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The state of health in the European Union (EU-27) in 2019: a systematic analysis for the Global Burden of Disease study 2019

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Abstract

Background The European Union (EU) faces many health-related challenges. Burden of diseases information and the resulting trends over time are essential for health planning. This paper reports estimates of disease burden in the EU and individual 27 EU countries in 2019, and compares them with those in 2010.

Methods We used the Global Burden of Disease 2019 study estimates and 95% uncertainty intervals for the whole EU and each country to evaluate age-standardised death, years of life lost (YLLs), years lived with disability (YLDs) and disability-adjusted life years (DALYs) rates for Level 2 causes, as well as life expectancy and healthy life expectancy (HALE).

Results In 2019, the age-standardised death and DALY rates in the EU were 465.8 deaths and 20,251.0 DALYs per 100,000 inhabitants, respectively. Between 2010 and 2019, there were significant decreases in age-standardised death and YLL rates across EU countries. However, YLD rates remained mainly unchanged. The largest decreases in age-standardised DALY rates were observed for "HIV/AIDS and sexually transmitted diseases" and "transport injuries" (each -19%). "Diabetes and kidney diseases" showed a significant increase for age-standardised DALY rates across the EU (3.5%). In addition, "mental disorders" showed an increasing age-standardised YLL rate (14.5%).

Conclusions There was a clear trend towards improvement in the overall health status of the EU but with differences between countries. EU health policymakers need to address the burden of diseases, paying specific attention to causes such as mental disorders. There are many opportunities for mutual learning among otherwise similar countries with different patterns of disease.

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Key-points

- This article, systematically analysing GBD 2019 study estimates, presents an overview of the state of health in the European Union in 2019, compared to 2010.
- There was an improvement in the overall health status of the EU, despite substantial differences between Member States.
- Cardiovascular diseases and neoplasms are the major contributors to the overall burden of diseases in the EU in 2019.
- The age-standardised rate of years lived with disability due to mental disorders has been increasing and is expected to increase even more because of the COVID-19 pandemic.
- This report provides a framework upon which to base further region- and country-specific health policies and interventions, to support health planning and priority setting.

Keywords European Union, Health status, Population health, Global Burden of Diseases, European Burden of Disease Network

Introduction

The European Union (EU) faces many challenges that impact current and future population health, including complex issues such as population ageing, digital and green transitions, socio-economic challenges and the organisation of health systems. In addition, there are still significant differences in health status between EU countries which are associated with factors such as structural and budgetary differences, variations in the effectiveness of public health policies and health related risk factors [1–6]. In fact, health systems differ across the EU and, for instance, while the 2008 global financial crisis reduced annual health budgets, this did not happen uniformly. In addition, as population ageing advances, multimorbidity and frailty are becoming more common and need to be addressed to improve the well-being of EU countries [7–9].

According to Eurostat, life expectancy at birth in the EU was 81.0 years in 2019, with women living, on average, 5.5 years longer than men [4, 10]. Beyond life expectancy, population health can be summarised through combined health metrics such as health-adjusted life expectancy (HALE) and disability-adjusted life years (DALYs). DALYs consist of two components: (i) years of life lost (YLLs), which captures health loss due to premature mortality, and (ii) years lived with disability (YLDs), which quantifies health loss due to morbidity. A previous study showed a decline in YLD and DALY rates, an increase in life expectancy of 5.9 years and an increase in HALE of 4.6 years, on average, from 1990 to 2017 among EU-28 countries [11]. However, another study concluded that, despite the improvement in the health status of the EU, several central and eastern European countries had not experienced such pronounced gains in overall health in comparison to the EU-15 [12].

Accurate and timely data on mortality and morbidity, caused by diseases and injuries and their trends over time are essential to assess the impact of health strategies and assist policy makers in improving health planning and priority setting. This information can also be used to understand between-region variations, providing opportunities for mutual learning among EU countries. The Global Burden of Disease (GBD) study generates estimates of population health using a wide range of metrics, capturing the impact of diseases, injuries and risk factors on health. Furthermore, it allows for comprehensive comparisons over time and across countries. Burden of disease estimates are increasingly used in the EU and globally, as they provide a comprehensive and comparable picture of the overall population health status. An earlier analysis of the results from the GBD 2017 study for the EU countries examined changes since 2007 for the burden of diseases and injuries in the EU-28 in 2017 [13]. Between the release of the GBD 2017 and the GBD 2019 datasets, several improvements were made, including key demographic modelling steps, preferred/reference case definitions or measurement methods and the development of a Bayesian meta-regression tool, as well as the inclusion of more data sources and 12 new causes [14, 15].

In this paper, we analyse the GBD 2019 study estimates (focusing on deaths, YLDs, YLLs, DALYs, life expectancy and HALE) and compare the years 2019 and 2010 to describe the current health status of the EU. The aim of this study is to provide a picture of the state of health in the EU-27 countries in 2019, to examine how these have changed since 2010 and to highlight meaningful opportunities that exist to improve health across the continent.

Methods

Data source and overview of the GBD 2019 study

We obtained estimates from the 2019 GBD study for the EU-27 region and for the 27 EU countries individually. Considering the period of analysis, the 27 EU member states countries included were: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

A detailed description of methods and results used in GBD 2019 has been published elsewhere [14–17]. In brief, the GBD 2019 study is a collaborative effort of more than 5,000 researchers, aiming to measure population health at global, regional and national levels by quantifying the burden of 369 diseases and injuries (i.e. 286 causes of death and 364 non-fatal causes) and 87 risk factors between 1990 and 2019 for 204 countries and territories. Several improvements were made in the GBD 2019 study, including key demographic modelling steps, reference case definitions or measurement methods and the Bayesian meta-regression tool. In addition, more data sources and 12 new causes were added to the GBD modelling framework, including pulmonary arterial hypertension, nine new sites of cancer, and two new sites of osteoarthritis (hand and other joints). The GBD produces estimates of incidence, prevalence, mortality, YLDs, YLLs, DALYs, life expectancy and HALE for the entire time span between 1990 and 2019. Cause-specific death rates and cause fractions are calculated using the Cause of Death Ensemble model (CODEm) and spatiotemporal Gaussian process regression. They are adjusted to match the total all-cause deaths calculated as part of the GBD population, fertility, and mortality estimates [15, 18].

DALYs consist of two main components: YLLs and YLDs. YLLs are calculated by multiplying the number of deaths of each age the remaining life expectancy (RLE) at age of death derived from the GBD standard life Table [19]. YLDs are estimated by multiplying the prevalence counts by the disability weight for each specific health outcome associated with a given disease or injury, with further adjustment for co-morbidity and severity. A Bayesian meta-regression modelling tool, DisMod-MR (Disease Modelling-Meta Regression) 2.1, ensures consistency between all epidemiologic metrics for most causes [16]. HALE accounts for years of life spent in good health and serves as a summary for both mortality and morbidity [13]. It thus corresponds to specific LE by age and geography, adjusted for the years spent living with disability and disability weights. All estimates are reported with their 95% uncertainty intervals (UI). UIs are propagated throughout the estimating process where 1000 draws are generated for each point estimate, and the 95% UIs are obtained by selecting the 2.5th and 97.5th percentiles of the draws. This approach ensures robustness in identifying meaningful differences and trends in health outcomes over time.

Analytic strategies

The statistical significance of the difference between two estimates was defined as the absence of overlap between the 95% UI of those estimates. We analysed the overall (all ages and both sexes) and age group-specific rates for men and women. To analyse trends between 2010 and 2019, we relied on age-standardised rates and their relative changes since 2010. Difference between 2010 and 2019 was expressed in percentage change since 2010 (i.e. $\%change_{2010-2019} = \frac{estimate_{2019} - estimate_{2010}}{estimate_{2010}} \times 100$). In the GBD 2019 study, the same methodology is applied across years, including for 2010 and 2019. Age-standardisation is based on the GBD 2019 world standard population, which adjusts for differences in age distributions across populations, ensuring comparability between groups with different age structures. These rates were calculated using methodologies outlined in the GBD study, which provides upper and lower bounds of the estimates, allowing for a comprehensive analysis of trends over time.

The GBD arranges diseases and injuries (causes) into hierarchically nested categories in four levels of aggregation. At every level of aggregation, causes are mutually exclusive and collectively exhaustive. We extended this analysis focusing on each of the 22 Level 2 causes, and including seven Level 2 causes from Level 1 in the "communicable, maternal, neonatal and nutritional diseases" group (enteric infections, respiratory infections and tuberculosis, HIV/AIDs and sexually transmitted infections, maternal and neonatal disorders, neglected tropical diseases and malaria, nutritional deficiencies, other infectious diseases), 12 in the "non-communicable diseases" (NCDs) group (cardiovascular diseases, chronic respiratory diseases, diabetes and kidney diseases, digestive diseases, mental disorders, musculoskeletal disorders, neoplasm, neurological disorders, sense organ diseases, skin and subcutaneous diseases, substance use disorders, other NCDs), and three in the "injuries" group (self-harm and interpersonal, unintentional injuries and transport injuries). We considered Level 2 causes to focus the analysis on broad disease categories due to their policy implications. These causes represent broad disease categories where policy implications can result in benefits for all conditions summarized in these broader categories. We thus provide insights into the major drivers of health outcomes within the population.

All results are based on the estimates extracted from the Global Burden of Disease Results database and GBD

Compare [20, 21]. All analyses were carried out with the open-source R Statistical Software (version 3.4, Foundation for Statistical Computing, Vienna, Austria) [22]. The GBD study adheres to the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER) standards developed by WHO and others [23].

Results

Overall disease burden in the European Union

In 2019, the EU-27 had a total of 5,354,279 (95% UI: 5,206,626; 5,502,691) all-cause deaths, yielding a crude death rate of 1040.3 (95% UI: 1011.6; 1069.1) per 100 000 inhabitants. The age-standardised death rate for all causes was 465.8 (95% UI: 451.2; 480.9) per 100,000 inhabitants in the EU, with high variability across countries, ranging from 894.8 per 100,000 in Bulgaria to 385.9 per 100,000 in Spain. The total number of all-cause DALYs was 157,884,271 (95% UI: 139,041,970; 178,511,173), with a crude rate of 30,675 (95% UI: 27,014; 34,683) per 100,000 inhabitants. The all-cause age-standardised DALY rate per 100 000 inhabitants in 2019 was 20 251.0 (95% UI: 17 408.1; 23 513.9).

Eight countries (Bulgaria, Romania, Latvia, Hungary, Lithuania, Slovakia, Croatia, and Poland) reported significantly higher (i.e., the lower limit of the individual country 95% UI was higher than the upper limit of the EU 95% UI) all-cause age-standardised death rates than the EU. In contrast, nine countries (Spain, Italy, France, Luxembourg, Sweden, Malta, Austria, Finland, and Ireland) had significantly lower rates than the EU (Fig. 1A; Table 1). The all-cause age-standardised death rate in the EU declined on average by 8.8% (95% UI: -11.7; -5.9), ranging from -4.8% (95% UI: -7.2; -2.3) in Greece to -18.5% (95% UI; -30.7%; -4.5%) in Lithuania.

In 2019, compared to the EU, all-cause age-standardised DALY rates were significantly higher only in Bulgaria (Fig. 1B; Table 1). All-cause age-standardised DALY rates have declined significantly since 2010 (i.e., the upper limit of the 95% UI below zero) in most countries, except for Bulgaria, Croatia, Czechia, Estonia, Hungary, Romania, Slovakia, and Slovenia. Whilst most countries showed a decreasing trend in all-cause age-standardised YLL rates, no significant changes were found in all-cause age-standardised YLD rates between 2010 and 2019. Only Belgium, Lithuania, Portugal, and Slovenia experienced significant declines, while the Netherlands experienced significant increases in YLD rates (Table 1).

In 2019, life expectancy in the EU at birth was 81.0 years, ranging from 73.3 years in Bulgaria to 83.1 years in Italy and Spain. All countries experienced improvements in life expectancy between 2010 and 2019, with Lithuania having the highest increase (4.5%) and the EU-27 showing a 1.4% increase (from 79.8 years to 81.0 years). HALE at birth for the EU in 2019 was 69.8 years, ranging from 64.6 years in Bulgaria to 71.6 years in Spain, with HALE at birth improving by 1.2% between 2010 (i.e. 69.0 years) and 2019 across the EU-27. However, the gap between life expectancy and HALE widened from 10.8 years (13.6% of LE) in 2010 to 11.2 in 2019 (13.8% of LE), which suggests that YLDs represent a growing share of DALY rates.

Overall disease burden by age and sex

DALY rates increased similarly with age in both males and females. However, across the EU in 2019, for most age groups, DALY rates were higher among males than females (Fig. 2). For males, DALY rates were mostly driven by YLLs in those aged above 44 years of age and by YLDs among younger (< 44 years old) age groups. For females, this cut-off occurred at a more advanced age, with DALY rates mostly driven by YLLs in groups aged above 64 years. YLLs dominated over YLDs in both sexes particularly in age extremes, i.e. younger and older age groups (Fig. 2).

Main causes of ill health

In 2019, the age-standardised death rates for cardiovascular diseases were significantly higher than the EU rate (159.0; 95% UI 142.2; 169.2) in most Central and Eastern European countries, with the highest values in Bulgaria, Romania, and Latvia, and significantly lower than the EU rate in some Western European countries (Fig. 1A). A similar geographic pattern was observed for age-standardised DALY rates for cardiovascular diseases, the second leading cause of age-standardised DALY in the EU (Fig. 1B).

Compared to the EU, the age-standardized death (143.6; 95% UI 133.8; 150.1) and DALY (3,342; 95% UI 3,175; 3,505) rates for neoplasms in 2019 were significantly lower in Spain, Sweden, Malta, Austria, and Finland (Fig. 1A and B). Hungary and Netherlands showed a significantly higher age-standardised death rate, with Hungary and Poland having a significantly higher age-standardized DALY rate (Fig. 1A and B). In fact, the age-standardised death rate in Hungary was almost two times higher than in France. Neoplasms were the leading cause of age-standardized DALY and the second highest cause of age-standardised mortality across the EU in 2019.

Digestive diseases are another example of high variability in death rates in EU countries. The highest (in Romania) to the lowest (in Malta) age-standardised death rates ratio is over 3.2. Additionally, countries of Central and Eastern Europe (Romania, Lithuania, Bulgaria, Hungary, Slovakia, Latvia, Poland) had significantly higher DALY rates than the EU rate.

A

	All causes	Cardiovascular diseases	Neoplasms	Neurological disorders	Digestive diseases	Chronic respiratory diseases	Diabetes and kidney diseases	Respiratory infections and tuberculosis	Unintentional injuries	Self-harm and interpersonal violence	Other non-communicable diseases	Transport injuries	Substance use disorders	Maternal and neonatal disorders	Musculoskeletal disorders	Enteric infections	Skin and subcutaneous diseases	Other infectious diseases	HIV/AIDS and sexually transmitted infections	Nutritional deficiencies	Mental disorders	Neglected tropical diseases and malaria
EU-27	465.8	159.0	143.6	31.0	23.8	22.0	19.0	15.0	13.1	10.2	9.1	6.2	4.8	3.3	1.4	1.1	1.0	1.0	0.6	0.6	0.02	0.02
Spain	385.9	106.8	127.4	29.6	21.0	29.0	19.2	11.4	8.9	6.4	10.3	5.5	1.8	2.7	1.2	1.0	1.3	0.9	1.1	0.4	0.01	0.03
Italy	386.8	126.1	129.1	31.7	17.7	16.8	20.9	6.8	9.4	5.7	7.2	6.8	1.2	2.8	1.2	0.6	0.7	0.9	0.8	0.4	0.01	0.02
France	387.5	91.4	140.5	31.8	19.6	12.8	14.2	12.3	19.2	13.3	9.1	6.4	5.6	3.4	1.9	0.9	1.3	1.1	0.6	2.2	0.03	0.01
Luxembourg	389.2	116.0	127.5	28.9	20.2	19.9	16.3	11.8	13.7	9.7	6.2	5.9	5.2	2.0	0.9	1.5	0.7	1.7	0.4	0.6	0.03	0.06
Sweden	397.9	138.6	120.9	29.0	14.2	17.8	16.0	10.9	11.8	11.9	7.1	3.4	6.7	2.2	1.5	2.7	1.4	1.1	0.2	0.5	0.01	0.01
Malta	400.4	146.7	108.9	29.4	13.4	15.4	22.7	18.9	10.0	5.5	10.2	4.7	2.3	5.5	1.0	0.3	4.0	0.9	0.3	0.1	0.01	0.18
Austria	420.8	150.6	122.3	28.7	18.2	16.9	26.2	5.9	12.5	12.0	11.2	5.2	5.0	2.7	1.1	0.6	0.4	0.8	0.3	0.1	0.05	0.02
Finland	428.4	173.8	115.0	31.0	22.9	14.6	8.7	5.6	15.3	14.4	5.9	4.9	11.6	1.6	1.4	0.3	0.4	0.8	0.1	0.1	0.01	0.01
Ireland	430.5	132.8	137.9	31.0	15.6	32.4	15.3	22.2	8.2	8.7	10.3	3.4	5.4	2.6	2.1	0.7	1.0	0.8	0.2	0.1	0.01	0.00
Portugal	439.9	127.9	131.1	28.2	21.9	23.7	28.3	28.5	10.0	9.3	11.4	7.7	1.5	2.6	1.1	0.9	0.8	0.9	3.7	0.6	0.00	0.06
Netherlands	443.1	113.0	163.0	33.0	17.9	28.6	18.9	16.7	13.1	9.9	11.8	3.8	2.6	3.6	1.9	1.1	2.0	1.3	0.2	0.5	0.04	0.01
Slovenia	447.4	151.1	144.4	31.2	26.0	12.7	12.3	13.3	17.9	14.5	5.8	6.7	7.2	1.8	1.2	0.1	0.3	0.6	0.1	0.0	0.00	0.01
Belgium	449.5	118.6	143.9	30.9	22.8	27.6	16.3	21.6	17.1	16.3	10.4	7.1	4.6	2.9	1.4	3.0	1.8	1.5	0.4	1.2	0.02	0.01
Denmark	462.4	118.8	157.6	29.1	23.3	36.0	20.6	18.7	10.8	9.2	10.3	4.5	11.8	3.6	2.4	2.9	0.9	1.1	0.4	0.6	0.01	0.01
Germany	462.5	159.4	140.5	30.6	25.0	20.8	24.8	11.3	11.3	10.2	9.3	4.7	6.3	3.0	0.9	1.8	1.0	0.9	0.4	0.3	0.03	0.01
Greece	472.9	186.8	143.3	28.2	15.2	20.4	20.1	19.4	9.3	4.5	7.1	11.1	2.1	3.4	0.5	0.2	0.2	0.7	0.2	0.0	0.02	0.07
Cyprus	519.4	190.3	121.8	31.0	21.8	32.5	48.1	11.8	15.3	5.6	14.1	14.4	1.6	3.4	2.0	1.4	2.7	0.7	0.3	0.5	0.00	0.02
Czechia	541.0	232.2	145.9	30.2	24.9	18.4	21.5	16.3	16.1	11.5	6.4	7.1	3.9	2.5	0.6	1.4	0.6	0.7	0.2	0.6	0.00	0.01
Poland	583.8	235.6	175.2	32.1	28.0	15.4	17.8	17.8	16.0	15.0	6.8	9.5	8.6	3.1	0.9	0.4	0.3	0.7	0.3	0.2	0.01	0.01
Estonia	584.3	270.6	144.8	30.8	25.0	10.3	16.8	10.5	18.0	15.9	6.3	6.0	22.1	1.7	1.1	0.1	0.7	0.9	2.6	0.1	0.00	0.00
Croatia	591.3	265.8	159.8	31.7	26.4	19.5	21.6	7.1	18.8	12.0	8.7	8.4	5.1	3.7	1.1	0.4	0.2	0.6	0.2	0.0	0.00	0.01
Slovakia	623.9	298.9	152.8	29.7	34.6	12.6	17.4	22.1	18.6	11.6	7.7	8.0	3.2	4.3	0.5	0.3	0.4	0.9	0.2	0.1	0.00	0.01
Lithuania	666.1	328.8	140.0	29.5	37.5	12.2	8.7	14.0	28.2	28.4	8.1	8.6	14.3	2.3	1.0	0.3	0.9	1.2	1.9	0.1	0.00	0.01
Hungary	667.5	301.6	181.9	29.9	36.0	29.7	21.3	7.0	16.9	14.8	8.8	7.3	4.1	3.5	1.3	1.4	0.6	0.8	0.4	0.2	0.00	0.01
Latvia	685.3	356.8	143.4	28.3	26.9	9.9	14.5	12.1	26.3	21.7	9.8	9.8	13.1	3.1	1.0	0.1	1.3	1.4	5.6	0.2	0.00	0.05
Romania	716.5	379.6	148.3	29.1	43.2	20.8	14.3	24.9	17.0	10.2	6.5	11.5	2.5	5.4	0.3	0.4	0.3	1.1	0.8	0.3	0.00	0.03
Bulgaria	894.8	541.1	161.0	31.9	35.3	20.5	30.2	17.7	15.0	13.0	8.2	9.8	2.0	5.5	0.4	0.4	0.3	1.6	0.6	0.1	0.00	0.10

B

	All causes	Neoplasms	Cardiovascular diseases	Musculoskeletal disorders	Mental disorders	Other non-communicable diseases	Neurological disorders	Unintentional injuries	Diabetes and kidney diseases	Digestive diseases	Chronic respiratory diseases	Skin and subcutaneous diseases	Substance use disorders	Self-harm and interpersonal violence	Sense organ diseases	Maternal and neonatal disorders	Transport injuries	Respiratory infections and tuberculosis	Nutritional deficiencies	Enteric infections	Other infectious diseases	HIV/AIDS and sexually transmitted infections	Neglected tropical diseases and malaria
EU-27	20251	3342	2759	2020	1874	1550	1408	1118	797	765	754	684	603	491	484	452	427	369	144	100	56	44	12
Spain	18033	2977	1834	1831	2192	1472	1350	910	789	551	752	698	469	309	538	380	349	281	125	84	54	66	20
Italy	18186	2976	2032	2184	1954	1532	1472	784	814	644	539	733	344	284	530	413	422	225	145	59	47	51	4
France	18782	3311	1628	2055	2045	1602	1426	1279	463	565	554	843	567	609	402	419	418	278	149	72	56	40	2
Luxembourg	18634	2933	1981	2141	1850	1496	1366	1091	804	610	787	728	664	467	380	347	389	275	117	108	71	28	4
Sweden	18069	2672	2329	2036	2017	1386	1321	1010	615	466	786	692	692	591	340	311	241	265	123	110	46	18	3
Malta	18983	2604	2511	2224	1903	1740	1329	1075	919	429	674	748	466	311	405	670	316	394	111	58	55	26	13
Austria	19104	2820	2408	1971	1905	1932	1326	1083	790	674	651	711	659	552	392	412	332	208	103	77	49	33	17
Finland	19569	2606	2864	2037	1887	1484	1396	1396	685	788	618	748	925	734	388	267	323	198	100	68	43	10	3
Ireland	19401	3049	2193	2273	2202	1666	1404	936	622	465	969	728	824	474	397	360	236	373	95	69	46	17	2
Portugal	19674	3135	2150	2256	2317	1428	1291	780	980	624	861	733	477	422	413	374	422	527	136	74	54	199	21
Netherlands	18888	3614	1883	2001	2069	1663	1414	874	637	438	977	721	428	480	371	477	251	321	109	74	60	24	2
Slovenia	19135	3341	2546	1521	1462	1337	1249	1694	697	864	505	451	621	665	568	366	635	277	127	143	42	14	8
Belgium	20170	3256	2021	2042	1875	1788	1579	1267	694	641	879	730	601	769	409	415	440	404	126	131	69	35	2
Denmark	19929	3494	1968	2485	1794	1709	1282	926	678	686	1030	776	890	423	374	459	289	347	109	127	53	28	3
Germany	20075	3221	2601	2211	1898	1692	1539	970	894	742	749	717	618	477	393	442	315	287	122	109	45	29	3
Greece	20201	3300	3198	2031	2260	1591	1330	947	790	470	724	677	432	242	419	476	672	408	83	69	45	18	19
Cyprus	19743	2648	2939	2225	1915	1556	1330	1064	1165	483	864	719	358	311	397	457	773	264	112	99	38	22	3
Czechia	21153	3405	3909	1548	1385	1271	1269	1561	1251	896	628	454	515	577	595	434	656	395	142	189	49	17	8
Poland	22749	4192	4183	1629	1259	1216	1337	1570	951	1033	651	460	765	743	637	437	768	478	196	121	55	27	42
Estonia	23061	3522	4651	1510	1573	1345	1337	1580	752	987	354	553	1646	773	642	317	517	424	130	186	62	167	31
Croatia	21886	3770	4267	1600	1451	1513	1289	1449	981	898	632	444	523	558	606	558	752	228	122	150	45	17	33
Slovakia	23352	3762	5134	1541	1373	1564	1281	1792	848	1242	476	451	477	572	606	544	653	559	162	182	76	22	36
Lithuania	25648	3573	5824	1496	1716	1619	1242	2020	547	1447	424	441	1053	1354	688	369	693	574	164	190	78	104	32
Hungary	24500	4551	5420	1605	1394	1399	1260	1517	1020	1269	947	489	490	659	614	526	574	265	152	237	56	23	33
Latvia	26016	3631	6603	1531	1614	1554	1260	1933	746	1069	391	419	1056	1042	691	471	732	502	161	187	89	300	31
Romania	26044	3998	6644	1579	1368	1405	1249	1777	781	1501	714	421	361	506	623	673	775	1083	211	190	85	59	41
Bulgaria	29375	4368	9570	1544	1349	1503	1313	1726	1265	1282	693	454	384	603	617	674	784	680	215	181	115	39	16

Fig. 1 Age-standardised death (**A**) and DALY (**B**) rates (per 100 000 inhabitants) by the Level 2 causes for the European Union and for each country in 2019. *Footnote (to be included next to the figure)—Cells in green (or lighter grey) have a rate statistically significantly lower than EU, red (or darker) higher and yellow (or medium grey) without statistically significant differences*

Table 1 All-cause age-standardised death, YLL, YLD and DALY rates (per 100 000 inhabitants), life expectancy and healthy life expectancy for the European Union and for each EU country in 2019 and their percentage change between 2010 and 2019

	AS Death rate		AS YLL rate		AS YLD rate		AS DALY rate		Life expectancy		Health-adjusted life expectancy	
	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)
European Union	**465.8 (451.2; 480.9)**	**-8.8 (-11.7; -5.9)**	**9564 (9158; 9997)**	**-12 (-15.7; -8.1)**	**10,687 (7908; 13,858)**	**0.6 (-0.1; 1.2)**	**20,251 (17,408; 23,514)**	**-5.8 (-8; -3.7)**	**81.0 (80.6; 81.3)**	**1.4 (1.0; 1.9)**	**69.8 (66.6; 72.7)**	**1.2 (0.7; 1.6)**
Austria	420.8 (413.4; 428.8)	-11.2 (-12.9; -9.4)	8360 (8154; 8584)	-14.9 (-17.2; -12.5)	10,744 (7927; 13,927)	-0.4 (-2; 1.2)	19,104 (16,292; 22,253)	-7.3 (-9.2; -5.6)	82.2 (82; 82.3)	1.7 (1.4; 2)	70.6 (67.2; 73.6)	1.6 (1.2; 1.9)
Belgium	449.5 (439.6; 460.2)	-9.4 (-11.6; -7.2)	9129 (8837; 9453)	-12.5 (-15.4; -9.4)	11,041 (8083; 14,321)	-2.1 (-3.7; -0.3)	20,170 (17,230; 23,435)	-7.1 (-9; -5.1)	81.4 (81.2; 81.6)	1.5 (1.2; 1.8)	69.7 (66.3; 72.8)	1.5 (1.1; 2)
Bulgaria	894.8 (744.3; 1070.7)	-7.1 (-23.7; 11)	19,339 (15,632; 23,799)	-9.4 (-27.9; 11.4)	10,036 (7413; 12,976)	0.3 (-1.5; 2.3)	29,375 (24,710; 34,547)	-6.3 (-18.7; 8)	73.3 (70.9; 75.7)	1.4 (-2; 4.9)	64.6 (61.4; 67.6)	1.3 (-1.9; 4.3)
Croatia	591.3 (486.8; 714.9)	-14.2 (-29.4; 3.6)	11,612 (9294; 14,433)	-16.7 (-33.4; 3.5)	10,274 (7607; 13,342)	0.2 (-2.1; 2.5)	21,886 (18,219; 26,054)	-9.5 (-19.5; 2)	78.7 (76.5; 80.8)	2.4 (-0.4; 5.2)	68.2 (64.8; 71.5)	2 (-0.5; 4.2)
Cyprus	519.4 (480.7; 563.4)	-14.4 (-21; -7.1)	9235 (8394; 10,194)	-12.4 (-20.6; -3)	10,508 (7709; 13,612)	0.4 (-1.1; 1.7)	19,743 (16,838; 22,880)	-6 (-10.7; -1.4)	80.8 (80; 81.6)	1.6 (0.6; 2.6)	69.9 (66.7; 72.9)	1.4 (0.5; 2.3)
Czechia	541 (457.8; 638.7)	-12.1 (-25.5; 3.6)	10,745 (8899; 12,953)	-15.2 (-29.7; 2.2)	10,409 (7680; 13,558)	0.2 (-1.8; 2.3)	21,153 (17,813; 24,971)	-8.2 (-16.7; 1.5)	79.5 (77.6; 81.3)	2.1 (-0.4; 4.4)	68.6 (65.1; 71.7)	1.7 (-0.4; 3.6)
Denmark	462.4 (449.3; 476.6)	-13.2 (-15.9; -10.5)	9162 (8798; 9566)	-14.9 (-18.4; -11.1)	10,768 (7956; 13,905)	-0.1 (-1.6; 1.6)	19,929 (17,111; 23,155)	-7.5 (-10; -5.2)	81.1 (80.8; 81.4)	2 (1.6; 2.4)	69.9 (66.7; 72.8)	1.7 (1.3; 2.2)
Estonia	584.3 (477.6; 707.2)	-12.8 (-28.8; 6)	13,026 (10,488; 16,078)	-15.4 (-32; 4.1)	10,035 (7400; 13,058)	-0.3 (-2.5; 1.8)	23,061 (19,316; 27,134)	-9.5 (-19.9; 2.3)	78 (75.6; 80.5)	2.4 (-0.9; 5.6)	68.1 (64.7; 71.4)	2.2 (-0.7; 5)
Finland	428.4 (414.9; 443.1)	-11.6 (-14.5; -8.5)	8765 (8419; 9144)	-15.4 (-18.9; -11.7)	10,805 (7991; 14,005)	-1.1 (-2.7; 0.6)	19,569 (16,724; 22,872)	-8.1 (-10.5; -5.9)	81.9 (81.5; 82.2)	1.8 (1.3; 2.3)	70.3 (67; 73.3)	1.8 (1.3; 2.3)
France	387.5 (380.3; 395.2)	-10.7 (-12.5; -8.9)	8282 (8061; 8526)	-13 (-15.5; -10.4)	10,499 (7719; 13,653)	0 (-1.8; 2)	18,782 (16,017; 21,919)	-6.2 (-8.2; -4.2)	82.9 (82.7; 83.1)	1.6 (1.3; 1.8)	71.5 (68.1; 74.5)	1.3 (0.9; 1.7)
Germany	462.5 (455.3; 471.1)	-5.2 (-6.7; -3.4)	9126 (8946; 9330)	-8.2 (-10.1; -6.2)	10,949 (8072; 14,255)	0.7 (-1.8; 3.2)	20,075 (17,158; 23,315)	-3.6 (-5.3; -1.7)	81.2 (81; 81.4)	0.9 (0.6; 1.1)	69.7 (66.4; 72.7)	0.6 (0.1; 1)

Table 1 (continued)

	AS Death rate		AS YLL rate		AS YLD rate		AS DALY rate		Life expectancy		Health-adjusted life expectancy	
	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)
European Union	**465.8 (451.2; 480.9)**	**-8.8 (-11.7; -5.9)**	**9564 (9158; 9997)**	**-12 (-15.7; -8.1)**	**10,687 (7908; 13,858)**	**0.6 (-0.1; 1.2)**	**20,251 (17,408; 23,514)**	**-5.8 (-8; -3.7)**	**81.0 (80.6; 81.3)**	**1.4 (1.0; 1.9)**	**69.8 (66.6; 72.7)**	**1.2 (0.7; 1.6)**
Greece	472.9 (461.8; 485.2)	-4.8 (-7.2; -2.3)	9543 (9206; 9929)	-6.1 (-9.6; -2.3)	10,658 (7853; 13,819)	-0.5 (-2.2; 1.3)	20,201 (17,423; 23,370)	-3.2 (-5.4; -1)	80.9 (80.7; 81.2)	0.7 (0.3; 1)	69.9 (66.7; 72.7)	0.7 (0.2; 1.1)
Hungary	667.5 (566.5; 785.6)	-13.1 (-26.1; 2.2)	14,296 (11,873; 17,181)	-15.9 (-30.1; 1)	10,204 (7532; 13,215)	0.4 (-1.6; 2.4)	24,500 (20,800; 28,629)	-9.8 (-18.7; 0.8)	76.6 (74.6; 78.6)	2.5 (-0.3; 5.1)	66.8 (63.6; 69.9)	2.1 (-0.2; 4.2)
Ireland	430.5 (416.4; 446)	-9.7 (-12.9; -6.4)	8320 (7935; 8752)	-14.5 (-18.6; -10.1)	11,081 (8177; 14,373)	0.2 (-1.5; 2)	19,401 (16,512; 22,745)	-6.7 (-9.4; -4.2)	82 (81.7; 82.4)	1.5 (1.1; 2)	70.4 (67; 73.3)	1.3 (0.7; 1.8)
Italy	386.8 (383.4; 390.1)	-9.2 (-10.1; -8.4)	7439 (7344; 7527)	-11.5 (-12.7; -10.4)	10,746 (7879; 14,084)	0.1 (-0.6; 0.8)	18,186 (15,294; 21,486)	-5 (-6.1; -4)	83.1 (83; 83.2)	1.2 (1.1; 1.4)	71.2 (67.8; 74.3)	1 (0.9; 1.2)
Latvia	685.3 (596.3; 797.8)	-15.7 (-26.6; -1.9)	15,938 (13,622; 18,804)	-19.9 (-31.5; -5.8)	10,078 (7427; 13,078)	-1 (-2.8; 0.9)	26,016 (22,399; 30,171)	-13.5 (-21.6; -3.9)	75.9 (73.8; 77.7)	3.5 (0.8; 6.1)	66.3 (63.2; 69.2)	3.3 (0.9; 5.6)
Lithuania	666.1 (565.5; 780)	-18.5 (-30.7; -4.5)	15,538 (13,039; 18,462)	-22.8 (-35; -8.1)	10,111 (7490; 13,073)	-2.1 (-4; -0.1)	25,648 (21,935; 29,654)	-15.8 (-24; -5.9)	76.2 (74.1; 78.3)	4.1 (1.2; 7)	66.6 (63.3; 69.6)	4 (1.4; 6.4)
Luxembourg	389.2 (353.4; 432.3)	-16.8 (-24.7; -7.4)	7794 (6939; 8847)	-16 (-25.7; -4.5)	10,840 (8014; 14,065)	-0.1 (-2; 1.8)	18,634 (15,642; 22,023)	-7.4 (-12.3; -1.9)	82.9 (81.8; 83.9)	2.3 (0.9; 3.7)	71 (67.5; 74.1)	1.9 (0.6; 3.1)
Malta	400.4 (365.8; 438.7)	-13.1 (-20.3; -5.3)	8350 (7400; 9502)	-12.7 (-22.6; -1.1)	10,633 (7845; 13,777)	-0.2 (-1.7; 1.3)	18,983 (16,094; 22,345)	-6.1 (-11.2; -0.6)	82.6 (81.6; 83.5)	1.8 (0.7; 3)	71.1 (67.7; 74.1)	1.5 (0.5; 2.6)
Netherlands	443.1 (432.3; 454.7)	-6.6 (-8.9; -4.1)	8503 (8200; 8844)	-9 (-12.3; -5.4)	10,385 (7710; 13,439)	2.3 (0.4; 4.5)	18,888 (16,190; 22,000)	-3.1 (-5.4; -0.8)	81.7 (81.5; 82)	2.1 (-0.2; 4.4)	70.6 (67.5; 73.4)	0.4 (-0.1; 0.9)
Poland	583.8 (504.2; 672.3)	-11.2 (-23.5; 2.1)	12,787 (10,894; 14,824)	-14.5 (-27.1; -0.5)	9963 (7364; 12,907)	0.1 (-0.7; 0.8)	22,749 (19,421; 26,563)	-8.7 (-16.6; -0.2)	78.1 (76.3; 79.9)	1.8 (1.5; 2.2)	68.1 (64.8; 71.2)	1.9 (-0.1; 3.8)
Portugal	439.9 (429.4; 451.3)	-12 (-14.3; -9.6)	8774 (8463; 9122)	-15.3 (-18.4; -11.8)	10,900 (8009; 14,120)	-2.2 (-3.8; -0.8)	19,674 (16,845; 22,930)	-8.5 (-10.7; -6.5)	81.7 (81.5; 82)	1.8 (1.5; 2.2)	70.2 (66.8; 73.2)	2 (1.6; 2.4)

Table 1 (continued)

	AS Death rate		AS YLL rate		AS YLD rate		AS DALY rate		Life expectancy		Health-adjusted life expectancy	
	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)	2019	2010–2019 (%)
European Union	**465.8 (451.2; 480.9)**	**-8.8 (-11.7; -5.9)**	**9564 (9158; 9997)**	**-12 (-15.7; -8.1)**	**10,687 (7908; 13,858)**	**0.6 (-0.1; 1.2)**	**20,251 (17,408; 23,514)**	**-5.8 (-8; -3.7)**	**81.0 (80.6; 81.3)**	**1.4 (1.0; 1.9)**	**69.8 (66.6; 72.7)**	**1.2 (0.7; 1.6)**
Romania	716.5 (611.7; 835.4)	-12.2 (-25.1; 2.2)	16,199 (13,757; 19,117)	-14.6 (-27.5; 0.5)	9844 (7318; 12,819)	0.1 (-2; 2.2)	26,044 (22,457; 29,967)	-9.6 (-18.4; 0.7)	75.5 (73.5; 77.5)	2.4 (-0.3; 5)	66.4 (63.3; 69.2)	2.1 (-0.3; 4.4)
Slovakia	623.9 (511.6; 756.9)	-12.6 (-28.6; 6)	13,208 (10,559; 16,428)	-15 (-32.1; 5.3)	10,144 (7480; 13,113)	0 (-2.1; 2.1)	23,352 (19,472; 27,684)	-9.1 (-19.4; 3.3)	77.6 (75.2; 79.9)	2.3 (-0.8; 5.4)	67.6 (64.1; 70.8)	2 (-0.7; 4.5)
Slovenia	447.4 (362.1; 560.3)	-14.2 (-30.3; 6.9)	9023 (7218; 11,474)	-16.2 (-32.7; 6.4)	10,112 (7485; 13,119)	-2.5 (-4.4; -0.8)	19,135 (15,775; 23,040)	-9.5 (-18.5; 2.1)	81.4 (78.9; 83.7)	2.1 (-1; 5)	70.4 (66.7; 73.9)	2.2 (-0.6; 4.5)
Spain	385.9 (378.7; 393.6)	-8.9 (-10.6; -7)	7570 (7372; 7792)	-11.4 (-13.8; -8.8)	10,463 (7734; 13,596)	1.3 (-0.5; 3.1)	18,033 (15,282; 21,170)	-4.5 (-6.3; -2.6)	83.1 (82.9; 83.3)	1.2 (1; 1.5)	71.6 (68.3; 74.5)	0.9 (0.5; 1.3)
Sweden	397.9 (393.1; 403)	-8.5 (-9.9; -7.2)	7595 (7477; 7723)	-10.2 (-11.8; -8.5)	10,474 (7727; 13,605)	0.9 (-0.5; 2.2)	18,069 (15,379; 21,133)	-4.1 (-5.5; -2.8)	82.8 (82.7; 83)	1.2 (1; 1.4)	71.4 (68.1; 74.3)	0.9 (0.6; 1.2)

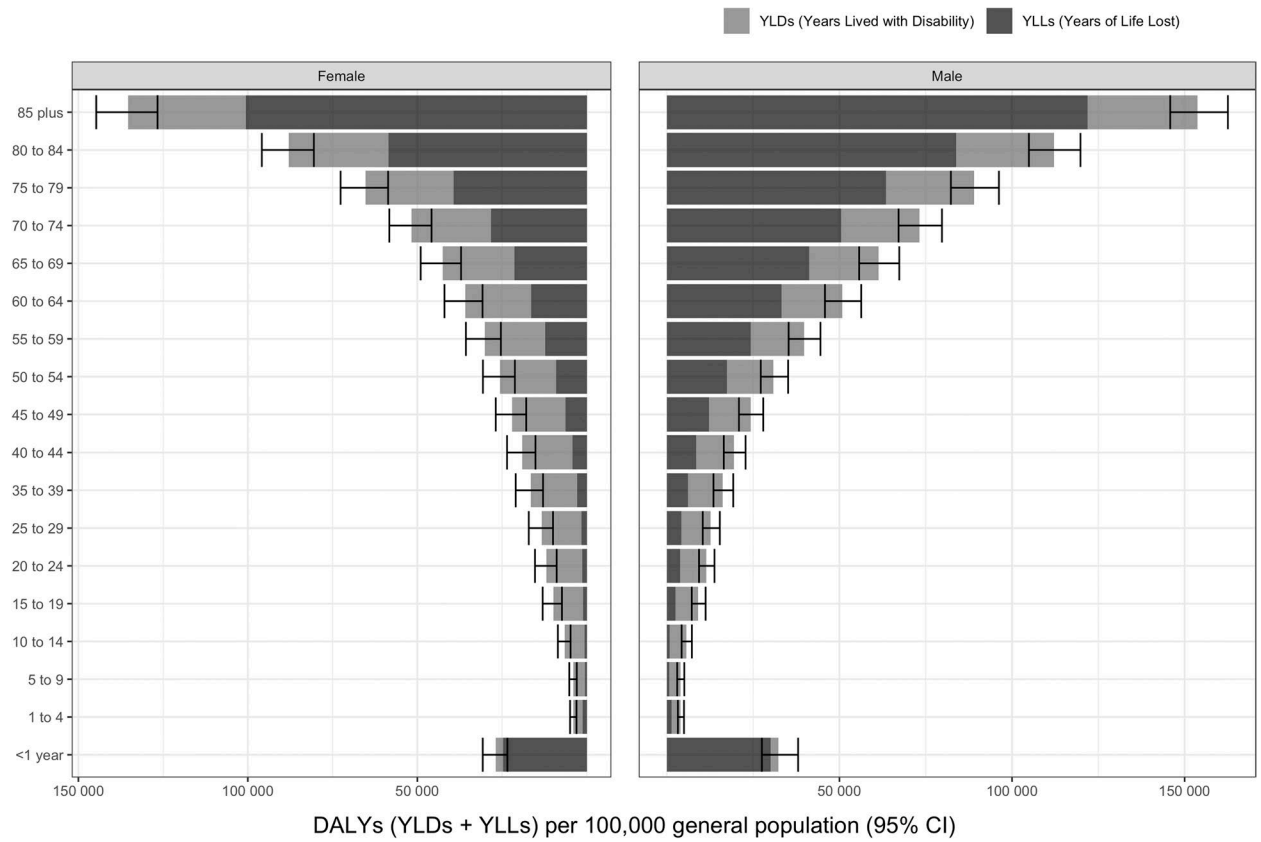

Fig. 2 Disability adjusted life years (DALYs) per 100,000 inhabitants, split into Years of life lost (YLL) and Years lived with disability (YLD), by sex and age group in the European Union in 2019. The error bars indicate the 95% uncertainty interval around the DALYs estimates

Figure 1A and B show the age-standardised death and DALY rates, respectively, for the EU and each EU country in 2019, for all Level 2 causes, comparing each country with the EU. Causes had different patterns across EU countries. For example, for HIV/AIDS and sexually transmitted infections, Latvia and Portugal had the highest age-standardised death and DALY rates, with more than five times the EU. The contribution of fatal and non-fatal components of age-standardised DALY rates varied substantially across Level 2 causes (Fig. 3A). For neoplasms and cardiovascular diseases, YLLs contributed more than YLDs, while for musculoskeletal and mental disorders, the total DALYs were almost exclusively YLDs.

Figure 3B highlights the relative change in age-standardised YLL, YLD and DALY rates between 2010 and 2019 for Level 2 causes. Age-standardised YLL rates declined for all causes except for mental disorders (14.5% increase) and skin and subcutaneous diseases (2.6% increase), while Level 2 causes were quite evenly split between increases and decreases for age-standardised YLD rates. The largest decreases in age-standardised DALY rates were observed for HIV/AIDS and sexually transmitted diseases (-19.2%) and transport injuries (-19.1%). On the other hand, only diabetes and kidney diseases showed a significant increase (3.5%) for age-standardised DALY rates in the EU between 2010 and 2019, mainly due to the age-standardised YLD rate increase. Finally, it is worth mentioning that mental disorders showed a non-significant increase for age-standardised DALY rates between 2010 and 2019 and this increase was mainly due to YLL rates, although there was also an increase in age-standardised YLD rates.

Discussion

This study presents an overview of the state of health of the EU-27 and individual Member States in 2019, comparing the findings with data from 2010 to examine changes over the last decade. The results indicate that most countries experienced a significant, albeit varied, reduction in all-cause, age-standardised mortality and YLL rates over this period, although this pattern differed by country and region. During this time period, there were no substantial changes in all-cause age-standardised YLD rates, with the increase in the Netherlands being the most notable. The EU all-cause,

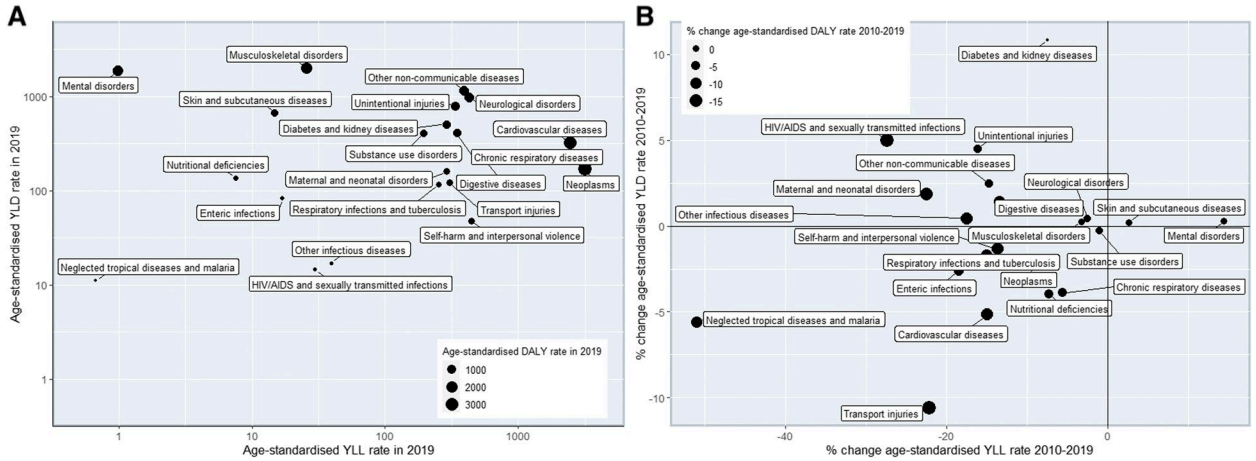

Fig. 3 Age-standardised YLL, YLD and DALY rates in 2019 (A), as well as changes (in %) between 2010 and 2019 (B) for the Level 2 causes in the European Union

age-standardised DALY rate fell by 5.8% over this period, mirroring global trends [15].

The observed variability in all-cause age-standardized death rates across countries in 2019 indicates that there are geographical clusters of mortality in the EU. The pattern of mortality burden clusters with a clear geographical variation across the EU was also observed for life expectancy rates and HALE measures. This pattern has been previously highlighted [13]. However, despite recent progress to reduce these differences, its persistence suggests that improvements may not continue uniformly across the EU without enhanced, combined and coordinated efforts to address a wide range of inequalities across health determinants, including socioeconomic factors.

Neoplasms and cardiovascular diseases were the leading causes for the burden of disease in the EU in 2019; both are attributable to the behavioural risk factors and depend on early diagnosis, treatment and management of risk factors. Inherently, these are among the costliest diseases for EU countries [24]. Additionally, with population ageing, NCDs are expected to increase over time and represent a greater proportion of overall deaths with higher mortality rates associated with cancer and cardiovascular disease relative to communicable diseases [25]. A recent analysis of changes in mortality and disability, comparing data from the GBD 1990–2019, confirmed this trend, finding that there has been an overall increase in disease burden among older Europeans during this time period, primarily driven by cardiovascular diseases [26]. These changes have not been homogeneous across the EU. As structures and systems take time to adapt to such changes, it suggests that existing differences may magnify if intervention strategies are not urgently introduced. Examining age-standardised DALY due to cancer, rates in the EU were between those of China (higher rate) and the United States of America (lower rate) [27]. EU countries had an estimated cancer burden of 4 million new cases annually in 2020, with cancer disproportionately affecting older Europeans and those living in Eastern EU Member States [28]. Future interventions must be designed to address the main drivers of NCDs, including population ageing, changes in population structure, and improvements in population-level risk factors, also considered in the Europe's Beating Cancer Plan. These must also address reasons for important differences across European regions. For example, despite the existence of cancer screening programmes across EU countries, differences in uptake of cancer screening varies according to socioeconomic factors; inequalities including lower household income, higher unemployment, and lower levels of educational attainment are associated with reduced uptake, especially in Eastern EU member states [29]. A similar trend is seen for cardiovascular diseases. EU member states with lower income levels and greater degrees of socioeconomic inequalities have disproportionately higher incidence rates and a greater burden of cardiovascular disease [30].

In this study, age-standardised death rates between countries varied widely by disease. For example, the results draw attention to the preventable high rates of self-harm and interpersonal violence across the EU in 2019. These mainly affected younger age groups. Although rates vary across the EU, we observed a geographical pattern with higher rates in the Baltic region. These differences in self-harm have been shown previously and likely relate to differences in the burden of mental disorders across the EU [31]. Baltic countries

have historically had the highest rates of alcohol-related mortality and suicide, as well as a high burden of mental and behavioural disorders [32].

Infectious diseases, in general, represented a small share of age-standardised death rates until 2019, presenting an optimistic scenario regarding these most preventable diseases. There was, however, considerable heterogeneity in age-standardised death rates for some infectious diseases such as HIV and sexually transmitted infections, which despite overall low rates, had prominent outliers with relatively high rates in Latvia and Portugal. This highlights the importance of national preventive programmes that tackle the different transmission pathways, alongside with strengthening of surveillance systems [33].

Besides this heterogeneity, such infectious diseases showed an increased age-standardised YLL rate. This will be difficult to overcome without tailored health policies as the incidence of HIV is still increasing in several EU countries [34]. Moreover, infectious diseases are likely to represent a growing share of total disease burden following the COVID-19 pandemic, and will likely be of great importance in future GBD revisions.

Regarding DALYs, remarkable regional differences were found in cardiovascular diseases, self-harm and transport injuries, which were significantly higher in Eastern EU countries. Mental disorders were the fourth highest cause of age-standardised DALY rates and did not show a decrease over recent years. In fact, they showed a non-significant increase, mainly due to a remarkable increase in YLL. These conditions also represent one of the leading causes of YLD, which has been rising over recent years and has increased even more following the COVID-19 pandemic [35, 36]. Additionally, self-harm and interpersonal violence may also be linked to mental disorders, as an example of interacting causes. Thus, viewed as a whole, mental health disorders and other related possible outcomes such as self-harm and mortality linked to mental disorders, deserve special attention in line with WHO priorities [37].

The age-standardised YLD estimates generated by the GBD 2019 study show slight variation over time and across geographic areas and are subject to large levels of uncertainty. The former is mainly driven by the fact that the GBD severity distributions do not vary over time and space [38], essentially reducing differences in YLD rates to differences in the underlying prevalence estimates. Since prevalence data are typically sparser and more uncertain than mortality data, the modelled prevalence estimates further tend to smooth out temporal and spatial heterogeneity. In parallel, EU countries would need to improve the quality and performance of their health information systems, strengthening and integrating data available through disease registers, claims data, primary care data, hospital discharge data and health surveys.

Strengths and limitations

This study is important and timely as it reflects the state of health in the EU prior to a number of major changes, including the COVID-19 pandemic and Brexit (the departure of the UK from the EU), and therefore will likely be important for policy-makers to understand the state of health of Europe at this pivotal moment in time. Although the UK is not included in the analysis and that potential adverse effects of Brexit on the health of the UK have been discussed [39], less is known about how it could impact the remaining EU-27. To date, there has been wide variation in the resilience and responses of health systems and governments to the pandemic across the EU, which replicates many of the regional variations presented in this study of the state of health of the EU. Comparing the results of this study with post-pandemic and post-Brexit GBD data will therefore be crucial to assess the impact of these 'shocks' on the health of EU citizens. Moreover, it could be pivotal for policy makers to address in future studies. Another strength of this study is that it provides estimates at the national level for EU countries for which burden of disease studies are lacking or are scarce and can support priority setting and resource allocations. This study used estimates provided by the GBD 2019 study and hence shares some limitations with other GBD studies, predominantly related mostly to the availability and quality of primary data, in particular for morbidity, which might not be homogeneous across EU countries. Moreover, there are some limitations pertaining to this paper related to: (1) the study design as it is a descriptive study, does not aim to estimate the effect of EU level policies; (2) timeline (as it provides an overall EU-level assessment across 10 years and excludes in-depth national assessment taking into account the year of accession to the EU); and (3) data availability. In addition, GBD metrics apply the same disability weights for all countries and regions. Such limitations have been widely discussed in the literature [15, 38].

Regarding the age-standardisation, it is also essential to highlight that while it is essential to ensure a global and comparable age standardisation, the used world standard population by GBD instead of a European standard population may change the ranking of causes [40].

Conclusions

In conclusion, although population health in the EU has been improving, large differences between countries persist. Health outcomes remain much better in Western or Southern Europe (e.g. Spain, Italy or France) than in Central and Eastern Europe (e.g. Bulgaria or Romania)

or the Baltic states (e.g. Latvia or Lithuania). NCDs, particularly neoplasms and cardiovascular diseases continue to be the leading causes of disease burden. This study suggests that addressing the prevalence and incidence of diseases and injuries should be a priority for EU health policy makers, emphasising reducing health inequalities across the block. Attention must be paid to specific causes, including mental disorders, given their impact on YLD [41]. This study highlights that there are many opportunities for mutual learning among otherwise similar EU countries with different patterns of disease and injury.

Supplementary Information

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Supplementary Material 1.

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Involvement of humans in the study

Only secondary data was used for this study.

Authors' contributions

JVS, APM, BB, DAG, DP, EAM, FG, FF, GS, CHN, IN, JLP, JAH, KK, LM, NG, RS, RH, RH, RO, SC, SM, ZK, AF and BD have conceived and designed the study and drafted the work. JVS, FG and RH performed the data analysis. Contributions for additional authors may be found in the appendix. All authors have given inputs on the interpretation of data, substantially revised the manuscript and have approved the submitted version.

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Availability of data and materials

The datasets analysed during the current study are publicly available in the GBD 2019 Results Tool and GBD 2019 Compare repositories (https://vizhub.healthdata.org/gbd-results/ and https://vizhub.healthdata.org/gbd-compare, respectively).

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

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References

1. Nicole Scholz, Members' Research Service. Addressing health inequalities in the European Union, Concepts, action, state of play. Eur Parliamentary Res Serv. 2020. https://doi.org/10.2861/567478.
2. Jutz R. Health inequalities in Europe: Does minimum income protection make a difference? Curr Sociol. 2021;69:99–118.
3. Costantini AS, Seniori Costantini A, Gallo F, et al. Population health and status of epidemiology in Western European, Balkan and Baltic countries. Int J Epidemiol. 2015;44:300–23.
4. Health at a glance: Europe 2020: State of health in the EU cycle. URL https://www.oecd-ilibrary.org/social-issues-migration-health/health-at-a-glance-europe-2020_82129230-en. Accessed 30 Apr 2021.
5. European Commission. The health status of the European Union narrowing the health gap. Luxembourg: Office for Official Publications of the European Communities; 2003. https://openlibrary.org/books/OL16254528M/The_health_status_of_the_European_Union.
6. Nuyts PAW, Hewer RMF, Kuipers MAG, et al. Youth Access to Cigarettes Across Seven European Countries: A Mixed-Methods Study. Nicotine Tob Res. 2020;22:1989–96.
7. Garin N, Koyanagi A, Chatterji S, et al. Global Multimorbidity Patterns: A Cross-Sectional, Population-Based, Multi-Country Study. J Gerontol A Biol Sci Med Sci. 2016;71:205–14.
8. O'Caoimh R, Galluzzo L, Rodríguez-Laso Á, et al. Prevalence of frailty at population level in European ADVANTAGE Joint Action Member States: a systematic review and meta-analysis. Ann Ist Super Sanita. 2018;54:226–38.
9. Colombo F, García-Goñi M, Schwierz C. Addressing multimorbidity to improve healthcare and economic sustainability. J Comorb. 2016;6:21–7.
10. Quality of life indicators - health. URL https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Quality_of_life_indicators_-_health&oldid=566497 Accessed 5 July 2022.
11. Santos JV, Lobo M, Neiva RM, et al. European Union state of health from 1990 to 2017: time trends and its enlargements' effects. Int J Public Health. 2020;65:175–86.
12. Boncz I, Vajda R, Ágoston I, Endrei D, Sebestyén A. Changes in the health status of the population of Central and Eastern European countries between 1990 and 2010. Eur J Health Econ. 2014;15(Suppl 1):S137–41.
13. Santos JV, Souza J, Valente J, et al. The state of health in the European Union (EU-28) in 2017: an analysis of the burden of diseases and injuries. Eur J Public Health. 2020;30:573–8.
14. GBD 2019 Demographics Collaborators. Global age-sex-specific fertility, mortality, healthy life expectancy (HALE), and population estimates in 204 countries and territories, 1950–2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396:1160–203.
15. Vos T, Lim SS, Abbafati C, et al. Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396:1204–22.
16. GBD 2019 Risk Factors Collaborators. Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396:1223–49.
17. GBD 2019 Viewpoint Collaborators. Five insights from the Global Burden of Disease Study 2019. Lancet. 2020;396:1135–59.
18. Foreman KJ, Lozano R, Lopez AD, Murray CJ. Modeling causes of death: an integrated approach using CODEm. Popul Health Metr. 2012;10:1.
19. Martinez R, Soliz P, Caixeta R, Ordunez P. Reflection on modern methods: years of life lost due to premature mortality—a versatile and comprehensive measure for monitoring non-communicable disease mortality. Int J Epidemiol. 2019;48:1367–76.
20. Global Health Data Exchange (GHDx). 2014.URL http://www.healthdata.org/about/ghdx. Accessed 30 Apr 2021.
21. GBD Compare. 2014.URL http://www.healthdata.org/data-visualization/gbd-compare. Accessed 30 Apr 2021.
22. R Core Team. R: A language and environment for statistical computing. Vienna: R Foundation for Statistical Computing; 2021. https://www.R-project.org/.
23. Stevens GA, Alkema L, Black RE, et al. Guidelines for Accurate and Transparent Health Estimates Reporting: the GATHER statement. Lancet. 2016;388:e19-23.
24. Vandenberghe D, Albrecht J. The financial burden of non-communicable diseases in the European Union: a systematic review. Eur J Public Health. 2020;30:833–9.
25. Wang Y, Wang J. Modelling and prediction of global non-communicable diseases. BMC Public Health. 2020;20:822.
26. Iburg KM, Charalampous P, Allebeck P, et al. Burden of disease among older adults in Europe-trends in mortality and disability, 1990–2019. Eur J Public Health. 2023;33(1):121–6.
27. Yang X, Chen H, Sang S, Chen H, Li L, Yang X, Burden of All Cancers Along With Attributable Risk Factors in China From,. to 2019: Comparison With Japan, European Union, and USA. Front Public Health. 1990;2022:10. https://doi.org/10.3389/fpubh.2022.862165.
28. Dyba T, Randi G, Bray F, Martos C, Giusti F, Nicholson N, Gavin A, Flego M, Neamtiu L, Dimitrova N, Negrão Carvalho R, Ferlay J, Bettio M. The European cancer burden in 2020: Incidence and mortality estimates for 40 countries and 25 major cancers. Eur J Cancer. 2021;157:308–47.
29 Bozhar H, McKee M, Spadea T, Veerus P, Heinävaara S, Anttila A, Senore C, Zielonke N, van Ravesteyn NT, Lansdorp-Vogelaar I, de Koning HJ, Heijnsdijk EAM. EU-TOPIA consortium. Socio-economic inequality of utilization of cancer testing in Europe: A cross-sectional study. Prev Med Rep. 2022;26:101733.
30. Sørensen HT, Bredahl Kristensen FP. Cardiovascular diseases and health inequalities in Europe-a pressing public health challenge. Lancet Reg Health Eur. 2023;4(33):100722.
31. Castelpietra G, Knudsen AKS, Agardh EE, et al. The burden of mental disorders, substance use disorders and self-harm among young people in Europe, 1990–2019: Findings from the Global Burden of Disease Study 2019. Lancet Reg Health Eur. 2022;1(16):100341.
32. Stumbrys D, Jasilionis D, Pūras D. The burden of mental health-related mortality in the Baltic States in 2007–2018. BMC Public Health. 2022;22(1):1776.
33. van de Laar MJ, Likatavicius G. HIV and AIDS in the European Union, 2008. Euro Surveill. 2009;14(47):19422.
34. GBD 2017 HIV collaborators. Global, regional, and national incidence, prevalence, and mortality of HIV, 1980–2017, and forecasts to 2030, for 195 countries and territories: a systematic analysis for the Global Burden of Diseases, Injuries, and Risk Factors Study 2017. Lancet HIV. 2019;6:e831-59.

35. Taquet M, Geddes JR, Husain M, Luciano S, Harrison PJ. 6-month neurological and psychiatric outcomes in 236 379 survivors of COVID-19: a retrospective cohort study using electronic health records. Lancet Psychiatry. 2021;8:416–27.
36. COVID-19 Mental Disorders Collaborators. Global prevalence and burden of depressive and anxiety disorders in 204 countries and territories in 2020 due to the COVID-19 pandemic. Lancet. 2021;398:1700–12.
37. Launch of new WHO Mental Health Report: Transforming mental health for all. https://www.who.int/news-room/events/detail/2022/06/17/default-calendar/launch-of-new-who-mental-health-report--transforming-mental-health-for-all. Accessed 2 Jun 2022.
38. Wyper GMA, Grant I, Fletcher E, Chalmers N, McCartney G, Stockton DL. Prioritising the development of severity distributions in burden of disease studies for countries in the European region. Arch Public Health. 2020;78:3.
39. Fahy N, Hervey T, Greer S, et al. How will Brexit affect health services in the UK? An updated evaluation. Lancet. 2019;393:949–58.
40. Wyper GMA, Grant I, Fletcher E, McCartney G, Fischbacher C, Stockton DL. How do world and European standard populations impact burden of disease studies? A case study of disability-adjusted life years (DALYs) in Scotland. Arch Public Health. 2020;78:1.
41. Park J-H, Eum J-H, Bold B, Cheong H-K. Burden of disease due to dementia in the elderly population of Korea: present and future. BMC Public Health. 2013;13:293.

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