THE IMPACT OF LIFESTYLE FACTORS ON CARDIOVASCULAR DISEASES

Sonata Čerkauskaitė
SMK College of Applied Sciences
Kaunas, Lithuania

SONATA ČERKAUSKAITĖ

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Reviewers:

Dr. Magdalena Korzyńska-Pietas (Medical University of Lublin, Poland)
Dr. Eirini Orovou (University of Western Macedonia, Greece)

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INTRODUCTION

Cardiovascular diseases (CVD) are the leading cause of morbidity and mortality worldwide (Lindstrom et al., 2022). In 2019, CVD were responsible for an estimated 18.6 million deaths globally, accounting for 32% of all deaths across the globe (World Health Organization, 2021). In the European Region, CVD are the predominant cause of disability and premature death, accounting for over 42.5% of all annual deaths that's approximately 10,000 deaths each day (World Health Organization, 2024). Despite significant advances in medical treatment, the prevalence of CVD remains high, largely due to modifiable lifestyle factors. Unhealthy eating habits, physical inactivity, smoking, excessive alcohol consumption, and chronic stress are among the primary contributors to CVD risk (Rippe, 2018). Understanding how these lifestyle components affect heart health is essential for developing effective prevention and intervention strategies (Ghodeshwar et al., 2023).

Lifestyle changes are the basis for preventing cardiovascular disease. Healthy behaviors such as maintaining a balanced diet, engaging in regular physical activity, avoiding tobacco use, managing stress, and sustaining a healthy weight directly reduce modifiable risk factors. When adopted early and practiced consistently, these habits can significantly lower the risk of developing CVD and contribute to long-term improvements in cardiovascular health (Rippe, 2019; Aggarwal et al., 2018).

Some of the most significant lifestyle factors are diet and physical activity, which play a key role in reducing the risk of cardiovascular disease and improving overall health. However, it is important to recognize that other factors such as stress management, sleep quality, smoking status, and social support also contribute in a complex and interconnected way to overall CVD risk (Rippe, 2018).

A heart-healthy diet is a powerful long-term strategy that targets key risk factors such as elevated low-density lipoprotein (LDL) cholesterol, high blood pressure, systemic inflammation, and excess body weight. Studies have shown that dietary patterns such as the Mediterranean and the Diet to Stop Hypertension (DASH) diets, which are rich in fruits, vegetables, whole grains, lean protein, and healthy fats, lower blood pressure, improve lipid profiles, reduce inflammatory markers, and support healthy weight management. These diets emphasize reduced intake of saturated and trans fats, sodium, and added sugars, while promoting foods high in potassium, magnesium, fiber, antioxidants, and omega-3 fatty acids, all of which support cardiovascular function and reduce the risk of CVD (Feingold, 2021; Challa et al., 2023; De Bacquer et al., 2022).

Low levels of physical activity is a leading independent predictor of poor cardiovascular health and associated with an increased prevalence of risk factors that predispose to CVD development (Isath et al., 2023). Regular physical activity that meets or exceeds recommended guidelines reduces cardiovascular risk and mortality, playing a key role in both primary and secondary prevention. Its cardioprotective effects are achieved through improved cardiorespiratory fitness and reduction of CVD risk factors. Unlike general physical activity guidelines, exercise recommendations for patients with CVD are more specific, outlining the mode, intensity, and duration of exercise. Training typically starts with moderate-intensity aerobic exercise, followed by progressively intense resistance training (Tucker et al., 2022).

An important factor in managing and preventing CVD is self-care, which is closely tied to lifestyle habits, particularly diet and physical activity. The individual's commitment to self-care directly influences adherence to risk-reducing behaviors, such as maintaining a healthy diet and engaging in regular physical activity. These lifestyle habits play a crucial role in improving health outcomes and supporting treatment goals. Strong evidence supports the emphasis on self-care in CVD prevention and management guidelines, as individuals who prioritize these behaviors can better manage modifiable risk factors and reduce their cardiovascular disease risk (Riegel et al., 2017).

The novelty of this study is that when assessing CVD rates in European countries, lifestyle factors such as diet, physical activity, smoking, alcohol consumption, body mass index (BMI) and their relationship with subjective health perceptions are analyzed. This method allows for a more detailed assessment of how objective health indicators are related to people's self-assessed health status and long-term health limitations.

By analyzing both objective and subjective health indicators across countries and by gender, it is possible to better understand the problem of CVD itself and identify effective prevention strategies tailored to individual lifestyle choices. This insight is even more important, considering that according to the Global Burden of Disease (GBD) and World Health Organization (WHO) data, CVD has remained the leading cause of death from noncommunicable diseases for two decades, and this trend is likely to continue in the future (GBD, 2016; GBD, 2017; GBD, 2021).

The aim of this study was to analyse the prevalence of CVD in European countries and their association with lifestyle risk factors, based on Eurostat health data, health determinants and cause-of-mortality data. The study assessed how the main lifestyle components BMI, physical activity, smoking, alcohol consumption and frequency of fruit and vegetable consumption are associated with health indicators such as healthy life expectancy, subjective health assessment, prevalence of long-term health problems, arterial hypertension rates and CVD mortality.

Tasks of the research:

1. To assess changes in healthy life years, limitations on independent activities, long-term health conditions and other health-related lifestyle indicators (smoking, alcohol consumption, physical activity, BMI, fruit and vegetable consumption) in European countries during the study period.
2. To analyse changes in morbidity and mortality from CVD (ischemic heart disease and hypertension) and hospitalisations in European countries during the study period.
3. To identify statistically significant associations between lifestyle factors (BMI categories, physical activity, smoking, diet, alcohol consumption, subjective health limitations) and CVD indicators.

The study analyzes the impact of lifestyle factors on CVD risk by examining how these behaviors relate to both objective health indicators and individuals' subjective perceptions of their own health. Since many CVD risk factors are modifiable, the inclusion of self-perceived health, long-standing health limitations, and other subjective measures provides valuable insights into people's readiness to adopt healthier behaviors and the degree to which their daily lifestyle choices reflect or influence their actual health status. Assessing lifestyle through the lens of self-perceived health allows for a deeper understanding of the links between behavior and disease risk, highlighting which lifestyle patterns may be most important for effective prevention. This approach is relevant for both primary prevention, reducing disease risk before CVD develops, and secondary prevention, where lifestyle modification can improve outcomes among individuals already affected by CVD. Conducted as a retrospective correlational study using aggregated Eurostat data, this research offers a population-level perspective on the interplay between lifestyle factors and health outcomes, contributing to the development of more targeted and effective prevention strategies.

1. THE IMPACT OF LIFESTYLE FACTORS ON CARDIOVASCULAR DISEASES

1.1. Overview of cardiovascular diseases

Cardiovascular diseases (CVD) are a class of diseases that affect the heart or blood vessels, and their prevalence is increasing worldwide, making CVD the leading cause of death worldwide. CVD includes coronary artery disease (CAD), such as myocardial infarction, cardiovascular and cerebrovascular diseases, as well as rheumatic heart disease, ischemic heart disease, stroke, and arterial hypertension (Olvera, 2020; GBD, 2021; Murray, 2021).

CVD is divided into several main groups: coronary heart disease, cardiac arrhythmias, atherosclerosis, mitral valve prolapse/regurgitation and myocardial infarction, as well as other vascular pathologies (e.g. stroke, peripheral arterial disease). Coronary heart disease is defined as narrowing of the coronary arteries due to atherosclerosis, causing myocardial ischemia and angina pectoris. Arrhythmias are heart rhythm and conduction disorders characterized by a heartbeat that is too fast, too slow or irregular. Atherosclerosis is defined as damage to the arterial wall and the formation of plaques, leading to narrowing of the lumen and possible complications such as thrombosis or infarction. Mitral valve prolapse and regurgitation mean that the valve fails to close properly and blood flows back into the atrium. Myocardial infarction is an acute injury to the heart muscle that occurs when a coronary artery becomes blocked and the blood supply is interrupted. All these diseases constitute the main spectrum of CVD, which is the leading cause of morbidity and mortality (Khan et al., 2024).

To standardize understanding, the European Society of Cardiology (ESC) classifies CVDs into three main categories: (1) cardiac diseases (e.g., ischemic heart disease, heart failure (HF), valvular diseases), (2) cerebrovascular diseases (e.g., ischemic and hemorrhagic stroke), and (3) peripheral vascular diseases (e.g., peripheral arterial disease). This classification helps to standardize epidemiological and clinical reporting across countries (European Society of Cardiology, 2025).

Baptista et al. (2022) results show that, among the 187 countries studied, the spatial distribution of age-standardized crude CVD mortality rates is larger in Asian, African and Eastern European countries than in the Americas (North, Central and South), Oceania and other European countries (North, Western and Southern Europe) (Figure 1).

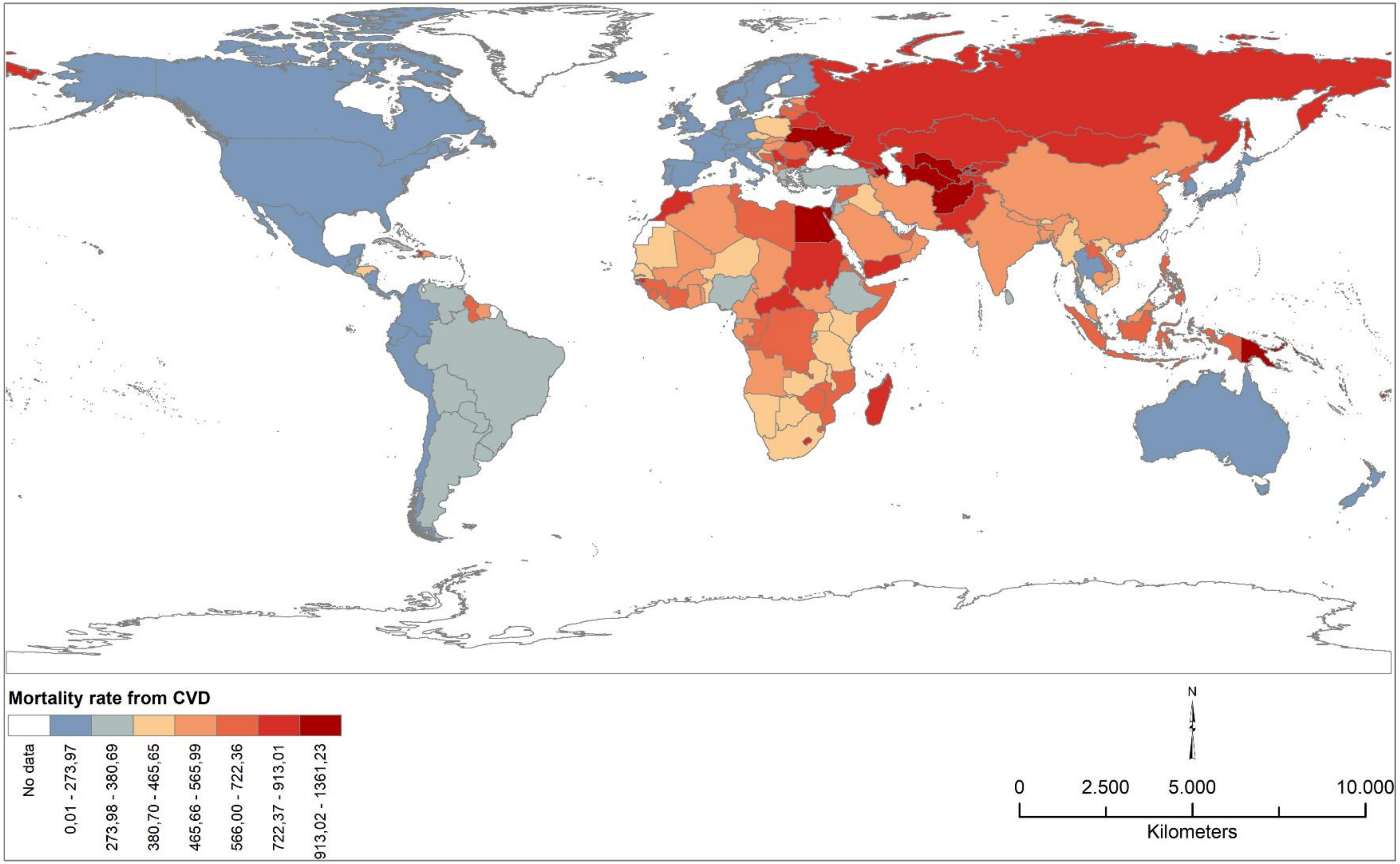

Figure 1. Age-standardized crude mortality rate from cardiovascular disease (per 100,000) by countries, 2013–2017 (Baptista et al., 2022)

The GBD study shows that between 1990 and 2023, CVD remains the leading cause of death worldwide, with its burden increasing every year due to population aging, urbanization, poor nutrition, and other lifestyle risk factors. The latest GBD 2023 results show that CVD caused more than 20.5 million deaths worldwide, accounting for about a third of all deaths. This is a significant increase compared to 1990, when CVD caused about 12 million deaths. The number of deaths has increased by almost 70% over three decades, mainly due to demographic changes (the increase in the number of older people) (GBD, 2023).

These regional differences are strongly influenced by socioeconomic status, healthcare accessibility, prevalence of modifiable risk factors and differences in public health policies. Studies indicate that countries with higher income inequality and limited access to primary prevention programs tend to have higher CVD mortality (Baptista et al. 2022).

In addition to population aging, other contributors to the rising CVD burden include metabolic disorders (such as obesity and diabetes), air pollution, psychosocial stress, reduced physical activity, and dietary changes associated with urbanized lifestyles. Together these factors form a complex interplay that accelerates atherosclerosis progression and increases cardiovascular risk across populations (Siam et al., 2024).

Gender and age differences have also been identified. In women, CVD is more likely to occur at an older age and presents with atypical symptoms (especially in the case of myocardial infarction), which may delay diagnosis. Younger adults, especially those under 50 years of age, are increasingly suffering from obesity, dyslipidemia, and early hypertension, which contribute to the increasing incidence of CVD in younger populations (Keteepe-Arachi et al., 2017).

Although the age-standardized prevalence CVD remains relatively stable, this is largely due to medical advances and improved disease diagnostics. However, the overall prevalence of CVD remains high due to the aging of the population, and further growth is mainly related to atherosclerotic diseases. Therefore, it is of utmost importance to analyze lifestyle factors, monitor their changes, and formulate effective prevention guidelines in order to reduce the long-term burden of CVD (Chong et al., 2024).

According to the 2017–2020 National Health and Nutrition Examination Survey, approximately 48.6% of Americans over the age of 20 have CVD, including congenital heart disease, HF, stroke, or hypertension. Prevalence remains highest among black women (59%) and black men (58.9%). Excluding hypertension, CVD prevalence remains highest among white and black men (11.3%, respectively). CVD is more common than cancer in those younger than 85 years of age (Martin & Aday, 2024).

The total burden of CVD is measured not only in terms of deaths, but also in terms of disability-adjusted life years (DALYs), which reflect years of disability and years of life lost due to disease. According to GBD 2023, CVD accounts for ~395 million DALYs, i.e. about 17% of the total global burden of disability. Ischemic heart disease (IHD) ranks first among all diseases in terms of DALYs, with stroke in second place (GBD, 2023).

Based on the report from the ESC Atlas Project CVD accounts for 11% of the European Union (EU's) total healthcare expenditure. It remains the most common cause of death in ESC member countries with over 3 million deaths per year. Proportionally more deaths from CVD occur in middle-income compared with high-income countries in both females (53% vs. 34%) and males (46% vs. 30%) (Timmis et al., 2024).

In Lithuania, 19,263 people died from circulatory system diseases in 2023, the largest share of whom were people who died from IHD (59.9%) and cerebrovascular diseases (23%). The majority (87.8%) of those who died from circulatory system diseases were people aged 65 and older (Higienos institutas, 2024).

CVDs pose a significant economic burden on societies worldwide. A study conducted in EU countries showed that health and social care costs alone amounted to 155 billion € in 2021, representing 11% of total EU healthcare expenditure. In addition to these direct healthcare costs, indirect societal costs related to patients' lost work or leisure time, as well as to caregivers who care for relatives or friends with CVD, should be added. The significant socio-economic consequences of CVDs place enormous strain on healthcare systems, productivity levels and national budgets (Timmis et al., 2024).

Lifestyle factors, such as diet, alcohol consumption, tobacco use and physical activity, are major risk factors for cardiovascular disease. Smoking increases the risk of death from cardiovascular disease by up to three times. Sugar intake is associated with rates of diabetes and cardiovascular disease. Physical activity also protects against cardiovascular disease. Insufficient levels of physical activity <150 min. of moderate-intensity physical activity per week or <75 min. of vigorous-intensity physical activity per week resulted in more DALYs per 100,000 population in middle-income countries compared with high-income ESC member countries (Tsai et al., 2020; Thun et al., 2013).

Consistent epidemiological studies have identified a number of modifiable risk factors for CVD, and adherence to a combination of health behaviors and health factors has been shown to be an effective way to prevent the onset of CVD and improve prognosis. In addition, lifestyle changes not only reduce the risk of CVD, but are also associated with reduced all-cause mortality and lead to longer life expectancy (Sun et al., 2022; Lv et al., 2017).

Research shows that patients with CVD experience a range of physical symptoms, such as fatigue, shortness of breath or chest pain, which affect their physical, emotional and social well-being and significantly reduce their quality of life (QOL) (Abu et al., 2018).

The WHO defines quality of life as a person's overall physical health, psychological state, level of independence, social relationships, and their relationship to the most important environmental factors (World Health Organization, 2025).

Previous studies have shown that CVD has a significant negative impact on quality of life, with conditions such as myocardial infarction, stroke and HF being associated with long-term impairment of quality of life and significant healthcare costs (Lewis et al., 2014; Ryder et al., 2019). However, other studies have also shown that improved lifestyle, management of environmental factors and advanced treatments such as statins, antihypertensive and antithrombotic drugs can reduce CVD morbidity, disease severity and mortality. Medical advances are improving not only clinical outcomes but also quality of life by reducing the burden of the disease on the patient and the healthcare system (Amini et al., 2021).

The EU uses the Healthy Life Years (HLY) indicator to measure the number of years a person would expect to live in good health, defined as the absence of disability. It combines information on mortality and morbidity and is used to monitor progress in increasing the average HLY of EU citizens (Jagger et al., 2010).

Studies show that a healthy lifestyle not smoking, sufficient physical activity, normal body weight is associated with a longer life expectancy and more years living without chronic diseases such as CVD, cancer or diabetes. People who avoid risk factors live up to 6-16 years longer without health problems. This confirms that lifestyle is crucial for healthy aging (Nusselder et al.,2009; Li et al., 2020).

It was found that people who maintained good CVD lived longer and had fewer CVD years compared to those with poor CVD and spent more years of their lives free of disease. This suggests that a healthy lifestyle is directly linked to a longer and healthier lifespan (Xia et al.,2023).

Studies show that good CVD status is associated with a longer life expectancy. People aged 50 years with good heart health live an average of 8.9 years longer than those with poor heart health. Almost half of this extra life is due to a reduced risk of death from CVD (Ma et al., 2023).

A strong relationship has been found between self-perceived health assessment not only with aspects of physical health, but also with mental health and cognitive functions. BMI, chronic diseases and medications, muscle strength and mobility problems have a significant impact on self-perceived health, as well as quality of life and depression. While other aspects, such as individual characteristics, limitations in daily activities and pain, have only a small impact (Caramenti & Castiglioni, 2022).

Self-rated health is a reliable way to assess a person's overall health status, which is related to the prognosis of mortality, chronic diseases and functional impairment. It reflects not only physical, but also mental and social well-being, as defined by the WHO. It is determined by functional status, chronic diseases such as CVD, pain, psychological well-being and cognitive function (World Health Organization, 2020; Barbosa et al., 2021).

Studies have shown that poorer self-rated health is associated with a higher risk of cardiovascular events and all-cause mortality. Even after controlling for other factors, this association remained significant. Poor health was also associated with a higher incidence of serious adverse events. Therefore, self-rated health may be useful in predicting risk in patients with hypertension (Kazibwe et al., 2024).

Table 1. Key indicators related to CVD

Indicator	**Value**
CVD prevalence in the USA (age 20+)	48.6%
Annual deaths from CVD in the EU	3 million per year
CVD-related deaths in Lithuania (2023)	19,263
EU CVD healthcare expenditure (2021)	€155 billion
Longer life expectancy with good heart health	+8.9 years

In summary, CVD is the leading cause of death worldwide and causes a significant economic and social burden. Although standardized incidence remains stable due to medical advances, overall incidence is increasing due to population aging and atherosclerotic diseases. Lifestyle factors, such as, smoking, diet, physical activity are the main risk factors for CVD. A healthy lifestyle can not only reduce the risk of CVD, but also extend life expectancy and improve quality of life. Studies show that people with good heart health live longer and more years free of disease. Self-rated health is also an important indicator, it is related to physical, psychological and social well-being and predicts CVD and mortality. Therefore, both medical and behavioral measures are necessary to reduce the burden of CVD on society.

1.2. Risk factors: nutrition, physical activity, smoking, alcohol, stress

Daily habits and lifestyle have a significant impact on CVD. Regular physical activity, proper nutrition, weight management, and smoking cessation have been shown to significantly reduce the risk of CVD. Studies show that lifestyle changes can reduce the risk of CVD by 80%. Despite the overwhelming evidence that lifestyle factors influence CVD, only a minority of individuals adhere to these practices. The American Heart Association (AHA) estimates that only 5% of individuals adhere to all of these lifestyle factors (Rippe et al., 2018).

Nutrition plays a crucial role in reducing the risk of CVD. Unhealthy diets contribute to atherogenesis, the main process that causes CVD (De Caterina 2006). The risk of developing CVD is associated with unhealthy dietary habits, such as excessive consumption of sodium and processed foods, added sugars, unhealthy fats, low intake of fruits and vegetables, whole grains, fiber, legumes, fish, and nuts), as well as obesity (Lacroix et al., 2017).

Nutritional effects are particularly important at the cellular level, affecting inflammatory processes that lead to endothelial dysfunction, plaque formation and rupture. One of the most important evidence-based dietary components is omega-3 fatty acids, which, as shown by both epidemiological and clinical studies, help reduce the risk of CVD and are recommended both as food supplements and as part of a healthy diet (De Caterina et al., 2006).

Studies show that atherosclerosis is a major mechanism in the development of cardiovascular disease, which is strongly influenced by diet. Poor nutrition promotes endothelial dysfunction, inflammatory processes and the accumulation of immune system cells in the walls of blood vessels, which leads to plaque formation and their instability. Excessive energy intake leads to obesity and insulin resistance, which increase inflammation and further promote atherosclerosis. Inflammatory cytokines and signaling molecules, the production of which is affected by both diet and metabolic disorders, play a crucial role in plaque rupture and thrombosis formation. Therefore, a balanced diet is essential in reducing the risk of cardiovascular disease (Libby et al., 2002; Grimble et al., 2002; Basta et al., 2004).

Atherosclerosis is a disease of the arterial wall characterized by the accumulation of lipoproteins (especially low-density lipoproteins, LDL) in the inner part of the arterial wall, accompanied by inflammation, exudation, cell migration, and remodeling of the extracellular matrix. As a result, the arterial wall thickens, narrows the lumen, restricts blood flow, and can lead to acute events (e.g., rupture, thrombosis) (Jebari-Benslaiman et al., 2022).

The ESC and the AHA's Committee on Nutrition recommend consuming plenty of fruits and vegetables daily to reduce the risk of cardiovascular disease (Dauchet et al., 2006). Studies suggest that higher fruit and vegetable intake may help reduce the risk of CVD by reducing inflammation in the body. Meta-analyses have shown that eating more fruit and vegetables is associated with lower levels of inflammatory markers such as C-Reactive Protein (CRP) and Tumor necrosis factor (TNF-α). People who eat more fresh fruit have been found to have lower levels of CRP in their blood. Studies in adolescents have also shown that fruit and vegetables are associated with lower inflammation, and certain vegetables even reduce oxidative stress (Hosseini et al., 2018; Arouca et al., 2018; Holt et al, 2009; Corley et al., 2015).

Research shows that regular physical activity is beneficial for CVD health. Frequent physical activity is strongly associated with a reduction in CVD mortality, as well as with a reduced risk of developing CVD. Physically active individuals have lower blood pressure, greater insulin sensitivity, and a more favorable plasma lipoprotein profile (Nystoriak et al., 2018).

Physical activity may reduce the risk of CVD through several mechanisms. First, endurance exercise increases high-density lipoprotein (HDL) levels and reduces triglyceride levels, thereby contributing to a lower risk of coronary heart disease. Second, exercise affects vascular function by increasing endothelial nitric oxide synthase (eNOS) activity and reducing oxidative stress, which may help to inhibit the progression of atherosclerosis. Third, regular physical activity improves systemic insulin sensitivity and promotes glucose and fatty acid uptake, thereby reducing dyslipidemia and endothelial dysfunction associated with insulin resistance (Laufs et al., 2005; Newsom et al., 2013).

Studies also suggest that regular exercise stimulates erythropoiesis through the hypoxia-inducible factor (HIF) and erythropoietin regulatory pathways, thereby improving oxygen delivery. The increased blood pressure and metabolic changes during exercise promote vasodilation and vascular plasticity, and prolonged exercise increases capillary density and endothelial sensitivity to vasodilators, including nitric oxide (NO). These structural and functional changes improve myocardial perfusion and oxygen delivery, thereby enhancing the cardiac response to exercise and reducing the risk of CVD (Semenza et al., 2009; Laughlin et al., 2017; Mobius-Winkler et al., 2016).

The tobacco epidemic causes more than 7 million deaths each year, as well as disability and long-term suffering from tobacco-related diseases. All forms of tobacco use are harmful, and there is no safe level of tobacco exposure. Cigarette smoking is the most common form of tobacco use worldwide. Other tobacco products include waterpipe tobacco, cigars, cigarillos, chewing tobacco, roll-your-own tobacco, pipe tobacco, bidi and kretek, and smokeless tobacco products. The economic costs of tobacco use are high and include high health care costs for tobacco-related diseases, as well as lost human capital resulting from tobacco-related morbidity and mortality (GBD, 2023).

Tobacco smoking, both active and passive (i.e., secondhand), increases the incidence of all phases of atherosclerosis, from endothelial dysfunction to various types. More than 7,000 chemicals, including nicotine, tar, and carbon monoxide, contribute to the development of CVD by increasing heart rate and myocardial contractility, causing inflammation, endothelial damage, thrombus formation, and lowering serum high-density lipoprotein cholesterol (Zaid et al., 2018; Kondo et al., 2011).

Studies show that smoking has a strong negative impact on CVD. Even low levels of exposure to tobacco smoke (e.g., passive or occasional smoking) significantly increase the risk of CVD. Smoking promotes chronic inflammation, which contributes to the development of atherosclerosis and increases inflammatory biomarkers. This increases the risk of heart disease, stroke, myocardial infarction, and peripheral arterial disease. These conditions impair the quality of life of smokers, impair recovery, and increase the likelihood of death and hospitalization (Parmar et al., 2023).

Alcohol consumption has a complex impact on CVD health. Low to moderate levels may have some benefits, but studies are conflicting and suggest that higher doses cause inflammation, oxidative stress, circulatory changes, and cardiac damage. The effects of alcohol depend on the dose and pattern of consumption, and long-term consumption is associated with a range of CVDs, from hypertension to cardiomyopathy (Piano et al., 2017).

As mentioned above, the association between alcohol consumption and CVD is complex and controversial. Decades of research have led to inconsistent recommendations and conflicting reports on alcohol consumption and cardiovascular diseases, such as hypertension, myocardial infarction (MI), stroke, HF, and cardiac arrhythmias. Although excessive alcohol consumption is a major preventable cause of chronic disease, low to moderate alcohol consumption (e.g., no more than 1–2 drinks per day) is thought to have cardioprotective effects, reducing the risk of several forms of CVD. Recent studies using new methodologies (e.g., meta-analysis of individual participant-level data and Mendelian randomization) have challenged the idea that any level of alcohol consumption has a beneficial effect on health (Piano et al., 2025).

Studies show that alcohol increases blood pressure, promotes systemic inflammation, impairs vascular function, and induces oxidative stress. It also damages mitochondria the cellular energy-producing structures leading to cell death and structural changes in heart muscle cells. These changes contribute to a variety of CVDs, including hypertension, atrial fibrillation, coronary heart disease, and even alcohol-induced cardiomyopathy. Binge drinking is particularly harmful, as it can cause sudden cardiac arrest, increase the risk of thrombosis, and can lead to acute cardiac complications. Thus, while alcohol is sometimes touted for its potential benefits, scientific evidence increasingly suggests that any consumption of alcohol should be severely limited or avoided altogether to prevent CVD (Piano et al., 2025; National Academies of Sciences, 2025).

It is widely accepted that psychological stress is associated with increased CVD risk. The mechanisms and possible causal relationships are speculative despite decades of research. Physiological responses to stress are well characterized, but their contribution to the development and progression of CVD has received little attention in empirical studies. Evidence suggests that physiological responses to stress play a fundamental role in CVD risk and that stress-induced hemodynamic, vascular, and immune disturbances are particularly important. The physiology of the stress response is regulated by corticolimbic brain areas, which have outputs to the autonomic nervous system. Differences in these regulatory pathways may explain individual differences in vulnerability to stress. Dynamic disturbances in autonomic, immune, and vascular functions are likely also involved in CVD risk mechanisms associated with chronic, repetitive, and cumulative stress, but more data from prospective studies and real-world assessments are needed. However, stress-reduction interventions can reduce perceived stress levels and potentially reduce CVD (Vaccarino et al., 2024).

Stress is the body's response to external or internal factors that activates the sympathetic nervous system and the hypothalamic-pituitary-adrenal (HPA) axis. The activity of these systems stimulates the release of stress hormones - cortisol and adrenaline - which in the short-term help to adapt to environmental changes, but in the long-term cause negative consequences. Continuous stress exposure to the CVD system can cause increased blood pressure, heart rhythm disorders, vascular endothelial dysfunction, inflammatory processes and blood vessel stiffening and reduced elasticity. In addition, stress often leads to harmful lifestyle changes, such as smoking, unhealthy diet or physical inactivity, which further increase the risk of cardiovascular diseases (Yaribeygi et al., 2017; Tortajada et al., 2017).

Studies also show that the risk of CVD disorders is higher in patients with a history of social isolation, marital stress, work stress, childhood violence or trauma (Giménez-Campos et al., 2017). Statistical studies show that about 40% of people working in stressful environments are at increased risk of developing cardiovascular diseases, and social exclusion increases this risk to 50%. Therefore, stress is considered a major risk factor for CVD, along with other known risk elements (Steptoe et al., 2023).

Figure 2 summarizes how lifestyle factors are associated with various pathological processes in the body that ultimately lead to CVD.

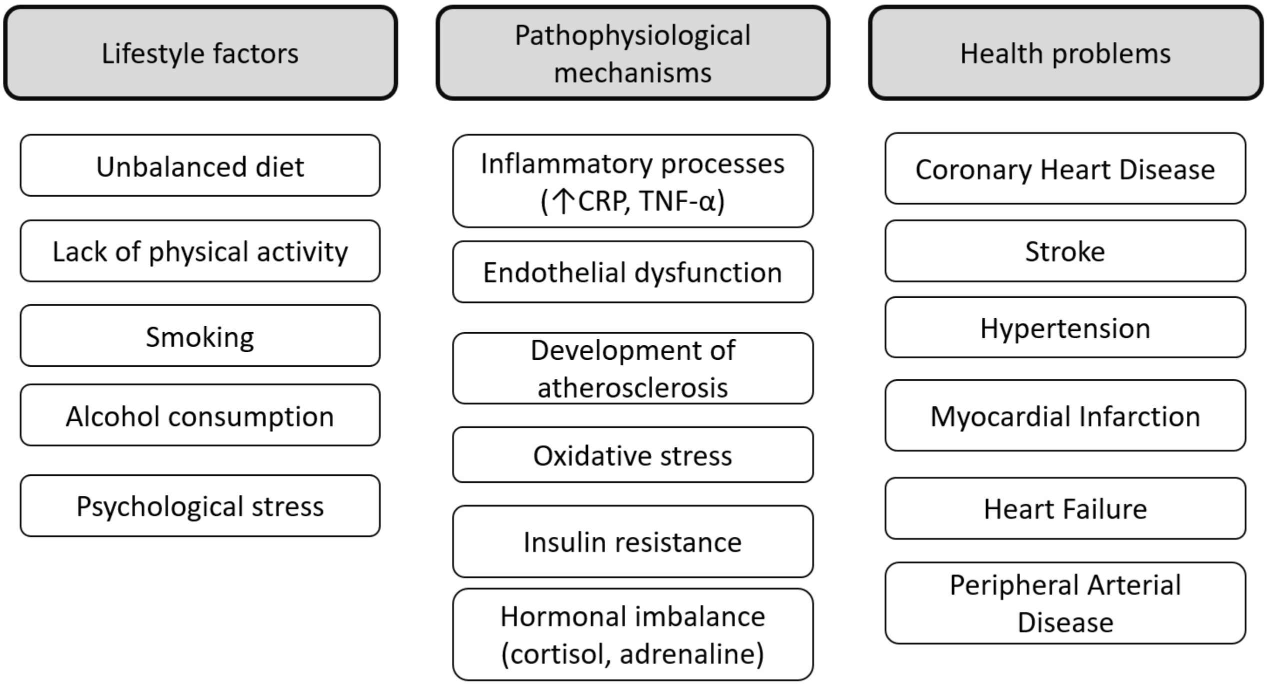

Figure 2. Key lifestyle factors and their impact on the pathogenesis of CVD

Socioeconomic status (SES) has a significant and measurable impact on the cardiovascular system. Biological, behavioral, and psychosocial risk factors, which are more common among socially disadvantaged individuals, reinforce the association between SES and CVD. The four main SES indicators consistently associated with CVD are income level, education, employment status, and socioeconomic environment of residence. In addition, many studies suggest that these differences may also be related to gender. Interventions targeting low SES groups tend to focus on modifying traditional CVD risk factors, such as diet, physical activity, or smoking. In recent years, new approaches have emerged that can be applied at the individual, community, or societal level to reduce health inequalities. For example, structured physical activity programs have been shown to be effective among low SES populations, and geographic mapping allows the identification of areas where larger-scale health promotion initiatives are needed (Schultz et al., 2018).

Recent studies suggest that SES is inversely correlated with CVD outcomes and CVD severity. Women may be more sensitive to income and education in terms of CVD incidence. Men may be more sensitive to income and education in terms of CVD mortality, and people from low- and middle-income countries are more sensitive to income and education (Wang et al., 2024).

Genetic influences and metabolic disorders also play a major role in CVD risk. The example of familial hypercholesterolemia clearly demonstrates that genetic factors such as high LDL ("bad" cholesterol) levels contribute to early atherosclerosis and significantly increase the risk of CVD (Smilde et al., 2001). In addition, metabolic syndrome, which includes insulin resistance, visceral fat accumulation, dyslipidemia, and hypertension, is quite often associated with CVD. Studies have shown that genetic markers of metabolic disorders have been associated with an increased risk of CVD (e.g., coronary heart disease, myocardial infarction, HF) (Wang et al., 2023).

Studies show that metabolic disorders cause oxidative stress, fatty deposition in the arterial walls, mitochondrial dysfunction and inflammation, which create a favorable environment for the progression of atherosclerosis and CVD (Wang et al., 2023). Genetic factors, such as predisposition to diabetes, dyslipidemia or obesity, act not only directly, but also through metabolic mediators, therefore genetic and metabolic links with CVD are complex and intertwined (Wong et al., 2022).

In summary, it can be stated that CVD risk factors are closely related to lifestyle, including diet, physical activity, smoking, alcohol consumption and stress. Up to 80% of CVD cases can be prevented by following the principles of a healthy lifestyle, but only a small proportion of the population adheres to them. An unbalanced diet, lack of physical activity, smoking and excessive alcohol consumption promote inflammatory processes, endothelial damage, the development of atherosclerosis and other pathological changes. Chronic stress also negatively affects blood circulation, increases blood pressure, disrupts heart rhythm and causes behavioral changes that contribute to an increase in the risk of CVD. Therefore, a healthy diet, regular exercise, giving up bad habits and stress management are essential for CVD prevention. Also, socio-economic status, genetic predisposition and metabolic disorders significantly affect the risk of CVD.

1.3. Principles of a healthy lifestyle and their preventive significance

Lifestyle medicine (LMM) is a new but rapidly growing discipline focused on the role of lifestyle factors in preventing and managing chronic disease. At this stage in the field's evolution, there is strong evidence that the six pillars of LMM whole foods, a plant-based diet, physical activity, restorative sleep, stress management, avoidance of harmful substances, and positive social connections are essential factors in creating and maintaining health (Lippman et al., 2024).

Lifestyle medicine differs from other aspects of medicine in that its guiding principles are the application of daily healthy habits to prevent, treat, and even reverse chronic disease. Unlike conventional medicine, which focuses on medications whose benefits depend on the specific condition, lifestyle benefits are not. Lifestyle practices are aimed at all diseases, whether prevention or treatment. There is a strong emphasis on education and behavioural change, so it must be acknowledged that this can be a time-consuming area for both the patient and the physician. Nevertheless, its value is seen both for patients and for the healthcare system (Ford et al., 2009; Lippman et al., 2024).

According to research, it can be stated that lifestyle has a significant impact on a person's physical and mental health in various forms. Consanguinity in a certain ethnic group is the dominant lifestyle form that causes genetic disorders. Changing this unhealthy lifestyle is a preventive factor that reduces the number of genetic diseases. In some countries, excessive drug use is the main form of unhealthy lifestyle. There are also countries that use a lot of medicines (e.g. Iran) (Karimi et al., 2010; Farhud et al., 2015). Although self-medication, such as antibiotics, negatively affects the immune system, self-care is very important in an aging society where chronic non-communicable diseases are increasing. Awareness of one's illness, adherence to treatment regimens, and maintaining a healthy lifestyle can prevent chronic diseases and be an excellent preventive measure (Riegel et al., 2017).

The GMM approach is also crucial to address the underlying causes of the growing burden of chronic diseases. A large proportion of healthcare spending is spent on treating diseases, with only a small proportion on prevention and lifestyle medicine. However, there is a wealth of evidence supporting the effectiveness of lifestyle and behavioural health in managing a range of health risks and medical conditions (Edington et al., 2020).

Therefore, the efforts of the health system should be directed towards prevention. For this purpose, it is important to know the prevalence of lifestyle habits in different population groups and how they vary depending on socio-economic variables. Studies show that nutrition is influenced by age, with adult women eating better than younger women, although they are less sedentary and do less exercise. Women with higher education and average or high incomes eat better, live healthier lives, have lower BMIs, and have higher self-esteem than women with basic education and lower incomes. It has been found that higher income and higher levels of education generally lead to healthier lifestyles (Sandri et al., 2023).

There is a wealth of scientific research supporting the importance of lifestyle in reducing the risk of chronic diseases, including CVD (Rippe et al., 2018). There are also many guidelines that provide lifestyle recommendations for the risk or prevention of chronic diseases. The ACC/AHA guidelines provide recommendations on how behavioural and motivational strategies can help people with high blood pressure (hypertension) change their lifestyle. The most important recommended lifestyle changes are: quitting smoking, losing weight if overweight, moderate alcohol consumption, increasing physical activity/movement, reducing salt intake, and following a healthy diet. It is indicated how to promote these changes (effective strategies): goal setting (realistic and achievable goals), receiving feedback on progress, self-monitoring (e.g., tracking nutrition or physical activity), regular monitoring/support (follow-up), motivational interviews with specialists, and promoting self-efficacy (belief that I can do it myself). It is stated that even small but long-term lifestyle changes can significantly reduce the risk of CVD. To achieve long-term results, lifestyle changes must be supported and tailored to the individual, considering their culture, financial situation, health, and environment (Whelton et al., 2018).

The AHA clearly emphasizes in its 2024-2028 strategic policy agenda that a healthy lifestyle is a key factor in achieving longer and healthier lives. The document emphasizes that in order to reduce the prevalence of CVD, stroke and other chronic diseases, it is necessary not only to promote healthy individual choices, but also to create environments and systemic conditions that facilitate the adoption of such choices. The AHA pays special attention to nutrition, physical activity and the prevention of addictions - especially tobacco. The aim is to ensure that healthy food is accessible, affordable and of good quality for everyone, and physical activity is integrated into everyday life through appropriate infrastructure, education and health systems solutions. It is emphasized that lifestyle changes, such as a healthy diet, regular physical activity and behaviour change, are the main evidence-based methods for the prevention and treatment of obesity and metabolic diseases - such as diabetes and hypertension. The AHA also advocates for people to be able to monitor and manage their own health, such as through self-monitoring of blood pressure or digital health technologies. Digital tools, the AHA says, can help both diagnose and manage health problems and encourage lifestyle changes (American Heart Associations, 2024).

The 2021 ESC guidelines also clearly emphasize that lifestyle changes are the first and essential step in CVD prevention. Both healthy and high-risk individuals are recommended to change their habits even before starting drug treatment. It is recommended to not smoke, limit alcohol consumption, eat a balanced diet (especially following the principles of the Mediterranean or DASH diet), maintain a normal body weight and exercise regularly - at least 150 minutes of moderate-intensity physical activity per week. These guidelines also set clear target limits for blood pressure (especially systolic - Systolic Blood Pressure (SBP)). The initial goal is to reduce SBP to <160 mmHg in all individuals, even if they appear healthy. However, long-term goals are more stringent: for most adults, the goal is to achieve an SBP of 130 to 139 mmHg. This is especially important if the individual belongs to an increased CVD risk group or has a history of atherosclerotic heart disease. An important innovation of the guidelines is the principle of “stepped” treatment. Lifestyle interventions are used first, and if blood pressure goals are not achieved within 3–6 months, drug therapy is considered. Decisions are made together with the patient, taking into account their age, health status, preferences and life circumstances. In summary, the ESC guidelines encourage a personalized approach: starting with a healthy lifestyle, assessing the individual's risk profile, applying an appropriate target blood pressure range (usually 130–140 mmHg) and, if necessary, supplementing treatment with drugs. Lifestyle remains a key aspect in all cases, from healthy young adults to older patients with complex medical conditions (Visseren et al., 2021).

The 2023 European Society of Hypertension (ESH) Guidelines for the management of arterial hypertension also emphasize that lifestyle changes are an essential and effective tool for reducing blood pressure and reducing the risk of CVD. A healthy lifestyle reduces blood pressure by as much as 4–5 mmHg and enhances the effect of medications, but in severe cases it should not delay the start of drug treatment. The main effective measures are weight loss, the DASH diet, reducing salt intake, increasing potassium in the diet, regular physical activity, limiting alcohol consumption and quitting smoking. Weight loss is particularly important, as each kilogram reduces blood pressure by about 1 mmHg, but long-term success requires an individualized approach and ongoing care. Salt restriction (up to 5.8 g per day) is effective in reducing blood pressure, but excessive restriction may be harmful, so further research is needed. Potassium intake (e.g., from fruits and vegetables) improves blood pressure control and reduces the risk of stroke. Physical activity, especially moderate-intensity aerobic activity, reduces the risk of hypertension and blood pressure in both normotensive and hypertensive patients. Smoking not only increases the risk of heart disease but also increases diurnal blood pressure fluctuations (Mancia et al., 2023).

Research shows that lifestyle assessment provides a more accurate understanding of how various daily habits, such as nutrition, physical activity, sleep quality, smoking or stress levels, directly affect health and the development of diseases. Such information is essential for assessing risk factors that can lead to CVD, diabetes, cancer and other chronic diseases. In addition, lifestyle assessment can identify risky behaviour patterns and more accurately adapt preventive measures or treatment plans focused on the individual needs of the patient. This increases the effectiveness of interventions and can significantly improve quality of life and reduce healthcare costs in the long term. Lifestyle assessment also provides an opportunity to monitor changes over time, allowing you to assess how various interventions affect the patient's health and what changes are needed to achieve better results (Rozanski et al., 2023).

Figure 3 summarizes the risk reduction for CVD and other chronic diseases based on four key lifestyle factors: a whole, plant-based diet, regular physical activity, stress management, and avoidance of harmful substances such as tobacco and alcohol. These interrelated factors contribute to a range of positive health outcomes, including improved mental health and emotional well-being, weight control and obesity prevention, reduced risk of type 2 diabetes, more effective prevention of cardiovascular disease, and reduced reliance on medications.

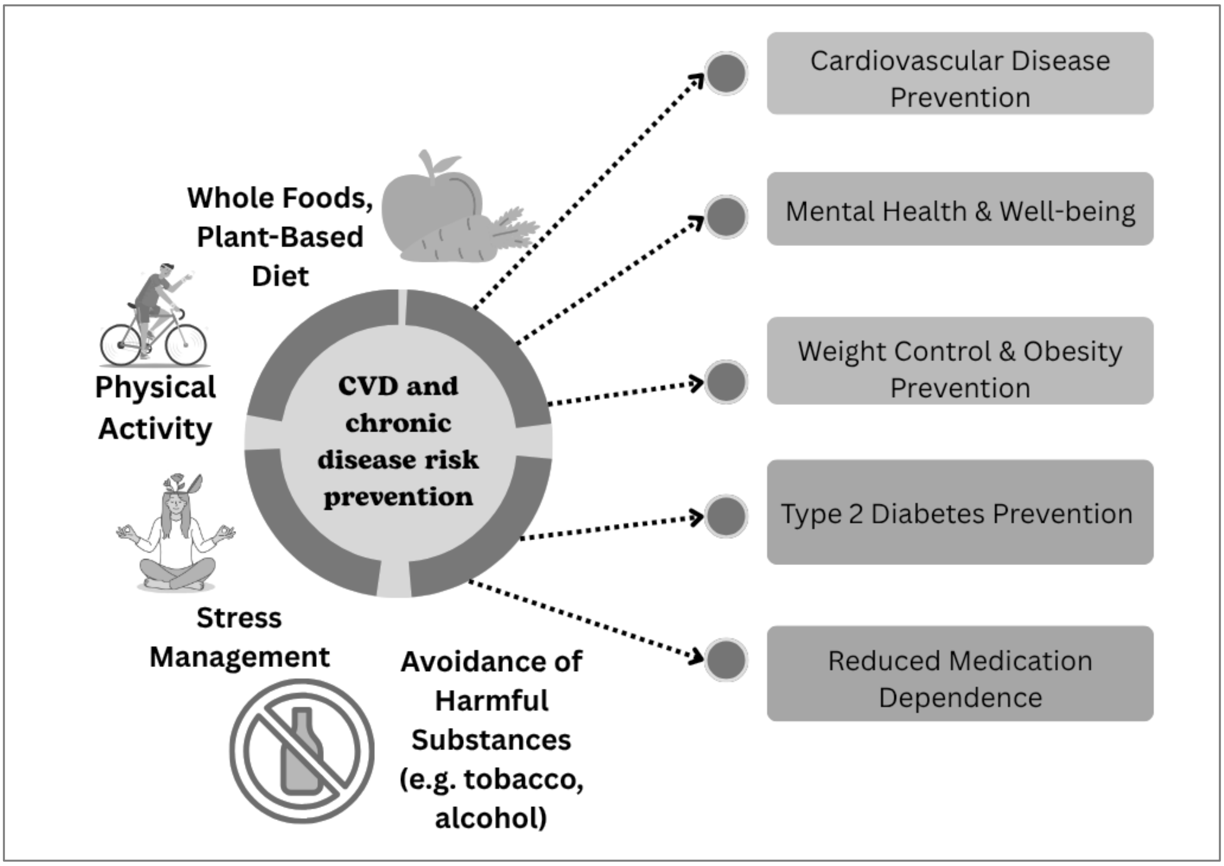

Figure 3. Principles of a healthy lifestyle and their preventive significance

In Lithuania, the main problems related to CVD are high morbidity and mortality from chronic non-communicable diseases, poor health literacy, insufficient physical activity, unhealthy diet, obesity, smoking, alcohol consumption and psychoactive substance use. Regional health disparities, limited access to public health services and insufficient application of comprehensive, integrated and science-based measures for CVD risk management are also evident. Therefore, the 2022–2030 Health Preservation and Strengthening Development Programme of the Republic of Lithuania is designed to implement the goals of the National Progress Plan, improve the health of the population, reduce morbidity and mortality from diseases that can be prevented by preventive measures, including CVD. The progress measures provided for in the Programme directly contribute to the prevention of CVD. The first measure – strengthening the management of health threats and risk factors – includes integrated preventive measures, such as healthy nutrition, promotion of physical activity, reduction of smoking and alcohol consumption, improvement of specialist qualifications and increasing health literacy of the population. The second measure focuses on strengthening the mental health of the population and prevention of addictions, including control of alcohol, tobacco and other addictive factors that directly affect the risk of cardiovascular diseases. The third measure – increasing the availability of public health services in the regions – ensures that preventive and therapeutic measures are available to all residents, reducing regional disparities and improving the management of CVD risk factors. The program also provides specific indicators for CVD prevention: the proportion of obese adults should decrease from 14.7% to 14%, physical activity of school-age children should increase from 38.1% to 44%, fruit and vegetable consumption per adult should increase from 346 g to 400 g per day, smoking rates should improve from 38.3% to 46%, and alcohol consumption should decrease from 11.4 to 9.4 l per person per year. These indicators directly contribute to reducing the risk of CVD and reducing mortality through preventive measures (Ministry of Health of the Republic of Lithuania, 2025).

The CVD prevention program implemented in Lithuania is intended for men and women aged 40 to 60 (inclusive), for whom the family doctor determines risk factors at a specified frequency and, if necessary, draws up an individual CVD prevention plan. If the doctor determines that the probability of CVD is very high, the patient is sent to specialized centers for a more detailed examination. If necessary, treatment is prescribed. The patient can have his blood glucose, cholesterol, triglycerides levels determined free of charge, an electrocardiogram and other tests performed to show whether the person is classified as a high-risk group (Ministry of Health of the Republic of Lithuania, 2024).

In summary, lifestyle principles such as healthy eating, a plant-based diet, physical activity, quality rest, stress management, avoidance of harmful substances and positive social relationships are essential factors for maintaining health and preventing CVD. Research shows that lifestyle has a significant impact on both physical and mental health, therefore, promoting a healthy lifestyle and preventing diseases should be the main goal of the health system. International guidelines, such as the recommendations of the AHA, the ESC and the ESH, emphasize the importance of lifestyle changes as the first and necessary step in the prevention and treatment of chronic diseases. The guidelines suggest a "stepped" treatment strategy, where lifestyle changes are applied first, and medications are prescribed only when the target results are not achieved. Lifestyle assessment helps to better understand how daily habits affect health and the development of diseases, allows identifying risky behavioral patterns and applying more effective preventive and treatment measures. This can significantly improve the quality of life and reduce healthcare costs in the long term.

2. RESEARCH METHODOLOGY ON THE IMPACT OF LIFESTYLE FACTORS ON CARDIOVASCULAR DISEASES

This study is a retrospective correlational based on aggregated secondary data. It analyses the association of lifestyle factors, such as diet, physical activity, smoking and alcohol consumption, with the incidence and mortality of cardiovascular diseases in European countries. The study uses freely available secondary health data from Eurostat from 2012 to 2024. This methodology allows for comparison of long-term trends across countries and the identification of associations between lifestyle factors and health indicators.

The aim of this study was to analyse the prevalence rates of CVD in European countries and their associations with lifestyle risk factors, based on Eurostat health data, health determinants and causes of mortality data. The study aims to assess how the main lifestyle components, BMI, physical activity, smoking, alcohol consumption and frequency of fruit and vegetable consumption, are associated with health indicators such as healthy life expectancy, subjective health assessment, prevalence of long-term health problems, arterial hypertension rates and CVD mortality.

Tasks of the research:

1. To assess changes in healthy life years, limitations on independent activities, long-term health conditions and other health-related lifestyle indicators (smoking, alcohol consumption, physical activity, BMI, fruit and vegetable consumption) in European countries during the study period.
2. To analyse changes in morbidity and mortality from CVD (ischemic heart disease and hypertension) and hospitalisations in European countries during the study period.
3. To identify statistically significant associations between lifestyle factors (BMI categories, physical activity, smoking, diet, alcohol consumption, subjective health limitations) and CVD indicators.

The study aims to test the following **hypotheses:**

H1. The impact of lifestyle risk factors (smoking, physical activity, diet, alcohol consumption, and BMI) on CVD indicators (CVD mortality, hypertension prevalence, and CVD hospitalizations) differs statistically significantly between genders and has a complex, interacting association.

H2. Subjective assessment of one's health is as important as objective health indicators (healthy life expectancy, hypertension prevalence, CVD mortality) and reflects lifestyle self-care, which influences CVD risk and is associated with less favorable objective health indicators.

The Eurostat health statistics, which measure both objective and subjective aspects of people's health, were chosen for analysis. They focus on various health-related aspects, including key indicators of the performance of healthcare systems and the health and safety of workers. The data analysed cover the following topics: health status, health determinants, causes of death.

Eurostat collects health data mainly through two main surveys: EU-SILC (European Statistics on Income and Living Conditions) and EHIS (European Health Interview Survey). EU-SILC is carried out annually and provides information on self-rated health, chronic diseases or long-term health problems and disability. These are long-term limitations in daily activities due to health conditions. EHIS is carried out every five years and covers a wider range of topics: health status, health determinants (lifestyle habits, barriers to access to healthcare) and health care use. EHIS targets the population aged 15 and over living in private households. Eurostat data are collected through national questionnaires, which can be carried out separately or embedded in other national surveys. Various collection methods are used: personal interviews, telephone interviews, self-administered questionnaires or a combination of these. Eurostat provides common questionnaire templates and methodological guidelines to ensure comparability across countries and time periods. Importantly, Eurostat data are standardized according to international classifications: regions – according to Nomenclature of territorial units for statistics (NUTS), education – according to International Standard Classification of Education (ISCED), occupations – according to International standard classification of occupations (ISCO-08), sectors of economic activity – according to Statistical Classification of Economic Activities in the EU (NACE Rev.2) (Eurostat, 2021). This allows them to be reliably used as secondary data

Figure 4 presents a diagram of the study.

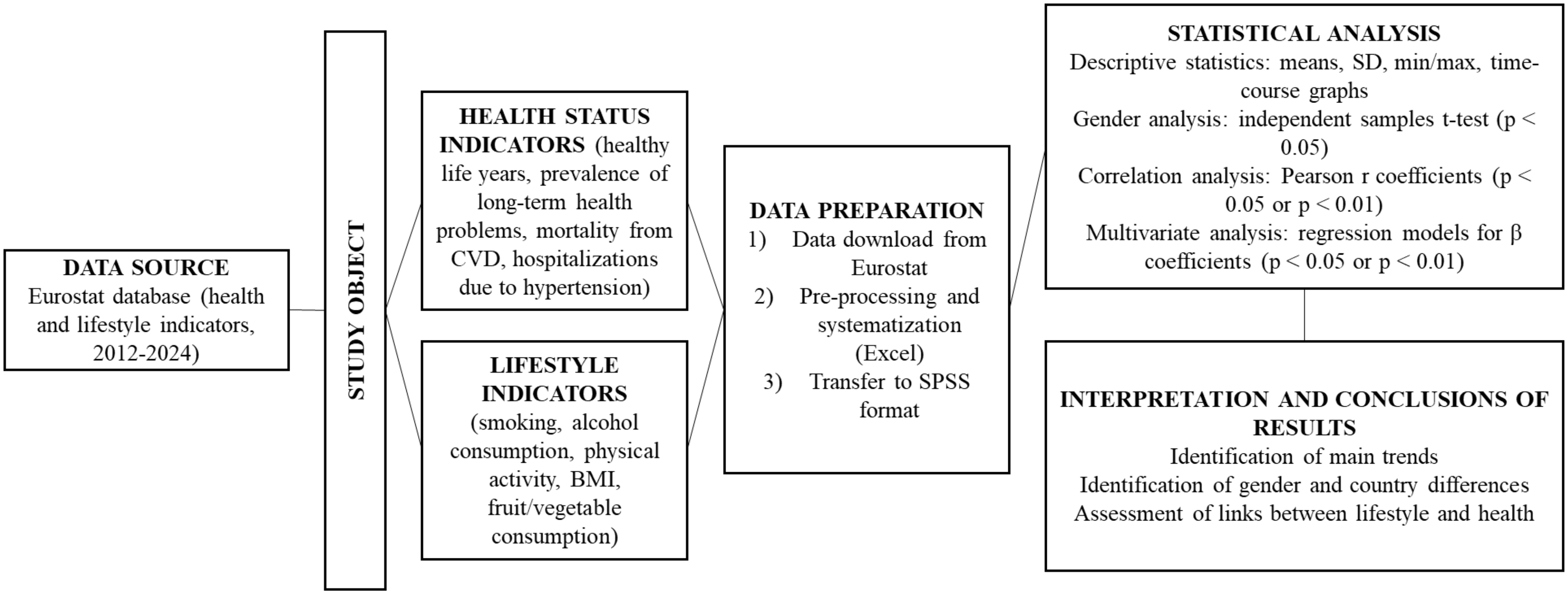

Figure 4. Study design scheme

2.1. General study data

All data were retrieved from the Eurostat database, specifically the Health status, Health determinants, and Causes of death sections. Data were available at the country and gender level and originated from nationally representative surveys and health registries.

The study variables were selected based on Eurostat methodology to assess the main CVD risk factors. BMI, physical activity, smoking, alcohol consumption, and fruit and vegetable consumption were included, as these factors are directly related to hypertension, ischemic heart disease, obesity, metabolic syndrome, and the overall CVD risk profile.

Before analysis, data were harmonized to ensure comparability across countries and years. Missing values were handled using appropriate imputation. Due to the small amount of missing data, missing values were imputed using the median by year.

To assess lifestyle factors in CVD, the indicators presented in Table 2 were analysed.

Table 2. Health indicators and units of measurement

Variable	Time	Unit of measurement
Health outcomes		
Healthy life years	2013-2022	Year
Self-perceived long-standing limitations in usual activities due to health problems categories: some, severe, none	2015-2024	Percentage of population
People having a long-standing illness or health problem	2015-2024	Percentage of population
Reporting chronic high blood pressure	2015-2024	Percentage of population
Mortality from ischemic heart disease	2013-2022	Per 100,000 population
Hospital discharges due to arterial hypertension	2012-2021	Number of discharges
Deaths caused by CVD	2021	Percentage of all deaths
Lifestyle factors		
Body mass index (BMI) categories: underweight, normal, overweight, obese	2015-2024	Percentage of population
Aerobic physical activity (leisure, non-work related, by minutes per week: 0, 1–149, 150–299, 300+)	2019	Percentage of population
Frequency of fruit consumption (daily, 1–3 times/week, never)	2014, 2019	Percentage of population

Table 2 continued

Frequency of vegetable consumption (daily, 1–3 times/week, never)	2014, 2019	Percentage of population
Smoking habits (non-smoker, daily smoker, occasional smoker)	2014, 2019	Percentage of population
Alcohol consumption frequency (every day, every week, every month, less than once/month, never or not in last 12 months)	2014, 2019	Percentage of population

2.2. Study objects and their characteristics

The study analysed changes in health status and lifestyle indicators of the population of European countries and their interrelationships. The data were analysed by country and gender (separately for men and women) to identify significant differences between the sexes. The objects of the study are aggregated indicators of the health status and lifestyle of the population, often used in international public health surveys. The number of healthy life years, which shows the average number of years of life that a person can expect to spend without getting sick. The proportion of people with long-term health problems, is a subjective indicator showing how many people report health problems lasting longer than 6 months. Mortality rates, such as the incidence of death from IHD (100,000 population). The incidence of hospitalizations due to arterial hypertension, these data are limited in some countries but cover several periods. These indicators allow us to assess both the subjective and objective health status of the population in European countries and form the basis for further analysis of the relationship between lifestyle factors and health status.

When assessing the impact of lifestyle on health, the following key lifestyle factors were analysed: smoking, alcohol consumption, physical activity, i.e. the BMI of individuals engaged in moderate-intensity physical activity, and nutrition, i.e. the frequency of fruit and vegetable consumption.

2.3. Statistical data analysis

Statistical analysis of data was performed using IBM SPSS Statistics 22.0 software. Data were downloaded from the Eurostat database. The initial data processing and systematization was performed using Microsoft Excel, and for further statistical analysis, the data was transferred to SPSS format. The created researcher's database was used for quantitative analysis.

Before applying correlation and regression analysis, basic statistical assumptions were checked. Normality was assessed using the Shapiro–Wilk test.

The following methods were used for the analysis:

- Descriptive statistics: means, standard deviations (SD), minimum and maximum values were calculated.
- Gender analysis: at all stages of the analysis, data were evaluated separately for men and women. The independent samples t-test was used to determine whether differences between genders were statistically significant (p value < 0.05).
- Correlation analysis: Pearson's correlation coefficient (r) was calculated to determine the associations between lifestyle factors (e.g., BMI, smoking, physical activity) and health indicators (e.g., healthy life years). Statistically significant correlations were assessed ($p < 0.05$ or $p < 0.01$).
- Univariate regression analysis was applied to each lifestyle factor (obesity and physical inactivity, fruit and vegetable consumption, smoking, alcohol consumption) to determine their associations with health indicators (cardiovascular mortality, hypertension, healthy life years). The results of the analysis are presented as β coefficients, standard errors (SE) and p values. A p value < 0.05 was considered statistically significant.
- Factor analysis was performed to identify the main lifestyle factors by grouping together interrelated variables such as smoking, alcohol consumption, physical activity, diet and BMI. This method reduces the number of variables and highlights latent factors that may influence CVD. The following interval lifestyle indicators were included in the analysis: frequency of fruit and vegetable consumption, smoking habits, alcohol consumption, physical activity level and BMI. Using a rotational component matrix, three main factors were identified: diet (fruit and vegetable consumption habits), harmful habits (smoking and alcohol consumption) and obesity (BMI categories). The factor scores were then calculated and stored as new variables in SPSS using the regression method to allow for subsequent regression analyses to assess the contribution of these lifestyle factors to CVD prevalence in Europe.
- To assess the association of these factors on the incidence of CVD, linear regression was performed, where the dependent variables were healthy life expectancy, high blood pressure, total CVD mortality (and deaths from ischemic heart disease).

2.4. Ethical aspects

The study used only publicly available, aggregated secondary data from Eurostat. No individual-level or personally identifiable information was used or processed. All Eurostat analyses were conducted in accordance with standard research ethics principles, ensuring confidentiality and responsible use of data. As this study did not directly involve human subjects, ethical review board approval was not required.

3. RESEARCH RESULTS ON THE IMPACT OF LIFESTYLE FACTORS ON CARDIOVASCULAR DISEASES

3.1. Descriptive statistics of lifestyle factors

This study analysed secondary freely available Eurostat data. The study assessed health indicators related to lifestyle and CVD. Descriptive statistics assessed trends in the analysed periods of the year in European countries.

Analysing the data on HLY for 2013–2022, several clear trends can be distinguished among European countries. Some countries have been characterized by a growth trend over the past decade, where the indicators have gradually increased. Among such countries, Slovenia stands out, where HLY increased from 58.5 to 66.7, as well as Bulgaria, Estonia, Hungary, Lithuania and Italy - all of them show stable growth despite intermediate fluctuations. Other countries, on the contrary, have encountered a downward trend in HLY. For example, Denmark and the Netherlands experienced a significant decrease, while in Sweden, after extremely high indicators in 2015–2019, a decline is later observed. In Germany, after significant growth until 2019, a decline in HLY is also observed in 2022. Among the countries whose indicators have remained relatively stable, Belgium, France, Poland and Portugal can be distinguished - here the fluctuations were minimal, and no long-term changes are visible. Exceptionally high rates were recorded throughout the period in Malta (around 72–73) and Ireland and Sweden until 2020, which often exceeded the European average (Table 3).

In Lithuania, a gently increasing rate is recorded in the HLY 2013–2022 period: from 59.2 in 2013 to 60.3 in 2022. Although there were some fluctuations and even a drop to 56.8 between 2015–2020. In 2020, however, the rate has started to rise again since then. This shows that the situation in Lithuania has generally improved over the decade, although the growth is not very pronounced (Table 1).

Overall, HLY in Europe increased quite consistently from 2014 to 2019. However, a significant decrease began to be observed from 2019. Only the data for 2023 show an increase again. So the future trend is interesting (Appendix 1).

Table 3. Healthy life years total average in all Europe countries, Eurostat data

Countries	Healthy life years									
	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Belgium	63.9	64.1	64.2	63.7	63.7	63.4	62.4	63.8	64.6	63.7
Bulgaria	64.5	64.0	63.2	65.7	64.5	65.8	66.3	65.6	63.3	66.7
Czechia	63.3	64.1	63.0	63.3	61.4	62.7	62.0	61.6	62.0	61.8
Denmark	60.5	60.9	59.1	60.3	59.7	60.9	58.9	58.0	56.6	55.9
Germany	57.4	56.5	66.4	66.4	66.0	65.8	66.3	65.7	65.6	61.1
Estonia	55.5	55.2	55.0	56.8	56.0	53.9	55.8	57.6	56.5	59.3
Ireland	66.9	66.9	67.2	68.5	68.6	69.4	69.6	66.2	67.2	66.0
Greece	64.9	64.5	64.0	64.3	64.8	65.4	66.0	65.9	65.6	67.0
Spain	64.3	65.0	64.0	66.2	69.4	68.0	69.9	66.3	62.8	61.2
France	63.6	63.8	63.6	63.4	63.7	63.9	64.1	64.6	66.2	64.4
Croatia	59.0	59.3	56.1	57.9	57.6	57.5	57.4	58.5	58.6	60.3
Italy	61.6	62.4	62.6	67.4	66.3	66.8	68.3	68.0	68.1	67.4
Cyprus	64.7	66.0	63.3	68.2	65.2	62.2	62.5	62.9	65.7	66.0
Latvia	53.0	53.4	53.0	53.6	51.4	52.3	53.1	53.4	53.8	54.2
Lithuania	59.2	59.7	56.5	57.8	58.1	57.7	57.5	56.8	57.6	60.3
Luxembourg	63.3	63.8	62.2	60.2	59.2	60.7	62.6	63.3	62.0	60.2
Hungary	59.5	59.9	59.1	59.8	60.2	61.1	61.7	62.5	62.5	62.6
Malta	72.1	73.4	73.6	71.7	72.7	72.7	73.2	70.5	68.7	70.2
Netherlands	59.5	61.2	59.1	60.3	60.0	59.2	61.0	61.1	60.3	58.5
Austria	59.9	57.7	58.0	57.0	57.1	56.9	57.3	58.7	61.8	60.9
Poland	61.0	61.3	61.6	62.9	62.0	62.4	62.5	62.3	62.6	62.4
Portugal	63.0	56.9	56.5	58.6	58.5	58.6	59.2	59.7	58.3	59.1
Romania	58.4	59.0	59.2	59.4	58.7	59.4	60.2	59.9	57.8	59.0
Slovenia	58.5	58.7	58.1	58.3	55.0	55.5	60.9	65.1	65.4	66.7
Slovakia	54.4	55.1	54.9	56.7	55.6	56.1	56.2	56.7	56.8	57.3
Finland	-	58.2	57.8	58.1	57.4	57.4	56.4	56.9	61.7	57.9
Sweden	65.8	72.9	72.7	73.2	72.6	72.8	73.3	72.7	68.4	66.5
Iceland	69.3	68.8	68.9	66.7	63.1	62.4	-	-	-	-
Norway	70.0	71.1	70.4	69.9	70.9	70.4	69.8	68.6	-	67.4

The overall average difference was found to be constant from 2013 to 2022, fluctuating around 62. However, there was an overall decrease in maximum healthy life years. The standard deviation (SD) decreased over time (from 5.45 to 4.04), indicating that differences between countries were decreasing (Table 4).

Table 4. Healthy life years total characteristics 2013-2022

Years	Mean (SD)	Min	Max
2013	62.04 (4.55)	53.00	72.10
2014	62.20 (5.17)	53.40	73.40
2015	61.84 (5.31)	53.00	73.60
2016	62.63 (5.04)	53.60	73.20
2017	62.05 (5.45)	51.40	72.70
2018	62.11 (5.39)	52.30	72.80
2019	62.66 (5.41)	53.10	73.30
2020	62.60 (4.64)	53.40	72.70
2021	62.24 (4.14)	53.80	68.70
2022	62.29 (4.04)	54.20	70.20

SD – standard deviation; min – minimum; max – maximum

When assessing HLY for men and women, no statistically significant difference was found between the averages of men and women in most of the years analysed. A significant difference between the sexes was found only in 2020 ($p = 0.021$) and 2021 ($p = 0.006$). In these years, the averages for women were slightly higher than for men (Table 5).

Table 5. Comparison of mean healthy life years between men and women, general Europa data

Years	Male			Female			p
	Mean (SD)	Min	Max	Mean (SD)	Min	Max	
2013	61.80 (5.01)	51.70	71.70	62.25 (4.33)	54.20	72.70	0.310
2014	61.93 (5.51)	51.50	73.00	62.43 (5.06)	54.60	74.50	0.224
2015	61.78 (5.61)	51.80	73.10	61.90 (5.28)	54.10	74.60	0.787
2016	62.49 (5.30)	52.30	73.00	62.76 (5.09)	54.90	73.30	0.565

Table 5 continued

2017	61.95 (5.51)	50.60	73.20	62.14 (5.61)	52.20	73.40	0.637
2018	62.06 (5.57)	51.00	73.70	62.14 (5.51)	53.70	73.40	0.863
2019	62.34 (5.58)	52.20	73.80	62.99 (5.38)	54.10	73.50	0.088
2020	62.14 (4.86)	52.60	72.80	63.07 (4.63)	54.30	72.70	0.021*
2021	61.67 (4.29)	52.20	68.90	62.79 (4.24)	54.80	68.50	0.006*
2022	62.03 (4.09)	53.00	70.10	62.51 (4.35)	54.60	70.30	0.308

SD – standard deviation; min – minimum; max – maximum; * p value <0.05

When analyzing the data, self-perceived long-standing limitations in usual activities due to health problems were evaluated in three levels of activity limitation: some, severe, none.

Between 2015 and 2024, the averages of self-perceived long-standing limitations in usual activities due to health problems remained relatively stable, fluctuating between 17.78% and 19.56%. No clear upward or downward trend was observed throughout the period – annual changes were small. The highest average was recorded in 2022, and the lowest in 2024 (Table 6).

Table 6. Self-perceived long-standing limitations in usual activities due to health problems of some activity limitation total characteristics 2015-2024

Years	**Level of activity limitation: some**		
	Mean (SD)	**Min**	**Max**
2015	18.42 (5.86)	7.30	28.40
2016	18.08 (5.65)	8.60	28.70
2017	18.88 (5.78)	8.60	30.90
2018	19.02 (5.91)	8.50	30.40
2019	18.84 (5.69)	9.00	30.80
2020	18.67 (6.55)	8.80	30.50
2021	18.29 (5.13)	0.00	29.40
2022	19.56 (5.27)	11.10	28.90
2023	19.38 (5.87)	9.00	30.60
2024	17.78 (4.48)	9.00	30.20

SD – standard deviation; * p value <0.01; min – minimum; max – maximum

In the period 2015–2024, severe self-perceived limitations in usual activities due to health problems amounted to about 6.5–7.8% and remained relatively stable, although a slight decrease has been observed since 2022. The highest average was recorded in 2015 (7.75%), and the lowest in 2024 (6.48%). There were no significant fluctuations, except for 2021, when a very large standard deviation (SD = 3.85) was recorded, indicating a greater dispersion of results in that year (Table 7).

Table 7. Self-perceived long-standing limitations in usual activities due to health problems of severe activity limitation total characteristics 2015-2024

Years	**Level of activity limitation: severe**		
	Mean (SD)	**Min**	**Max**
2015	7.75 (2.24)	2.50	11.00
2016	7.18 (2.14)	3.50	11.50
2017	7.52 (2.28)	2.60	11.80
2018	7.51 (2.50)	2.50	12.80
2019	7.35 (2.45)	2.60	13.10
2020	7.33 (2.19)	3.10	11.20
2021	7.45 (3.85)	3.40	24.50
2022	6.97 (1.92)	2.70	10.30
2023	6.94 (2.24)	2.50	11.50
2024	6.48 (2.43)	2.30	11.10

SD – standard deviation; * p value <0.01; min – minimum; max – maximum

The averages for self-perceived complete absence of limitations in usual activities due to health problems were similar in the period 2015–2024, with values ranging between 73% and 75% in most years. The lowest average was in 2017 (73.59%), and the highest was in 2024 (75.75%) (Table 8).

Table 8. Self-perceived long-standing limitations in usual activities due to health problems of no activity limitation total characteristics 2015-2024

Years	**Level of activity limitation: none**		
	Mean (SD)	**Min**	**Max**
2015	73.82 (7.18)	61.50	90.20
2016	74.74 (6.67)	62.50	87.40
2017	73.59 (7.21)	58.60	88.10

Table 8 continued

2018	**73.46 (7.34)**	**59.90**	**88.00**
2019	73.80 (7.00)	60.50	88.10
2020	73.99 (6.41)	60.20	87.10
2021	74.28 (5.70)	62.80	83.30
2022	73.45 (5.92)	61.50	85.30
2023	73.70 (6.87)	59.30	88.10
2024	75.75 (6.91)	58.70	88.00

SD – standard deviation; * p value <0.01; min – minimum; max – maximum

Comparing the averages in limitation levels, the majority of Europeans report having no long-term health-related activity limitations each year, while the proportion with "some" or "severe" limitations remains smaller and relatively stable. No significant changes or trends of increase or decrease have been identified over the analysed period (Table 6-8).

It was found that in the period 2015–2024. the share of people with a long-term illness or health disorder increased - from 32.94% in 2015. to 34.60% in 2024. The averages increased slightly every year, and the highest value was recorded in 2024. (56.6%), which indicates a constant upward trend in the prevalence of long-term health problems (Table 9).

Table 9. Total data people having a long-standing illness or health problem, percentages

Years	Mean (SD)	Min	Max
2015	32.94 (7.08)	20.10	46.60
2016	32.91 (7.48)	15.20	47.20
2017	33.91 (8.00)	13.80	48.00
2018	33.67 (8.03)	15.40	48.90
2019	33.86 (7.94)	15.90	49.50
2020	34.07 (7.70)	18.60	50.20
2021	34.13 (7.81)	18.60	50.90
2022	34.95 (8.29)	17.90	53.00
2023	34.49 (8.60)	16.00	55.80
2024	34.60 (7.73)	17.00	56.60

SD – standard deviation; * p value <0.01; min – minimum; max – maximum

Comparison of means between men and women shows that in all years women had statistically significantly higher rates than men (all years p-values < 0.001). This means that women's self-perceived prevalence of long-term health problems or limitations was higher than men's throughout the period under study. This consistent and significant difference suggests that gender is an important factor related to the perception of health status or actual differences between men and women (Table 10).

Table 10. Comparison between men and women of people having a long-standing illness or health problem, percentages

Years	Male			Female			
	Mean (SD)	Min	Max	Mean (SD)	Min	Max	p
2015	16.10 (6.88)	51.70	71.70	23.60 (7.40)	54.20	72.70	<0.001
2016	13.30 (7.12)	51.50	73.00	16.90 (8.05)	54.60	74.50	<0.001
2017	12.10 (7.75)	51.80	73.10	15.40 (8.38)	54.10	74.60	<0.001
2018	13.40 (7.75)	52.30	73.00	17.20 (8.42)	54.90	73.30	<0.001
2019	14.30 (7.56)	50.60	73.20	17.50 (8.44)	52.20	73.40	<0.001
2020	16.20 (7.35)	51.00	73.70	20.10 (8.28)	53.70	73.40	<0.001
2021	15.90 (7.41)	52.20	73.80	20.10 (8.34)	54.10	73.50	<0.001
2022	16.10 (7.89)	52.60	72.80	19.40 (8.79)	54.30	72.70	<0.001
2023	14.30 (8.17)	52.20	68.90	17.70 (9.12)	54.80	68.50	<0.001
2024	15.40 (8.36)	53.00	70.10	18.50 (9.19)	54.60	70.30	<0.001

SD – standard deviation; * p value <0.01; min – minimum; max – maximum

The study found that the prevalence of high blood pressure increased slightly from 21.57% to 22.68% between 2014 and 2019. Although a strong positive correlation was found between year and incidence (r = 0.879), this correlation was not statistically significant (p = 0.054). This suggests that a trend exists, but it cannot be firmly stated that the increase in incidence is not due to chance (Table 11).

Table 11. Total data reporting chronic high blood pressure, percentages

Years	Mean (SD)	Min	Max	r	p
2014	21.57 (5.11)	12.70	21.57	0.879	0.054
2019	22.68 (6.21)	11.60	22.68		

SD – standard deviation; min – minimum; max – maximum; r – correlation coefficient

The study data show that the distribution of BMI categories changed significantly from 2014 to 2019. Underweight increased from 2.11% to 2.56% ($r = 0.584$, $p = 0.002$), the proportion of normal weight increased from 36.06% to 47.45% ($r = 0.814$, $p < 0.001$), and the proportion of obese decreased significantly from 23.86% to 14.40% ($r = 0.867$, $p < 0.001$). Changes in all categories were statistically significant. A strong correlation was found, meaning that significant positive changes in BMI occurred during this period (Table 12).

Table 12. Body mass index at different levels, in percentages

Variable	Mean (SD)		r	p
	2014	2019		
Underweight	2.11 (0.69)	2.56 (0.85)	0.584	0.002
Normal	36.06 (3.98)	47.45 (4.55)	0.814	<0.001
Obese	23.86 (4.43)	14.40 (3.38)	0.867	<0.001

SD – standard deviation; r – correlation coefficient

2019 years data show that overweight individuals engage in significantly less health-promoting aerobic physical activity during their leisure time compared to normal-weight individuals. 53.6% of overweight individuals do not engage in any physical activity at all, while this figure is 41.5% for normal-weight individuals ($r = 0.985$, $p < 0.001$). Only 14.96% of overweight individuals achieve the recommended level of physical activity of 300 or more minutes per week, compared to 22.12% for normal-weight individuals ($r = 0.985$, $p < 0.001$). These results indicate that a significant proportion of overweight individuals are physically inactive, which is closely related to overweight, highlighting the importance of physical activity for weight control and improving overall health (Table 13).

Table 13. Time spent on health-enhancing non-work-related aerobic physical activity, percentage (2019)

Variable	Mean (SD)		r	p
	Normal	Overweight		
Zero minutes	41.54 (18.14)	53.60 (18.82)	0.985	<0.001
1 to 149 min	20.02 (5.37)	18.72 (5.72)	0.847	0.035
150 to 299 min	16.32 (5.30)	12.73 (6.19)	0.933	<0.001
300 min over	22.12 (12.64)	14.96 (9.97)	0.985	<0.001

SD – standard deviation; r – correlation coefficient

Data from 2014 and 2019 show that the frequency of fruit and vegetable consumption in Europe remained almost unchanged. About half of the population consumed fruit at least once a day (52.41% in 2014, 51.52% in 2019), and slightly fewer consumed vegetables (49.94% and 49.24%, respectively), but the changes were not statistically significant ($p > 0.05$). Also, no significant changes were recorded among less frequent consumers or those who do not consume fruit and vegetables at all, so it can be concluded that the dietary habits of the population did not change significantly during the period analyzed (Table 14).

Table 14. Frequency of fruit and vegetables consumption 2014 and 2019 comparison

Variable	Mean (SD)		r	p
	2014	2019		
At least once a day fruit	52.41 (9.48)	51.52 (10.09)	0.878	0.335
At least once a day vegetables	49.94 (10.57)	49.24 (11.87)	0.791	0.614
1-3 times fruit	19.74 (4.29)	19.96 (4.99)	0.846	0.669
1-3 times vegetables	18.78 (5.17)	19.04 (6.94)	0.807	0.735
Never fruit	7.82 (2.94)	8.20 (2.49)	0.611	0.399
Never vegetables	4.27 (2.29)	4.47 (2.69)	0.700	0.601

SD – standard deviation; r – correlation coefficient

The study found a positive and statistically significant correlation between the changes in the distribution of non-smokers (from 74.91% to 76.90%, $r = 0.877$, $p < 0.001$) and daily smokers (from 19.82% to 17.96%, $r = 0.912$, $p < 0.001$) over time between 2014 and 2019. This indicates that daily smoking decreased during this period, while the proportion of non-smokers increased (Table 15).

Table 15. Smoking prevalence and correlation of their changes 2014–2019, in percentages

Variable	Mean (SD)		r	p
	2014	2019		
Non smoker	74.91 (4.42)	76.90 (5.02)	0.877	< 0.001
Daily smoker	19.82 (5.00)	17.96 (5.23)	0.912	<0.001
Occasional smoke	5.26 (1.55)	5.13 (1.63)	0.786	0.515

SD – standard deviation; r – correlation coefficient

The study data show significant differences in smoking habits between men and women in 2014 and 2019. The proportion of non-smokers was higher among women than men in both years (2014: 80.16% of women and 69.16% of men; 2019: 81.87% of women and 71.46% of men), while daily smoking was more common among men (2014: 24.89% of men and 15.24% of women; 2019: 22.51% of men and 13.81% of women). All changes were statistically significant ($p < 0.001$), and the correlations show a consistent trend of decreasing smoking among both men and women (Table 16).

Table 16. Differences in smoking habits by gender in 2014 and 2019

Variable	2014				2019			
	Mean (SD)		r	p	Mean (SD)		r	p
	Male	Female			Male	Female		
Nonsmoker	69.16 (7.42)	80.16 (3.90)	0.218	<0.001	71.46 (7.60)	81.87 (4.24)	0.459	<0.001
Daily smoker	24.89 (8.10)	15.24 (3.83)	0.416	<0.001	22.51 (7.66)	13.81 (4.27)	0.566	<0.001
Occasional smoke	5.95 (1.75)	4.62 (1.47)	0.846	<0.001	6.03 (1.95)	4.32 (1.45)	0.834	<0.001

SD – standard deviation; r – correlation coefficient

The study data show that between 2014 and 2019, the averages of different frequency of alcohol consumption changed slightly, but the results remained strongly related (high correlation coefficients, $p<0.001$). The significance of daily consumption decreased, while the significance of other consumption groups increased or decreased slightly. This means that the distribution of these indicators remained largely stable over the five years (Table 17).

Table 17. Comparison of alcohol consumption frequency in 2014 and 2019, percentage

Variable	Mean (SD)		r	p
	2014	2019		
Every day	7.13 (5.58)	6.33 (4.75)	0.979	<0.001
Every week	25.22 (9.72)	26.39 (9.14)	0.959	<0.001
Every month	27.05 (7.05)	25.25 (5.52)	0.770	<0.001

Less than once month	15.33 (7.29)	16.73 (5.87)	0.805	<0.001
Never or not in the last 12 months	25.27 (9.56)	25.30 (6.81)	0.825	<0.001

SD – standard deviation; r – correlation coefficient

The results show that from 2013 to 2022, there is a decreasing trend in the mortality rate of ischemic heart disease (IHD) in Europe. In 2013, the average mortality rate was 200.14 (SD 140.53), and in 2022 it decreased to 152.51 (SD 115.69). This indicates an overall decrease in mortality during this period. It is noted that a significant decrease occurred in 2013–2019, when the average rates decreased from 200.14 to 153.38. This trend may reflect progress in the field of health protection, better prevention and treatment of heart disease in Europe during the period under consideration (Table 18).

Table 18. Mortality frequency from ischemic disease in Europe 2013-2022

Years	Mean (SD)	Min	Max
2013	200.14 (140.53)	51.92	589.25
2014	189.84 (133.87)	49.30	564.37
2015	190.55 (136.82)	49.08	586.13
2016	176.32 (125.76)	46.43	561.06
2017	173.82 (122.64)	45.25	530.31
2018	164.01 (115.76)	43.61	499.09
2019	153.38 (108.68)	42.00	464.08
2020	157.08 (117.57)	40.45	494.35
2021	158.94 (121.83)	40.33	488.20
2022	152.51 (115.69)	39.95	469.51

SD – standard deviation; min – minimum; max – maximum

The study revealed significant differences in the number of hospital discharges due to arterial hypertension in European countries from 2012 to 2021. The general trend shows that the number of discharges increased in some countries, while others recorded a significant decrease. For example, in Belgium, an increase in the number of discharges is observed from 673 cases in 2012 to 2,481 cases in 2021. A similar trend is observed in Spain, where there were 3,091 discharges in 2012, and in 2021 - already 34,908. In contrast, in Italy, the number of discharges decreased from 19,715 in 2012 to 2,175 in 2021, and in Romania from a very high 44,925 cases in 2012 to 1,430 in 2021. In Germany, although the number of discharges was one of the highest, it decreased from 9,056 in 2012 to 6,882 in 2021. There was also a noticeable decrease in Latvia and Poland, from 7,176 to 5,126 and from 19,242 to 10,942 cases, respectively. Other countries, such as France and Croatia, maintained a relatively stable or fluctuating, but not so sharply decreasing number. According to the data provided, the number of hospital discharges due to arterial hypertension in Lithuania remained generally low in 2012–2021 and ranged from 306 cases in 2012 to 27 cases in 2021, showing a significant downward trend over the period under review (Table 19).

Table 19. Hospital discharges by arterial hypertension in Europe 2012-2021

Countries	Hospital discharges by arterial hypertension (measured numbers)									
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Belgium	673	583	572	-	-	1425	1886	2220	1932	2481
Bulgaria	-	-	-	-	-	-	-	-	-	-
Czechia	233	256	253	312	315	353	298	338	349	241
Denmark	1274	1364	1309	1296	1261	-	-	-	-	-
Germany	9 056	9046	9948	10301	11175	10627	9939	10230	8307	6882
Estonia	-	-	-	-	-	-	-	-	-	-
Ireland	465	270	194	191	208	213	195	201	97	158
Greece	-	1308	1 343	1 335	-	-	-	-	-	-
Spain	3091	2492	2689	2934	3515	7041	4036	28078	29105	34908
France	5809	5451	5645	5651	5724	5698	5878	6521	5956	7102
Croatia	2117	1540	2042	3791	6021	7220	7788	10242	9051	11852
Italy	19715	13328	9947	7971	6439	4886	3890	3350	1835	2175
Cyprus	1	6	7	7	4	7	2	5	7	42
Latvia	7176	6688	6050	6003	6305	5659	4380	3490	3639	5126
Lithuania	306	332	441	529	246	31	37	47	23	27
Luxembourg	40	35	43	22	25	-	-	-	-	-
Hungary	103	78	54	89	64	115	948	860	729	446
Malta	1	2	0	0	1	1	3	0	1	-
Netherlands	5660	2999	2802	1569	1371	1263	1138	1147	897	988
Austria	1942	1886	1735	1697	1493	1363	1062	917	666	619
Poland	19242	18450	18356	15818	14428	15792	15018	14242	9309	10942
Portugal	379	578	512	506	-	-	6847	6158	4855	3765

Romania	44925	63981	70899	87709	88444	94052	28976	2262	1125	1430
Slovenia	127	148	118	103	108	114	140	162	193	170
Slovakia	149	-	104	117	72	50	63	45	28	26
Finland	467	491	444	580	626	557	587	-	499	465
Sweden	-	412	428	432	403	397	367	383	317	303
Norway	693	696	640	509	756	693	472	496	449	523

According to 2021 data, the lowest mortality rates from CVD were recorded in France (20.9%), Denmark (20.9%), the Netherlands (21.3%) and Belgium (23.9%). In these countries, CVD accounts for only about a fifth of all deaths, and in terms of gender structure, both men and women remain among the lowest in Europe. The situation is the opposite in Lithuania, where CVD mortality is one of the highest. According to the figure, the overall CVD mortality rate in Lithuania is 53.8%, for men – 48.7%, for women – 53.8%. This means that more than half of all deaths in the country are related to CVD. When compared with neighboring countries, a clear regional trend is visible. In Poland, the overall CVD mortality rate is 39.1% (men – 34.8%, women – 39.1%), and in Latvia – 53.9% (men – 44.2%, women – 53.9%). Thus, Lithuania and Latvia have almost identically high rates, exceeding 50%, while Poland stands out with significantly lower mortality (Appendix 2).

In summary, this part of the study observed that women more often than men report having long-term health problems, although the level of self-assessed health limitation remains quite similar in both gender groups. Thus, it can be assumed that women take more care of their health. Among lifestyle factors, the results of physical activity stand out the most. It is observed that overweight individuals are less active, and this trend is consistent in all periods examined. This suggests that physical activity is one of the most sensitive behavioural indicators clearly related to health status.

3.2. Risk assessment of lifestyle factors

Based on 2014 data, only weak associations were found between BMI categories and healthy life years. A statistically significant positive correlation was found only between underweight and HLY from age 50 ($r = 0.401$; $p < 0.05$). Other associations between BMI and HLY (overall or by sex) were weak or non-significant (Table 20).

Table 20. Relationship between BMI categories and healthy life years (2014 data)

Variable	Healthy life years total	Healthy life years in absolute value at 50	Healthy life years, male	Healthy life years, female
BMI, underweight	0.305	0.401*	0.335	0.254
BMI, normal	0.085	0.283	0.168	-0.12
BMI, obese	-0.003	-0.089	-0.100	0.104

*p<0.05

The duration of physical activity was found to have a variable effect on healthy life years. Low activity duration (1–149 min/week) was associated with shorter HLY in men ($\beta = -0.417$, $p < 0.05$) compared to the general population. Meanwhile, physical activity exceeding 300 min/week was associated with longer HLY in the 50-year-old age group ($\beta = 0.324$), but this association was not statistically significant (Table 21).

Table 21. Relationship between time spent on health-enhancing non-work-related aerobic physical activity categories and healthy life years (2019 data)

Variable	Healthy life years total	Healthy life years in absolute value at 50	Healthy life years, male	Healthy life years, female
Zero minutes	0.101	-0.170	0.036	0.174
1 to 149 min	-0.395*	-0.296	-0.417*	-0.359
150 to 299 min	-0.100	0.144	-0.034	-0.175
300 min over	0.076	0.324	0.152	-0.016

*p<0.05

The study found that daily fruit consumption was consistently associated with longer HLY in all groups studied: the general population ($r = 0.346$), men ($r = 0.335$), women ($r = 0.347$), and those aged 50 and over ($r = 0.287$). These indicators indicate a positive relationship between fruit consumption and health, regardless of gender or age. Daily vegetable consumption also shows a positive correlation with HLY ($r = 0.159$), but a significant difference is observed between the sexes: among women this relationship is particularly strong ($r = 1.184$), and among men - much lower ($r = 0.130$). Meanwhile, fruit consumption 1-3 times a week is negatively associated with healthy life years. Unexpectedly, complete non-consumption of fruit in some groups correlates with positive indicators of healthy life years. These results may be explained by external factors and indicate that correlation does not imply causation, and the data should therefore be viewed with caution. Vegetable consumption also shows a weak positive association (r = 0.119), which, although not strong, is contrary to general health recommendations. This paradoxical result may be explained by methodological limitations or confounding factors, and therefore a complex analysis is needed to include more variables to better understand the causality of these associations (Table 22).

Table 22. Relationship between frequency of fruit and vegetables consumption and healthy life years (2019 data)

Variable	Healthy life years total	Healthy life years in absolute value at 50	Healthy life years, male	Healthy life years, female
At least once a day fruit	0.346	0.287	0.335	0.347
At least once a day vegetables	0.159	0.190	0.130	1.184
1-3 once a week fruit	-0.275	-0.279	-0.290	-0.248
1-3 once a week vegetables	0.041	-0.081	0.028	0.057
Never fruit	0.293	0.423*	0.359	0.210
Never vegetables	0.119	0.106	0.141	0.091

*p<0.05

The relationship between tobacco smoking and healthy life years was established in 2019. The results reveal that non-smoking is positively associated with a longer healthy life span, especially when assessing healthy life years at age 50, where the relationship is statistically significant. Meanwhile, daily smoking is clearly associated with a shorter number of healthy life years, also significantly reducing health indicators at the age of 50 (Table 23).

Table 23. Relationship between smoking of tobacco products and healthy life years (2019 data)

Variable	Healthy life years total	Healthy life years in absolute value at 50	Healthy life years, male	Healthy life years, female
Nonsmoker	0.203	0.416*	0.303	0.080
Daily smoker	-0.158	-0.415*	-0.270	-0.023
Occasional smoke	-0.111	0.048	-0.063	-0.163

*p<0.05

The results show a clear trend that non-smoking men have a more favorable situation in terms of healthy life years, especially when assessing healthy life years from the age of 50, where the relationship is statistically significant. Meanwhile, for women, non-smoking is not so clearly associated with a better indicator of healthy life years. In the case of daily smoking men, a negative and strong relationship is visible, especially when assessing healthy life years from the age of 50, this relationship is also statistically significant and indicates a clear negative effect of smoking. For women, daily smoking is also associated with a worse indicator of healthy life years, but the relationship is weaker and statistically insignificant. Occasional smokers, both men and women, show only a slight and insignificant negative relationship with healthy life years, therefore this group stands out with the weakest relationships. In summary, the most pronounced differences are observed among men, with non-smoking being associated with better indicators of healthy life years, and daily smoking with clearly worse ones. The results for women are much weaker, and the connections are less clear (Table 24).

Table 24. Relationship between smoking of tobacco products and healthy life years by sex (2019 date)

Variable		**Healthy life years total**	**Healthy life years in absolute value at 50**
Nonsmoker	Male	0.342	0.546*
	Female	-0.053	0.088
Daily smoker	Male	-0.295	-0.540**
	Female	0.071	-0.119
Occasional smoke	Male	-0.158	0.010
	Female	-0.057	0.076

*p<0.05, **p<0.01

An analysis of the impact of alcohol consumption frequency on healthy life years, based on 2019 data, found that this factor has a multifaceted effect that varies depending on the frequency of consumption and gender. The results of the study showed that daily alcohol consumption is associated with a small positive relationship with healthy life years: the overall correlation was +0.090, and when assessed by gender, this value was +0.141 for men and +0.038 for women. These relationships are not statistically significant, but they indicate that daily alcohol consumption is not associated with a significant decrease in healthy life years, but its positive effect is also not pronounced. These data highlight that the relationship between alcohol consumption and health is complex, depending on the frequency of consumption, amount, context and other factors, so further detailed research is necessary to provide clear recommendations (Table 25).

Table 25. Relationship between frequency of alcohol consumption and healthy life years by sex (2019 date)

Variable	Healthy life years total	Healthy life years in absolute value at 50	Healthy life years, male	Healthy life years, female
Every day	0.090	0.060	0.141	0.038
Every week	0.386*	0.565**	0.455*	0.294
Eevery month	-0.249	-0.214	-0.300	-0.189
Less than once month	-0.471*	-0.499**	-0.524**	-0.403*
Never or not in the last 12 months	-0.006	-0.257	-0.056	0.055

*p<0.05, **p<0.01

Based on data from 2014 and 2019, several significant trends were identified in the association of lifestyle factors with chronically elevated blood pressure. Obesity is strongly associated with a higher incidence of elevated blood pressure in both years (2014 $r = 0.494$, $p < 0.01$; 2019 $r = 0.449$, $p < 0.05$), confirming the role of obesity as an important risk factor. Non-smoking is associated with a lower likelihood of elevated blood pressure in both 2014 ($r = –0.375$, $p < 0.05$) and 2019 ($r = –0.375$, $p < 0.05$). ($r = –0.395$, $p < 0.05$), while daily smoking was associated with a higher likelihood of having high blood pressure (2014 $r = 0.433$, $p < 0.05$; 2019 $r = 0.447$, $p < 0.05$). Fruit consumption was significantly associated with increased blood pressure in 2019 ($r = –0.446$, $p < 0.05$). These data indicate that obesity and smoking remain the main risk factors (Table 26).

Table 26. Relationship between lifestyle factors and reporting chronic high blood pressure (2014 and 2019 data)

Variable	2014 Reporting high blood pressure	2019 Reporting high blood pressure
Obese	0.494**	0.449*
Never fruit	-0.239	-0.446*
Never vegetables	0.332	0.012
1-3 once a week fruit	0.096	0.054
1-3 once a week vegetsbles	0.321	0.015

Non smoker	-0.375*	-0.395*
Daily smoker	0.433*	0.447*
Alco every day	0.031	0.039
Alco never	0.106	0.391*

*p<0.05, **p<0.01

The results show a statistically significant negative association between total CVD mortality and HLY in the general population (r = -0.415, $p < 0.05$), and an even stronger correlation was found in the analysis from the age of 50 (r = -0.617, $p < 0.01$). This indicates that higher CVD mortality is significantly associated with shorter healthy life years, especially in older age. Gender analysis showed that in men the association between CVD mortality and HLY is stronger and statistically significant. This suggests that the male population is more vulnerable to the health consequences of CVD, and their HLY are more sensitive to these indicators. Overall, these results support the hypothesis that CVD mortality is significantly associated with healthy life years, especially among men and the elderly population. This highlights the need for preventive health programs and targeted interventions focused on CVD risk reduction and health promotion in older age groups (Table 27).

Table 27. Relationship between healthy life years by sex and CVD mortality (2021 data)

Variable	Healthy life years total	Healthy life years in absolute value at 50	Healthy life years, male	Healthy life years, female
CVD mortality, total data	-0.415*	-0.617**	-0.546**	-0.255
CVD mortality, male	-0.372	-0.560**	-	-0.226
CVD mortality, female	-0.432	-0.645**	-0.568**	-

*p<0.05, **p<0.01

In summary, based on data from 2014 and 2019, the association between lifestyle factors and health outcomes is variable and mostly weak or moderate. A statistically significant positive association was found between low BMI (leanness) and HLY after age 50. Physical activity of less than 150 min per week was associated with shorter HLY in men, and more intense activity with longer, but the latter association was not statistically significant. Daily fruit consumption was consistently associated with longer healthy life years, especially in women and those over 50, while smoking was associated with significantly shorter HLY in men. Thus, obesity and daily smoking remain the main risk factors associated with increased blood pressure and reduced healthy life years. Alcohol has complex effects that depend on frequency of consumption and gender, and further research is needed. In addition, a statistically significant negative association was found between total CVD mortality and healthy life years, especially in men and older population groups.

3.3. The complex relationship between lifestyle factors

The results of the univariate regression analysis show that never eating vegetables (β = 26.20, p = 0.059) has a tendency towards higher mortality, but the significance is borderline (p = 0.059). 1-3 times a week eating fruit (β = 15.13, p = 0.036) – such a diet is associated with significantly higher mortality ($p < 0.05$). This may mean that eating only 1–3 times a week vegetable is an insufficient amount. And eating vegetables 1–3 times a week (β = -8.00, p = 0.107) reduces the risk, but the relationship is not statistically significant (Table 28).

Table 28. Multivariate associations between deaths due to IHD with lifestyle factors

Variables	β (SE)	p
	Univariate association	
Obese, no activity	2.59 (7.28)	0.727
Never vegetables	26.20 (12.97)	0.059
1-3 once a week fruit	15.13 (6.63)	0.036
1-3 once a week vegetables	-8.00 (4.90)	0.107
Non smoker	1.60 (15.69)	0.920
Daily smoker	6.31 (16.49)	0.707
Alco every day	-5.04 (4.65)	0.294
Alco never	3.41 (3.53)	0.348

β – coefficient, SE – standard error

When analysing CVD mortality, it was found that obesity and physical inactivity (β = -0.26, p = 0.618) were associated with CVD mortality, albeit insignificantly. Eating vegetables (β = 2.31, p = 0.019) had significantly higher mortality. Fruit 1–3 times a week (β = 1.92, p = 0.002) such a diet is associated with significantly higher mortality. This again may indicate an insufficient amount of fruit consumption. Meanwhile, vegetables 1-3 times a week (β = -0.81, p = 0.021) were associated with significantly lower mortality. Again, paradoxically, non-drinkers (β = 0.53, p = 0.037) have a statistically significantly higher mortality rate (Table 29).

Table 29. Multivariate associations between all mortality CVD with lifestyle factors

Variables	β (SE)	p
	Univariate association	
Obese, no activity	-0.26 (0.51)	0.618
Never vegetables	2.31 (0.88)	0.019
1-3 once a week fruit	1.92 (0.50)	0.002
1-3 once a week vegetables	-0.81 (0.31)	0.021
Nonsmoker	0.34 (1.11)	0.764
Daily smoker	0.98 (1.19)	0.481
Alco every day	-0.17 (0.33)	0.606
Alco never	0.53 (0.23)	0.037

β – coefficient, SE – standard error

Univariate regression showed that obesity and physical inactivity had a positive ($\beta = 0.48$, $p = 0.183$) but non-significant association with hypertension. Those who never ate vegetables ($\beta = 1.53$, $p = 0.024$) were significantly more likely to have high blood pressure.

Eating fruit 1–3 times a week ($\beta = 1.05$, $p = 0.004$) was associated with a higher likelihood of having high blood pressure, while eating vegetables at least 1–3 times a week ($\beta = -0.81$, $p = 0.002$) was associated with a lower likelihood of having high blood pressure (Table 30).

Table 30. Multivariate associations between reporting high blood pressure with lifestyle factors

Variables	β (SE)	p
	Univariate association	
Obese, no activity	0.48 (0.35)	0.183
Never vegetables	1.53 (0.62)	0.024
1-3 once a week fruit	1.05 (0.32)	0.004
1-3 once a week vegetables	-0.81 (0.22)	0.002
Nonsmoker	0.75 (0.75)	0.329
Daily smoker	0.92 (0.79)	0.258
Alco every day	0.37 (0.22)	0.114
Alco never	0.13 (0.17)	0.445

β – coefficient, SE – standard error

Obesity and inactivity (β = -0.04, p = 0.928) were found to be insignificantly associated with fewer healthy life years. Those who never eat vegetables (β = -1.20, p = 0.139) have fewer healthy life years, but the relationship is not statistically significant. The results show that consuming fruit 1–3 times a week (β = -1.12, p = 0.013) is associated with significantly fewer healthy life years. This indicates that this number is not sufficient. While consuming vegetables 1–3 times a week (β = 0.63, p = 0.037) is statistically sufficient. Both smoking and alcohol consumption lead to fewer healthy life years (Table 31).

Table 31. Multivariate associations between health life years with lifestyle factors

Variables	**β (SE)**	**p**
	Univariate association	
Obese, no activity	-0.04 (0.46)	0.928
Never vegetables	-1.20 (0.77)	0.139
1-3 once a week fruit	-1.12 (0.40)	0.013
1-3 once a week vegetables	0.63 (0.28)	0.037
Nonsmoker	-0.74 (0.93)	0.435
Daily smoker	-0.67 (0.98)	0.504
Alco every day	-0.32 (0.28)	0.259
Alco never	0.09 (0.21)	0.695

β – coefficient, SE – standard error

The results showed that the dietary factor was not statistically significant for any indicator, and unhealthy habits were strongly associated with CVD indicators: high blood pressure (β = -1.93, p = 0.010), total CVD mortality (β = -5.29, p < 0.01) and IHD deaths (β = -53.24, p < 0.01). The data suggest that fewer unhealthy habits are associated with a lower risk of CVD mortality. Obesity was significant for high blood pressure (β = 2.54, p = 0.015) and IHD mortality (β = 35.32, p = 0.041), but did not affect total CVD mortality or healthy life expectancy. A combination of factor analysis and regression allows us to identify which lifestyle factors are the strongest predictors of CVD. This study found that unhealthy habits are the main risk factor, and obesity is an important predictor of mortality from hypertension and ischemic heart disease, while diet is currently statistically insignificant (Table 32).

Table 32. Linear regression of cardiovascular health indicators on lifestyle factors derived from factor analysis

Variables	Factor 1		Factor 2		Factor 3	
	β (SE)	p	β (SE)	p	β (SE)	p
Health life years	1.05 (0.69)	0.145	1.31 (0.71)	0.077	-0.56 (0.98)	0.574
Reporting high blood pressure	-0.43 (0.684)	0.535	-1.93 (0.68)	0.010	2.54 (0.97)	0.015
All mortality CVD	-1.47 (0.97)	0.131	-5.29 (0.96)	<0.01	0.29 (1.33)	0.827
Deaths due to ischemic heart disease	-7.25 (11.52)	0.536	-53.24 (11.52)	<0.01	35.32 (16.30)	0.041

β – coefficient, SE – standard error; factor 1 – nutrition; factor 2 – bad habits; factor 3 – obesity

In summary, the analysis of Eurostat data showed a clear relationship between lifestyle factors and CVD rates in Europe. In 2013–2022, most European countries observed an increase in healthy life years, but in some countries, such as Denmark and the Netherlands, the rates decreased. Lithuania recorded a small but positive change during this period. BMI analysis revealed that the proportion of the population with normal weight increased and that of the obese decreased, but physical inactivity remained high, especially among overweight individuals. Dietary habits, such as fruit and vegetable consumption, and the frequency of alcohol consumption did not change significantly during the period under review.

The study confirms that smoking, obesity and lack of physical activity are the most important modifiable factors determining a higher prevalence of CVD and a shorter healthy life expectancy. Regular physical activity, smoking cessation and a healthy diet are essential conditions for maintaining health, reducing the prevalence of CVD and extending HLY among the European population.

SCIENTIFIC DISCUSSION

An analysis of Eurostat data found that lifestyle factors have a significant, although mostly moderate, association with CVD rates and HLY in European countries.

The statistically significant trends identified in this study have clear clinical implications for the prevention of CVD. The significant changes in BMI structure, the decreasing prevalence of obesity and the increasing prevalence of normal weight are clinically important, as obesity is directly associated with a higher risk of hypertension and ischemic heart disease. It was also found that overweight individuals are significantly less physically active, and physical inactivity is one of the most important modifiable risk factors for CVD. The significant changes in smoking prevalence and consistent gender differences confirm the clinical impact of smoking, which remains one of the strongest determinants of cardiovascular damage. Nutritional indicators are also important: insufficient vegetable consumption was statistically associated with higher blood pressure and CVD mortality, which emphasizes the role of nutrition in clinical practice. Finally, the significant negative correlation between CVD mortality and healthy life years shows that these trends have a direct impact on quality of life and are important for planning public health interventions.

Descriptive statistics revealed that in the period 2012-2022. The number of HLY increased in many European countries, especially in Slovenia, Bulgaria, Estonia, Hungary, Lithuania and Italy. Meanwhile, in some countries, such as Denmark or the Netherlands, a consistent decrease was recorded. In Lithuania, the indicator of HLY also increased slightly from 59.2 years. (2013) to 60.3 years. (2022), although there were periods when the indicator briefly decreased.

Most international studies analyze various concepts or assessment tools of morbidity (Klar et al., 2021; Majewska et al., 2020), while self-rated health is examined much less frequently (Welsh et al., 2021). Studies that analyze the duration of HLY show that it varies greatly across European countries. It has been found that women generally live longer, but men often have a higher proportion of healthy life years. In addition, the number of HLY is significantly influenced by social, economic and lifestyle factors (Straka et al., 2024).

Population aging is one of the most significant global demographic changes of the 21st century, driven by increasing life expectancy and declining fertility rates. Healthy ageing, as defined by the WHO, is focused on maintaining intrinsic capacities, physical, mental and social well-being throughout life. It emphasizes the importance of preventive health care, proper nutrition and regular physical activity in delaying the onset of chronic diseases and maintaining functional independence (Rudnicka et al., 2020).

Studies show that although life expectancy is improving in many countries, the growth in HLY (functional health, independence) is slower. The main factors influencing this are 1) biological and the body's internal power, physical, mental and social maintenance of capacity; 2) lifestyle factors, physical activity, healthy nutrition, social engagement, prevention; 3) environmental and systemic factors, accessibility of health care services, social and economic conditions, healthy living environment (Gianfredi et al., 2025).

Chronic diseases such as diabetes, heart disease, stroke and cancer have been and continue to be among the leading causes of morbidity and mortality worldwide. Now, as people live longer, the prevalence and cost of chronic diseases continue to rise. Individual lifestyle, behaviour and community factors play an important role in the development and management of chronic diseases. Many of these diseases (diabetes, heart disease and respiratory diseases) are preventable, and their main risk factors are physical inactivity, poor diet, tobacco use and excessive alcohol consumption. Unfortunately, investment in prevention remains low compared to treatment, both in terms of lifestyle and social health factors. Given the future trend of chronic diseases, technological and pharmaceutical innovations and appropriate investment in prevention will be needed (Hacker et al., 2024).

BMI analysis showed that the proportion of the population with normal weight increased during the period under review, while the proportion of obese people decreased. However, the level of physical activity remains insufficient – more than half of overweight people reported that they did not exercise at all. This confirms the close relationship between physical inactivity and obesity. The frequency of fruit and vegetable consumption did not change significantly during 2014–2019, while alcohol consumption habits remained stable.

Many factors can affect weight, including your genes, age, sex, lifestyle, family habits, culture, sleep, and even where you live and work. Some of these factors can make it hard to maintain or achieve a healthy weight. Nevertheless, a healthy diet and regular exercise can help maintain optimal health, especially as you age and have chronic conditions (Fontana et al., 2014).

Excess body weight and adiposity cause insulin resistance, inflammation, and numerous other alterations in metabolic and hormonal factors that promote atherosclerosis, tumorigenesis, neurodegeneration, and aging (Tchernof et al., 2013). From a clinical and public health point of view, maintaining a healthy weight through diet and physical activity should remain the cornerstone in the prevention of chronic diseases and the promotion of healthy aging (Fontana et al., 2014).

Current research suggests that weight gain is a risk factor for CVD, especially in hypertension (Cai et al., 2021). Weight control is therefore the cornerstone of hypertension management. Therefore, it is important to understand the relationship between weight changes and CVD risk among patients with hypertension. Both weight loss (≥10%) and weight gain (>10%) are associated with cardiac and CVD risk. Weight loss ≥10% significantly increases the risk of stroke, and weight gain >10% significantly increases the risk of myocardial infarction. Therefore, hypertension, for which it is recommended to monitor body weight and take an optimal body weight to avoid negative health consequences (Liu et al., 2024).

Obesity is associated with heart and CVD and other serious diseases. Obesity and elevated BMI are significant risk factors for CVD, and their effects may differ by gender, so it is important to monitor your body and take preventive measures to reduce your risk of CVD (Khosravi et al., 2012).

BMI is an important risk factor for CVD, directly related to dyslipidemia, type 2 diabetes, hypertension, and sleep disorders. Obesity independently increases the risk of developing and mortality from CVD. Abdominal obesity (waist circumference) and excess visceral and ectopic fat are independent markers of CVD risk. Lifestyle changes and weight loss improve metabolic syndrome, inflammation, and endothelial function, but medical weight loss methods often do not reduce the incidence of CAD (Powell-Wiley et al., 2021).

A study conducted in the United Kingdom with more than 438,000 adults examined the relationship between obesity and a healthy lifestyle. Healthy lifestyle factors were defined as not smoking, regular physical activity, moderate alcohol consumption and a balanced diet. The results of the study showed that obese individuals who followed all four principles of a healthy lifestyle had a lower risk of developing obesity-related diseases, such as hypertension, diabetes and heart disease. However, even with a healthy lifestyle, the risk of diseases in obese individuals remained higher than in people of normal body weight. This suggests that a healthy lifestyle can reduce the risk of obesity, but complete neutralization of the risk is not possible without weight loss (Rassy et al., 2023).

Promoting healthy eating habits, reducing the consumption of processed foods, and increasing physical activity are essential components of weight gain prevention. Research also shows that behavioral changes need to be consistent and integrated into daily routines, as one-off interventions are often not effective in the long term. Furthermore, a comprehensive strategy that includes nutrition, physical activity, and psychological support significantly increases the likelihood of success in reducing BMI and maintaining a healthy weight. This suggests that only consistent lifestyle changes can effectively reduce the risk of obesity and its associated chronic diseases (Feraco et al., 2025).

The results of multivariate regression analysis confirmed that harmful habits (smoking, frequent alcohol consumption) are the strongest risk factors directly associated with higher levels of arterial hypertension, total CVD mortality and IHD mortality. Obesity also had a significant effect on arterial hypertension and IHD mortality, but did not have a significant effect on overall healthy life expectancy. The dietary factor (fruit and vegetable consumption), although positive, did not show a statistically significant effect.

Other studies have shown that smoking is a strong risk factor for CVD, and smoking cessation is the single most effective lifestyle intervention to prevent many cardiovascular diseases. Endothelial dysfunction, arterial stiffness, inflammation, lipid modification, and changes in antithrombotic and prothrombotic factors are the main factors induced by smoking that initiate and accelerate the atherothrombotic process that can lead to CVD. Smoking has a hypertensive effect in the short term, mainly due to stimulation of the sympathetic nervous system. Regarding the effect of chronic smoking on blood pressure, the available data do not clearly indicate a direct causal relationship between these two cardiovascular risk factors, as is supported by the fact that no reduction in blood pressure values has been observed after long-term smoking cessation. However, smoking, by affecting arterial stiffness and wave reflection, may have a more negative effect on blood pressure, which is more closely related to target organ damage than brachial blood pressure (Virdis et al., 2010).

Studies have shown that alcohol consumption is associated with increased blood pressure and the risk of hypertension, especially at levels exceeding 12 g of alcohol per day. A meta-analysis of 23 studies showed a nearly linear relationship between the amount of alcohol consumed and the risk of hypertension, with the increase in risk being greater for women at higher levels of consumption than for men. For men, the relationship was nearly linear across the range of consumption, but for women only above 12 g/d. The increase in risk was similar in Western and Asian populations, but was greater in whites, especially women, compared with blacks. These data support a causal relationship between alcohol consumption and the risk of hypertension and support recommendations to limit or avoid alcohol, with gender and ethnicity as important modifiers of the relationship (Cecchini et al., 2024).

As in this study, other studies evaluating alcohol consumption and CVD have shown conflicting results. Moderate wine consumption, defined as 1–4 drinks per week, was associated with a reduced risk of CVD mortality compared with beer or spirits. However, the higher risk of CVD mortality was generally observed with higher daily or weekly alcohol consumption, across all types of beverages (Krittanawong et al., 2022).

Although moderate wine consumption is likely associated with a lower incidence of CVD, there are many confounding factors, particularly lifestyle, genetic, and socioeconomic associations with wine consumption, which likely explain a large proportion of the association between wine and reduced cardiovascular disease. Further prospective studies of alcohol and all-cause mortality, including cancer, are needed (Krittanawong et al., 2022).

Everyday behavior has a significant impact on both short- and long-term health outcomes and quality of life. Behavior modification is a key approach to preventing chronic diseases. In order to successfully change behavior, it is important to understand how people acquire, maintain, and re-establish new habits. This means that interventions must be tailored to the individual, taking into account their stage of readiness for change, motivation, social environment, and potential barriers. In addition, relapse is considered a normal process, so it is essential to have preventive strategies and a support network when planning changes (Espinosa-Salas & Gonzalez-Arias, 2023).

The study data confirm the internationally recognized trend that a healthy lifestyle, including regular physical activity, non-smoking and a balanced diet, are necessary conditions to reduce the risk and prevalence of CVD. The analysis highlights the importance of healthy life years, especially in chronic diseases and CVD. Therefore, the adjustment of lifestyle factors is complexly related to the subjective habits of the population and the importance of self-care.

This work has certain limitations that are important to consider when interpreting the results and formulating conclusions. First, the study was conducted using secondary, aggregated data from the Eurostat database, so only national-level indicators could be analyzed, not individual data. As a result, it was not possible to assess differences in individual behavior or control for other possible factors. This limits the ability to establish direct causal relationships between lifestyle factors and the prevalence of cardiovascular disease.

Another limitation is related to the periodicity and heterogeneity of data collection. Although the study covers more than a decade (2012–2024), some indicators were not collected annually or at the same time in all European countries. This makes it difficult to identify accurate long-term trends and make comparisons between countries. In addition, although Eurostat data are standardized, their primary collection methodology varies depending on the country - survey questionnaires, sampling methods and respondent groups differ, which may affect the reliability and comparability of the data.

A large part of the lifestyle factors analyzed, such as dietary habits, physical activity, smoking or alcohol consumption, are based on self-report surveys of the population. Such data may be affected by memory errors or social desirability bias, when respondents tend to provide more socially acceptable answers. This may lead to some inaccuracy in assessing real behavioral patterns.

In addition, this study assessed key lifestyle indicators, but did not include other important factors, such as stress levels, sleep quality, psychological well-being or work-life balance. These factors also have a significant impact on CVD risk, so their exclusion may somewhat simplify the overall picture of causal relationships. At the same time, it is important to note that cross-country differences in the quality of healthcare, disease prevention strategies and public health policies may have had an additional impact on the results, but due to lack of data, these aspects were not included in the analysis.

Finally, the statistical analysis methods used, such as correlation and regression analysis, allow us to identify relationships between variables, but do not confirm causal effects. Therefore, the results of the study should be viewed as indications of trends and associations, rather than as definitive causal evidence. Despite these limitations, the work provides valuable insights into the associations between lifestyle factors and CVD in European countries and highlights the importance of healthy lifestyles and prevention for public health.

CONCLUSIONS

1. Analysis of Eurostat data shows that between 2013 and 2022, the prevalence and mortality of CVDs decreased in most European countries, although differences between countries remained significant. At the same time, the healthy life years index increased in many countries, especially in Slovenia, Bulgaria, Estonia, Hungary, Lithuania and Italy. However, a decrease in this indicator was recorded in some countries (e.g. Denmark and the Netherlands). In Lithuania, the duration of healthy life years increased from 59.2 (2013) to 60.3 years (2022), although short-term fluctuations were observed in some years. These data indicate a general trend of improving health status, although health inequalities persist in some places.
2. The results of the analysis showed that lifestyle factors have changed unevenly over the past decade. Although the prevalence of obesity has decreased in some countries and the proportion of people with a normal body weight has increased, physical activity levels remain insufficient - more than half of overweight people do not exercise at all. Smoking prevalence is gradually decreasing, but alcohol consumption habits have not changed much. Fruit and vegetable consumption rates have also remained stable. These results indicate that while some health-promoting behavioural changes are taking place, they are not yet strong enough to significantly affect the overall health of the population.
3. Multivariate regression analysis showed that there is a significant, although mostly moderate, relationship between lifestyle factors and CVD indicators. Harmful habits, smoking and frequent alcohol consumption are most strongly associated with higher mortality from arterial hypertension, total CVD and ischemic heart disease. Obesity is also significantly associated with arterial hypertension and ischemic mortality, but does not have a significant impact on healthy life expectancy. Nutritional indicators (fruit and vegetable consumption) had a positive, but statistically insignificant effect. The study confirms that the main modifiable risk factors (smoking, lack of physical activity and obesity) increase CVD mortality and shorten healthy life expectancy, while a balanced diet and sufficient physical activity are the most important for maintaining health and preventing diseases.

RECOMMENDATIONS

For patients and society

The results show that CVD diseases can be prevented by applying the principles of a healthy lifestyle. Therefore, it is recommended to actively form healthy daily habits, such as a balanced diet, sufficient physical activity, and avoiding smoking and excessive alcohol consumption. Self-care knowledge is an essential part of patient responsibility. Patients must actively take care of their own health in order to avoid risks and contribute to the success of treatment. Residents are suggested to regularly monitor their health indicators, blood pressure, BMI, cholesterol levels and consult with family doctors about prevention. Special attention should be paid to middle-aged and older people, who are at the highest risk of CVD. Healthy lifestyle education should also be integrated into school programs so that health skills are formed from an early age.

For healthcare professionals

Healthcare workers are recommended to more actively include lifestyle assessment in daily clinical practice. Along with traditional diagnostics, the patient's nutritional and physical activity habits should be assessed. It is important to apply motivational interviewing methodologies that help patients change their behaviour. t is especially important to recommend physical activity to patients who have gained weight. Primary healthcare institutions should implement preventive programs aimed at lifestyle monitoring and maintaining healthy behaviour, and doctors and nurses should be trained to effectively advise on lifestyle changes. The discipline of lifestyle medicine should be incorporated into primary health care.

For health policy makers and the public sector

Health policy should focus not only on disease treatment, but also on prevention. It is recommended to strengthen CVD prevention strategies by integrating them with healthy nutrition, physical activity and addiction reduction programs. Intersectoral cooperation should be promoted between health, education and social policy areas to create a health-friendly environment. It is important to ensure that healthy food and sports infrastructure are accessible to all social groups, and public health education campaigns are consistently implemented at the national level. Policy makers should rely on scientific evidence, and prevention measures should be based on data and periodically evaluated for their effectiveness.

Researchers

Future studies are recommended to expand the analysis of lifestyle factors to include more individual-level data and additional health indicators, such as stress levels, sleep duration, psychological well-being, or work environment factors. It would be worthwhile to combine quantitative and qualitative research methods to gain a deeper understanding of the causal relationships between behaviour and CVD prevalence. It is also suggested to develop long-term studies that would allow us to determine how lifestyle changes affect health outcomes over time. Such studies would help to identify not only statistical relationships, but also real causal mechanisms between behaviour and disease prevalence. Researchers should actively cooperate with public health institutions and international organizations to standardize data collection methodologies, apply similar assessment criteria, and ensure comparability of results across countries.

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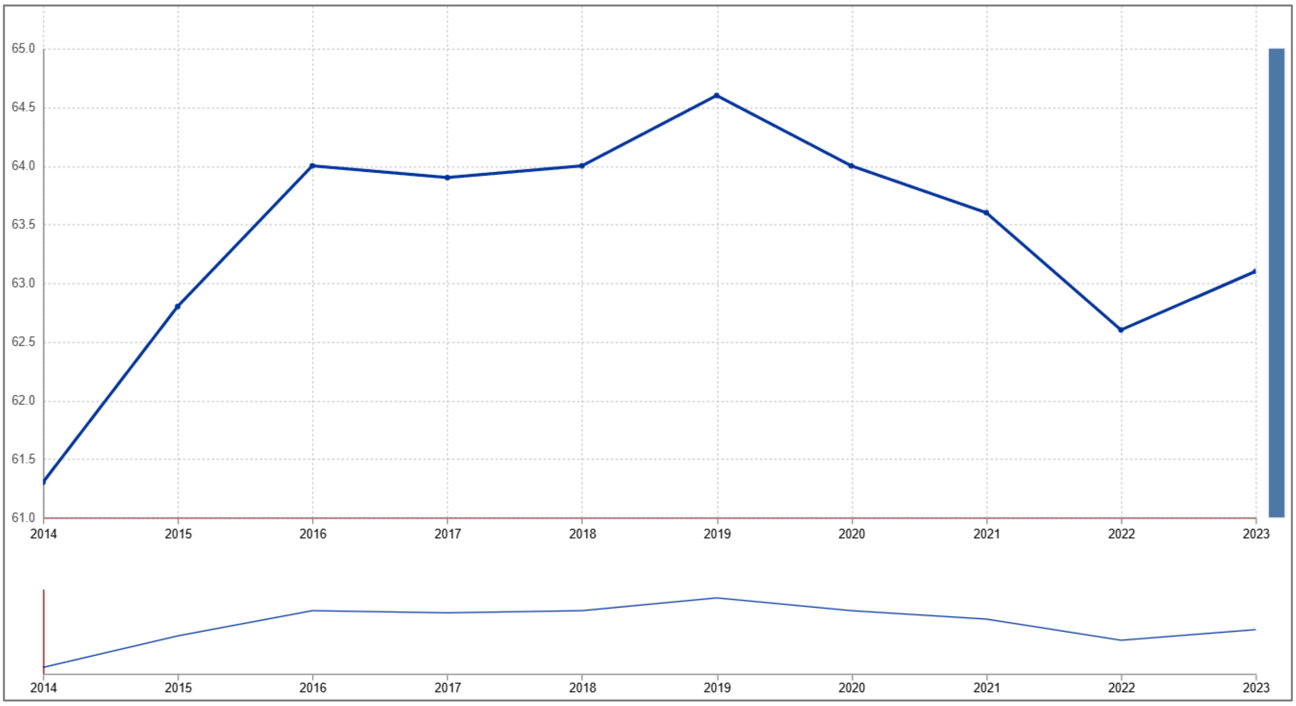
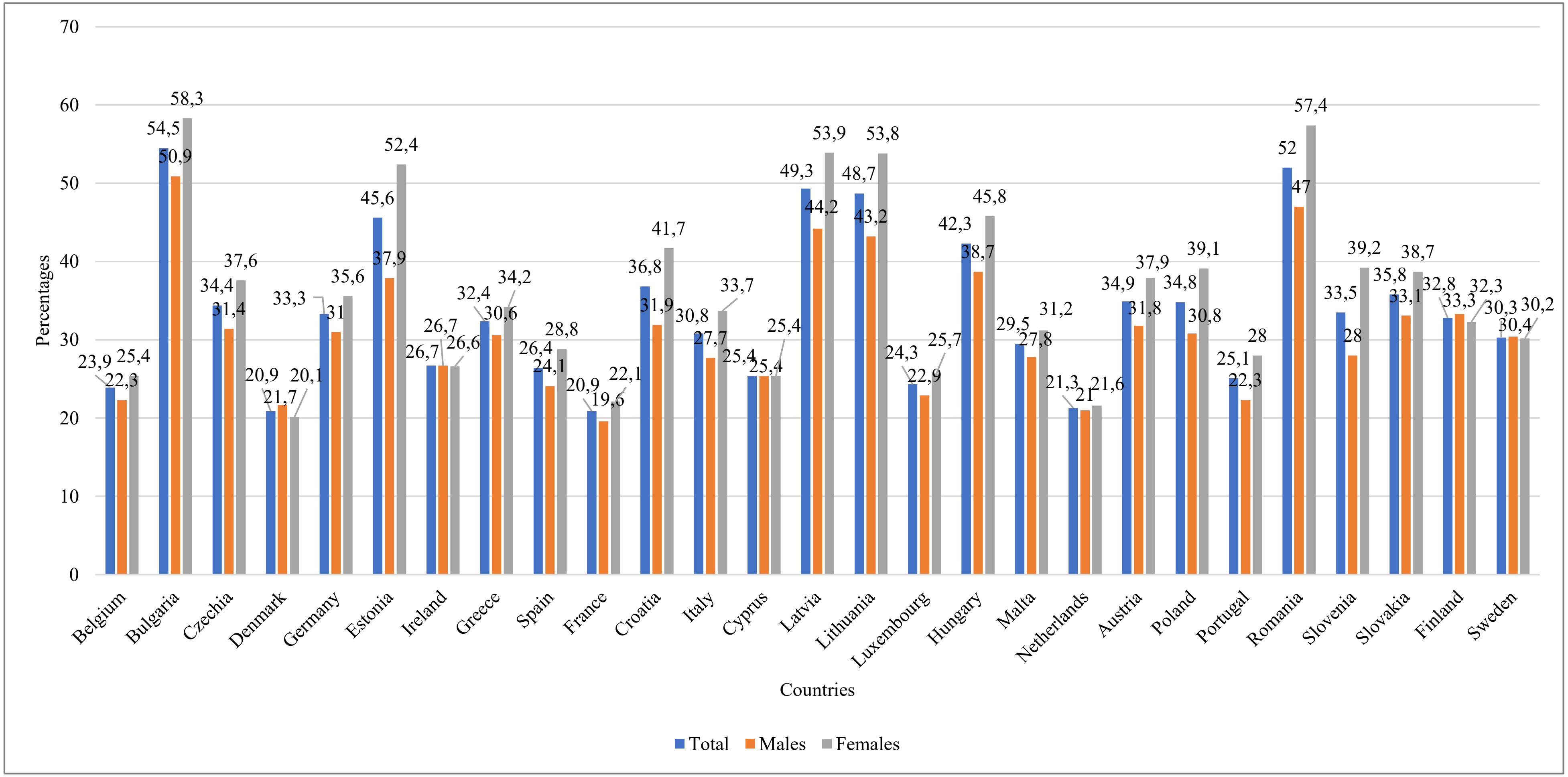
APPENDIXES

Appendix 1. Trend in average healthy life years in Europe. Eurostat data



The indicator of healthy life years measures the number of remaining years that a person of specific age is expected to live without any severe or moderate health problems.

Appendix 2. Causes of death from circulatory system diseases in 2021. Eurostat data



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