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Original Research

Epidemiology and demographic patterns of cardiovascular diseases and neoplasms deaths in Western Europe: a 1990–2019 analysis

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ABSTRACT

Objectives: Cardiovascular diseases (CVDs) and neoplasms have been considered as public health concerns worldwide. This study aimed to estimate the epidemiological patterns of death burden on CVDs and neoplasms and its attributable risk factors in Western Europe from 1990 to 2019 to discuss the potential causes of the disparities.

Study design and methods: We collected data on CVDs and neoplasms deaths in 24 Western European countries from the Global Burden of Disease Study. We analyzed patterns by age, sex, country, and associated risk factors. The results include percentages of total deaths, age-standardized death rates per 100,000 population, and uncertainty intervals (UIs). Time trends were assessed using annual percent change.

Results: In 2019, CVDs and neoplasms accounted for 33.54% and 30.15% of Western Europe's total deaths, with age-standardized death rates of 128.05 (95% UI: 135.37, 113.02) and 137.51 (95% UI: 142.54, 128.01) per 100,000. Over 1990–2019, CVDs rates decreased by 54.97%, and neoplasms rates decreased by 19.54%. Top CVDs subtypes were ischemic heart disease and stroke; top cancers for neoplasms were lung and colorectal. Highest CVD death burdens were in Finland, Greece, Austria; neoplasm burdens in Monaco, San Marino, Andorra. The major risk factors were metabolic (CVDs) and behavioral (neoplasms). Gender differences revealed higher CVDs death burden in males, while neoplasms burden varied by risk factors and age groups.

Conclusion: In 2019, CVDs and neoplasms posed significant health risks in Western Europe, with variations in death burdens and risk factors across genders, age groups, and countries. Future interventions should target vulnerable groups to lessen the impact of CVDs and neoplasms in the region.

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Introduction

Non-communicable diseases (NCDs), which account for 74% of all deaths globally, are the primary causes of mortality and disability. Over 80% of disability-adjusted life years (DALYs) and

over 90% of fatalities in Europe are caused by NCDs.^{1,2} Approximately 25% of healthcare spending and 2% of gross domestic product (GDP) is lost due to the financial burden of the most common NCDs in Europe.³ It is expected that the economic effect of NCDs will continue to climb dramatically in future.⁴

In Europe, which is mostly made up of high-income nations,⁵ the issue of high illness burden associated with NCDs has been a major political issue for more than 30 years.⁶ Despite overall improvements in health outcomes across many European nations, significant disparities in NCDs-related health exist. These disparities show a social gradient, with the majority of illnesses having greater incidence rates of NCDs among lower socio-economic levels.⁷ It is clear that poor socio-economic level has a constant and significant effect on the death and morbidity linked to NCDs.

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Therefore, it has long been acknowledged that addressing and minimizing these inequities is essential to the field of public health.⁸

On a global level, several strategies have been developed for the prevention and management of NCDs. In 2013, the World Health Organization (WHO) Member States endorsed a Global Action Plan on the Prevention and Control of NCDs.⁹ In addition, Sustainable Development Goal 3.4 was introduced, aiming to reduce premature mortality from NCDs by one-third by the year 2030.^{10,11} As well, the WHO European Region has developed a strategic plan titled "Action Plan for the Prevention and Control of NCDs in the WHO European Region 2016–2025." This plan outlines priority actions and interventions for the next decade to reduce premature mortality, decrease disease burden, improve quality of life, and promote equitable healthy life expectancy.¹²

Neoplasms and cardiovascular diseases (CVDs) have consistently been identified as leading causes of deaths and DALYs in Western Europe over the period from 1990 to 2019.¹³ To the best of our knowledge, there is not a single comprehensive study specifically addressing the trends and patterns of CVDs and neoplasms mortality rates in Western Europe. Previous studies have focused on specific countries, but our research covers the entire region using data from the Global Burden of Disease Study. By examining this extensive data set, we aim to identify prevailing trends, patterns, and underlying risk factors contributing to the burden of CVDs and neoplasms in Western Europe. The findings will contribute to the existing knowledge and inform public health policies and interventions to reduce the burden of these diseases.

Methods

Data sources

All anonymized data about CVDs and neoplasms used in this study were extracted from the Global Burden of Disease Study 2019 (GBD 2019), which is a comprehensively collaborative effort coordinated by the Institute for Health Metrics and Evaluation (IHME) at the University of Washington, USA.¹⁴ GBD 2019 has released the findings of the incidence, prevalence, mortality, and DALYs burden of 369 diseases in 204 countries and territories on its official website <https://vizhub.healthdata.org/gbd-results/>^{14,15} to enable comparisons among different health issues, populations, and countries. In this study, we extracted data on deaths related to CVDs and neoplasms in 2019, as well as attributable risk factors for both genders in Western European countries. This included the percent of total deaths, age-standardized deaths, and their 95% uncertainty intervals (UIs). All anonymized data are accessible online at <http://ghdx.healthdata.org/gbd-results-tool>, the Institute for Health Metrics and Evaluation. The deidentified, compiled data were used in the GBD investigation. As a result, the University of Washington Institutional Review Board examined and approved a waiver of informed consent.

Definition of CVDs, neoplasms, and locations

The International Classification of Diseases of Tenth Revision was used to identify the cases of CVDs and neoplasms, and the detail codes were listed on IHME website (<https://ghdx.healthdata.org/record/ihme-data/gbd-2019-cause-icd-code-mappings>).¹⁶ CVDs included 20 subtypes, including ischemic heart disease, stroke, and ischemic stroke, and neoplasms included 37 subtypes of cancer including lung cancer, colorectal cancer, and breast cancer.¹⁴ In the GBD 2019 study, Europe was divided into three regions: Central European, Eastern European, and Western European. Our study focused specifically on the Western European region, which

comprises 24 countries: Andorra, Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Israel, Italy, Luxembourg, Malta, Monaco, the Netherlands, Norway, Portugal, San Marino, Spain, Sweden, Switzerland, and United Kingdom.¹⁷

Estimation of attributable risk factors for CVDs and neoplasms

GBD 2019 provided estimates of death-related burden attributable to 87 risk factors and clusters, which were categorized as level 1 group, including behavioral risk factors, environmental and occupational risk factors, and metabolic risk factors, level 2 group including 20 risk factors, and level 3 group including 52 risk factors, and level 4 group including 69 risk factors.^{15,18} The GBD comparative risk assessment framework was carried out to evaluate the relationship between death of CVDs and neoplasms and potential risk factors, and the details can be found elsewhere.¹⁵ In this study, we present three clusters of level 1 risk factors attributable to CVDs and neoplasms deaths and its subtypes in 24 Western European countries in 2019.

Statistical analysis

The descriptive analysis was conducted across different age groups, genders, locations, and disease categories. The death burden was expressed as the percentage of total deaths and the age-standardized death rate per 100,000 population, along with its corresponding 95% uncertainty interval (UI). The age-standardized death rates were calculated by the world standard population evaluated by the GBD 2019 study. Time trends were presented by annual percent change between 1990 and 2019. All analysis and visualization were conducted using R software (version: V.4.3.2).

Results

Causes of disease burden 2019 and annual percent change 1990–2019 in Western Europe

Among the top 11 most important NCDs, CVDs and neoplasms prevailed as the top two causes of age-standardized death rates in all Western European countries in 2019 (Fig. S1). The majority of Western European countries (18/24) had owned the highest age-standardized death rates of neoplasms and the second highest rates of CVDs, and males and females had the similar ranking patterns in these countries (Fig. S1).

In 2019, there were 33.54% (95% UI: 35.69, 29.44) of total deaths were caused by CVDs in Western Europe, and age-standardized death rate of CVDs was 128.05 per 100,000 (135.37, 113.02) in Western Europe in 2019. Specifically, ischemic heart disease, stroke, and ischemic stroke were the three top subtypes of CVDs death-related burden (Table 1). The death burden of CVDs in Western Europe showed the downward trends from 1990 to 2019, and the age-standardized death rate of CVDs decreased by 54.97% (–53.63, –57.06), of which ischemic heart disease, stroke, and ischemic stroke decreased by 61.17% (–59.05, –62.94), 60.43% (–58.57, –62.66), and 61.17% (–59.05, –62.94), respectively (Table 1).

In 2019, about 30.15% (31.42, 27.63) of total deaths were caused by neoplasms in Western Europe, and its age-standardized death rate of neoplasms was 137.51 per 100,000 (142.54, 128.01) in 2019 (Table 1). For subtypes, lung cancer, colorectal cancer, and breast cancer were the top three cancers with the highest death burden in Western Europe in 2019 (Table 1). The death burden of neoplasms in Western Europe also presented the downward trends from 1990 to 2019, and the age-standardized death rate of neoplasms decreased by 19.54% (–17.81, –21.98), of which lung cancer,

Table 1

Percent of total deaths_2019 (95% UI) all ages, age-standardized deaths_2019 (95% UI), and annual percent change between 1990 and 2019, by diseases, overall Western Europe.

Diseases	Percent of total deaths_2019 (95%UI)			Age-standardized deaths_2019 (95% UI)			Annual percent change 1990–2019 (95% UI), ASR		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
CVDs	33.54 (35.69, 29.44)	30.9 (32.18, 28.36)	36.14 (39.19, 30.35)	128.05 (135.37, 113.02)	153.72 (160.39, 140.17)	105.99 (114.16, 90.51)	–54.97 (–53.63, –57.06)	–56.72 (–55.64, –58.38)	–54.69 (–52.62, –57.43)
Ischemic heart disease	15.60 (16.73, 13.77)	16.21 (17.06, 14.95)	15.00 (16.60, 12.51)	60.69 (64.88, 54.18)	81.31 (85.85, 74.72)	43.98 (48.30, 37.65)	–61.17 (–59.05, –62.94)	–61.63 (–60.06, –63.19)	–62.46 (–59.55, –64.99)
Stroke	8.66 (9.38, 7.42)	7.16 (7.60, 6.48)	10.13 (11.21, 8.32)	32.46 (34.97, 28.29)	35.06 (37.25, 31.66)	30.01 (32.94, 25.31)	–60.43 (–58.57, –62.66)	–61.90 (–60.24, –63.72)	–60.09 (–57.70, –62.92)
Ischemic stroke	5.84 (6.36, 4.96)	4.53 (4.85, 4.03)	7.11 (7.92, 5.81)	20.60 (22.39, 17.61)	21.64 (23.18, 19.26)	19.47 (21.53, 16.15)	–61.17 (–59.05, –62.94)	–67.08 (–65.39, –69.01)	–64.00 (–61.46, –67.07)
Hypertensive heart disease	2.37 (2.70, 1.60)	1.47 (1.65, 1.00)	3.26 (3.74, 1.94)	8.37 (9.45, 5.82)	7.23 (8.07, 4.87)	8.78 (10.02, 5.44)	4.54 (15.28, –31.66)	2.48 (12.56, –29.94)	6.24 (17.85, –31.35)
Intracerebral hemorrhage	2.24 (2.42, 1.97)	2.16 (2.30, 1.97)	2.32 (2.58, 1.97)	9.12 (9.77, 8.20)	10.81 (11.53, 9.88)	7.70 (8.43, 6.72)	–52.53 (–49.70, –56.16)	–52.42 (–49.15, –56.06)	–53.46 (–49.66, –57.82)
Arterial fibrillation	1.64 (1.97, 1.30)	1.20 (1.58, 0.80)	2.06 (2.57, 1.59)	5.75 (6.99, 4.59)	5.75 (7.66, 3.88)	5.67 (7.05, 4.42)	–0.18 (7.80, –14.54)	–2.38 (8.38, –20.84)	1.16 (8.45, –14.54)
Non-rheumatic valve disease	1.32 (1.46, 1.11)	1.04 (1.11, 0.91)	1.60 (1.83, 1.29)	4.82 (5.28, 4.07)	5.02 (5.39, 4.42)	4.57 (5.17, 3.74)	0.99 (8.38, –8.05)	1.83 (9.73, –6.36)	1.01 (10.53, –9.40)
Non-rheumatic calcific aortic valve disease	1.12 (1.25, 0.93)	0.90 (0.98, 0.78)	1.34 (1.55, 1.06)	4.04 (4.51, 3.39)	4.33 (4.72, 3.78)	3.76 (4.32, 3.03)	12.79 (21.66, 2.47)	8.73 (18.22, –1.05)	16.58 (27.60, 4.47)
Cardiomyopathy	1.10 (1.28, 0.94)	1.10 (1.36, 0.89)	1.10 (1.33, 0.89)	4.50 (5.31, 3.93)	5.77 (7.17, 4.71)	3.34 (4.03, 2.78)	–57.63 (–31.16, –62.50)	–53.52 (–17.49, –59.73)	–63.25 (–20.56, –68.08)
Other CVDs	0.90 (0.98, 0.79)	0.73 (0.78, 0.66)	1.07 (1.19, 0.91)	3.72 (4.04, 3.31)	3.79 (4.04, 3.44)	3.58 (4.01, 3.12)	–45.86 (–43.02, –49.43)	–50.17 (–47.41, –53.88)	–43.33 (–39.57, –47.46)
Other cardiomyopathy	0.88 (1.06, 0.75)	0.79 (1.00, 0.65)	0.97 (1.22, 0.77)	3.42 (4.18, 2.95)	4.02 (5.13, 3.35)	2.88 (3.69, 2.34)	–60.70 (–24.88, –66.32)	–57.68 (–14.67, –64.29)	–63.90 (–13.21, –69.72)
Aortic aneurysm	0.74 (0.78, 0.66)	0.96 (1.01, 0.88)	0.52 (0.57, 0.44)	3.06 (3.22, 2.80)	4.75 (5.01, 4.38)	1.77 (1.92, 1.56)	–31.63 (–28.99, –34.77)	–40.15 (–37.17, –43.08)	–21.46 (–16.82, –26.32)
Subarachnoid hemorrhage	0.58 (0.63, 0.52)	0.47 (0.52, 0.42)	0.69 (0.75, 0.60)	2.73 (2.93, 2.48)	2.60 (2.88, 2.36)	2.82 (3.02, 2.52)	–33.98 (–29.09, –38.83)	–26.71 (–18.45, –34.78)	–37.57 (–32.74, –43.12)
Peripheral artery	0.51 (0.94, 0.24)	0.51 (1.20, 0.17)	0.52 (1.12, 0.18)	1.88 (3.49, 0.89)	2.43 (5.75, 0.82)	1.46 (3.18, 0.50)	11.02 (32.63, –20.46)	3.36 (15.41, –23.58)	11.42 (52.42, –33.18)
Rheumatic heart disease	0.38 (0.42, 0.32)	0.25 (0.27, 0.22)	0.50 (0.58, 0.42)	1.46 (1.62, 1.26)	1.24 (1.35, 1.11)	1.60 (1.81, 1.34)	–51.52 (–46.97, –55.95)	–48.29 (–43.74, –52.53)	–53.20 (–48.40, –58.26)
Endocarditis	0.32 (0.40, 0.15)	0.26 (0.33, 0.10)	0.38 (0.47, 0.18)	1.28 (1.57, 0.62)	1.34 (1.67, 0.54)	1.189 (1.45, 0.58)	76.77 (162.98, –35.89)	103.84 (225.71, –39.29)	65.29 (138.07, –32.62)
Non-rheumatic degenerative mitral valve disease	0.20 (0.27, 0.14)	0.13 (0.18, 0.10)	0.26 (0.38, 0.17)	0.75 (1.03, 0.56)	0.66 (0.87, 0.47)	0.79 (1.17, 0.54)	–35.60 (–11.93, –43.71)	–28.24 (–1.84, –35.26)	–38.19 (–14.52, –48.18)
Alcoholic cardiomyopathy	0.14 (0.17, 0.11)	0.25 (0.32, 0.20)	0.03 (0.04, 0.02)	0.73 (0.90, 0.59)	1.41 (1.75, 1.09)	0.14 (0.18, 0.09)	–55.52 (–44.08, –69.02)	–46.91 (–28.03, –65.94)	–83.53 (–67.50, –87.53)
Myocarditis	0.08 (0.11, 0.04)	0.05 (0.07, 0.03)	0.10 (0.14, 0.05)	0.33 (0.43, 0.18)	0.33 (0.42, 0.17)	0.31 (0.42, 0.16)	36.14 (80.85, –18.38)	37.94 (88.88, –33.17)	37.35 (87.20, –14.99)
Other non-rheumatic valve	0.01 (0.01, 0.00)	0.00 (0.01, 0.00)	0.01 (0.01, 0.00)	0.02 (0.03, 0.01)	0.01 (0.02, 0.01)	0.02 (0.03, 0.01)	23.53 (63.78, –15.11)	15.81 (53.78, –11.02)	27.82 (83.13, –18.16)
Neoplasms	30.15 (31.42, 27.63)	34.04 (35.42, 31.91)	26.36 (27.78, 23.56)	137.51 (142.54, 128.01)	175.03 (181.57, 164.92)	108.95 (113.55, 100.33)	–19.54 (–17.81, –21.98)	–25.68 (–24.01, –27.99)	–15.63 (–13.50, –18.54)
Lung cancer	6.10 (6.33, 5.73)	8.23 (8.53, 7.81)	4.02 (4.22, 3.68)	28.98 (29.96, 27.43)	42.52 (44.08, 40.46)	17.87 (18.63, 16.68)	–17.60 (–15.11, –20.51)	–36.02 (–34.04, –38.27)	41.25 (45.85, 36.00)
Colorectal cancer	4.03 (4.25, 3.66)	4.32 (4.53, 4.04)	3.75 (4.03, 3.27)	17.31 (18.13, 15.83)	21.79 (22.84, 20.39)	13.76 (14.60, 12.36)	–22.12 (–19.64, –24.96)	–20.42 (–17.38, –23.46)	–26.90 (–24.06, –30.49)
Breast cancer	2.30 (2.43, 2.06)	0.04 (0.05, 0.04)	4.51 (4.77, 4.04)	10.89 (11.45, 10.01)	0.22 (0.24, 0.20)	19.79 (20.76, 18.32)	–32.75 (–30.15, –35.67)	–8.72 (0.46, –16.95)	–30.24 (–27.57, –33.22)

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Table 1 (continued)

Diseases	Percent of total deaths_2019 (95%UI)			Age-standardized deaths_2019 (95% UI)			Annual percent change 1990–2019 (95% UI), ASR		
	Both sexes	Male	Female	Both sexes	Male	Female	Both sexes	Male	Female
Prostate cancer	2.24 (3.10, 1.86)	4.53 (6.29, 3.76)	—	8.73 (12.09, 7.25)	21.60 (29.77, 17.87)	—	−13.50 (6.36, −20.04)	−25.49 (−9.83, −31.02)	—
Pancreatic cancer	2.15 (2.28, 1.95)	2.12 (2.23, 1.98)	2.18 (2.35, 1.90)	9.66 (10.22, 8.94)	10.92 (11.51, 10.27)	8.50 (9.09, 7.64)	15.08 (20.45, 9.48)	8.57 (13.72, 3.29)	20.24 (26.74, 12.80)
Stomach cancer	1.48 (1.56, 1.34)	1.71 (1.80, 1.59)	1.24 (1.34, 1.08)	6.47 (6.81, 5.97)	8.74 (9.15, 8.17)	4.63 (4.92, 4.16)	−52.87 (−51.06, −54.72)	−55.17 (−53.43, −56.92)	−52.67 (−50.44, −54.85)
Bladder cancer	1.18 (1.27, 1.05)	1.77 (1.90, 1.61)	0.60 (0.66, 0.52)	4.78 (5.14, 4.32)	8.62 (9.26, 7.84)	2.047 (2.22, 1.79)	−21.62 (−17.09, −26.09)	−28.00 (−23.71, −31.95)	−20.76 (−16.08, −25.95)
Leukemia	1.05 (1.11, 0.93)	1.19 (1.26, 1.10)	0.91 (0.99, 0.75)	4.90 (5.14, 4.45)	6.36 (6.69, 5.90)	3.79 (4.02, 3.30)	−17.52 (−14.45, −22.35)	−17.47 (−13.79, −21.28)	−20.55 (−16.60, −27.74)
Other malignant	0.94 (1.02, 0.80)	0.90 (0.97, 0.76)	0.99 (1.08, 0.83)	4.68 (5.017, 4.048)	5.10 (5.50, 4.32)	4.31 (4.64, 3.73)	−22.97 (−18.13, −29.88)	−32.47 (−22.91, −39.51)	−12.56 (−7.27, −19.68)
Liver cancer	0.94 (1.00, 0.87)	1.26 (1.35, 1.17)	0.63 (0.68, 0.56)	4.41 (4.67, 4.10)	6.56 (7.04, 6.11)	2.53 (2.68, 2.29)	28.54 (36.25, 21.40)	23.60 (32.97, 15.09)	27.02 (33.89, 19.69)
Non-Hodgkin lymphoma	0.90 (0.95, 0.81)	0.97 (1.04, 0.90)	0.82 (0.89, 0.72)	4.06 (4.28, 3.74)	5.073 (5.42, 4.71)	3.23 (3.45, 2.91)	−10.94 (−6.92, −15.67)	−11.46 (−5.96, −16.62)	−11.97 (−7.16, −17.77)
Esophageal cancer	0.82 (0.86, 0.76)	1.21 (1.27, 1.14)	0.43 (0.46, 0.38)	3.87 (4.06, 3.64)	6.42 (6.74, 6.06)	1.67 (1.78, 1.52)	−15.70 (−12.12, −19.11)	−20.05 (−16.31, −23.44)	−13.04 (−8.39, −17.01)
Kidney cancer	0.80 (0.85, 0.74)	1.04 (1.09, 0.97)	0.58 (0.62, 0.51)	3.64 (3.82, 3.39)	5.34 (5.58, 5.01)	2.27 (2.41, 2.04)	4.08 (8.83, −0.93)	4.05 (8.51, −1.22)	−2.81 (2.58, −8.33)
Brain and central nervous system cancer	0.72 (0.81, 0.45)	0.84 (0.94, 0.50)	0.60 (0.71, 0.32)	4.17 (4.65, 2.67)	5.19 (5.78, 3.14)	3.24 (3.77, 1.80)	−1.37 (10.56, −45.23)	1.62 (13.32, −47.19)	−7.07 (10.14, −44.30)
Ovarian cancer	0.72 (0.78, 0.64)	—	1.42 (1.53, 1.25)	3.39 (3.65, 3.06)	—	6.27 (6.75, 5.70)	−27.23 (−16.05, −33.70)	—	−23.49 (−10.91, −30.23)
Multiple myeloma	0.61 (0.65, 0.50)	0.65 (0.70, 0.48)	0.57 (0.62, 0.45)	2.63 (2.81, 2.21)	3.23 (3.47, 2.42)	2.18 (2.39, 1.81)	15.62 (21.83, −2.93)	14.96 (22.92, −18.80)	12.46 (19.07, 0.68)
Acute myeloid leukemia	0.42 (0.45, 0.32)	0.47 (0.52, 0.34)	0.37 (0.41, 0.28)	2.08 (2.22, 1.64)	2.54 (2.76, 1.88)	1.71 (1.84, 1.38)	24.27 (34.76, −4.06)	25.27 (40.61, −14.33)	19.58 (28.58, 3.90)
Other neoplasms	0.41 (0.54, 0.31)	0.44 (0.69, 0.27)	0.38 (0.41, 0.31)	1.58 (2.11, 1.19)	2.13 (3.33, 1.31)	1.19 (1.30, 1.00)	22.83 (47.30, −8.59)	11.01 (43.70, −25.05)	27.65 (45.25, −1.40)
Myelodysplastic, myeloproliferative, and other hematopoietic neoplasms	0.41 (0.54, 0.31)	0.44 (0.69, 0.27)	0.38 (0.41, 0.31)	1.58 (2.11, 1.19)	2.13 (3.33, 1.31)	1.19 (1.30, 1.00)	22.83 (47.30, −8.59)	11.01 (43.70, −25.05)	27.65 (45.25, −1.40)
Gallbladder and biliary tract cancer	0.40 (0.45, 0.33)	0.33 (0.36, 0.24)	0.46 (0.56, 0.36)	1.70 (1.93, 1.43)	1.65 (1.79, 1.22)	1.74 (2.13, 1.40)	−42.26 (−32.30, −45.54)	−31.01 (−18.13, −42.90)	−47.43 (−36.49, −51.66)
Malignant skin melanoma	0.37 (0.41, 0.22)	0.42 (0.48, 0.21)	0.32 (0.36, 0.17)	1.88 (2.09, 1.12)	2.35 (2.69, 1.16)	1.50 (1.72, 0.78)	13.25 (25.35, −28.22)	19.11 (36.46, −43.93)	4.61 (13.32, −36.64)
Lip and oral cavity cancer	0.34 (0.35, 0.31)	0.45 (0.47, 0.43)	0.22 (0.24, 0.20)	1.66 (1.73, 1.56)	2.51 (2.63, 2.37)	0.90 (0.97, 0.82)	−28.01 (−25.20, −30.82)	−38.25 (−35.19, −41.11)	1.77 (7.60, −3.78)
Uterine cancer	0.32 (0.34, 0.29)	—	0.64 (0.68, 0.57)	1.43 (1.51, 1.28)	—	2.59 (2.73, 2.35)	−7.72 (−3.69, −12.16)	—	−0.54 (3.83, −5.39)
Other leukemia	0.28 (0.32, 0.24)	0.31 (0.37, 0.27)	0.25 (0.28, 0.20)	1.20 (1.34, 1.05)	1.59 (1.88, 1.40)	0.91 (1.03, 0.77)	−30.01 (−20.65, −35.08)	−28.28 (−14.94, −34.28)	−34.50 (−27.86, −41.12)
Cervical cancer	0.27 (0.30, 0.24)	—	0.54 (0.59, 0.47)	—	1.41 (1.52, 1.26)	2.65 (2.84, 2.38)	−41.89 (−37.83, −45.37)	—	−39.22 (−35.15, −42.86)
Mesothelioma	0.24 (0.25, 0.22)	0.40 (0.42, 0.37)	0.09 (0.10, 0.06)	1.09 (1.15, 1.017)	1.98 (2.09, 1.86)	0.37 (0.43, 0.24)	1.80 (11.32, −6.53)	0.89 (8.96, −6.96)	−17.93 (1.68, −38.96)
Chronic lymphoid leukemia	0.23 (0.28, 0.20)	0.28 (0.35, 0.24)	0.19 (0.22, 0.15)	0.93(1.11, 0.82)	1.36 (1.69, 1.18)	0.62 (0.73, 0.51)	−11.59 (5.51, −19.07)	−13.95 (7.59, −22.57)	−14.65 (−1.53, −24.12)
Larynx cancer	0.23 (0.24, 0.21)	0.40 (0.42, 0.38)	0.05 (0.06, 0.04)	1.11 (1.16, 1.04)	2.13 (2.24, 2.02)	0.24 (0.27, 0.19)	−53.33 (−51.28, −55.41)	−57.84 (−55.96, −59.79)	−27.60 (−19.81, −39.98)
Other pharynx cancer	0.22 (0.23, 0.20)	0.36 (0.39, 0.34)	0.08 (0.08, 0.07)	1.17 (1.25, 1.09)	2.06 (2.21, 1.92)	0.36 (0.39, 0.33)	−9.61 (−2.84, −15.41)	−16.58 (−9.38, −22.15)	21.31 (30.22, 13.15)
Non-melanoma skin cancer	0.15 (0.16, 0.13)	0.18 (0.19, 0.16)	0.13 (0.14, 0.10)	0.60 (0.64, 0.52)	0.90 (0.97, 0.79)	0.38 (0.41, 0.32)	−5.20 (−1.69, −10.13)	−2.64 (2.71, −10.13)	−15.06 (−9.63, −20.06)

Non-melanoma skin cancer (squamous cell carcinoma)	0.15 (0.16, 0.13)	0.18 (0.19, 0.16)	0.13 (0.14, 0.10)	0.60 (0.64, 0.52)	0.91 (0.97, 0.79)	0.38 (0.41, 0.32)	-5.20 (-1.69, -10.13)	-2.64 (2.71, -10.13)	-15.06 (-9.63, -20.06)
Thyroid cancer	0.10 (0.11, 0.09)	0.09 (0.09, 0.07)	0.11 (0.12, 0.10)	0.45 (0.48, 0.40)	0.45 (0.49, 0.36)	0.44 (0.47, 0.40)	-32.53 (-28.13, -36.54)	-12.70 (-4.88, -25.64)	-41.43 (-37.34, -44.82)
Chronic myeloid leukemia	0.06 (0.07, 0.05)	0.07 (0.09, 0.06)	0.05 (0.06, 0.04)	0.27 (0.32, 0.24)	0.36 (0.45, 0.32)	0.20 (0.24, 0.18)	-67.24 (-62.87, -69.88)	-66.37 (-59.91, -69.63)	-69.27 (-64.24, -72.93)
Hodgkin lymphoma	0.06 (0.07, 0.05)	0.06 (0.07, 0.05)	0.05 (0.07, 0.04)	0.32 (0.39, 0.28)	0.38 (0.41, 0.32)	0.27 (0.40, 0.21)	-51.32 (-42.36, -55.52)	-55.92 (-51.23, -58.72)	-44.69 (-31.42, -52.64)
Acute lymphoid leukemia	0.06 (0.06, 0.05)	0.06 (0.08, 0.05)	0.05 (0.06, 0.04)	0.41 (0.46, 0.36)	0.49 (0.59, 0.41)	0.33 (0.38, 0.28)	-37.21 (-17.65, -45.16)	-37.07 (-14.76, -46.47)	-37.71 (-20.56, -47.76)
Nasopharynx cancer	0.05 (0.05, 0.04)	0.07 (0.07, 0.06)	0.03 (0.03, 0.02)	0.25 (0.27, 0.24)	0.40 (0.42, 0.37)	0.12 (0.13, 0.11)	-44.45 (-41.19, -47.69)	-47.84 (-44.28, -51.23)	-37.98 (-34.72, -40.99)
Testicular cancer	0.02 (0.02, 0.02)	0.04 (0.04, 0.04)	-	0.14 (0.15, 0.13)	0.29 (0.31, 0.27)	-	-38.75 (-33.91, -43.91)	-40.34 (-35.77, -45.10)	-

ASR, age-standardized rate; CVD, cardiovascular disease; UI, uncertainty interval.
The UI presents a range from highest to lowest values. All estimated values are considered significant as their UI does not contain a value of 0.

colorectal cancer, and breast cancer decreased by 17.60% (−15.11, −20.51), 22.12% (−19.64, −24.96), and −32.75% (−30.15, −35.67) respectively (Table 1).

Disease burden of CVDs and neoplasms by countries in Western Europe, 2019

Across Western Europe, Finland, Greece, and Austria had the highest CVDs death burden in 2019, and the percent of total deaths were 45.24% (48.14, 39.72), 43.46% (46.25, 38.35), and 40.00% (42.66, 34.93), respectively, while Andorra, the Netherlands and Israel had the lowest death burden, and the percent of total death were 27.22% (29.82, 23.07), 27.11% (29.05, 23.84), and 25.86% (27.72, 22.66) in 2019, respectively (Fig. 1A and Table S1).

Regarding Neoplasms, Monaco, San Marino, and Andorra were the top three Western Europe countries with the highest death burden of neoplasms, specifically, the percent of total deaths were 42.89% (45.54, 39.84) in Monaco, 38.68% (41.32, 34.80) in San Marino, and 37.01% (38.94, 34.20) in Andorra. Conversely, Malta (26.50%, 95% UI: 27.80, 24.47), Cyprus (26.30%, 95% UI: 27.86, 24.44), and Finland (25.83%, 95% UI: 27.01, 23.74) were three Western Europe countries with the lowest death burden of neoplasms (Fig. 1B and Table S1).

Sex–age distribution of disease burden of CVDs and neoplasms in Western Europe, 2019

Males suffered from a higher death burden of CVDs in Western Europe in 2019. The age-standardized death rate for males was 153.72 per 100,000 (95% UI: 160.39, 140.17), while for females, it was 105.99 per 100,000 (95% UI: 114.16, 90.51) (Table 1). For subtypes of CVDs, the death burden of all CVDs subtypes, except for hypertensive heart disease, non-rheumatic degenerative mitral valve, and other non-rheumatic valve, leaned toward higher rates in males rather than females (Table 1). Across Western Europe, the death rates due to CVDs for males were higher than those for females in almost all Western European countries (Fig. 2A).

The percent of total deaths and age-standardized death rates of neoplasms for males were 34.04% (95% UI: 35.42, 31.91) and 175.03 per 100,000 (95% UI: 181.57, 164.92), respectively, which were all higher than those for females (percent: 26.36%, 95% UI: 27.78, 23.56; rate: 108.95 per 100,000, 95% UI: 113.55, 100.33; see Table 1). For subtypes, the death burden of all neoplasm subtypes, except for breast cancer, ovarian cancer, gallbladder and biliary tract cancer, uterine cancer, and cervical cancer, had higher rates in males rather than females (Table 1). Besides, males had higher deaths caused by neoplasms than females in all 24 Western European countries (Fig. 2B).

CVDs death burden increased significantly with advancing age, and elder groups suffered from the higher CVDs deaths, of which rheumatic heart disease, ischemic heart disease, stroke, hypertensive heart disease, non-rheumatic valvar disease, and cardiomyopathy comprised the majority of death burden caused by CVDs (Fig. 3A). Furthermore, we conducted an analysis on the age distribution about subtypes of stroke, non-rheumatic valvar disease and cardiomyopathy, in which the age distribution of subtypes about stroke and non-rheumatic valvar disease remained largely consistent with that of CVDs, while cardiomyopathy exhibited distinct age characteristics across its different subgroups. Specifically, myocarditis and alcoholic cardiomyopathy had higher death burden among 0–40 years of age and 20–70 years of age, whereas other cardiomyopathy did not have obvious age characteristics (Fig. 3A).

Neoplasms death burden appeared in two peaks in the age groups of 1–15 years and 50–70 years of age (Fig. 3B). We can see

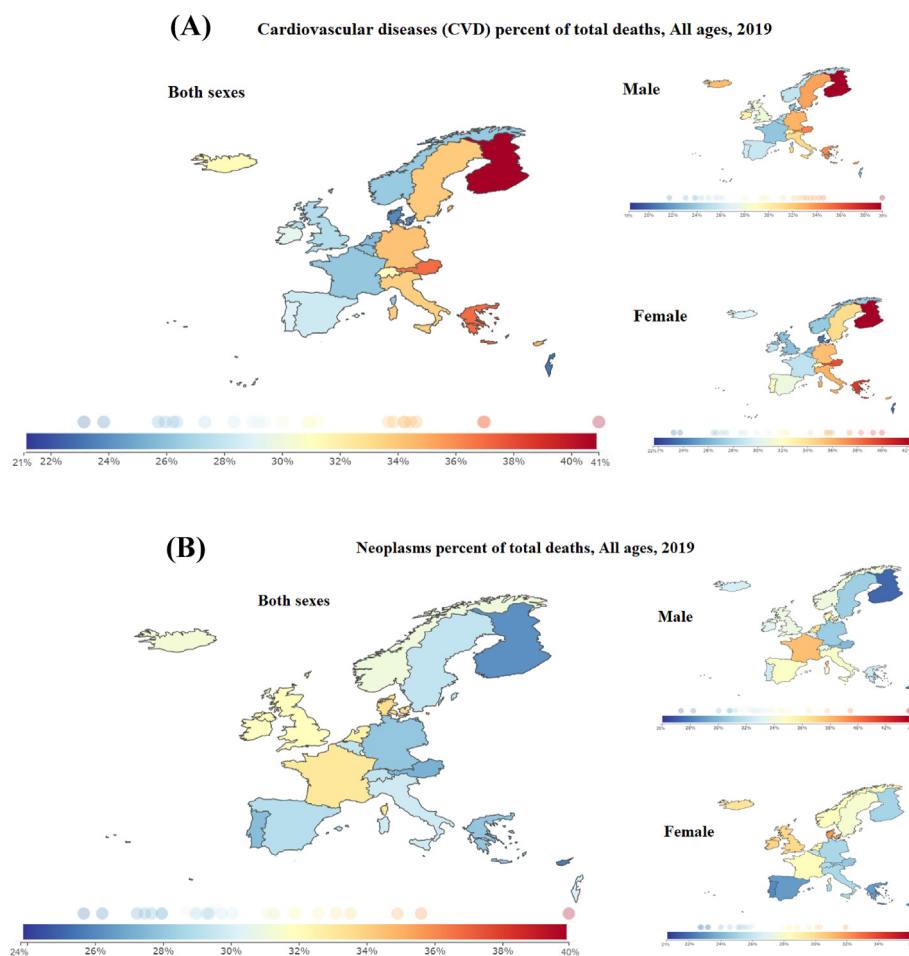


Fig. 1. (A) CVD deaths burden 2019 both sexes and by gender in Western Europe countries. Percent of total deaths 2019 were summarized for both sexes, by gender and by Western Europe countries. (B) Neoplasms deaths 2019 both sexes and by gender in Western Europe countries. Percent of total deaths 2019 were summarized for both sexes, by gender and by Western Europe countries.

that the occurrence of two peaks in death burden was attributed to different types of cancer, to be specific, the death peak in younger groups was mainly caused by eye cancer, leukemia, lymphoma, neuroblastoma, and other peripheral nerve tumors, whereas the death peak in elder groups was mainly due to lung cancer, breast cancer, pancreatic cancer, and other age-related cancers (Fig. 3B).

Disease burden of CVDs and neoplasms by attributable risk factors

Metabolic risk was the major risk factor of CVDs deaths, and 70.20% (75.67, 64.14) of CVD deaths were attributable to metabolic risk in Western Europe in 2019 (Table 2). Across Western Europe, Malta (76.77%, 95% UI: 82.46, 69.99), Finland (75.01%, 95% UI: 81.24, 68.17), and Germany (74.96%, 95% UI: 80.07, 69.04) were the top three countries with the highest percent of CVDs deaths attributable to metabolic risk. Furthermore, there were approximately 42.14% (46.99, 37.66) and 12.72% (15.44, 10.37) of CVDs deaths were due to behavioral and environmental risks in 2019. The attributable CVDs deaths of behavioral risk were the highest in Malta, Iceland, and Ireland, and the attributable CVDs deaths of environmental risk were the highest in Malta, Greece, and Italy in 2019 (Table 2). Generally, males had the higher attributable CVDs deaths to metabolic, behavioral, and environmental risk factors than females in most Western European countries (Table 2).

Behavioral risk was the major risk factor of neoplasms deaths, and there were 36.70% (38.31, 35.21) of neoplasms deaths were

attributable to behavioral risk in Western Europe in 2019 (Table S2). Specifically, Denmark (41.21%, 95% UI: 43.44, 39.53), Greece (40.96%, 95% UI: 43.00, 39.14), and Belgium (39.37%, 95% UI: 41.18, 37.40) had the highest neoplasms deaths attributable to behavioral risk. Then metabolic risk had caused about 11.08% (95% UI: 17.76, 5.61) of neoplasms deaths in Western Europe in 2019, and the United Kingdom (13.20%, 95% UI: 21.02, 6.83), Germany (12.65%, 95% UI: 20.30, 6.41), and Luxembourg (12.03%, 95% UI: 19.78, 5.88) were the top three countries with the highest neoplasm deaths attributable to the risk. Besides, environmental risks were also important risk factors for neoplasms, and there were approximately 9.01% (10.39, 7.53) of neoplasm deaths in Western Europe were due to environmental risks in 2019, and Belgium (11.27%, 95% UI: 13.21, 9.24), the United Kingdom (11.24%, 95% UI: 12.68, 9.54), and the Netherlands (11.17%, 95% UI: 12.87, 9.40) suffered from the higher attributable deaths (Table S2). Besides, the gender disparities in attributable burden of neoplasm death manifested different patterns across various risk factors, with metabolic factors causing more attributable death burden to females, whereas behavioral and environmental factors being predominantly attributed to males in most countries (Table S2).

Discussion

Our study is the inaugural attempt to estimate the epidemiological trends in the burden of mortality from CVDs and neoplasms,

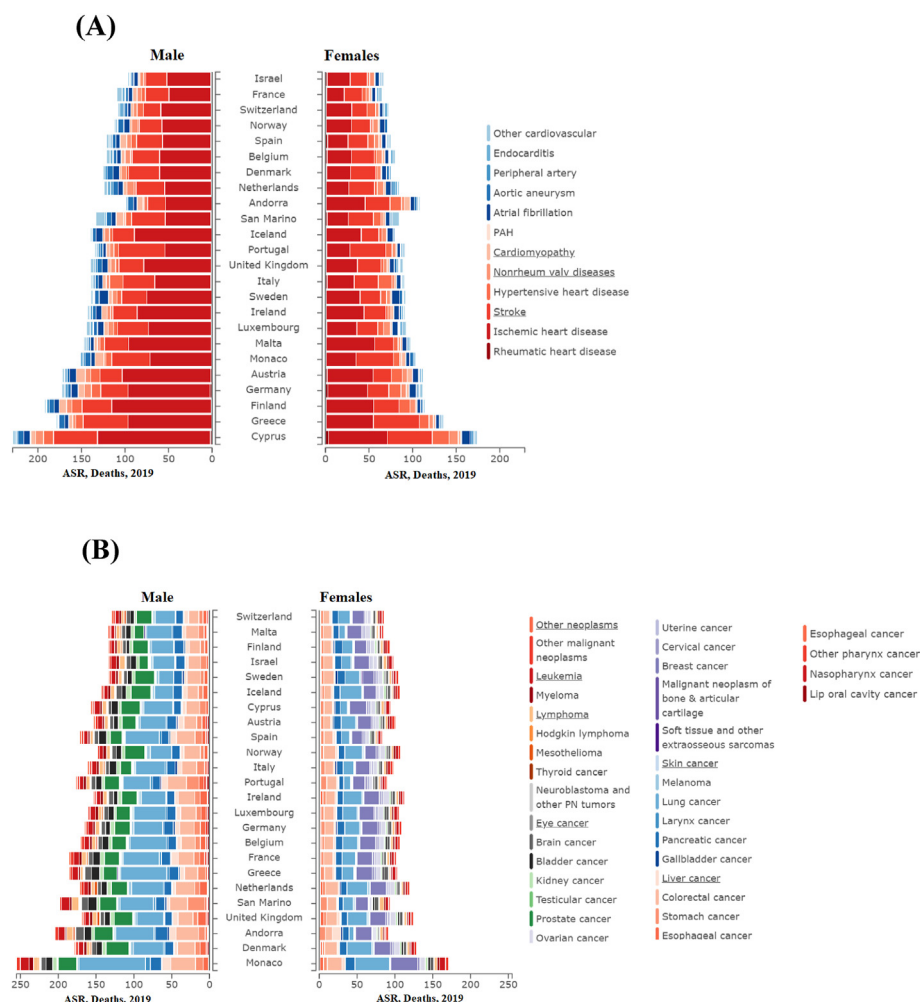


Fig. 2. (A) CVD age-standardized death rate by sex and countries in Western Europe 2019. The age-standardized rate (ASR) of death were calculated by the world standard population evaluated by the GBD 2019 study. PAH, pulmonary arterial hypertension; Nonrheum valve disease, non-rheumatic valve disease. (B) Neoplasm death burden by sex and countries in Western Europe 2019. The age-standardized rate (ASR) of death was calculated by the world standard population evaluated by the GBD 2019 study.

as well as the associated risk factors, in Western Europe spanning the years 1990–2019. Our research highlights that CVDs and neoplasms are significant health threats in Western Europe. Notably, many risk factors are common to both diseases (CVDs and neoplasms) and have been extensively studied as shared risk factors in the field of cardio-oncology.^{19,20} Our findings underscore the importance of addressing risk factors, implementing targeted interventions, and reducing disparities to effectively reduce the death burden associated with these diseases. The study provides valuable insights that can inform public health policies and interventions aimed at reducing the burden of CVDs and neoplasms in Western Europe, ultimately improving population health outcomes.

In Western Europe, a significant number of countries (18 of 24) experienced the highest age-standardized death rates in males and females both for neoplasms, while they ranked second highest for CVDs. This finding deviates from the global epidemiological trend, which typically places CVDs as the leading cause of death and cancer as the second highest cause.²¹ A recent study conducted in 157 countries has identified an epidemiological transition where CVDs are the leading cause of premature death in 70 countries, while cancer takes the lead in 57 countries. These findings suggest that cancer has the potential to become the primary cause of premature death in the majority of countries throughout this century.²² In 2019, there were 33.54% (95% UI: 35.69, 29.44) of total

deaths caused by CVDs in Western Europe. Notably, the three primary subtypes of CVDs contributing to this burden were ischemic heart disease, stroke, and ischemic stroke. These subtypes burden align with the global pattern and highlight the significant impact of these conditions on the population's health.²³ Moreover, contrary to the global epidemiological trend of CVDs, Western Europe experienced a decline in the overall death burden attributed to CVDs from 1990 to 2019. This result is in accordance with previous research.²⁴ Moreover, the age-standardized death rate of CVDs in Western Europe also decreased by 54.97%, and this outcome aligns with the global epidemiological trend observed in 2019.²³ Reportedly, the decline in the burden of CVD can be attributed to significant reductions in cigarette smoking, advancements in hypertension treatment and control, widespread use of statins to lower cholesterol levels, and timely interventions. These measures have reduced the prevalence and severity of CVD, leading to improved health outcomes.²⁵ Furthermore, in 2019, about 30.15% (31.42, 27.63) of total deaths were caused by neoplasms in Western Europe, and lung cancer, colorectal cancer, and breast cancer were the top three cancers with the highest death burden in Western Europe. The death burden of overall neoplasms in Western Europe also presented the downward trends from 1990 to 2019, and the age-standardized death rate of neoplasms decreased by 19.54% (−17.81, −21.98). This result is not in accordance with global

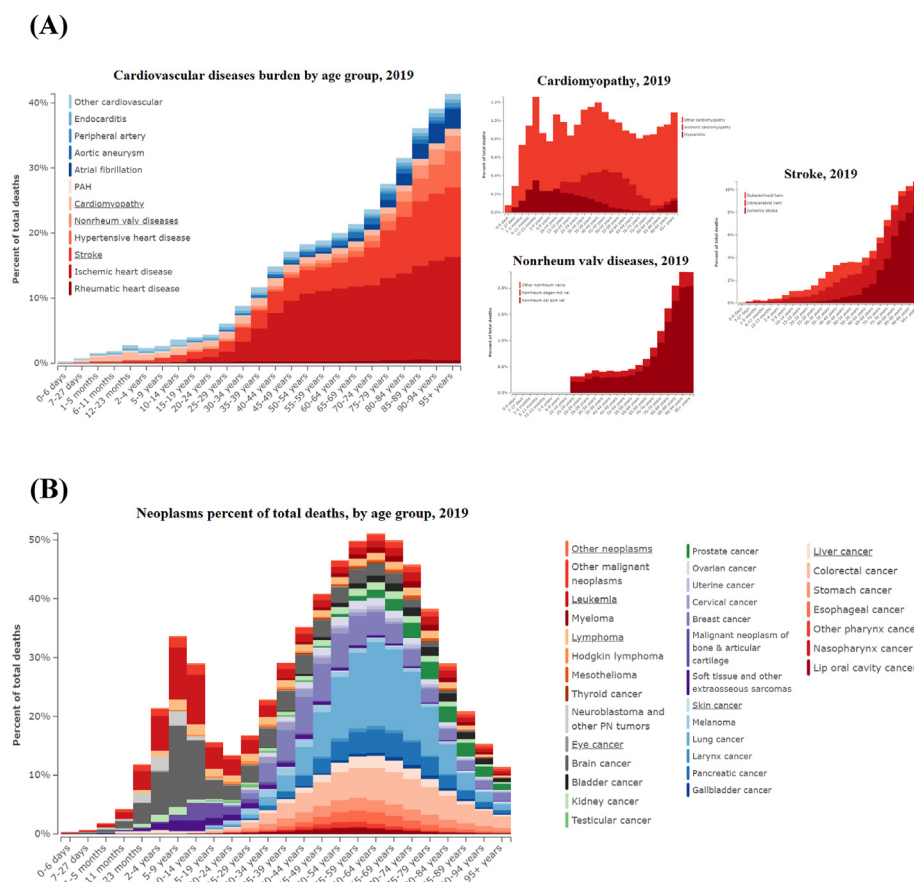


Fig. 3. (A) CVD death burden by age group 2019 both sexes in overall Western Europe. Percent of total deaths 2019, by age group and by causes. PAH, pulmonary arterial hypertension. (B) Neoplasm death burden by age group in overall Western Europe 2019. Percent of total deaths 2019, by age group and by causes. PN tumors, peripheral nerve tumors.

pattern, as different researchers estimated that the number of new cancer cases reached 19.3 million globally, and nearly 10 million people died from cancer in 2020.^{26,27} Reportedly, the occurrence of cancer is on the rise in both developed and developing countries, cancer has the potential to surpass CVDs as the leading cause of death in the near future, and this can be attributed to a multitude of complex factors.^{28,29}

In 2019, among Western European countries, Finland, Greece, and Austria had the highest burden of CVDs in terms of death rates. Conversely, Andorra, the Netherlands, and Israel had the lowest death burden from CVDs. In regard to neoplasms (cancer), Monaco, San Marino, and Andorra emerged as the top three Western European countries with the highest death burden. On the other hand, Malta, Cyprus, and Finland had the lowest death burden from neoplasms. It has been reported that health disparities related to NCDs still persist in numerous European countries, despite overall advancements in health.¹ These disparities, known as health inequalities, refer to unjust and avoidable differences in health status within and between population groups.^{30,31} To address these disparities, efforts should focus on enhancing educational opportunities, promoting equitable income distribution, improving health-related behaviors, and ensuring access to healthcare services.^{32,33}

In regard to gender disparities, the death rates from CVDs were consistently higher among males compared to females in almost all Western European countries. These results are not aligned with previous studies where CVDs continue to be a major leading cause of death in women.^{34,35,36} There is a possibility that men in Western Europe often exhibit higher rates of certain risk factors associated with CVDs. These risk factors include smoking, excessive alcohol

consumption, unhealthy dietary habits, sedentary lifestyle, and lower rates of physical activity.³⁷ These lifestyle choices can significantly contribute to the development of CVDs. Moreover, our finding revealed that elderly populations faced a higher risk of CVDs mortality in Western Europe. Older patients have a higher prevalence of CVDs due to the accumulation of CVDs risk factors and the presence of age-related comorbidities. Aging-related changes in the cardiovascular system, reduced physiological reserve, and the use of multiple medications further contribute to the increased incidence of CVDs in this population.³⁸

In case of neoplasms, the death burden of all neoplasm subtypes, except for breast cancer, ovarian cancer, gallbladder and biliary tract cancer, uterine cancer, and cervical cancer, had higher rates in males rather than females. This result is similar of a previous study where males had significantly higher incidence rate of cancer.³⁹ Sex disparities in cancer incidence and survival are influenced by a combination of behavioral and environmental factors as well as biological differences. Variations in behaviors, such as tobacco use, exposure to occupational hazards, and genetic susceptibility, contribute to differences in cancer risk.^{40–43} Addressing these factors can help reduce sex disparities in cancer burden. Furthermore, we observed the occurrence of two peaks in neoplasm death burden, which were attributed to different types of cancer. To be specific, the death peak in younger groups (1–15 years) was mainly caused by eye cancer, leukemia, lymphoma, neuroblastoma, and other peripheral nerve tumors. Reportedly, cancers in children and young adults (aged 0–24 years) are rare; however, cancer represents a leading cause of death in this age group.⁴⁴ In many cases, the exact cause of cancer in children

Table 2
Burden of CVD deaths attributable to risk factors, by sex and Western European countries, percent of total deaths_2019 (95% UI), all ages.

Countries	CVD deaths attributable to risk factors								
	Metabolic			Behavioral			Environmental		
	Both sexes 2019_estimate (%) (95% UI)	Male 2019 estimate (%) (95% UI)	Female 2019 estimate (%) (95% UI)	Both sexes 2019 estimate (%) (95% UI)	Male 2019 estimate (%) (95% UI)	Female 2019 estimate (%) (95% UI)	Both sexes 2019_estimate (%) (95% UI)	Male 2019 estimate (%) (95% UI)	Female 2019 estimate (%) (95% UI)
Western Europe	70.20 (75.67, 64.14)	71.21 (76.48,65.45)	69.37 (75.13, 63.20)	42.14 (46.99, 37.66)	49.12 (54.15, 44.33)	36.30 (41.30, 31.89)	12.72 (15.44, 10.37)	13.56 (16.48, 10.95)	12.03 (14.50, 9.79)
Austria	73.64 (79.19, 67.01)	74.90 (80.26, 68.44)	72.64 (79.16, 64.84)	44.16 (51.03, 38.20)	51.35 (57.91, 45.07)	38.45 (45.57, 32.31)	11.96 (15.51, 8.85)	12.27 (15.99, 9.01)	11.72 (15.17, 8.70)
Iceland	72.69 (78.83, 65.36)	75.06 (81.25, 67.82)	69.58 (76.98, 61.29)	48.90 (54.32, 43.21)	54.10 (60.04, 47.81)	42.06 (47.10, 36.80)	11.80 (18.69, 5.55)	12.08 (19.39, 5.30)	11.42 (17.66,5.91)
Luxembourg	71.20 (76.90, 64.50)	73.97 (79.17, 67.84)	68.85 (75.82, 60.40)	43.84 (48.93, 39.30)	51.71 (56.77, 46.61)	37.17 (42.30, 32.58)	11.24 (15.87, 7.13)	12.18 (17.27, 7.57)	10.44 (14.66, 6.76)
Finland	75.01 (81.24, 68.17)	75.80 (81.58, 69.36)	74.30 (81.39, 65.95)	46.15 (51.38, 40.60)	52.56 (58.29, 46.81)	40.37 (45.48, 34.96)	9.39 (15.58, 4.14)	9.45 (15.90, 3.83)	9.35 (15.36, 4.46)
Cyprus	73.44 (78.65, 67.44)	76.35 (81.08, 71.00)	70.50 (77.16, 62.59)	45.35 (50.70, 40.58)	55.93 (60.96, 50.83)	34.72 (40.24, 29.84)	15.10 (18.21, 12.30)	16.89 (20.29, 13.80)	13.29 (16.24, 10.66)
Germany	74.96 (80.07, 69.04)	74.33 (79.51, 68.39)	75.49 (81.07, 69.02)	44.16 (49.56, 39.09)	51.33 (57.01, 45.81)	38.19 (43.64, 33.34)	11.58 (15.33, 8.27)	12.53 (16.62, 8.86)	10.80 (14.27, 7.75)
Israel	70.95 (76.45, 64.71)	72.53 (77.99, 66.41)	69.44 (76.00, 61.95)	36.87 (42.31, 31.39)	42.56 (48.69, 36.49)	31.48 (36.52, 26.30)	14.66 (17.45, 12.03)	16.19 (19.20, 13.33)	13.21 (15.88, 10.70)
San Marino	67.52 (73.64, 60.71)	68.57 (74.46, 62.13)	66.65 (73.87, 58.67)	36.31 (41.98, 30.59)	42.43 (48.51, 35.91)	31.17 (36.69, 26.11)	11.37 (14.54, 8.23)	12.13 (15.42, 8.64)	10.72 (13.64, 7.87)
Sweden	71.11 (77.23, 64.38)	72.30 (78.20, 65.65)	70.00 (77.12, 62.14)	44.49 (50.02, 39.26)	48.37 (54.46, 42.44)	40.85 (46.02, 35.82)	9.35 (13.84, 5.76)	9.74 (14.79, 5.81)	8.99 (13.39, 5.55)
Ireland	72.21 (77.79, 65.49)	74.80 (80.33, 68.57)	69.42 (76.41, 61.27)	47.77 (52.33, 42.92)	52.13 (57.20, 46.79)	43.08 (47.44, 38.47)	11.71 (17.63, 6.30)	12.21 (18.47, 6.48)	11.18 (16.90, 6.13)
The Netherlands	65.89 (71.89, 59.37)	68.77 (74.70, 62.42)	63.35 (70.85, 54.89)	40.17 (45.07, 35.67)	46.48 (51.90, 41.23)	34.60 (38.99, 30.36)	12.39 (16.99, 8.48)	13.05 (17.94, 8.84)	11.80 (16.19, 8.08)
Portugal	68.86 (76.54, 61.20)	70.80 (77.51, 64.00)	67.37 (76.02, 58.54)	37.99 (42.65, 33.55)	46.46 (51.59, 41.55)	31.45 (36.22, 26.80)	14.39 (16.66, 12.07)	15.67 (18.15, 13.16)	13.40 (15.63, 11.23)
The United Kingdom	68.46 (74.36, 62.17)	70.71 (76.29, 64.59)	66.21 (72.67, 59.59)	45.97 (50.32, 41.56)	51.56 (56.42, 46.86)	40.36 (44.65, 36.25)	11.77 (16.03, 7.90)	12.29 (16.84, 8.07)	11.25 (15.21, 7.59)
Malta	76.77 (82.46, 69.99)	78.12 (83.53, 72.22)	75.46 (82.25, 66.99)	49.80 (55.12, 44.48)	54.87 (60.56, 48.98)	44.90 (50.23, 39.49)	17.58 (21.99, 13.59)	21.59 (26.22, 17.31)	13.70 (18.09, 9.78)
Italy	69.93 (76.32, 63.15)	70.44 (76.59, 63.67)	69.55 (76.53, 62.24)	40.47 (46.02, 35.70)	47.34 (53.25, 41.94)	35.29 (41.20, 30.57)	15.22 (17.63, 13.10)	16.27 (18.82, 13.96)	14.42 (16.78, 12.34)
France	64.59 (70.62, 58.08)	66.44 (72.48, 60.43)	63.09 (70.37, 54.73)	40.04 (44.86, 35.65)	46.67 (51.66, 42.06)	34.68 (39.84, 30.25)	12.63 (15.48, 9.98)	13.56 (16.67, 10.67)	11.88 (14.66, 9.33)
Norway	69.82 (75.58, 62.96)	71.72 (77.16, 65.60)	68.12 (74.66, 59.99)	40.91 (45.45, 36.00)	46.68 (52.09, 41.26)	35.75 (40.08, 31.15)	10.39 (15.31, 6.23)	11.00 (16.21, 6.59)	9.85 (14.45, 5.97)
Belgium	67.50 (73.57, 60.82)	68.73 (74.37, 62.20)	66.49 (73.32, 59.15)	42.63 (48.25, 37.53)	49.28 (54.77, 43.71)	37.20 (43.15, 32.06)	14.93 (19.02, 11.40)	16.05 (20.31, 12.25)	14.02 (17.83, 10.77)
Andorra	71.17 (76.50, 64.94)	71.96 (77.38, 65.84)	70.45 (76.62, 62.85)	40.96 (46.13, 36.38)	48.67 (54.22, 43.46)	33.97 (39.20, 29.34)	11.00 (16.18, 6.62)	11.79 (17.07, 7.05)	10.28 (15.25, 6.17)
Greece	69.66 (76.57, 62.02)	71.02 (78.01, 63.99)	68.56 (76.19, 59.80)	43.59 (48.70, 38.87)	52.91 (58.47, 48.04)	36.01 (41.19, 31.10)	16.17 (18.50, 13.90)	17.78 (20.36, 15.25)	14.86 (17.16, 12.63)
Denmark	69.67 (75.65, 63.19)	70.69 (76.37, 64.33)	68.67 (75.60, 60.87)	46.85 (51.70, 42.36)	51.30 (56.61, 46.41)	42.44 (47.18, 37.70)	11.41 (16.33, 7.16)	11.65 (16.67, 7.26)	11.18 (16.03, 6.98)
Monaco	71.79 (77.90, 64.94)	73.67 (79.53, 66.59)	70.19 (77.28, 62.24)	39.76 (46.23, 33.75)	44.85 (52.29, 38.16)	35.40 (41.63, 29.26)	13.02 (16.59, 9.67)	13.72 (17.63, 10.19)	12.43 (15.74, 9.32)
Switzerland	69.36 (75.78, 62.19)	70.45 (76.45, 63.42)	68.48 (76.19, 60.39)	43.93 (49.41, 38.64)	49.67 (55.31, 44.05)	39.28 (45.20, 33.89)	11.76 (15.61, 8.51)	12.41 (16.43, 8.99)	11.23 (14.95, 8.08)
Spain	67.63 (73.51, 61.32)	69.40 (75.16, 63.20)	66.27 (72.54, 59.15)	34.95 (38.61, 30.92)	43.94 (47.77, 39.58)	28.08 (32.07, 24.07)	11.76 (15.61, 8.51)	12.41 (16.43, 8.99)	11.23 (14.95, 8.08)

CVD, cardiovascular disease; UI, uncertainty interval.

The UI presents a range from highest to lowest values. All estimated values are considered significant as their UI does not contain a value of 0.

remains unknown. The development of cancer is a complex process influenced by a combination of genetic, environmental, and random factors that can vary from case to case. On the other hand, the death peak in elder groups was mainly due to lung cancer, breast cancer, pancreatic cancer, and other age-related cancer, same as those in the elder population of the United States.⁴⁵ Basically, cancer is more common in older adults due to the accumulation of DNA damage over time, longer exposure to risk factors, weakening of the immune system, age-related changes in cellular processes, higher prevalence of comorbidities, and increased opportunities for screening and detection. These factors collectively contribute to the higher incidence of cancer in the older adult population.

Metabolic risk factors emerged as the primary contributors to CVD deaths in Western Europe in 2019. The incidence of metabolic risk factors, such as high systolic blood pressure, elevated low-density lipoprotein cholesterol, increased fasting plasma glucose, and high body mass index, has significantly risen due to rapid economic development and social progress in recent decades.⁴⁶ Conversely, behavioral risk factors played a predominant role in neoplasm-related deaths in Western Europe during the same period. According to reports, cancer development in high-income countries is linked to unhealthy behaviors such as tobacco use, poor diet, sedentary lifestyle, excessive alcohol consumption, and exposure to environmental factors. Lifestyle factors are believed to contribute to more than 50% of cancer cases.⁴⁷ It is estimated that around 30–45% of cancer cases could be prevented by promoting healthier lifestyles.⁴⁸ Therefore, raising awareness among individuals about health-related behaviors and encouraging the adoption of lifelong habits that reduce the risk of developing cancer is crucial in cancer prevention.⁴⁹

Limitations

Despite the valuable insights provided by this study, there are certain limitations that should be acknowledged. First off, the research uses data from the 2019 Global Burden of Disease Study, which is based on estimating and modeling methods. Despite efforts to guarantee data accuracy, these approaches may have inherent limits and uncertainties. Second, the study's focus on Western Europe may limit its generalizability to other regions with different healthcare, socio-economic, and demographic contexts. Third, the study focuses on aggregate data analysis rather than investigating individual-level causes or particular actions that could have impacted the patterns that were found. To examine these elements in further detail, more investigation is required. Fourth, the research does not offer a thorough examination of the socio-economic factors and inequalities linked to cancer and CVDs. Effective public health interventions need a thorough understanding of the social gradient and addressing the negative effects of low socio-economic status on these illnesses.

Conclusion

To sum up, neoplasms and CVDs continue to be major health risks in the Western Europe. Age-standardized death rates for neoplasms and CVDs decreased over the research period, according to the study, suggesting some advancements in the management of these conditions. Nonetheless, there exist significant variations in the mortality toll and risk factors that may be attributed to various subtypes, genders, age groups, and nations. According to the findings, the leading causes of mortality in Western Europe are ischemic heart disease, stroke, lung cancer, and colorectal cancer. Moreover, metabolic risk factors account for the majority of fatalities linked to CVDs, whereas behavioral and environmental hazards are important contributors to deaths due to neoplasms. Men

are more likely than women to suffer from CVDs and neoplasms. The population 80 years of age and above is considered high risk for CVDs, while the age categories of 50–70 years old have greater rates of neoplasms. The findings emphasize the need for targeted interventions and public health policies to address the specific risk factors and vulnerable groups associated with CVDs and neoplasms in Western Europe. By addressing these disparities, it is possible to reduce the death burden and improve the overall health outcomes in the region.

Author statements

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Ethical approval

Not applicable.

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Competing interests

All authors declare that no conflict of interest exists.

Credit author statement

SM: Conceptualization, Data curation, Formal analysis, Methodology, Software, Validation, Visualization, Writing – original draft, Writing – review & editing; **LL:** Formal analysis, Investigation, Software, Visualization, Writing – review & editing; **SN:** Formal analysis, Investigation, Writing – review & editing, Data curation; **RM:** Formal analysis, Investigation, Software, Data curation, Validation, Visualization; **MI:** Investigation, Software, Data curation, Validation, Visualization; **EH:** Conceptualization, Investigation, Validation, Visualization, Resources, Supervision; **CY:** Conceptualization, Funding acquisition, Investigation, Project administration, Resources, Supervision, Validation.

Availability of data and materials

The data set analyzed during the present study are available in the Institute for Health Metrics and Evaluation (IHME): <http://ghdx.healthdata.org/gbd-results-tool>.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.puhe.2024.04.003>.

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