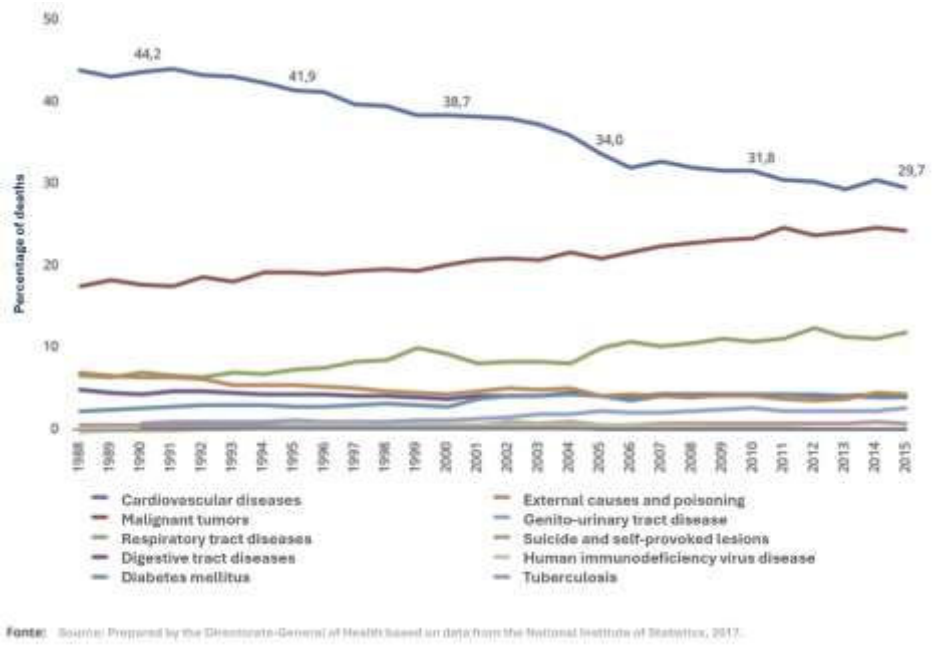

Fonte: Source: Prepared by the Directorate-General of Health based on data from the National Institute of Statistics, 2017.

Figure 1. Evolution of the proportion of deaths from the main causes of death out of the total causes of death in Portugal (%), from 1988 to 2015 (Source: DGS based on data from NIS, 2017).

In 2021 and 2022, CVDs accounted for 25.9% and 26.6% of total deaths, respectively, surpassing other areas such as oncological diseases (22.1% and 22.4% in the same years). Within the group of diseases of the circulatory system, cerebrovascular diseases and ischemic heart disease were particularly prominent.[16] In comparative terms, the mortality rate from preventable causes in Portugal in 2020 was 19% lower than the EU average, while the mortality rate from treatable causes was 14% lower.[14]

Ischemic heart disease was one of the leading causes of preventable and treatable deaths, accounting for a higher number of fatalities compared to cerebrovascular disease among individuals under 55 years of age. In Portugal, premature mortality from cardiovascular causes is higher in men, while in women, cardiovascular mortality reaches higher rates starting at age 75. This pattern is consistent with trends observed in the EU, with age-standardized cardiovascular mortality—both overall and premature—lower in Portugal than in its European counterparts. [17–21]

These data suggest that, although notable progress has been made, there remains a significant risk of premature CVD in Portugal. Therefore, it is imperative to adopt a balanced approach in prevention and treatment strategies that address the needs of both sexes to ensure continued positive outcomes at the national level and in comparison with similar countries.

Among CVDs, coronary artery disease (CAD), heart failure (HF), sudden cardiac death (SCD), atrial fibrillation (AF), and valvular heart diseases stand out due to their significant disease burden and impact on society. Each of these conditions presents distinct epidemiological and clinical-pathological characteristics, yet they are all strongly influenced by risk factors prevalent in the Portuguese population:

- **Coronary Artery Disease**

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Coronary artery disease encompasses acute coronary syndromes and chronic coronary disease, making it one of the leading causes of hospital admissions. Acute myocardial infarction results in an average of 12 deaths per day in Portugal, with the country reporting over 10 000 episodes each year.[22] In 2021, countries within the Organization for Economic Co-operation and Development (OECD) reported varying mortality rates from myocardial infarction, with Portugal ranking 55% below the average. This reflects the significant investments made over the past two decades to enhance the organization and quality of care provided during the acute phase of the disease.[23] In 2022, the number of deaths from ischemic heart disease rose compared to 2021 (6826 vs. 6622 deaths, a rise of 3.1%). This was accompanied by a 2.7% increase in crude mortality rate (65.3 vs. 63.6 deaths per 100 000 inhabitants). However, mortality from acute myocardial infarction decreased by 0.7% (3908 deaths vs. 3936 deaths). Nevertheless, the number of deaths from acute myocardial infarction in individuals under 70 years old grew.

- **Heart Failure**

Acute HF stands out as a cause of hospital admissions and is associated with high mortality and morbidity rates: one in every 25 patients hospitalized with a primary diagnosis of HF does not survive the initial admission, and one in every 10 dies within thirty days after being admitted.[24,25]

The epidemiological data on HF available in Portugal comes primarily from studies conducted over two decades ago. A recent global systematic review reports an average prevalence of HF in adults of 3.4%, with significant variation among different populations.[26] Of the 22 studies reporting the prevalence of HF in adults, three were conducted in Portugal: the EPICA, EPICA-RAM, and EPI-PORTO studies. Notably, all three reported a high prevalence of HF, ranking among the five highest in the this review. In fact, 20 years ago, the EPICA study estimated an overall prevalence of HF in mainland Portugal at 4.4%. More recently, the PORTHOS study[27], conducted in 2023, revealed that the estimated prevalence of HF in mainland Portugal among adults over 50 is 16.5%. This prevalence is 2.3 times higher in women than in men and increases sharply with age, reaching around 30% in individuals aged 70 and older. This means that approximately one in six Portuguese individuals over 50 live with HF, representing a significant disease burden for both the national health service (NHS) and society as a whole. Another significant finding of the study was the predominance of HF with preserved ejection fraction, which had an estimated prevalence of 15.2%. This phenotype, often underdiagnosed and misunderstood, is the most common type of HF in the studied population, highlighting the need for targeted diagnosis and treatment strategies. The study also revealed a high number of undiagnosed HF cases: nine out of 10 patients with HF were unaware of their condition, indicating a substantial gap in early detection and referral for appropriate treatment. This underscores the urgency of optimizing diagnostic strategies, particularly in primary healthcare settings.[28]

- **Sudden Arrhythmic Death and Atrial Fibrillation**

Sudden death accounts for 20% of global mortality, with the incidence of SCD in Portugal being about one per 1000 inhabitants per year. Additionally, it is estimated to account for approximately 50% of

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deaths from cardiac causes, with atherosclerotic CAD artery disease being the most common etiology (approximately 35% of cases). Remarkably, the causes of these deaths are largely preventable.[29–31]

Although AF is not typically the direct cause of sudden death, it is the most common cardiac arrhythmia and plays a crucial role in increasing the risk of severe cardiovascular events. AF is a significant risk factor for stroke and other thromboembolic complications, and it is associated with higher mortality and a poorer quality of life. The FAMA Epidemiological Study (Study on the Prevalence of Atrial Fibrillation in Portugal), which included 10 447 individuals, estimated the prevalence of AF in Portugal at 2.5% among individuals aged 40 or older, regardless of gender or geographical area. Due to its design, this study was unable to capture paroxysmal forms of the disease, leading to the assumption that it underestimates true prevalence. Prevalence tends to increase with age, reaching 6.6% in patients aged 70–79 years and 10.4% in patients over 80 years.[32] However, it can also affect young individuals, especially those with another heart condition, and it may be the initial manifestation of this health problem.

- **Valvular Heart Disease**

Valvular diseases, including aortic stenosis and mitral insufficiency, are common, particularly among the elderly. The global prevalence of aortic stenosis in individuals over 75 years of age is 12.4%, while the prevalence of severe forms of the disease is estimated to be 3.4%,[33] with the only available treatment being surgical or percutaneous intervention.[34] Estimates from 2018 indicated that there were approximately 115 000 patients in Europe and 2500 in Portugal eligible for transcatheter aortic valve implantation (TAVI) each year.[35] These numbers are expected to increase significantly as the indications for TAVI expand to include patients with progressively lower surgical risk. In terms of mitral insufficiency, it is currently the most common vascular heart disease, regardless of its severity, with a prevalence of 1.7%, rising to 10% among individuals over 75 years of age.[36] This disease remains the second leading cause of valvular surgery in European countries, and the secondary form, which is associated with other heart diseases, is currently the most common.[37]

Cardiovascular Risk Factors

In 2019, 30% of all recorded deaths in Portugal were attributed to behavioral risk factors, such as tobacco use, poor diets, alcohol intake, and low levels of physical activity. Nevertheless, this percentage was lower than the EU average of 39%.[14]

The cardiovascular risk factors that influence the burden of CVD can be classified into two groups: modifiable and non-modifiable.

- **Modifiable risk factors**: These include biological factors such as hypertension, diabetes mellitus, dyslipidemia, overweight/obesity, and pregnancy-related complications; lifestyle factors like tobacco use, diet type, excessive alcohol consumption, sedentary behavior, and low levels of physical activity; and psychosocial factors such as depression, income level,

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education, occupation, and living conditions.[38,39] It is important to emphasize the role of environmental risk factors, particularly air pollution. Air pollution, which is recognized as a significant threat to public health, is closely linked to CVD. Its impact on mortality risk is comparable to that of tobacco use, accounting for 25% of heart disease-related deaths.[40,41]

- **Non-modifiable risk factors:** These include sex, age, and genetic inheritance.

In Portugal, there is a significant prevalence of modifiable risk factors, including hypertension, diabetes mellitus, dyslipidemia, obesity, physical inactivity, and tobacco use. Recently, in the e_COR study,[42] which analyzed a sample of 1688 individuals from 2012 to 2014, the prevalence of various health determinants was estimated across three age groups in the Portuguese population (18-34, 35-64, and 65-79 years). The following factors were highlighted:

- Inadequate diet: 71.3%
- Pre-obesity/Obesity: 62.1%
- Hypertension: 43.1%
- Low level of physical activity: 29.2%
- Smoking: 25.4%
- Alcohol abuse: 18.8%
- Hypercholesterolemia with LDL cholesterol levels ≥160 mg/dL: 31.5%
- Hypercholesterolemia with LDL cholesterol levels ≥130 mg/dL: 51.5%
- Family history of premature CVD: 11.8%
- Diabetes: 8.9%
- Hypertriglyceridemia with levels ≥200 mg/dL: 8.6%
- Hypertriglyceridemia with levels ≥150 mg/dL: 18.6%

Self-awareness regarding clinical conditions, prescribed medication for treatment, and control rates of risk factors across the three age groups evaluated were as follows:

- Diabetes: 80.7%, 82.0%, and 64.0%
- Hypercholesterolemia (LDL cholesterol ≥160 mg/dL): 73.0%, 71.4%, and 52.1%
- Hypertriglyceridemia (≥200 mg/dL): 24.7%, 24.7%, and 12.9%
- Hypertension: 62.8%, 69.9%, and 32.1%

Additionally, around 68% of the population was found to have two or more risk factors for CVD, while 22% had four or more. The primary risk factors identified included diabetes, hypercholesterolemia, hypertension, pre-obesity/obesity, and smoking. It is also important to highlight that the thresholds used in this study to evaluate the management of some of these risk factors do not align with current recommendations tailored to individual risk profiles.

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I. Lifestyle-related Risk Factors

Table 1. Lifestyle-Related Risk Factors

Risk factor	Data and Trends
Smoking	− The prevalence of daily tobacco use among adults in Portugal decreased from nearly 17% in 2014 to 14% in 2019, which is below the EU average of 18.7% − Among adolescents, tobacco use has also declined. In 2022, only 9% of Portuguese youths aged 15 reported having smoked in the past month, down from 11% in 2018 and nearly half of the EU average (17%).[14].
Alcohol Consumption	− The annual per capita alcohol consumption among Portuguese adults decreased from 11.3 liters (2010) to 10.4 liters (2019), still above the EU average of 10 liters. − In 2019, 14.6% of adults reported regular and excessive alcohol consumption, an increase of 4.4 percentage points since 2014, marking one of the largest increases in the EU (average of 18.5%).[14]
Physical Activity	− In 2019, only 17% of adults in Portugal engaged in at least 150 minutes of physical exercise weekly, which is nearly half the average for the EU. − Among adolescents, 14% engaged in some form of physical exercise daily, slightly below the EU average.[14]

II. Clinical Risk Factors

Table 2. Clinical Risk Factors

Risk factor	Data and Trends
Dyslipidemia	− Epidemiological studies and national surveys indicate that approximately two-thirds of the Portuguese population has dyslipidemia, typically due to raised cholesterol levels. [43] − The control rate of dyslipidemia is concerning due to inadequate treatment or poor adherence to recommended therapies, which increases the risk of cardiovascular events.[43]

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Hypertension	− Hypertension is a concerning risk factor, with a prevalence of 42% in the adult population as reported in studies conducted in 2003 and confirmed in subsequent studies (VIVA 2007 and 2009, PHYSA 2011-2012).[43] − In the PRECISE study conducted in Health Centers (2019),[44] 56.7% of hypertensive patients under treatment did not have their blood pressure under control, and 40.7% had a cardiovascular risk greater than 5%, according to the SCORE risk calculator.
Obesity	− In 2019, the percentage of obese adults in Portugal was slightly higher than the EU average (16%), standing at 16.9%. More than 50% of the population had obesity or excess weight. [45,46] − In 2022, 20% of Portuguese youth aged 15 had excess weight or suffered from obesity,[14] a concerning level given the potential risk of increasing obesity among adults in the future.

There is considerable difficulty in obtaining comprehensive, representative, and up-to-date epidemiological data in Portugal regarding both CVD and the associated risk factors. The absence of precise and current data highlights the urgent need to revise surveillance strategies and improve the collection of epidemiological information for CVD and its risk factors. Without a solid foundation of information, formulating public health policies and implementing prevention and treatment programs become extremely challenging, potentially compromising the effectiveness of necessary interventions aimed at reducing the burden of CVD and its risk factors in the population.

Access to Cardiovascular Healthcare

The increase in life expectancy has significantly impacted demographics, resulting in a growing senior population accompanied by a rise in chronic diseases. This surge in demand has created challenges in accessing healthcare across various countries, with Portugal being no exception. Additionally, the country is recovering from the COVID-19 pandemic, during which access to healthcare was severely restricted.

When considering access to cardiovascular healthcare, it is essential to analyze three main areas:

I. Infrastructure, equipment, and healthcare professionals allocated to the cardiovascular field;
II. Access to healthcare services (including consultations, diagnostic tests, invasive procedures, and surgeries);
III. Access to innovative health technologies (such as medications and medical devices).

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I. Infrastructure, Equipment, and Healthcare Professionals in the Cardiovascular Field

In Portugal, the network of cardiovascular healthcare is organized into three levels based on the degree of specialization. The public hospital network has remained stable, with plans for some new hospitals in the future, although they are still in the early stages of development. In contrast, the private sector has experienced significant growth, increasing the number of hospitals in both metropolitan (Lisbon and Porto) and rural areas.

The distribution of dedicated cardiovascular healthcare facilities in Portugal, both public and private, is as follows:[47]

Table 3. Comparison of Cardiac Infrastructure between Portugal and ESC Member Countries

Cardiac Infrastructure per million inhabitants, by type	**Portugal**	**ESC Members**
Hospitals with Hemodynamic Laboratory	3.1	4.3 **EU**
Hospitals with 24/7 Hemodynamic Laboratory	2.1	3.2 **EU**
Centers Performing TAVI Public Hospitals: 8 Private Centers: 14 (low volume, < 25/year)	2.1	1.2
Centers Performing Aortic, Mitral, and Tricuspid Structural Valve Interventions Public Hospitals: 6 Private Centers: 6 (low volume)	1.1	1.2 **EU**
Hospitals with Electrophysiology Laboratory	2.5	1.9
Centers with Cardiac Surgery Public Hospitals: 7 (5 in Lisbon and Tagus Valley, and 2 in the North) Private Centers: 11	1.8 (2020)	1.5 **EU** (2020)

ESC: European Society of Cardiology; EU: ESC Members belonging to the European Union; TAVI: Percutaneous Aortic Valve Prosthesis Implantation; Data from 2022, except where indicated.

Overall, it is evident that we are positively aligned with our European counterparts in this regard. However, when focusing exclusively on the public healthcare network, which provides over three-quarters of cardiovascular care, the number of centers performing TAVI decreases to 0.8 centers per million inhabitants, while the number of centers offering cardiac surgery drops to 0.7 centers per million inhabitants.

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In terms of equipment, there is still a significant gap in investment. Various deficiencies persist: according to OECD data, in 2021, Portugal had only 30 advanced imaging devices per million inhabitants—specifically, computed tomography (CT), magnetic resonance imaging (MRI), and positron emission tomography (PET). This figure is notably lower than the OECD average of 48 and the numbers in Spain (44), Italy (76), and Greece (80).[23] This shortfall contributes to the challenges of accessing these imaging studies within the public healthcare system, negatively impacting cardiology practice.

Table 4. Comparison of Medical Equipment between Portugal, OECD Countries, Spain, Italy, and Greece

Equipment per million inhabitants, by type	**Portugal**	**OECD**	**Spain**	**Italy**	**Greece**
CT, MRI, PET	30*	48	44	76	80

*Data excludes equipment outside hospitals; CT (computed tomography); MRI (magnetic resonance imaging); PET (positron emission tomography); Data from 2021

Investment in these diagnostic tools is essential to keep pace with technological advancements in cardiology, ensuring state-of-the-art support for diagnosis, decision-making, and intervention planning, and ultimately leading to improved health outcomes.

On the healthcare professionals' front, and according to the latest *ESC Atlas of Cardiology*,[47] in 2023 Portugal had 588 practicing cardiologists, with a stronger gender balance — 42.2% of cardiologists were female, compared to the European average of 29%. This equates to approximately 57 cardiologists per million inhabitants, below the EU average of 101.4 per million. Portugal also lags significantly behind countries like Spain, Greece, and Italy, which have 84, 297, and 226 cardiologists per million inhabitants, respectively.[49] Data from the Central Administration of the Health System indicates that the distribution of cardiologists is uneven, with a majority concentrated in the Lisbon and Tagus Valley region and the North. Together they account for three-quarters of all cardiologists. In contrast, areas such as Alentejo, Algarve, and some inland regions face significant shortages. Portugal has only nine interventional cardiologists per million inhabitants, which is notably below the EU average of 13.5.[50] Additionally, Portugal has also a considerably lower number of electrophysiologists, with just 3.7 per million inhabitants, compared to 4.7 per million in ESC member countries. A similar trend is seen in cardiac surgery, where there are 7.4 cardiac surgeons per million inhabitants (of which 18% are female), compared to an EU average of 12.1 per million.[51]

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Table 5. Comparison of the number of doctors between Portugal and ESC member countries

Doctors per million inhabitants, by type	**Portugal**	**ESC Members**
Cardiologists *Female*	57 *42%*	101 **EU** *29%*
Interventional Cardiologists	9 (2022)	13,5 **EU**
Electrophysiologists	3,7 (2022)	4,7 (2022)
Cardiac Surgeons *Female*	7,4 (2022) *18%*	12,1 **EU** –

ESC: European Society of Cardiology; EU: ESC members belonging to the European Union; Data from 2023, unless otherwise noted.

It is noted that the primary shortcoming in Portugal is not in infrastructure, but rather in human resources and advanced imaging equipment

II. Access to Cardiovascular Healthcare

Since Portugal's healthcare system is built on a public model through the NHS, with complementary inputs from private and social systems, it is essential to analyze indicators of public service availability to evaluate healthcare accessibility.

According to the Portuguese Health Regulatory Authority, 19 642 initial cardiology consultations were conducted in hospitals during the second half of 2023 (+0.3% compared to 2022), along with 4329 scheduled cardiac surgeries (+5.8% compared to 2022), indicating increased activity in this area compared to the corresponding period in the previous year.[52] The legally defined guaranteed maximum response time (TMRG),[53] based on priority level, was exceeded in 91.8% of initial consultations (up from 88.5% in 2022) and 33.2% of cardiac surgeries (up from 28.0% in 2022). By the end of 2023, 23 448 patients were on the waiting list for consultations (up from 15 406 in 2022), with median waiting times longer than in the same period last year (119.9 days vs. 104 days). Additionally, 2724 patients were waiting for cardiac surgery (down from 2880 in 2022). These figures indicate worsening access to cardiology services, despite an increase in response capacity. Regarding equity in access, geographically, the most affected region is Greater Lisbon, with 44.6% of cardiac surgeries failing to meet the TMRG, compared to 24.9% in the North and 29.7% in the Center. Although the overall picture is poor across mainland Portugal, the Algarve leads in unmet TMRG for consultations, with an almost 100% non-compliance rate (98.8%). These data reflect broad territorial trends but do not capture the disparities between inland and coastal areas. For consultations, it is also worth noting that after the COVID-19 pandemic, the pattern of primary healthcare appointments shifted significantly: in 2019, only

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31% of consultations were conducted remotely, whereas this figure has now risen to 48%.[23] This strategy may also be relevant in other specialty areas, such as cardiology.

In this field, it is also important to analyze comparative access to various invasive cardiological procedures, including percutaneous coronary interventions, the implantation of percutaneous valves and cardiac devices, and cardiac surgery:

Table 6. Comparison of percutaneous coronary interventions between Portugal and ESC Member countries

Percutaneous coronary interventions per million inhabitants, by type	**Portugal**	**ESC Members**
PCI	1358	2384 **EU**
Primary Angioplasty	420	500 **EU**

ESC: European Society of Cardiology; EU: ESC members belonging to the European Union; PCI: Percutaneous Coronary Intervention; Data: 2022

These comparative results reflect the lower prevalence of coronary disease in our population.

Table 7. Comparison of structural valve interventions between Portugal and ESC member countries

Structural valve intervention per million inhabitants, by type	**Portugal**	**ESC Members**
TAVI	144 (2022)	138 **EU** (2022)
Transcatheter mitral intervention	11 (2022)	14**UEU**
Transcatheter tricuspid intervention	2,5 (2022)	3 **EU**

ESC - European Society of Cardiology; EU - ESC members belonging to the European Union; TAVI - transcatheter aortic valve implantation; Data from 2023, except where noted

In 2022, Portugal performed 144 TAVI procedures per million inhabitants, exceeding the EU average of 138.[47] However this figure is not adjusted for demographic differences; in that year, 24% of Portugal's population was over 65, compared to 21% in the EU, and this predominance of elderly individuals affects the demand for TAVI procedures. Despite the growth in interventions in recent years, the number of procedures remains well below the population's needs, which is particularly concerning. In 2018, the estimated annual number of eligible candidates in Portugal was 2516 (over 200 per million inhabitants), potentially rising to 3,900 with the expected expansion of indications.[35] A national study evaluating different scenarios for the use of this technique in Portugal estimated that the annual need ranges from 189 to 391 procedures per million inhabitants, highlighting a significant gap between the population's needs and the actual procedures performed.[54]

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Table 8. Comparison of the number of cardiac surgeries between Portugal and ESC member countries

Number of cardiac surgeries per million inhabitants, by type	**Portugal**	**ESC Members**
Coronary artery bypass grafting (CABG)	201 (2022)	263 **EU** (2022)
Implantation of ventricular assist devices (left, right, and both, in chronic heart failure)	0,2 (2020)	2,3 **EU** (2022)
Surgical interventions for the aortic valve (repair and replacement)	101,0 (2020)	167,4 **EU** (2022)
Heart transplant surgery	3,0 (2022)	3,1 **EU** (2023)

ESC - European Society of Cardiology; EU - ESC members belonging to the European Union

Regarding cardiac devices or electrophysiology interventions, the national reality is expressed according to Table 9:[47]

Table 9. Comparison of the number of cardiac device implantations and ablations between Portugal and ESC member countries

Number of interventions per million inhabitants, by type	**Portugal**	**ESC Members**
Pacemaker implantation	1 098	866 **EU**
Implantable cardioverter-defibrillators implantation	139	120 **EU**
Cardiac resynchronization therapy devices (CRT-D and CRT-P) implantation	132	84 **EU**
Ablation procedures	360	404 **EU**

ESC - European Society of Cardiology; EU - ESC members belonging to the European Union; Data from 2022

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It is important to note that the comparative interpretation of this data should not be taken literally, as the observed differences may be attributed to factors such as healthcare organization, national adoption of techniques and procedures, demographic and epidemiological factors, and the methods used for data collection.

The analysis of access to complementary means of diagnosis and therapy (MCDT), particularly regarding the availability of non-invasive cardiovascular imaging techniques (CT, MRI, standard and advanced echocardiography, and nuclear medicine), is not included here due to the lack of systematic information on access in this area. This lack of data highlights a substantial weakness in the system. Notably, only very recently (Dispatch No. 12876-C/2024, dated October 29) was access to cardiac CT, coronary calcium scoring, natriuretic peptides, Doppler echocardiograms, and 24-hour ambulatory blood pressure monitoring regulated for primary health care. This regulation is expected to address the existing inequity that has regressed current clinical practice to standards from decades past. However, access to MRI remains limited to hospital settings.

In terms of access and costs, Portugal is one of the European countries that places the greatest burden on users concerning direct healthcare expenses. Users are responsible for 37% of the total costs (including out-of-pocket expenses and health insurance), nearly double the OECD average of 22%.[23] This is particularly significant because half of the 'out of the pocket' expenses are associated with outpatient care, which includes chronic pharmacological therapies and the demand for specialized cardiology consultations in the private sector. As previously mentioned, these services face challenges in terms of access within the public system.

III. Access to Innovative Health Technologies

The availability and accessibility of innovative cardiovascular treatments, such as novel procedures and new drugs, are essential components for the development of cardiovascular care. Access to leading-edge invasive therapies has already been addressed in the previous section. In Portugal, entry into the market of breakthrough pharmacological therapies has been evaluated by the European Federation of Pharmaceutical Industries and Associations through the Patient W.A.I.T. Indicator (**W**aiting to **A**ccess **I**nnovative **T**herapies), which assesses the rate of drugs with reimbursement compared to the total number of drugs approved for marketing at the national level. In this regard, Portugal is above the EU average, with 50% compared to 43%. The greatest challenge regarding access to drug innovation is the average time until reimbursement begins. The distribution of this time, measured from European Medicines Agency approval to local prior approval by the Portuguese regulatory authority, INFARMED, is 710 days in Portugal, compared to 661 days in Spain, 424 days in Italy, or 344 days in the United Kingdom.[55]

In terms of access to medications, it is crucial to ensure that the population has access to effective, safe, and affordable medications at manageable prices. In this context, the 'generification' of certain

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outpatient therapies in the cardiovascular field, such as oral anticoagulants, has made a positive contribution to this goal.

Similarly, regarding medication for cardiovascular conditions and associated risk factors, it is important to note that drugs for hypertension or dyslipidemia (the latter of which is subject to only 37% reimbursement of the selling price) do not qualify for the maximum reimbursement rates available for other chronic conditions, such as diabetes. This creates a barrier to the effective management of these diseases, a challenge that also extends to other cardiovascular issues like HF and AF.

In conclusion, the provision of healthcare in the cardiovascular field has improved, with an increase in consultations, procedures, and surgeries performed, as well as a growing number of professionals in this area. However, it still falls short of population needs and lags behind the reality in countries with similar economic levels. In terms of infrastructure, growth has primarily occurred through an increase in offerings in the private sector. Nevertheless, significant challenges remain concerning the responsiveness of the NHS to the defined guaranteed maximum response times. While there is access to major pharmacological therapies, it is delayed compared to European counterparts, with the reimbursement of a product taking approximately two years.

Additionally, limited unofficial information is available regarding areas such as waiting lists for invasive cardiology procedures, MCDTs, and medical devices, which hinders a more concrete evaluation in these areas.

Economic Impact of Cardiovascular Disease

In Portugal, investment in the cardiovascular field has been insufficient. The existing funding has primarily concentrated on curative measures, with minimal emphasis on prevention. This is particularly significant, as CVDs contribute substantially to morbidity and mortality in the Portuguese population.[56]

Healthcare Expenditures and Costs of Cardiovascular Disease

Analyzing healthcare expenditure in Portugal, particularly that associated with CVDs, is complex due to the limited availability of information sources, especially regarding their economic impact. However, a general overview can still be outlined based on existing data.

In 2023, Portugal's GDP reached EUR 265.5 billion. In the same year, current healthcare expenditure was EUR 26.6 billion, which accounts for approximately 10% of GDP.[57] This figure underscores the importance of health to the country's economy and aligns with trends observed in other European nations. Furthermore, total costs per patient are projected to rise by 34% by 2036. This significant increase in the disease-related cost burden in the medium term highlights the need for more effective health policies and increased investment in the prevention of CVD, considering their substantial impact on overall morbidity and mortality.

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The costs associated with CVD in Portugal are considerable, representing a significant portion of healthcare expenditures:

- In 2016, the total cost of atherosclerosis amounted to EUR 1.9 billion, which is approximately 0.7% of Portugal's GDP and 11% of healthcare expenditure;[3]
- In 2014, the direct and indirect costs of HF were EUR 299 million and EUR 106 million, respectively, representing approximately 0.2% of Portugal's GDP and 2% of total healthcare expenditure;[58]
- In 2013, the total cost associated with AF was EUR 140 million, representing approximately 0.1% of Portugal's GDP and 1% of total healthcare expenditure.[59]

In 2021, the annual per capita cost of CVDs in Portugal was EUR 428 (adjusted for purchasing power parity), placing it just above Cyprus and Croatia. In comparison, the EU average was EUR 630, totaling EUR 3.772 billion across all member states.[60] In Portugal, the adjusted costs related to healthcare and social security associated with CVDs accounted for 8.5% of total healthcare spending, ranking just above Croatia and Latvia and below the EU average of 10.6%. Cost segmentation shows that hospital and informal care consume the most resources. These figures illustrate the significant economic impact of CVD in Portugal. If current trends continue in the medium term, it is expected that expenditure on CVD will remain high and may even rise in the future, largely due to demographic changes and advancements in medical technology and science.

Overall, the costs associated with major CVDs in Portugal represent more than 1% of our GDP, considering the direct, indirect, and opportunity costs involved.

The increasing prevalence of these diseases underscores the urgent need for prevention. Investment in this area should be prioritized upstream—before the disease manifests—rather than downstream, where the focus is on treatment once the disease is already established. This preventive investment can take various forms, including the promotion of healthy lifestyles, early detection and management of risk factors, and the implementation of effective public health policies. By preventing the population from developing these diseases, we also avoid the associated treatment and management costs, allowing for better allocation of available resources.

In summary, the economic impact of CVD in Portugal is significant and projected to rise. It is imperative to invest more effectively in prevention strategies to mitigate the rising prevalence and associated costs. Furthermore, ensuring access to specialized cardiological care that aligns with best practices and scientific advancements is essential.

4. Strategic Pillars

1. Primordial Prevention (Health Promotion);
2. Primary Cardiovascular Prevention (Promotion of Cardiovascular Health) and Health Determinants;

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3. Screening and Early Diagnosis;
4. Secondary Cardiovascular Prevention;
5. Rehabilitation and Promotion of Quality of Life.

Foundational Principles:

I. Empowerment and Health Literacy
II. Access and Equity
III. Innovation and Transformation

5. PRIORITY AREAS

The selection of priority areas for the Strategic Plan for Cardiovascular Health in Portugal (PESCP-SPC) reflects a comprehensive yet focused approach, taking into account both the epidemiological context and the specific needs of the population. The identified areas have been carefully chosen based on epidemiological evidence that underscores their significant contribution to the overall CVD burden in Portugal. They also represent conditions with concrete needs that require preferential and timely intervention (Figure 2.).

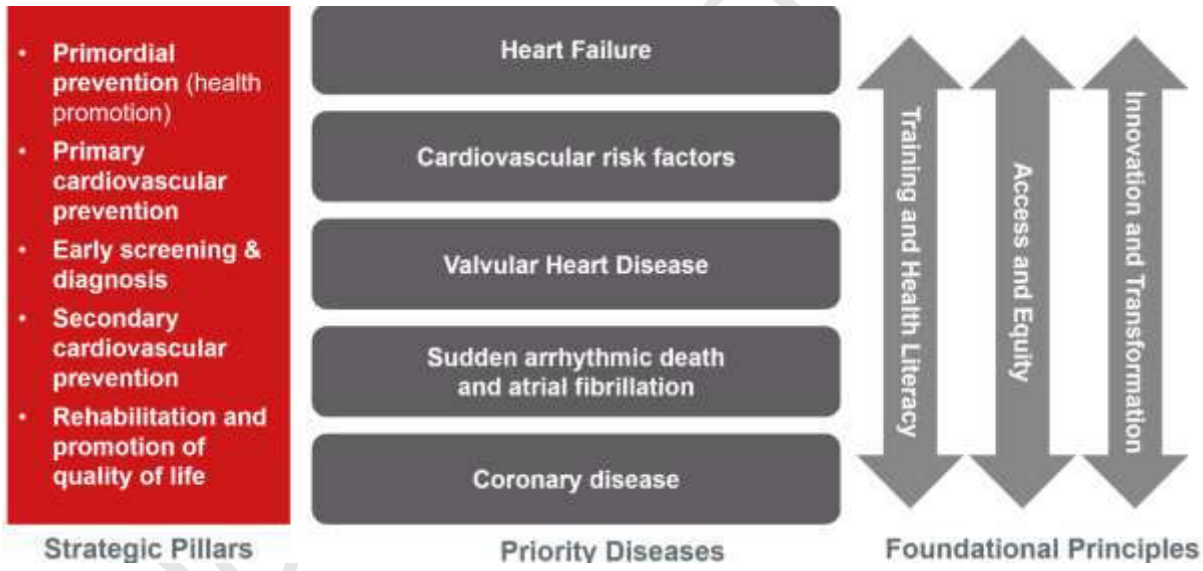

Figure 2. Strategic Pillars and Foundational Principles by Priority Area

I. Heart Failure

Focus on early diagnosis and care integration.

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II. Cardiovascular Risk

Focus on concrete measures to mitigate the most common vascular risk factors, including:

- Tobacco Use (e.g., national cessation campaigns and reimbursement for smoking cessation medications);
- Dyslipidemia (e.g., reimbursement for anti-dyslipidemic drugs similar to that provided for chronic diseases with a significant social impact, such as diabetes);
- Hypertension (e.g., implementation of early screening campaigns and access, at the Primary Health Care level,MCDTs that allow for evaluation and monitoring);
- Obesity (e.g., free Body Mass Index (BMI) calculation in pharmacies, dissemination of targets based on age and sex, structured support programs promoting weight loss and maintenance).

III. Valvular Heart disease

Focus on aortic stenosis with emphasis on:

- Health education on aortic stenosis;
- Early diagnosis;
- Time to first appointment with Cardiology, Cardiac Surgery, Structural Interventional Cardiology, and any necessary complementary examinations (CT-TAVI);
- “Fast track” for intervention in aortic stenosis, whether percutaneous or surgical;
- Establishment of guaranteed maximum response times and registration on waiting lists for intervention, regardless of type;
- Pre-TAVI rehabilitation to optimize outcomes, particularly in patients with a higher risk of frailty.

IV. Sudden Arrhythmic Death and Atrial Fibrillation

Focus on organizing pre-hospital response to prevent sudden arrhythmic death and support functional recovery:

- Community awareness and education;
- Organization of automated external defibrillator (AED) networks;
- Structured basic life support training and AED use for citizens;
- Facilitation of coordination between pre-hospital emergency services and hospital care teams;
- Optimization of post-resuscitation care.

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Focus on early diagnosis and access to therapies that prevent AF-related complications, including differentiating interventions such as ablation:

- Early detection with AF screening for at-risk individuals and evaluation of wearable device contributions;
- Thromboembolic risk stratification supported by validated risk scores;
- Ablation as a differentiating intervention;
- Comprehensive AF management with emphasis on lifestyle modifications, management of comorbidities (such as obesity, hypertension, and sleep apnea), and patient education;
- Personalized treatment strategies tailored to each patient's needs and health profile.

V. Coronary Artery Disease

Focus on early diagnosis, secondary prevention, rehabilitation, and integration of care.

6. AREAS OF INNOVATION

Across all domains of CDV, we have witnessed the emergence of innovative areas that shape current clinical practice and are distinctive features of contemporary medicine, unparalleled in previous eras, and posing new challenges. Among the most impactful developments are technological innovations, particularly in the digital realm, the management of data in cardiovascular health, and the incorporation of the patient's perspective.

The introduction of advanced digital technologies, such as artificial intelligence (AI) and the analysis of large data sets, has redefined diagnostic and therapeutic approaches, enabling a deeper and more personalized understanding of cardiovascular conditions. The application of these tools also extends to enhancing the patient experience, with user-centered solutions like remote monitoring and teleconsultation that encourage more active participation in the individual management of cardiovascular health. The convergence of these elements not only differentiates clinical practices but also enriches the overall approach to heart diseases, addressing the specific needs and expectations of patients.

I. Digital Health

The provision of cardiovascular healthcare is being redefined by the instruments of what is known as Health 4.0, and Portugal is actively keeping pace with this transformative movement. Key innovations in cardiology include tools such as telemedicine, remote monitoring through implanted devices or wearables, and the application of AI solutions for diagnosing and monitoring patients. These advancements enhance the increasing technical and scientific differentiation within the field.

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Telehealth solutions in Cardiology, regulated by the Central Unit for Telehealth Care within the Shared Services of the Ministry of Health, EPE (SPMS-EPE), are incorporated into the Strategic Plan of SPMS for Telehealth 2019-2022. Cardiology has been designated as one of the priority areas for implementing these tools, as outlined in its founding dispatch (Dispatch No. 3571/2013).[62] The NHS provides independent funding for two telemonitoring programs in the cardiovascular area—post-acute myocardial infarction (P-EAM) and chronic HF (CHF). In 2021, 13 CHF programs and 4 P-EAM programs were contracted prospectively across 13 hospitals in the hospital network, but they cover an unacceptably low number of patients (309) given the prevalence of these conditions[63,64] and the preliminary gains already demonstrated.[65,66] According to the 2nd Barometer of Digital Health Adoption, in 2022, 53% of hospitals had telemonitoring services for CHF, while 33% offered such services for post-acute myocardial infarction (P-EAM). This reflects a positive response to the COVID-19 pandemic in managing chronic patients, although it remains insufficient to meet overall needs. For patients with implanted cardiac devices, the benefits and safety of telemonitoring are well established, and it is now considered the standard of care by the European Heart Rhythm Association. In Portugal, this practice has been increasingly adopted and is recommended by the Portuguese Association of Arrhythmology, Pacing, and Electrophysiology.

Wearable technology, which allows for monitoring biosignals such as heart rate, blood pressure, physical activity, and electrocardiographic signals, has emerged as a valuable tool for tracking and predicting cardiovascular events in high-risk individuals. These tools are becoming more prevalent in both clinical settings and among the general population, influencing clinical practice while presenting concrete challenges, including trust in the data collected, uncertainty regarding their impact on health outcomes, and concerns related to privacy, data protection, and cybersecurity.

Available data indicate that we are in the early stages of implementing these solutions in Portugal. Their development and adoption should be encouraged, as long as they are properly regulated, due to their potential impact on improving accessibility, health outcomes, and the efficiency of the care delivery network. However, the digital maturity of the health system must be accompanied by an increase in the digital skills of the populations served.

II. Cardiovascular Health Data

Data on cardiovascular health includes a wide array of information, such as demographic aspects, clinical records, diagnostic test results, treatment outcomes, lifestyle-related risk factors, and genetic predisposition. This information is essential for various stakeholders in the healthcare system, including clinicians, researchers, public health authorities, and policymakers.

From a clinical perspective, information on cardiovascular health is essential for managing the disease at both individual and community levels. It facilitates the development of personalized care plans, anticipates complications, and supports epidemiological studies that identify risk factors for the development and progression of CVD. Longitudinal data are particularly valuable for understanding the

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natural history of these diseases and the long-term effects of various prevention and treatment strategies. Furthermore, information on biomarkers and genetic markers associated with cardiovascular conditions drives precision medicine, allowing for personalized treatments tailored to the genetic and/or biomarker profile of each individual.

Cardiovascular health data is essential for public health initiatives aimed at reducing the CVD burden. By analyzing large population datasets with the help of AI and machine learning algorithms, public health authorities can identify patterns and predict outcomes. Predictive models can estimate the likelihood of cardiovascular events, enabling the timely implementation of preventive measures. Additionally, funding and resource allocation decisions are informed by these data analyses, which reveal the prevalence and economic impact of CVD. For instance, a high incidence of CVD in a region may result in increased funding for local healthcare facilities, public health campaigns, and preventive services.

Data Security and Privacy

Given the sensitivity of health data, ensuring its privacy and security is essential. Rigorously structured data governance frameworks, such as the General Data Protection Regulation, guarantee that health data are used ethically and securely.

Harmonization of Health Data with the European Health Data Space

The harmonization of health data with the European Health Data Space is essential for improving interoperability, security, and the effective use of health data within the EU. This process involves standardizing the collection, storage, and sharing of health data, which facilitates medical research, informs health policy development, and enables the delivery of high-quality care.

Cardiovascular health data play a strategic role in various areas of healthcare. It enhances patient care, advances medical research, supports public health initiatives, drives innovation, and informs policy-making. The strategic use of this data, along with robust privacy and security measures, has the potential to significantly improve cardiovascular health outcomes and reduce the overall CVD burden. Portugal should prioritize integrating its health data into this European network, ensuring the necessary interoperability and security for efficient federated health data analysis.

The SPC, through its National Center for Data Collection in Cardiology (CNCDC), has pioneered the establishment of structured clinical registries at the national level for acute myocardial infarction and Interventional Cardiology. These initiatives serve as a model for the collection and dissemination of data in various other areas of cardiovascular pathology. However, the quality and representativeness of these registries depend on the voluntary participation of researchers from national cardiology centers, which limits their effectiveness in shaping health policies.

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The establishment of mandatory national registries, similar to those already in place for other conditions and leveraging the experience of scientific societies, would be both advisable and more effective. This is the position of the SPC, which intends to work with the competent authorities to identify suitable solutions for their implementation.

7. PATIENT PERSPECTIVE

The patient perspective encompasses the understanding and appreciation of individuals' experiences, concerns, values, and preferences. Studies indicate that patients who feel heard and actively involved in decisions regarding their health are more likely to adhere to therapeutic recommendations, resulting in better clinical outcomes.[67]

Integrating the patient perspective into healthcare practices fosters a trusting relationship between patients and healthcare professionals, enabling personalized treatment. By understanding individual experiences, healthcare professionals can tailor therapeutic interventions to meet each patient's specific needs, maximizing treatment effectiveness and facilitating shared decision-making. Additionally, scientific research benefits from including the patient's perspective. Clinical trials that incorporate patient-reported outcomes provide a more comprehensive view of the efficacy and tolerability of therapeutic interventions, ensuring that the observed clinical benefits are meaningful to patients.

The Importance of Patient Participation in the Strategic Plan for Cardiovascular Health

Active patient participation in developing and implementing strategies for cardiovascular health promotion enhances health literacy as well as the quality and effectiveness of healthcare. Involving patients allows their needs, expectations, and experiences to be considered, making interventions better aligned with the everyday experiences of those living with CVD. This alignment is essential for treatment adherence, as patients who actively engage in decision-making tend to feel more committed and motivated to follow recommended treatment regimens.

Furthermore, integrating patients into the Strategic Plan enables more effective evaluation and monitoring of health outcomes. Tools such as quality-of-life assessment questionnaires and direct collection of patient feedback provide valuable data on the effectiveness of implemented interventions. This continuous feedback allows for adjustments and improvements in care plans, ensuring that health strategies remain relevant and effective over time.

In health policy, including patients can positively impact resource allocation and priority setting. Health policies that incorporate the patient perspective tend to be more equitable and address the actual challenges patients face, promoting a more effective and efficient use of resources.

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By recognizing the role of psychosocial, behavioral, and environmental factors in managing CVD, the resulting strategies become more comprehensive and integrative, supporting patients' overall health and well-being. Patient participation in the Strategic Plan for CVD is essential to creating more effective, personalized, and patient-centered healthcare. Systematically incorporating patient input into strategic decisions not only improves clinical outcomes but also strengthens the therapeutic relationship, optimizes resource allocation, and fosters a holistic approach to cardiovascular health.

Research and scientific societies have embraced this reality, as reflected in the designs of studies and the recommendations issued. This is exemplified by the ESC guidelines, which involve the Patient Forum in their development.

In Portugal, a culture of patient participation and inclusion is gradually being integrated into clinical practice. Additionally, civil society has taken significant steps in this direction through the creation of patient associations that represent specific conditions. In the area of CVD, these initiatives are already gaining traction, and the empowerment and inclusion of these groups should be further encouraged.

8. CARDIOVASCULAR HEALTH GOALS

The strategic plan is defined and segmented for each priority area based on the guiding principles of the outlined strategic pillars and foundational principles. It also takes into account the distinctive aspects of both acute and chronic disease presentations, where applicable, as well as areas of innovation (Digital Health and Cardiovascular Health Data) and the patient perspective.

To maximize its impact, this plan aims to achieve objectives and goals in each priority area that can be executed within a short to medium-term timeframe and that effectively contribute to improving the cardiovascular health of the Portuguese population. These goals, along with the strategies for achieving them, will be formulated based on criteria that are specific, measurable, achievable, relevant, realistic, and time-bound (the SMART model and principles).

This strategic consideration for each area will be based on the following elements:

- Relevant epidemiological aspects;
- The current state of the art, including technical and scientific developments and innovations at various stages of the patient journey (prevention, early diagnosis, treatment, rehabilitation);
- Identification of gaps and areas for improvement in organization, access, human resources, and technical resources to better align with the abovementioned elements.

The content will be organized by expert working groups and presented in tables (one for each working group across the five areas), customized to each specific area (Figure 3.). The sector proposals will be consolidated into a final operational document for this plan.

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Figure 3. Working Table - Objectives, Goals, and Strategy by Priority Area

9. FINAL CONSIDERATIONS

In concluding this **Strategic Plan for Cardiovascular Health**, we reaffirm the commitment of the Portuguese Society of Cardiology to enhancing cardiovascular health in Portugal.

We revisit the challenges encountered, highlight essential strategic objectives, and identify emerging areas for intervention.

Our goal is to outline priority actions with achievable short- to medium-term goals. We emphasize the importance of multi- and interdisciplinary collaboration among the scientific community, healthcare professionals, organizations, patient representatives, and government entities.

We advocate for a holistic approach that addresses both the technical and scientific aspects, along with improving patients' quality of life.

We will engage with decision-makers to promote the implementation of the proposed measures, which we believe will have a significant impact on improving cardiovascular care in Portugal.

Finally, we conclude with a call to action, urging the effective execution of those measures and the necessary collective efforts to achieve them.

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Disclosures

All authors declare no conflicts of interest for this contribution.

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Acknowledgments

We thank IQVIA Portugal for the editorial support provided for this manuscript.

Ética de la publicación

1. ¿Su trabajo ha comportado experimentación en animales?:
No
2. ¿En su trabajo intervienen pacientes o sujetos humanos?:
No
3. ¿Su trabajo incluye un ensayo clínico?:
No
4. ¿Todos los datos mostrados en las figuras y tablas incluidas en el manuscrito se recogen en el
apartado de resultados y las conclusiones?:
Sí

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REFERENCES

1. National Institute of Statistics. Demographic Statistics: 2021. Lisbon: INE, 2023. https://www.ine.pt/xurl/pub/13932532

2. National Institute of Statistics. Demographic Statistics: 2022. Lisbon: INE, 2023. https://www.ine.pt/xurl/pub/280978178

3. Costa J, Alarcão J, Amaral-Silva A, et al. Atherosclerosis: The cost of illness in Portugal. *Rev Port Cardiol*. 2021;40(6):409-419. doi:10.1016/j.repce.2020.08.003

4. National Institute of Statistics. Health Statistics: 2021. Lisbon: INE, 2023. https://www.ine.pt/xurl/pub/11677508

5. Timmis A, Vardas P, Townsend N, et al. European Society of Cardiology: cardiovascular disease statistics 2021. *Eur Heart J*. 2022;43(8):716-799. doi:10.1093/eurheartj/ehab892

6. World Health Organization. *Global Action Plan for the Prevention and Control of Noncommunicable Diseases 2013–2020*. {World Health Organization}

7. United Nations Sustainable Development Goals – Goal 3: Ensure healthy lives and promote well-being for all at all ages. Accessed October 2023. https://www.un.org/sustainabledevelopment/health/

8. National Institute of Statistics. Sustainable Development Goals - Agenda 2030. Indicators for Portugal. Infographics: 2015-2022. Lisbon: INE, 2023. https://www.ine.pt/xurl/pub/618368840

9. corporate-body. SANTE: Directorate-General for Health, Safety F. *Healthier Together: EU Non-Communicable Diseases Initiative*. Publications Office of the European Union; 2022. doi:10.2875/195572

10. Poulsen RE. Report - A9-0366/2023 of the European Parliament - Non-Communicable Diseases. Committee on the Environment, Public Health and Food Safety. https://www.europarl.europa.eu/doceo/document/A-9-2023-0366_EN.html

11. Official Gazette No. 158/2023 Series I of 2023-08-16, pages 72 - 126 National Health Plan 2030. Published online 2023.

12. *European Heart Health Charter*.; 2023. https://www.escardio.org/static-file/Escardio/Advocacy/Documents/EHHC-Brochure-2023.pdf

13. European Alliance for Cardiovascular Health (EACH). *A European Cardiovascular Health Plan: The Need and the Ambition*.; 2022. https://www.cardiovascular-alliance.eu/wp-content/uploads/2022/05/EACH-Plan-Final_130522.pdf

14. OCDE. *State of Health in the EU Portugal Perfil de Saúde Do País 2023*.; 2023.

Journal Pre-proof

15. *National Program for Cerebrovascular and Cardiovascular Diseases 2017; General Directorate of Health, Ministry of Health, 2017*

16. National Institute of Statistics, IP. Health Statistics 2022

17. European Society of Cardiology. Cardiovascular disease mortality Premature deaths due to cardiovascular diseases, male (crude rate per 100000). ESC Atlas of Cardiology variables. Accessed August 13, 2024. https://eatlas.escardio.org/Data/Cardiovascular-disease-mortality/hs_dth_cvd_prem_100k_m_r-prenature-deaths-due-to-cardiovascular-diseases-male

18. European Society of Cardiology. Deaths due to cardiovascular diseases, male (crude rate per 100000). ESC Atlas of Cardiology variables. Accessed August 22, 2024. https://eatlas.escardio.org/Data/Cardiovascular-disease-mortality/hs_dth_cvd_crude_100k_m_r-deaths-due-to-cardiovascular-diseases-male-crude-rat

19. European Society of Cardiology. Premature deaths due to cardiovascular diseases, female (crude rate per 100000). ESC Atlas of Cardiology variables. Accessed August 22, 2024. https://eatlas.escardio.org/Data/Cardiovascular-disease-mortality/hs_dth_cvd_prem_100k_f_r-premature-deaths-due-to-cardiovascular-diseases-female

20. European Society of Cardiology. Deaths due to cardiovascular diseases, female (crude rate per 100000). ESC Atlas of Cardiology variables. Accessed 22 August 2024. https://eatlas.escardio.org/Data/Cardiovascular-disease-mortality/hs_dth_cvd_crude_100k_f_r-deaths-due-to-cardiovascular-diseases-female-crude-r

21. WHO. Deaths by sex and age group for a selected country or area and year. WHO Mortality Database Interactive platform visualizing mortality data. Accessed August 22, 2024. https://platform.who.int/mortality/themes/theme-details/topics/topic-details/MDB/cardiovascular-diseases

22. DGS. Acute Myocardial Infarction. Published 21 January 2024. Accessed August 9, 2024. https://www.sns24.gov.pt/tema/doencas-do-coracao/enfarte-agudo-do-miocardio/

23. OECD. *Health at a Glance 2023: OECD Indicators*. OECD; 2023. doi:10.1787/7a7afb35-en

24. Fonseca C, Brás D, Araújo I, et al. Heart Failure in Numbers: Estimates for the 21st Century in Portugal. Port J Cardiol. 2018;37(2):97-104. doi:10.1016/j.repc.2017.11.010

25. Ceia F, Fonseca C, Mota T, et al. Prevalence of chronic heart failure in Southwestern Europe: the EPICA study. *Eur J Heart Fail*. 2002;4(4):531-539. doi:10.1016/s1388-9842(02)00034-x

26. Emmons-Bell S, Johnson C, Roth G. Prevalence, incidence and survival of heart failure: a systematic review. *Heart*. 2022;108(17):1351-1360. doi:10.1136/heartjnl-2021-320131

27. Gavina C, PORTHOS - The Portuguese Heart Failure Prevalence Observational Study. Heart Failure 2024. [Personal communication at Heart Failure 2024].

28. Baptista R, Silva Cardoso J, Canhão H, et al. Portuguese Heart Failure Prevalence Observational Study (PORTHOS) rationale and design - A population-based study. *Rev Port Cardiol*. 2023;42(12):985-995. doi:10.1016/j.repc.2023.10.004

29. Carrington M, de Gouveia RH, Teixeira R, et al. Sudden death in young South European population: a cross-sectional study of postmortem cases. *Sci Rep*. 2023;13(1):1-12. doi:10.1038/s41598-023-47502-0

30. De Gouveia F. Corte-Real L. Goncalves R. et al Characterization of sudden death etiologies in a Portuguese population younger than 40 years-old. Eur Heart J;2022;43 /supplement 2)ehac544.676. doi.org/10.1093/eurheartj/ehac544.676

Journal Pre-proof

31. de Gouveia RH, Martins A, Vieira DN. Sudden death as the outcome of cardiac arrest, in a Portuguese region: Where do resuscitation manoeuvres stand? *World J Cardiovasc Dis*. 2015;05(08):227-232. doi:10.4236/wjcd.2015.58026

32. Bonhorst D, Mendes M, Adragão P, et al. Prevalência de fibrilhação auricular na população portuguesa com 40 ou mais anos: Estudo FAMA. Rev Port Cardiol., 2010;29: 331-350

33. Osnabrugge RLJ, Mylotte D, Head SJ, et al. Aortic Stenosis in the Elderly: Disease Prevalence and Number of Candidates for Transcatheter Aortic Valve Replacement: A Meta-Analysis and Modeling Study. *J Am Coll Cardiol*. 2013;62(11):1002-1012. doi:10.1016/j.jacc.2013.05.015

34. Iung B, Baron G, Butchart EG, et al. A prospective survey of patients with valvular heart disease in Europe: The Euro Heart Survey on Valvular Heart Disease. *Eur Heart J*. 2003;24(13):1231-1243. doi:10.1016/s0195-668x(03)00201-x

35. Durko AP, Osnabrugge RL, Van Mieghem NM, et al. Annual number of candidates for transcatheter aortic valve implantation per country: current estimates and future projections. *Eur Heart J*. 2018;39(28):2635-2642. doi:10.1093/eurheartj/ehy107

36. Van Mieghem NM, Piazza N, Anderson RH, et al. Anatomy of the mitral valvular complex and its implications for transcatheter interventions for mitral regurgitation. *J Am Coll Cardiol*. 2010;56(8):617-626. doi:10.1016/j.jacc.2010.04.030

37. Iung B, Delgado V, Rosenhek R, et al. Contemporary presentation and management of valvular heart disease: The EURObservational Research Programme valvular heart disease II survey. *Circulation*. 2019;140(14):1156-1169. doi:10.1161/CIRCULATIONAHA.119.041080

38. Caldeira D, Dores H, Franco F, et al. Global warming and heat wave risks for cardiovascular diseases: A position paper from the Portuguese Society of Cardiology. *Rev Port Cardiol*. 2023;42(12):1017-1024. doi:10.1016/j.repc.2023.02.002

39. Caldeira D, Franco F, Bravo Baptista S, et al. Air pollution and cardiovascular diseases: A position paper. *Rev Port Cardiol*. 2022;41(8):709-717. doi:10.1016/j.repc.2022.05.006

40. Brauer M, Casadei B, Harrington RA, et al, WHF Air Pollution Expert Group. Taking a Stand Against Air Pollution - The Impact on Cardiovascular Disease: A Joint Opinion From the World Heart Federation, American College of Cardiology, American Heart Association, and the European Society of Cardiology. *Circulation*. 2021;143(14):e800-e804. doi:10.1161/CIRCULATIONAHA.120.052666

41. Vahanian A, Beyersdorf F, Praz F, et al. 2021 ESC/EACTS Guidelines for the management of valvular heart disease. *Eur Heart J*. 2022;43(7):561-632. doi:10.1093/eurheartj/ehab395

42. Bourbon M, Catarina Alves A, Rato Q. Prevalence of Cardiovascular Risk Factors in the Portuguese Population. National Institute of Health Doctor Ricardo Jorge; 2019.

43. *Integrated Care Pathway for Vascular Risk in Adults. General Directorate of Health; 2014*

44. Marques da Silva P, Lima MJ, Neves PM, et al. Prevalência de fatores de risco cardiovascular e outras comorbilidades em doentes com hipertensão arterial assistidos nos Cuidados de Saúde Primários: estudo Precise. *Rev Port Cardiol*. 2019;38(6):427-437. doi:10.1016/j.repc.2018.09.011

45. Prevalence of adult overweight & obesity (%). Global Obesity Observatory. Accessed September 16, 2024. https://data.worldobesity.org/tables/prevalence-of-adult-overweight-obesity-2/

46. Xiao C, Graf S. Overweight, poor diet and physical activity: Analysis of trends and patterns. In: *The Heavy Burden of Obesity*. OECD Health Policy Studies. OECD; 2019:40-73. doi:10.1787/561b552e-en

47. ESC atlas of cardiology. Accessed September 20, 2024. https://eatlas.escardio.org/Atlas/ESC-Atlas-of-Cardiology

Journal Pre-proof

48. European Society of Cardiology. Cardiologists (total) (per million people). ESC Atlas in General Cardiology. https://eatlas.escardio.org/Data/Cardiovascular-healthcare-delivery/Cardiological-specialists/chr_card_1m_r-cardiologists-total-per-million-people

49. Cardiologists (total) (per million people). Accessed September 17, 2024. https://eatlas.escardio.org/Atlas/ESC-Atlas-of-Cardiology/Cardiovascular-healthcare-delivery/Cardiological-specialists/chr_card_1m_r-cardiologists-total-per-million-people

50. Interventional cardiologists (per million people). Accessed September 17, 2024. https://eatlas.escardio.org/Atlas/ESC-Atlas-of-Cardiology/Cardiovascular-healthcare-delivery/Cardiological-specialists/chr_icard_1m_r-interventional-cardiologists-per-million-people

51. Cardiac surgeons (per million people). Accessed September 17, 2024. https://eatlas.escardio.org/Atlas/ESC-Atlas-of-Cardiology/Cardiovascular-healthcare-delivery/Cardiological-specialists/chr_cards_1m_r-cardiac-surgeons-per-million-people

52. *Monitoring information on waiting times in the national health service for the 2nd semester of 2023. Health Regulatory Authority of Portugal; MAY 2024*.

53. Official Gazette No. 86/2017 Series I of 2017-05-04, pages 2204-2209. Maximum Guaranteed Response Times in the National Health Service. Published online 2017.

54. Fontes-Carvalho R, Guerreiro C, Oliveira EI, et al. Present and future economic impact of transcatheter aortic valve replacement on the Portuguese national healthcare system. *Rev Port Cardiol (Engl Ed)*. 2020;39(9):479-488. doi:10.1016/j.repce.2020.02.014

55. Max Newton, Kelsey Stoddart, Marco Travaglio, et al. EFPIA Patients W.A.I.T. Indicator 2023 Survey. Published online June 2024.

56. INE Portal. Accessed September 17, 2024. https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_destaques&DESTAQUESdest_boui=594418921&DESTAQUESmodo=2&xlang=pt

57. Statistics Portugal - web portal. Accessed September 17, 2024. https://www.ine.pt/xportal/xmain?xpid=INE&xpgid=ine_destaques&DESTAQUESdest_boui=473138405&DESTAQUESmodo=2

58. Gouveia MRA, Ascenção RMSS, Fiorentino F, et al. Current costs of heart failure in Portugal and expected increases due to population aging. *Rev Port Cardiol (Engl Ed)*. 2020;39(1):3-11. doi:10.1016/j.repce.2019.09.009

59. Gouveia M, Costa J, Alarcão J, et al. Carga e custo da fibrilhação auricular em Portugal. *Rev Port Cardiol*. 2015;34(1):1-11. doi:10.1016/j.repc.2014.08.005

60. Luengo-Fernandez R, Walli-Attaei M, Gray A, et al. Economic burden of cardiovascular diseases in the European Union: a population-based cost study. *Eur Heart J*. 2023;44(45):4752-4767. doi:10.1093/eurheartj/ehad583

61. Henrique Martins, Micaela Monteiro, Patrícia Loureiro, et al. National Strategic Plan for Telehealth 2019-2022. SPMS - Shared Services of the Ministry of Health, E.P.E.; 2019

62. Official Gazette, 2nd series - No. 46 — March 6, 2013 (2013); 8325-8326. Published online 2013. https://diariodarepublica.pt/dr/detalhe/despacho/3571-2013-1759945

63. Hospital Healthcare. Accessed July 2024. https://www.acss.min-saude.pt/category/cuidados-de-saude/hospitalares/

64. Miranda R, Oliveira MD, Baptista FM, et al. Telemonitoring in Portugal: where do we stand and which way forward? *Health Policy*. 2023;131:104761. doi:10.1016/j.healthpol.2023.104761

Journal Pre-proof

65. Nunes-Ferreira A, Agostinho JR, Rigueira J, et al. Non-invasive telemonitoring improves outcomes in heart failure with reduced ejection fraction: a study in high-risk patients. *ESC Heart Fail*. 2020;7(6):3996-4004. doi:10.1002/ehf2.12999

66. Cruz IO, Costa S, Teixeira R, et al. Telemonitoring in Heart Failure - A Single Center Experience. *Arq Bras Cardiol*. 2022;118(3):599-604. doi:10.36660/abc.20201264

67. Marzban S, Najafi M, Agolli A,et al. Impact of Patient Engagement on Healthcare Quality: A Scoping Review. *J Patient Exp*. 2022;9:23743735221125440. doi:10.1177/23743735221125439

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