

Burden of non-communicable diseases among adolescents aged 10–24 years in the EU, 1990–2019: a systematic analysis of the Global Burden of Diseases Study 2019

Benedetta Armocida, Lorenzo Monasta, Susan Sawyer, Flavia Bustreo, Giulia Segafredo, Giulio Castelpietra, Luca Ronfani, Maja Pasovic, Simon Hay, GBD 2019 Europe NCDs in Adolescents Collaborators*, Pablo Perel, David Beran



Summary

Background Disability and mortality burden of non-communicable diseases (NCDs) have risen worldwide; however, the NCD burden among adolescents remains poorly described in the EU.

Methods Estimates were retrieved from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019. Causes of NCDs were analysed at three different levels of the GBD 2019 hierarchy, for which mortality, years of life lost (YLLs), years lived with disability (YLDs), and disability-adjusted life-years (DALYs) were extracted. Estimates, with the 95% uncertainty intervals (UI), were retrieved for EU Member States from 1990 to 2019, three age subgroups (10–14 years, 15–19 years, and 20–24 years), and by sex. Spearman's correlation was conducted between DALY rates for NCDs and the Socio-demographic Index (SDI) of each EU Member State.

Findings In 2019, NCDs accounted for 86·4% (95% uncertainty interval 83·5–88·8) of all YLDs and 38·8% (37·4–39·8) of total deaths in adolescents aged 10–24 years. For NCDs in this age group, neoplasms were the leading causes of both mortality (4·01 [95% uncertainty interval 3·62–4·25] per 100 000 population) and YLLs (281·78 [254·25–298·92] per 100 000 population), whereas mental disorders were the leading cause for YLDs (2039·36 [1432·56–2773·47] per 100 000 population) and DALYs (2040·59 [1433·96–2774·62] per 100 000 population) in all EU Member States, and in all studied age groups. In 2019, among adolescents aged 10–24 years, males had a higher mortality rate per 100 000 population due to NCDs than females (11·66 [11·04–12·28] vs 7·89 [7·53–8·23]), whereas females presented a higher DALY rate per 100 000 population due to NCDs (8003·25 [5812·78–10701·59] vs 6083·91 [4576·63–7857·92]). From 1990 to 2019, mortality rate due to NCDs in adolescents aged 10–24 years substantially decreased (–40·41% [–43·00 to –37·61]), and also the YLL rate considerably decreased (–40·56% [–43·16 to –37·74]), except for mental disorders (which increased by 32·18% [1·67 to 66·49]), whereas the YLD rate increased slightly (1·44% [0·09 to 2·79]). Positive correlations were observed between DALY rates and SDIs for substance use disorders ($r_s=0·58$, $p=0·0012$) and skin and subcutaneous diseases ($r_s=0·45$, $p=0·017$), whereas negative correlations were found between DALY rates and SDIs for cardiovascular diseases ($r_s=-0·46$, $p=0·015$), neoplasms ($r_s=-0·57$, $p=0·0015$), and sense organ diseases ($r_s=-0·61$, $p=0·0005$).

Interpretation NCD-related mortality has substantially declined among adolescents in the EU between 1990 and 2019, but the rising trend of YLL attributed to mental disorders and their YLD burden are concerning. Differences by sex, age group, and across EU Member States highlight the importance of preventive interventions and scaling up adolescent-responsive health-care systems, which should prioritise specific needs by sex, age, and location.

Funding Bill & Melinda Gates Foundation.

Copyright © 2022 The Author(s). Published by Elsevier Ltd. This is an Open Access article under the CC BY 4.0 license.

Introduction

Adolescence is a period of major physical growth, psychological development, and shifting social relationships, with major repercussions for health.¹ The inclusion of adolescents within the Global Strategy for Women's, Children's, and Adolescents' Health² and the Countdown to 2030,³ has reinforced the importance of tracking adolescent health. However, so far, global progress has been slow,⁴ and adolescents remain a neglected age group in the quest for universal health coverage.⁵ In this context, the scarcity of adolescent-specific country data, disaggregated by sex and age, is a major barrier.⁵ The non-communicable

disease (NCD) agenda has so far predominantly focused on adults,^{6,7} reflecting historical assumptions of adolescents as largely healthy. However, globally among adolescents, the burden of disability and mortality from NCDs has risen substantially,⁸ with the leading causes being mental disorders, substance use disorders, and chronic physical illness.⁹

EU Member States, although committed to addressing certain issues in adolescent health, particularly mental health and wellbeing,¹⁰ are yet to conduct a broad assessment of the disability and mortality burden of NCDs among adolescents. Although most EU Member

Lancet Child Adolesc Health 2022; 6: 367–83

Published Online
March 24, 2022
[https://doi.org/10.1016/S2352-4642\(22\)00073-6](https://doi.org/10.1016/S2352-4642(22)00073-6)
See [Comment](#) page 354

*Collaborators are listed at the end of the Article

Division of Tropical and Humanitarian Medicine, University of Geneva, Geneva, Switzerland (B Armocida MD); Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy (B Armocida, L Monasta DSc, L Ronfani PhD); Department of Paediatrics, University of Melbourne, Melbourne, VIC, Australia (Prof S Sawyer PhD); Murdoch Children's Research Institute, Melbourne, VIC, Australia (Prof S Sawyer); Centre for Adolescent Health, Royal Children's Hospital Melbourne, Melbourne, VIC, Australia (Prof S Sawyer); Fondation Botnar, Geneva, Switzerland (F Bustreo MD); Medicines Patent Pool, Geneva, Switzerland (G Segafredo PhD); Outpatient and Inpatient Care Service, Central Health Directorate, Friuli Venezia Giulia Region, Trieste, Italy (G Castelpietra PhD); Institute for Health Metrics and Evaluation, University of Washington, Seattle, WA, USA (M Pasovic MA, Prof S Hay DSc); Department of Non-Communicable Disease Epidemiology, London School of Hygiene and Tropical Medicine, London, UK (Prof P Perel PhD); Division of Tropical and Humanitarian Medicine, University of Geneva and Geneva University Hospitals, Switzerland (D Beran PhD)

Correspondence to:
Dr Lorenzo Monasta, Institute for Maternal and Child Health IRCCS Burlo Garofolo, 34137 Trieste TS, Italy
lorenzo.monasta@burlo.trieste.it

Research in context

Evidence before this study

We searched Embase and PubMed for research articles published in English on Nov 22, 2021, using the following terms in titles or abstracts: (“adolescent” OR “young people”) AND (“disability” OR “mortality”) AND (“Europe” OR “European Union”) AND (“non communicable disease” OR “NCD”). Although we identified several studies, these primarily examined adolescent mortality, mainly at the global level, and did not specifically focus on non-communicable diseases (NCDs). Moreover, studies either included smaller age groups (10–14 years, 10–19 years) or were country specific, disease specific, or part of a wider study on mortality or disability burden in other age groups. We only found one study, reporting analyses from 2015 on NCDs in adolescents that confirmed that NCDs are a major public health problem among adolescents globally, and that mental disorders were a large proportion of disability-adjusted life-years (DALYs) in people aged 10–19 years. To our knowledge, a comprehensive and detailed assessment of the burden of both mortality and disability of NCDs and their trends across EU Member States in adolescents aged 10–24 years old has not previously been published.

Added value of this study

This study provides a comprehensive description of the mortality and disability burden of NCDs among adolescents aged 10–24 years in EU Member States from 1990 to 2019. We retrieved estimates from Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019, the largest systematic, data-driven, and most recent peer-reviewed assessment of mortality and disability burden by age group, sex, cause, and location. GBD 2019 estimates replace those from previous GBD cycles, as in each iteration the GBD generates revised estimates

for the whole time series based on the most updated data and modelling methodology. This study highlights that for the adolescent population mortality has substantially decreased in the past 30 years, and adds to previous studies the important aspect of the rising trend of years of life lost (YLL) rate attributed to mental disorders in this population. It also describes the heavy disability burden attributed to NCDs at the regional and country level in the EU and the concerning increase of years lived with disability (YLDs) due to mental disorders. We also report wide variation in both the mortality and disability burden of NCDs by age group, sex, and location, suggesting opportunities for improvements. We were also able to identify association between the EU Member State level of socioeconomic development and the DALY burden of specific NCDs.

Implications of all the available evidence

These findings provide data for evidence-based decision making and highlight priority areas for interventions and investments, such as the importance of promotion of mental wellbeing and prevention of mental disorders, improvements in access to quality mental health services, and investments in dedicated primary and specialist health-care services. The extent of current disability burden of NCDs in adolescents suggests there is a need to scale up high-quality health-care services; establish, develop, and strengthen public health prevention policies, school programmes, specialised training pathways; and ensure that investments address the specific needs of adolescent health. Leadership around these elements could be enhanced by greater access to primary data sources to increase the accuracy of future findings and facilitate timely response to rapid changes in adolescents’ health and wellbeing, such as those caused by the COVID-19 pandemic.

States have high economic development and relatively high-quality health services, and fall into the category of NCD-predominant countries,⁹ differences in culture, governance, and prioritisation of public health policies and investments mean it is a region where changing NCD profiles among adolescents can be explored. Moreover, despite prevention policies implemented in the EU leading to progress in the reduction of premature mortality from NCDs, such as control measures targeting tobacco products, alcoholic beverages, and unhealthy food for young people, about a third of the EU population aged 15 years or older still lives with an NCD, and €700 billion is spent on treating NCDs annually in the region.¹¹ Given considerable heterogeneity and inconsistency in data collection systems and major data gaps, we used estimates from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 to: provide a comprehensive assessment of the burden of mortality and disability due to NCDs in adolescents aged 10–24 years in EU Member States by cause, sex, age, location, and trend over time for the 30-year period; and

evaluate the association between the disability-adjusted life-year (DALY) rates, which comprise both years lived with disability (YLDs) and years of life lost (YLLs), of the NCDs with the developmental stage of each EU Member State, using a composite measure of income per capita, average educational attainment, and fertility rate. Growing concerns about the effects of the COVID-19 pandemic and its containment measures on NCDs and their risk factors among adolescents^{12,13} suggest that this assessment can be considered a pre-pandemic baseline from which subsequent data can be compared at the regional and country level.

Methods

Overview

This study adopted the broad age definition for adolescence from 10 to 24 years because it accurately captures the biological, social, and neurocognitive development of this population.¹ We included the UK in these analyses, as it was still an EU Member State in 2019.

Estimates were retrieved from GBD 2019, which provides a complete set of comparable health estimates for 204 countries, including the 28 EU Member States, for 286 causes of death, 369 causes of disease and injury, and 87 risk factors. GBD 2019 generated estimates using 86 249 sources, and produced estimates of incidence, prevalence, mortality, YLDs, YLLs, DALYs, life expectancy, and health-adjusted life expectancy. To estimate deaths due to different causes, GBD 2019 used vital registration and verbal autopsy data as sources, modelled using the Cause of Death Ensemble model, which used geospatial information from covariates to produce estimates of death for all locations across time (1990–2019). Deaths from vital registration systems coded as unspecified were reassigned using statistical methods.¹⁴ For most diseases and injuries, data were also modelled using a spatiotemporal Gaussian process regression to allow for smoothing over age, time, and location, and a Bayesian meta-regression modelling tool (DisMod-MR 2.1) that ensured internally consistent estimates among all epidemiological metrics for most causes, by age, sex, location, and year.¹⁴ Methods for GBD 2019 estimates are described in detail in the capstone papers and appendices.¹⁴ The GBD 2019 cause list is composed of a four-level hierarchy, with each level comprising mutually exclusive and collectively exhaustive causes. There are 22 level 2 causes, 174 level 3 causes, and 301 level 4 causes (including 131 level 3 causes that are not further disaggregated at level 4). GBD 2019 estimates generated and reported here are in accordance with the Guidelines for Accurate and Transparent Health Estimates Reporting.¹⁵

Data analysis

Causes are reported following the GBD hierarchy. To give a general insight of the predominant causes of burden, we analysed all three level 1 causes: communicable, maternal, neonatal, and nutritional conditions; NCDs; and injuries. At level 2 and 3, we exclusively focused on NCD causes (appendix pp 31–33). We excluded self-harm and interpersonal violence from the analysis because the GBD hierarchy includes these in the injuries group (level 1).

Estimates were retrieved for the 28 EU Member States. The analyses covered the period 1990 to 2019, and were stratified by sex and age groups as follows: 10–14 years (younger adolescents), 15–19 years (older adolescents), and 20–24 years (young adults).⁶ Mortality, YLLs, YLDs, and DALYs were all reported as rates per 100 000 population. DALYs are the sum of YLLs and YLDs. YLLs are calculated by subtracting the age at death from the longest possible life expectancy for a person at that age. YLDs are estimated by multiplying the prevalence counts with the disability weight for a given disease or injury. As described in detail in the GBD 2019 capstone paper,¹⁴ disability weights represent the magnitude of health loss associated with specific health outcomes, and are used to estimate YLDs through

a series of severity splits. These metrics were subsequently subdivided by level of causes, specifically total all-cause, level 1, NCD level 2, and cause-specific NCD level 3 (appendix pp 31–33); sex (both sexes, female, and male), and age (10–24 years, 10–14 years, 15–19 years, and 20–24 years); country (28 EU Member States); and trend over time (1990–2019), for which we calculated the percentage change (rate) between 1990 and 2019 in 10–24-year-olds. All estimates generated in GBD 2019 are accompanied by 95% uncertainty intervals (UIs), which represent the 25th and 975th ordered estimates of 1000 draw estimates of the posterior distribution.¹⁴ We considered estimates to be significantly different by determining whether the 95% UIs overlapped.

Spearman's correlation was used to analyse the social, economic, and demographic diversity of NCD burden between EU Member States by correlating the DALY rates of level 2 NCDs (which comprise both YLDs and YLLs) with each country's score of the Socio-demographic Index (SDI). The SDI is a composite measure of a country's lag-distributed income per capita, average years of schooling, and the fertility rate in females younger than 25 years.^{14,16} The metric is scaled from 0 to 1, where 0 represents the lowest combination of the three indicators and 1 represents the highest. *p* values of less than 0.05 were set as the threshold of significance. The analysis was done with IBM SPSS Statistics (version 27.0).

Role of the funding source

The funder of the study had no role in study design, data collection, analysis, and interpretation, or writing of the report.

Results

Mortality

In 2019, total all-cause mortality for adolescents aged 10–24 years in the EU was 25.35 (95% UI 24.44–26.27) per 100 000 population (appendix pp 3–4). NCDs accounted for 38.8% (37.4–39.8) of total deaths in this age group (appendix pp 34–35). The leading level 2 cause of death for NCDs in adolescents aged 10–24 years was neoplasms (4.01 [3.62–4.25] per 100 000 population), which accounted for 40.8% (36.8–43.2) of all NCD mortality. The leading level 3 cause of death for NCDs was other malignant neoplasms (1.05 [0.88–1.14] per 100 000 population).

In 2019, NCDs were the leading level 1 cause of death in females of all age categories (52.1% [95% UI 50.3–53.3] for 10–24 years, 63.9% [61.1–65.6] for 10–14 years, 48.0% [45.8–49.5] for 15–19 years, and 50.6% [49.0–51.9] for 20–24 years) and in males aged 10–14 years (54.1% [52.0–56.0]; appendix pp 36–37). Additionally, for both sexes, mortality due to NCDs increased across the three age groups from 5.57 (5.31–5.84) per 100 000 population for 10–14 years to 9.47 (8.96–9.99) per 100 000 population for 15–19 years, and 14.30 (13.67–14.95) per 100 000 population for

See Online for appendix

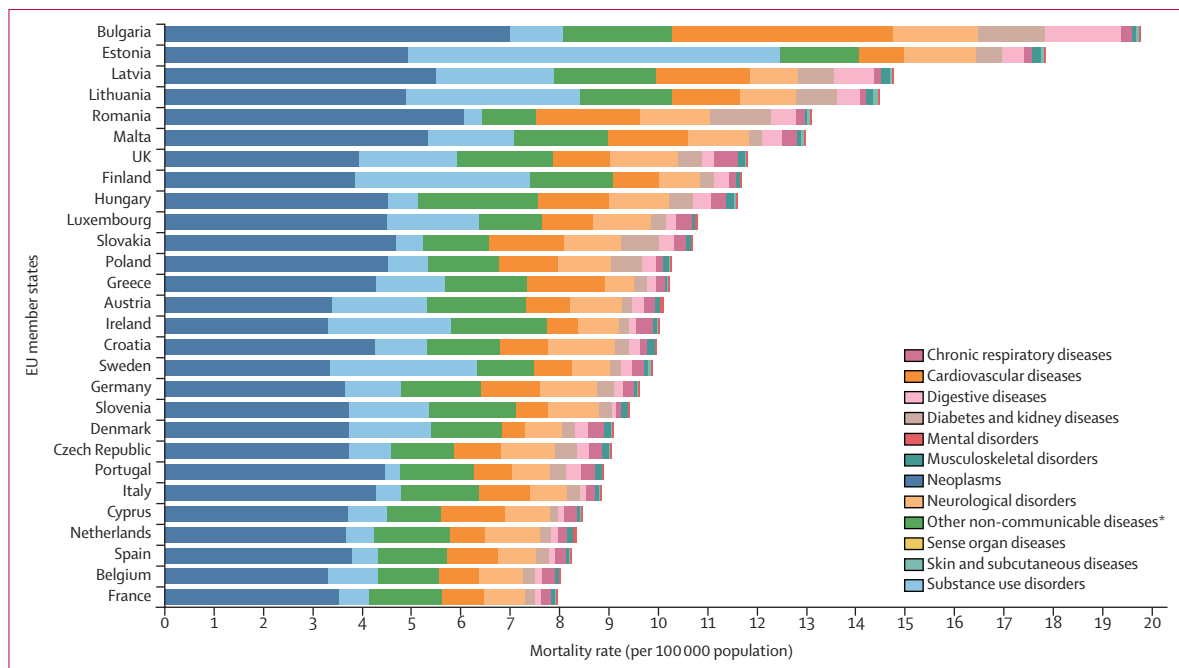


Figure 1: Mortality rate per 100 000 population due to level 2 non-communicable diseases in adolescents aged 10–24 years in both sexes, by country, 2019
 *This aggregate cause contains the following level 3 causes: congenital birth defects; urinary diseases; gynaecological diseases; haemoglobinopathies and haemolytic anaemias; endocrine, metabolic, blood, and immune disorders; and oral disorders.

20–24 years (appendix pp 34–35). Differences by age and sex in NCD level 2 mortality rates are reported in the appendix (pp 5–6).

In 2019, the highest mortality rate due to level 2 NCD causes (Bulgaria and Estonia) was more than double the lowest rate (France, Belgium, and Spain; figure 1). Significant differences in the excess mortality rate due to NCDs were observed between eight Member States and the EU overall (composite estimate): Bulgaria, Estonia, Latvia, Lithuania, Romania, Malta, the UK, and Finland. In all EU Member States, the leading level 2 cause of death was neoplasms, except in Estonia, where it was substance use disorders.

From 1990 to 2019, the mortality rate due to NCDs among adolescents aged 10–24 years significantly declined by 40.4% (95% UI –43.0 to –37.6; table; appendix p 7). For level 2 causes, the highest reduction in mortality rate from NCDs was observed in cardiovascular diseases (–62.00% [–64.37 to –59.63]) and chronic respiratory diseases (–58.81% [–62.27 to –50.24]), whereas the highest increase was in mental disorders (32.36% [2.25 to 66.96]), completely attributed to eating disorders (table; appendix p 7).

Years of life lost

In 2019, all-cause YLL rates per 100 000 population in the EU were 1758.00 (95% UI 1694.58–1822.04) among adolescents aged 10–24 years (appendix p 8). Among NCDs, the leading level 2 cause of YLLs was neoplasms (281.78 [254.25–298.92] per 100 000 population), whereas

at level 3, the three leading causes were other malignant neoplasms (74.01 [62.15–80.22] per 100 000 population), drug use disorders (65.02 [59.34–72.26] per 100 000 population), and leukaemia (64.64 [60.62–69.01] per 100 000 population; appendix pp 38–39).

In 2019, all-cause YLL rates per 100 000 population were significantly higher in males (2415.92 [95% UI 2321.65–2509.04]) than in females (1060.34 [1024.01–1099.59]), with the largest differences in those aged 20–24 years, with a male-to-female ratio of 2.8:1 (appendix p 8). NCDs were the leading cause of YLLs among females in all three age groups (63.9% [61.1–65.6] for 10–14 years, 48.0% [45.8–49.5] for 15–19 years, and 50.6% [49.0–51.9] for 20–24 years) and in the youngest males (54.1% [52.0–56.0] for 10–14 years; appendix pp 36–37). Sex and age-group differences for NCD level 2 causes of YLL are reported in figure 2A and the appendix (pp 9–10). Significant sex differences in YLL rates per 100 000 population in adolescents aged 10–24 years were apparent for several NCD level 3 causes, most notably for drug use disorders (98.38 [88.76–111.23] for males vs 29.64 [27.09–32.33] for females), other neurological disorders (45.93 [42.44–49.72] vs 13.1 [12.0–14.4]), alcohol use disorders (15.25 [13.04–17.02] vs 3.16 [2.82–3.50]; appendix p 11).

In 2019, the five countries with the largest burden of YLL rate per 100 000 population for NCDs in adolescents aged 10–24 years were Bulgaria (1381.32 [95% UI 1102.73–1714.70]), Estonia (1230.34 [1004.84–1511.39]), Latvia (1028.11 [870.39–1237.01]),

	Mortality rate per 100 000 population			DALY rate per 100 000 population		
	1990	2019	Percentage change, 1990 to 2019	1990	2019	Percentage change, 1990 to 2019
All non-communicable diseases	16.50 (16.20 to 16.72)	9.83 (9.39 to 10.28)	-40.41% (-43.00 to -37.61)	7394.59 (5591.11 to 9580.25)	7015.44 (5181.20 to 9224.35)	-5.13% (-7.55 to -3.21)
Neoplasms	6.32 (6.12 to 6.47)	4.01 (3.62 to 4.25)	-36.61% (-42.27 to -32.78)	461.02 (445.96 to 472.95)	300.48 (271.26 to 321.31)	-34.82% (-40.62 to -30.47)
Lip and oral cavity cancer	0.04 (0.04 to 0.04)	0.02 (0.02 to 0.03)	-33.96% (-39.54 to -28.14)	2.66 (2.53 to 2.81)	1.78 (1.66 to 1.91)	-33.06% (-38.90 to -27.12)
Nasopharynx cancer	0.04 (0.04 to 0.04)	0.02 (0.02 to 0.03)	-41.28% (-48.05 to -32.99)	3.07 (2.89 to 3.26)	1.85 (1.65 to 2.06)	-39.93% (-46.80 to -31.53)
Other pharynx cancer	0.01 (0.01 to 0.01)	0.01 (0.01 to 0.01)	-13.21% (-25.89 to 3.02)	0.46 (0.42 to 0.51)	0.41 (0.36 to 0.47)	-11.41% (-24.25 to 5.13)
Oesophageal cancer	0.01 (0.01 to 0.01)	0.01 (0.01 to 0.01)	-26.32% (-34.25 to -14.02)	0.68 (0.63 to 0.73)	0.5 (0.46 to 0.56)	-26.12% (-34.05 to -13.75)
Stomach cancer	0.10 (0.09 to 0.10)	0.03 (0.03 to 0.04)	-65.39% (-68.63 to -62.07)	6.67 (6.35 to 6.99)	2.32 (2.14 to 2.51)	-65.27% (-68.54 to -61.93)
Colon and rectum cancer	0.13 (0.13 to 0.14)	0.09 (0.08 to 0.10)	-32.71% (-38.30 to -26.95)	9.61 (9.24 to 9.98)	6.57 (6.06 to 7.08)	-31.58% (-37.40 to -25.59)
Liver cancer	0.08 (0.08 to 0.08)	0.07 (0.06 to 0.07)	-13.45% (-20.87 to -4.91)	5.72 (5.46 to 6.00)	4.96 (4.58 to 5.37)	-13.18% (-20.43 to -4.74)
Gallbladder and biliary tract cancer	0.01 (0.01 to 0.01)	0.00 (0.00 to 0.00)	-32.91% (-39.98 to -23.07)	0.41 (0.34 to 0.44)	0.27 (0.25 to 0.3)	-32.66% (-39.71 to -22.71)
Pancreatic cancer	0.03 (0.03 to 0.03)	0.02 (0.02 to 0.03)	-19.65% (-28.73 to -9.72)	2.03 (1.91 to 2.15)	1.63 (1.47 to 1.81)	-19.67% (-28.65 to -9.85)
Larynx cancer	0.01 (0.01 to 0.01)	0.00 (0.00 to 0.00)	-43.85% (-48.99 to -38.68)	0.59 (0.54 to 0.65)	0.37 (0.32 to 0.41)	-38.03% (-43.52 to -32.58)
Tracheal, bronchus, and lung cancer	0.13 (0.12 to 0.13)	0.08 (0.07 to 0.09)	-35.97% (-42.35 to -28.10)	8.76 (8.37 to 9.15)	5.62 (5.12 to 6.17)	-35.85% (-42.23 to -27.99)
Malignant skin melanoma	0.10 (0.07 to 0.12)	0.08 (0.05 to 0.10)	-11.37% (-37.22 to 7.00)	7.07 (5.14 to 8.85)	6.88 (4.44 to 8.14)	-2.71% (-31.93 to 18.35)
Non-melanoma skin cancer	0.01 (0.01 to 0.01)	0.01 (0.01 to 0.01)	-35.15% (-42.61 to -24.91)	0.66 (0.60 to 0.71)	0.43 (0.39 to 0.47)	-35.05% (-42.48 to -24.87)
Breast cancer	0.05 (0.05 to 0.06)	0.03 (0.03 to 0.04)	-34.91% (-41.12 to -28.20)	3.90 (3.67 to 4.15)	2.68 (2.43 to 2.95)	-31.32% (-38.15 to -23.90)
Cervical cancer	0.04 (0.03 to 0.05)	0.02 (0.02 to 0.02)	-53.01% (-59.70 to -44.39)	3.09 (2.38 to 3.4)	1.49 (1.24 to 1.72)	-51.75% (-58.62 to -42.71)
Uterine cancer	0.00 (0.00 to 0.00)	0.00 (0.00 to 0.00)	-28.44% (-36.45 to -18.94)	0.32 (0.29 to 0.35)	0.24 (0.21 to 0.27)	-24.07% (-33.32 to -13.51)
Ovarian cancer	0.11 (0.09 to 0.11)	0.07 (0.06 to 0.08)	-34.00% (-45.95 to -8.11)	7.72 (6.57 to 8.28)	5.18 (4.48 to 6.18)	-32.99% (-45.09 to -6.30)
Prostate cancer	0.01 (0.00 to 0.01)	0.01 (0.00 to 0.01)	-24.99% (-43.26 to 8.07)	0.51 (0.35 to 0.6)	0.43 (0.33 to 0.67)	-16.33% (-37.24 to 21.13)
Testicular cancer	0.18 (0.17 to 0.20)	0.10 (0.09 to 0.11)	-46.67% (-53.97 to -37.89)	14.00 (13.03 to 15.2)	8.62 (7.48 to 10.13)	-38.43% (-46.69 to -26.98)
Kidney cancer	0.06 (0.05 to 0.06)	0.05 (0.05 to 0.06)	-3.94% (-13.76 to 7.43)	4.12 (3.89 to 4.35)	3.99 (3.65 to 4.37)	-3.18% (-13.14 to 8.91)
Bladder cancer	0.01 (0.01 to 0.01)	0.01 (0.01 to 0.01)	-29.00% (-35.00 to -22.42)	0.88 (0.83 to 0.95)	0.66 (0.6 to 0.71)	-25.72% (-31.91 to -18.13)
Brain and CNS cancer	1.01 (0.86 to 1.23)	0.80 (0.53 to 0.90)	-20.92% (-55.57 to -9.71)	73.56 (62.02 to 89.41)	58.46 (38.55 to 65.75)	-20.53% (-55.31 to -9.09)
Thyroid cancer	0.02 (0.02 to 0.02)	0.01 (0.01 to 0.01)	-42.24% (-47.52 to -32.32)	1.78 (1.63 to 1.93)	1.13 (1.02 to 1.29)	-36.27% (-42.70 to -25.51)
Mesothelioma	0.01 (0.00 to 0.01)	0.01 (0.00 to 0.01)	-14.41% (-41.60 to 6.91)	0.39 (0.31 to 0.57)	0.34 (0.28 to 0.38)	-14.42% (-41.55 to 6.88)
Hodgkin lymphoma	0.30 (0.24 to 0.33)	0.11 (0.10 to 0.15)	-61.87% (-67.17 to -50.97)	22.10 (17.75 to 24.29)	9.43 (8.07 to 12.45)	-57.32% (-63.71 to -44.81)
Non-Hodgkin lymphoma	0.53 (0.51 to 0.55)	0.33 (0.30 to 0.36)	-38.46% (-43.45 to -31.88)	38.55 (37.07 to 40.05)	23.93 (22.11 to 26.39)	-37.93% (-43.13 to -30.95)

(Table continues on next page)

	Mortality rate per 100 000 population			DALY rate per 100 000 population		
	1990	2019	Percentage change, 1990 to 2019	1990	2019	Percentage change, 1990 to 2019
(Continued from previous page)						
Multiple myeloma	0.01 (0.00 to 0.01)	0.00 (0.00 to 0.01)	-5.49% (-22.86 to 15.11)	0.35 (0.28 to 0.39)	0.33 (0.27 to 0.38)	-4.81% (-22.21 to 16.04)
Leukaemia	1.75 (1.69 to 1.81)	0.91 (0.86 to 0.97)	-47.81% (-51.21 to -43.69)	127.46 (123.25 to 131.6)	68.64 (63.95 to 73.69)	-46.14% (-49.95 to -41.92)
Other neoplasms	0.03 (0.02 to 0.04)	0.03 (0.02 to 0.03)	-3.37% (-32.86 to 19.83)	2.37 (1.80 to 3.21)	2.17 (1.65 to 2.60)	-8.33% (-32.97 to 10.63)
Other malignant neoplasms	1.52 (1.38 to 1.59)	1.05 (0.88 to 1.14)	-30.96% (-40.75 to -25.24)	111.51 (101.05 to 116.76)	79.17 (66.46 to 86.48)	-29.01% (-38.83 to -22.78)
Cardiovascular diseases	2.96 (2.88 to 3.04)	1.13 (1.06 to 1.19)	-62.00% (-64.37 to -59.63)	249.35 (234.21 to 266.61)	119.45 (105.24 to 135.71)	-52.10% (-55.50 to -48.70)
Rheumatic heart disease	0.17 (0.16 to 0.17)	0.04 (0.03 to 0.04)	-77.67% (-80.38 to -74.85)	11.90 (11.17 to 12.58)	2.90 (2.57 to 3.24)	-75.63% (-78.69 to -72.57)
Ischaemic heart disease	0.64 (0.61 to 0.67)	0.20 (0.18 to 0.22)	-69.05% (-71.99 to -65.00)	43.78 (41.62 to 45.99)	13.68 (12.56 to 15.15)	-68.75% (-71.65 to -64.72)
Stroke	1.15 (1.09 to 1.21)	0.32 (0.29 to 0.35)	-72.45% (-75.16 to -69.34)	106.97 (97.41 to 117.94)	47.55 (39.23 to 56.93)	-55.55% (-60.74 to -50.71)
Hypertensive heart disease	0.03 (0.02 to 0.03)	0.02 (0.01 to 0.02)	-30.41% (-46.03 to -6.92)	1.86 (1.43 to 2.11)	1.30 (0.97 to 1.55)	-30.14% (-45.26 to -7.21)
Non-rheumatic valvular heart disease	0.08 (0.07 to 0.08)	0.05 (0.05 to 0.06)	-33.99% (-42.33 to -23.86)	5.4 (4.97 to 5.81)	3.57 (3.24 to 3.97)	-33.95% (-42.22 to -23.87)
Cardiomyopathy and myocarditis	0.49 (0.43 to 0.57)	0.26 (0.22 to 0.31)	-48.12% (-55.30 to -36.24)	36.54 (31.98 to 41.32)	19.5 (17.13 to 22.87)	-46.62% (-53.59 to -35.22)
Endocarditis	0.04 (0.04 to 0.07)	0.05 (0.02 to 0.06)	13.52% (-55.14 to 62.70)	3.03 (2.51 to 4.62)	3.42 (1.75 to 4.26)	12.76% (-54.50 to 60.20)
Aortic aneurysm	0.06 (0.06 to 0.07)	0.04 (0.04 to 0.05)	-34.78% (-42.20 to -25.29)	4.32 (3.96 to 4.66)	2.81 (2.54 to 3.10)	-34.92% (-42.30 to -25.43)
Other cardiovascular and circulatory diseases	0.30 (0.28 to 0.34)	0.16 (0.14 to 0.20)	-47.64% (-53.26 to -37.53)	35.56 (28.29 to 45.62)	24.72 (18.03 to 34.22)	-30.48% (-38.01 to -23.39)
Chronic respiratory diseases	0.62 (0.56 to 0.65)	0.26 (0.24 to 0.29)	-58.81% (-62.27 to -50.24)	315.34 (216.22 to 447.66)	286.65 (186.47 to 427.65)	-9.10% (-17.36 to 0.36)
Chronic obstructive pulmonary disease	0.13 (0.12 to 0.14)	0.07 (0.07 to 0.09)	-43.65% (-50.45 to -32.58)	30.64 (25.37 to 35.74)	25.70 (20.54 to 30.95)	-16.13% (-22.76 to -9.10)
Pneumoconiosis	0.00 (0.00 to 0.00)	0.00 (0.00 to 0.00)	-51.97% (-61.14 to -36.90)	0.20 (0.18 to 0.23)	0.10 (0.08 to 0.12)	-51.16% (-59.49 to -37.99)
Asthma	0.38 (0.33 to 0.41)	0.1 (0.09 to 0.12)	-73.21% (-75.86 to -66.90)	270.58 (174.63 to 400.11)	242.61 (147.7 to 383.76)	-10.34% (-20.31 to 0.46)
Interstitial lung disease and pulmonary sarcoidosis	0.04 (0.03 to 0.05)	0.04 (0.03 to 0.05)	5.96% (-30.52 to 32.52)	3.26 (2.52 to 4.04)	3.38 (2.29 to 4.02)	3.59% (-28.84 to 26.10)
Other chronic respiratory diseases	0.07 (0.04 to 0.07)	0.04 (0.03 to 0.05)	-45.60% (-56.53 to -8.81)	10.66 (8.85 to 12.33)	14.86 (11.67 to 18.08)	39.47% (21.16 to 68.42)
Digestive diseases	0.80 (0.78 to 0.83)	0.39 (0.37 to 0.42)	-51.40% (-54.62 to -48.09)	133.81 (108.81 to 169.8)	103.19 (78.74 to 137.38)	-22.88% (-27.90 to -18.26)
Cirrhosis and other chronic liver diseases	0.39 (0.37 to 0.41)	0.15 (0.14 to 0.17)	-61.08% (-64.62 to -56.85)	29.86 (28.14 to 31.92)	13.09 (11.57 to 14.94)	-56.15% (-60.29 to -52.20)
Upper digestive system diseases	0.08 (0.07 to 0.08)	0.02 (0.02 to 0.02)	-73.23% (-76.10 to -69.75)	42.47 (26.44 to 70.23)	36.19 (20.95 to 63.71)	-14.80% (-21.15 to -10.23)
Appendicitis	0.05 (0.03 to 0.06)	0.01 (0.01 to 0.02)	-69.98% (-74.37 to -52.73)	8.98 (6.47 to 12.55)	7.39 (4.80 to 11.1)	-17.76% (-32.31 to -1.46)
Paralytic ileus and intestinal obstruction	0.07 (0.06 to 0.08)	0.05 (0.05 to 0.07)	-24.14% (-32.57 to -12.44)	5.61 (4.65 to 6.23)	4.4 (3.72 to 5.18)	-21.50% (-29.31 to -10.85)
Inguinal femoral and abdominal hernia	0.01 (0.01 to 0.01)	0.00 (0.00 to 0.00)	-69.74% (-73.02 to -63.05)	8.17 (5.03 to 12.55)	6.2 (3.72 to 9.66)	-24.06% (-32.63 to -15.71)
Inflammatory bowel disease	0.05 (0.04 to 0.06)	0.04 (0.04 to 0.05)	-7.94% (-35.06 to -6.70)	12.18 (8.87 to 16.06)	13.38 (9.60 to 17.81)	9.84% (-0.88 to 18.84)
Vascular intestinal disorders	0.02 (0.02 to 0.03)	0.02 (0.01 to 0.02)	-33.51% (-42.43 to -22.53)	1.8 (1.6 to 2.04)	1.26 (1.10 to 1.45)	-29.99% (-38.77 to -19.78)

(Table continues on next page)

	Mortality rate per 100 000 population			DALY rate per 100 000 population		
	1990	2019	Percentage change, 1990 to 2019	1990	2019	Percentage change, 1990 to 2019
(Continued from previous page)						
Gallbladder and biliary diseases	0.02 (0.01 to 0.02)	0.01 (0.01 to 0.01)	-47.21% (-55.57 to -33.61)	14.57 (8.82 to 22.32)	13.9 (8.40 to 21.85)	-4.63% (-11.67 to 2.30)
Pancreatitis	0.09 (0.08 to 0.09)	0.05 (0.04 to 0.06)	-42.43% (-50.53 to -31.94)	6.62 (5.94 to 7.35)	4.09 (3.56 to 4.72)	-38.20% (-46.01 to -28.41)
Other digestive diseases	0.03 (0.02 to 0.04)	0.03 (0.02 to 0.04)	-5.22% (-51.06 to 15.59)	3.54 (2.85 to 4.48)	3.29 (2.36 to 4.06)	-7.31% (-36.65 to 5.40)
Neurological disorders	1.45 (1.41 to 1.50)	1.03 (0.97 to 1.09)	-29.25% (-34.04 to -24.15)	996.17 (321.61 to 2018.69)	985.14 (292.58 to 2019.32)	-1.11% (-10.77 to 5.54)
Parkinson's disease	0.00 (0.00 to 0.00)	0.00 (0.00 to 0.00)	-31.45% (-43.52 to -16.55)	0.11 (0.09 to 0.13)	0.08 (0.06 to 0.10)	-25.92% (-37.78 to -12.75)
Idiopathic epilepsy	0.69 (0.66 to 0.73)	0.53 (0.48 to 0.57)	-23.74% (-31.41 to -17.55)	152.76 (104.4 to 220.04)	140.18 (87.22 to 225.90)	-8.23% (-30.47 to 19.70)
Multiple sclerosis	0.02 (0.02 to 0.03)	0.02 (0.01 to 0.02)	-26.81% (-41.08 to 13.84)	5.61 (3.99 to 7.67)	5.93 (4.22 to 8.18)	5.72% (-4.62 to 20.57)
Motor neuron disease	0.06 (0.06 to 0.07)	0.06 (0.05 to 0.06)	-12.42% (-19.69 to -5.21)	5.19 (4.89 to 5.55)	4.68 (4.27 to 5.10)	-9.72% (-15.94 to -3.27)
Headache disorders	..	..	..	761.17 (79.43 to 1792.62)	769.30 (78.52 to 1814.32)	1.07% (-3.41 to 3.70)
Other neurological disorders	0.67 (0.65 to 0.70)	0.43 (0.40 to 0.46)	-36.56% (-41.28 to -31.01)	71.33 (60.51 to 86.13)	64.96 (47.53 to 93.37)	-8.94% (-25.33 to 14.49)
Mental disorders	0.01 (0.01 to 0.02)	0.02 (0.01 to 0.02)	32.36%* (2.25 to 66.96)	2008.04 (1420.6 to 2729.61)	2040.59 (1433.96 to 2774.62)	1.62% (-0.61 to 3.87)
Schizophrenia	..	..	..	63.18 (40.35 to 96.96)	60.24 (38.50 to 92.15)	-4.65% (-11.64 to 1.59)
Depressive disorders	..	..	..	587.35 (384.87 to 850.24)	569.42 (365.86 to 847.34)	-3.05% (-9.63 to 3.40)
Bipolar disorder	..	..	..	184.63 (100.79 to 295.7)	187.81 (102.26 to 301.80)	1.72% (-1.93 to 5.58)
Anxiety disorders	..	..	..	612.59 (398.42 to 900.04)	641.37 (416.23 to 938.58)	4.70% (0.65 to 8.99)
Eating disorders	0.01 (0.01 to 0.02)	0.02 (0.01 to 0.02)	32.36% (2.25 to 66.96)	130.56 (79.11 to 199.61)	15.24% (9.24 to 230.68)	15.24% (9.65 to 20.43)
Autism spectrum disorders	..	..	..	89.21 (57.78 to 127.52)	92.27 (60.45 to 132.16)	3.43% (0.55 to 6.17)
Attention deficit hyperactivity disorder	..	..	..	30.39 (17.04 to 52.32)	32.22 (17.80 to 55.80)	6.03% (0.48 to 11.90)
Conduct disorder	..	..	..	227.6 (128.22 to 360.70)	234.52 (132.20 to 374.35)	3.04% (0.84 to 5.27)
Idiopathic developmental intellectual disability	..	..	..	33.67 (15.13 to 57.43)	24.14 (9.31 to 42.55)	-28.29% (-38.34 to -23.60)
Other mental disorders	..	..	..	48.87 (26.04 to 79.52)	48.14 (25.31 to 77.72)	-1.49% (-6.71 to 3.85)
Substance use disorders	1.30 (1.24 to 1.37)	1.10 (1.01 to 1.21)	-15.28% (-23.50 to -4.57)	492.33 (358.21 to 650.25)	503.94 (361.14 to 665.94)	2.36% (-2.42 to 7.78)
Alcohol use disorders	0.19 (0.18 to 0.20)	0.14 (0.12 to 0.15)	-27.27% (-37.58 to -17.87)	204.46 (125.09 to 318.64)	187.23 (112.67 to 299.64)	-8.43% (-14.78 to -3.61)
Drug use disorders	1.11 (1.05 to 1.17)	0.96 (0.88 to 1.07)	-13.22% (-22.66 to -0.90)	287.87 (218.6 to 368.70)	316.72 (234.37 to 412.93)	10.02% (3.03 to 17.91)
Diabetes and kidney diseases	0.46 (0.44 to 0.47)	0.22 (0.21 to 0.24)	-51.23% (-54.66 to -47.98)	69.75 (58.24 to 84.76)	67.92 (51.26 to 88.78)	-2.62% (-13.50 to 8.34)
Diabetes	0.18 (0.18 to 0.19)	0.10 (0.09 to 0.11)	-46.34% (-50.04 to -42.76)	32.56 (25.46 to 42.02)	42.59 (29.59 to 60.23)	30.83% (14.12 to 44.41)
Chronic kidney disease	0.27 (0.26 to 0.28)	0.12 (0.11 to 0.13)	-54.13% (-57.79 to -50.04)	36.78 (29.79 to 45.67)	25.21 (18.50 to 33.33)	-31.45% (-38.30 to -25.46)
Acute glomerulonephritis	0.01 (0.00 to 0.01)	0.00 (0.00 to 0.00)	-74.99% (-79.98 to -68.66)	0.41 (0.35 to 0.49)	0.12 (0.10 to 0.13)	-71.73% (-77.32 to -65.33)

(Table continues on next page)

	Mortality rate per 100 000 population			DALY rate per 100 000 population		
	1990	2019	Percentage change, 1990 to 2019	1990	2019	Percentage change, 1990 to 2019
(Continued from previous page)						
Skin and subcutaneous diseases	0.02 (0.01 to 0.03)	0.02 (0.01 to 0.03)	-7.51% (-38.94 to 9.70)	731.21 (487.33 to 1051.3)	774.92 (512.68 to 1117.83)	5.98% (4.17 to 7.50)
Dermatitis	..	..	..	171.24 (94.57 to 280.83)	180.58 (99.20 to 296.53)	5.45% (3.14 to 7.84)
Psoriasis	..	..	..	100.98 (69.49 to 136.48)	93.69 (64.76 to 126.6)	-7.22% (-10.78 to -3.44)
Bacterial skin diseases	0.01 (0.01 to 0.02)	0.01 (0.01 to 0.02)	27.07% (-26.87 to 54.15)	6.81 (3.63 to 12.3)	7.21 (3.92 to 12.73)	5.82% (-2.50 to 12.14)
Scabies	..	..	..	12 (6.39 to 19.95)	9.79 (5.21 to 16.32)	-18.44% (-20.76 to -16.15)
Fungal skin diseases	..	..	..	26.05 (9.86 to 57.17)	26.39 (9.98 to 57.99)	1.32% (-0.10 to 2.72)
Viral skin diseases	..	..	..	82.32 (52.54 to 123.64)	85.86 (55.49 to 128.88)	4.31% (2.61 to 6.07)
Acne vulgaris	..	..	..	253.02 (149.86 to 400.58)	293.19 (174.43 to 464.77)	15.88% (13.70 to 18.20)
Alopecia areata	..	..	..	7.05 (4.44 to 10.68)	7.01 (4.39 to 10.61)	-0.49% (-5.86 to 5.53)
Pruritus	..	..	..	5.16 (2.34 to 9.82)	5.27 (2.4 to 10.08)	2.21% (-0.84 to 5.66)
Urticaria	..	..	..	36.57 (22.68 to 55.92)	34.64 (21.53 to 53.01)	-5.28% (-8.54 to -1.74)
Decubitus ulcer	0.00 (0.00 to 0.00)	0.00 (0.00 to 0.00)	-48.30% (-67.63 to -29.59)	0.52 (0.36 to 0.73)	0.51 (0.34 to 0.71)	-3.19% (-11.98 to 5.52)
Other skin and subcutaneous diseases	0.01 (0.00 to 0.01)	0.00 (0.00 to 0.00)	-57.16% (-64.92 to -44.05)	29.49 (14.21 to 54.82)	30.78 (14.58 to 57.44)	4.36% (2.36 to 6.00)
Sense organ diseases	..	..	..	161.30 (104.92 to 232.98)	150.24 (98.94 to 216.39)	-6.86% (-10.66 to -3.53)
Blindness and vision loss	..	..	..	57.93 (35.68 to 88.02)	55.65 (33.94 to 85.36)	-3.95% (-7.47 to -1.02)
Age-related and other hearing loss	..	..	..	89.07 (53.43 to 131.61)	79.48 (48.09 to 118.58)	-10.77% (-16.00 to -5.55)
Other sense organ diseases	..	..	..	14.30 (7.93 to 23.33)	15.12 (8.43 to 24.67)	5.73% (0.53 to 11.81)
Musculoskeletal disorders	0.14 (0.09 to 0.19)	0.09 (0.07 to 0.14)	-33.92% (-42.01 to -11.15)	975.56 (670.99 to 1372.96)	974.22 (674 to 1377.19)	-0.14% (-2.31 to 2.10)
Rheumatoid arthritis	0.01 (0.01 to 0.02)	0.01 (0.01 to 0.01)	-55.60% (-63.33 to -38.51)	9.19 (5.98 to 13.52)	9.80 (6.18 to 14.89)	6.59% (-3.50 to 15.33)
Low back pain	..	..	..	678.57 (439.08 to 992.73)	634.68 (410.14 to 938.51)	-6.47% (-8.88 to -3.94)
Neck pain	..	..	..	157.22 (89.41 to 267.77)	172.02 (97.60 to 290.28)	9.41% (6.44 to 12.68)
Gout	..	..	..	0.35 (0.15 to 0.68)	0.38 (0.16 to 0.71)	6.34% (2.60 to 13.07)
Other musculoskeletal disorders	0.12 (0.08 to 0.17)	0.08 (0.07 to 0.13)	-31.37% (-39.81 to -7.66)	130.22 (76.37 to 204.72)	157.34 (91.23 to 246.73)	20.82% (14.31 to 29.20)

(Table continues on next page)

Lithuania (1004.40 [842.92–1192.36]), and Romania (918.53 [779.76–1079.00]; appendix pp 12–13). The highest YLL rate (in Bulgaria) was double the lowest (in France). Neoplasms were the leading cause of YLL rate in all Member States in adolescents aged 10–24 years, except for Estonia, where it was substance use disorders (appendix pp 12–13). In comparison to the EU overall, eight Member States had significantly higher YLL rates

due to NCDs (Bulgaria, Estonia, Latvia, Lithuania, Malta, Romania, the UK, and Finland), whereas five had lower rates (Italy, the Netherlands, Spain, Belgium, and France).

Among adolescents aged 10–24 years, YLL rates due to NCDs decreased by 40.56% (95% UI -43.16 to -37.74) from 1990 to 2019 (appendix pp 14, 38–39). The only NCD level 2 cause of YLLs that increased was mental disorders,

	Mortality rate per 100 000 population			DALY rate per 100 000 population		
	1990	2019	Percentage change, 1990 to 2019	1990	2019	Percentage change, 1990 to 2019
(Continued from previous page)						
Other non-communicable diseases	2.41 (2.11 to 2.62)	1.57 (1.42 to 1.85)	-34.70% (-39.50 to -21.57)	800.72 (594.95 to 1076.26)	708.7 (515.60 to 964.73)	-11.49% (-14.60 to -8.10)
Congenital birth defects	1.53 (1.24 to 1.70)	0.87 (0.71 to 1.10)	-42.91% (-48.73 to -21.92)	191.85 (161.2 to 226.95)	143.82 (117.64 to 175.65)	-25.03% (-30.85 to -12.47)
Urinary diseases and male infertility	0.09 (0.08 to 0.10)	0.05 (0.05 to 0.06)	-45.11% (-49.24 to -35.04)	14.45 (11.1 to 19.37)	11.37 (7.99 to 16.99)	-21.31% (-29.82 to -9.92)
Gynaecological diseases	0.00 (0.00 to 0.01)	0.00 (0.00 to 0.00)	-65.55% (-71.31 to -43.29)	277.7 (180.92 to 410.57)	272.17 (176.44 to 402.67)	-1.99% (-4.86 to 1.22)
Haemoglobinopathies and haemolytic anaemias	0.22 (0.22 to 0.23)	0.08 (0.08 to 0.09)	-63.33% (-66.84 to -59.22)	34.79 (27.39 to 45.83)	13.88 (10.67 to 18.53)	-60.11% (-64.82 to -54.56)
Endocrine, metabolic, blood, and immune disorders	0.56 (0.44 to 0.66)	0.57 (0.49 to 0.77)	1.17% (-7.60 to 24.29)	183.24 (124.57 to 260.31)	176.43 (122.63 to 245.60)	-3.72% (-8.14 to 2.88)
Oral disorders	..	..	..	98.69 (53.76 to 163.39)	91.03 (50.27 to 150.71)	-7.76% (-10.76 to -4.85)

Data in parentheses are 95% uncertainty intervals. *Note that deaths were only attributed to eating disorders.

Table: Mortality and DALY rate per 100 000 population in adolescents aged 10–24 years in EU Member States in 1990 and 2019, and percentage change from 1990 to 2019

albeit not significantly, from 0.93 (0.80–1.10) in 1990 to 1.23 (1.00–1.50) in 2019 (change 32.18% [1.67–66.49]), and for which YLLs were only attributed to eating disorders (appendix pp 38–39).

Years lived with disability

The all-cause YLD rate across the EU in 2019 was 7322.85 (95% UI 5268.10–9748.95) per 100 000 population among adolescents aged 10–24 years and increased by age group (appendix p 15). The leading level 1 causes of YLDs in adolescents aged 10–24 years were NCDs (6328.51 [4489.66–8533.25] per 100 000 population), which overall constituted 86.4% (83.5–88.8) of all YLDs (appendix p 34). The leading NCD level 2 causes of YLDs were mental disorders (2039.36 [1432.56–2773.47] per 100 000 population), and the top three level 3 causes of YLDs were headache disorders (769.30 [78.52–1814.32] per 100 000 population), anxiety disorders (641.37 [416.23–938.51] per 100 000 population), and low back pain (634.68 [410.14–938.51] per 100 000 population; appendix pp 40–42).

Among adolescents aged 10–24 years, all-cause YLD rates per 100 000 population in 2019 were higher in females (8383.40 [95% UI 6003.72–11292.01]) than in males (6322.73 [4586.09–8354.55]; appendix p 15). NCDs were the leading level 1 cause of YLDs, with the greatest burden in individuals aged 20–24 years (7813.15 [5546.85–10334.38] per 100 000 population) (appendix pp 34–35). For all three age subgroups, mental disorders were the leading level 2 cause of YLDs in the EU overall (appendix pp 16–17). Differences by age group and sex in level 2 causes are reported in figure 2B and the appendix (pp 16–17). For level 3 causes, significant differences in YLD rates per 100 000 population between females and males aged 10–24 years were observed for

eating disorders (236.68 [141.97–365.30] for females vs 66.76 [38.98–104.81] for males) and autism spectrum disorders (32.77 [21.26–47.87] vs 148.39 [97.20–211.37]; appendix p 18).

In 2019, among adolescents aged 10–24 years, country NCD YLD rates per 100 000 population ranged from 4593.38 (95% UI 3234.52–6166.79) in Romania to 7018.56 (4996.04–9428.21) in Portugal (appendix pp 19–20). However, no significant differences were observed between individual Member States and the EU overall. Mental disorders were the leading cause of YLDs in all countries.

Among adolescents aged 10–24 years, there was no change in all-cause YLD rates from 1990 (7372.49 [95% UI 5298.54–9758.09] per 100 000 population) to 2019 (7322.85 [5268.10–9748.95] per 100 000 population; appendix p 15), although a slight increase in YLDs due to NCDs was observed (1.44% [0.09–2.79]; appendix pp 21, 40–42). Within NCD level 2 causes, from 1990 to 2019, the greatest increase in YLD rates was observed for diabetes and kidney diseases (37.8% (25.1–51.5), mainly due to an increase in level 3 cause diabetes (80.5% [69.5–90.4]; appendix pp 40–42).

Disability-adjusted life-years

In 2019, the all-cause rate of DALYs per 100 000 population was 9080.85 (95% UI 7024.87–11479.33) among adolescents aged 10–24 years (appendix p 22). NCDs accounted for 77.1% (73.5–80.5) of DALYs among adolescents aged 10–24 years in the EU (appendix pp 34–35). Mental disorders (2040.59 [1433.96–2774.62] per 100 000 population) were the leading level 2 cause (table), accounting for 29.1% (20.4–39.6) of the overall NCD DALY rate. Headache disorders (769.30 [78.52–1814.32] per 100 000 population), anxiety disorders

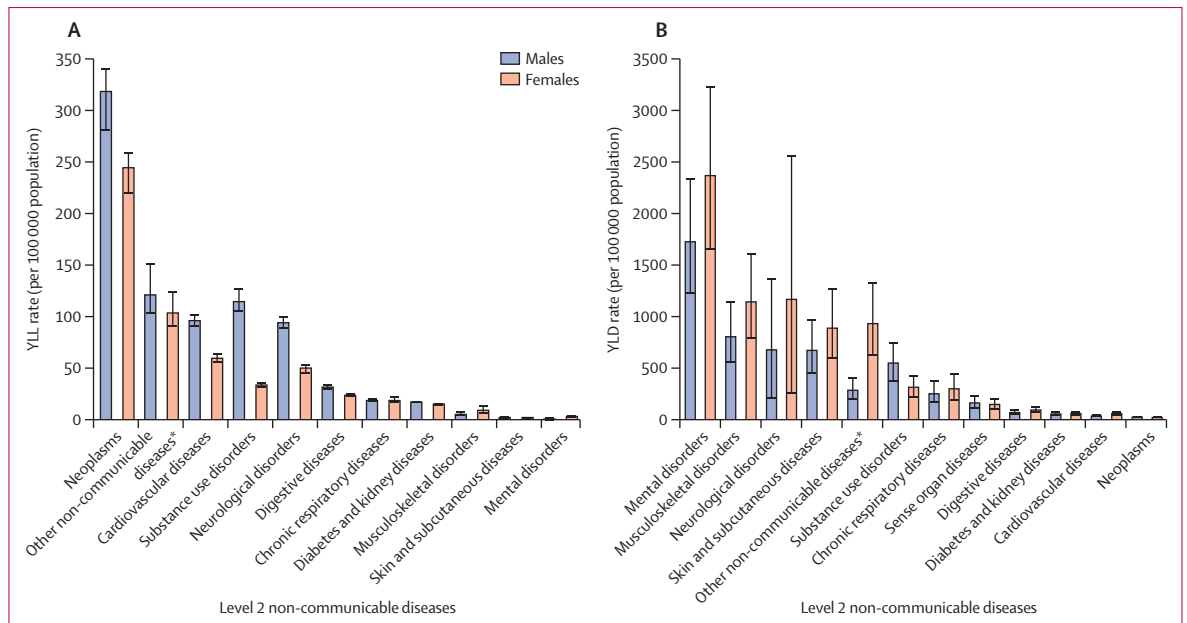


Figure 2: YLL (A) and YLD (B) rates per 100 000 population due to level 2 non-communicable diseases in adolescents aged 10–24 years in EU Member States, by sex, 2019

YLDs=years lived with disability. YLLs=years of life lost. *This aggregate cause contains the following level 3 causes: congenital birth defects; urinary diseases; gynaecological diseases; haemoglobinopathies and haemolytic anaemias; endocrine, metabolic, blood, and immune disorders; and oral disorders.

(641·37 [416·23–938·58] per 100 000 population), and low back pain (634·68 [410·14–938·51] per 100 000 population) were the top three level 3 causes.

The total all-cause DALY rate per 100 000 population in 2019 increased with age and was higher in females than males in all age groups (appendix p 22). NCDs were the leading causes of DALYs in all age groups and in both sexes (appendix pp 34–37). Differences between sexes were larger in the age groups of 15–19 years and 20–24 years. For adolescents aged 10–24 years, sex differences were significant for level 2 causes of substance use disorders, neurological disorders, and other NCDs (appendix pp 23–24), and at level 3 they were significant for drug use disorders (221·64 [156·16–299·71] per 100 000 population for females vs 406·38 [304·06–522·44] per 100 000 population for males) and eating disorders (239·16 [143·64–367·68] per 100 000 population vs 66·82 [39·04–104·88] per 100 000 population; appendix p 25).

In 2019, DALY rates per 100 000 population due to NCDs in adolescents aged 10–24 years ranged from 5248·13 [95% UI 3890·06–6787·39]) in the Czech Republic to 7828·83 [5815·44–10 207·98]) in the UK (figure 3). In all EU Member States, mental disorders were the leading level 2 cause of DALYs from NCDs (figure 3), accounting for more than 22·5% (15·8–30·6) of the DALY burden. Significantly higher rate differences between Member States and the EU overall were observed at level 2 causes for the following diseases and countries: cardiovascular diseases (Bulgaria, Romania, and Latvia), digestive diseases (Bulgaria, Romania, and

Lithuania), diabetes and kidney diseases (Bulgaria), neoplasms (Bulgaria, Romania, Latvia, and Malta), and substance use disorders (Estonia; appendix pp 26–28).

In the 30-year period, the DALY rate due to NCDs across the EU decreased by 5·1% (95% UI –7·6 to –3·2; table; appendix p 29). Among level 2 NCD causes, there was a significant change in the DALY rate from 1990 to 2019 for cardiovascular diseases, which decreased by 52·10% (–55·50 to –48·70), and neoplasms, which decreased by 34·82% (–40·62 to –30·47; table).

Correlation between SDI and NCD DALY rates

In 2019, the SDI ranged from 0·74 (Portugal) to 0·90 (Germany and Luxembourg; appendix p 43). Moderate rank correlations of higher developmental index and higher DALY rates of substance use disorders ($r_s=0·58$, $p=0·0012$) and skin and subcutaneous diseases ($r_s=0·45$, $p=0·017$) and of lower developmental index and higher DALY rates of cardiovascular diseases ($r_s=-0·46$, $p=0·015$), neoplasms ($r_s=-0·57$, $p=0·0015$), and sense organ diseases ($r_s=-0·61$, $p=0·0005$) were observed (appendix pp 30, 44).

Discussion

This study presents the first systematic analysis of the NCD burden among adolescents in the EU Member States using GBD 2019 estimates. It found that the burden of NCD mortality and disability increases between the age groups 10–14 and 20–24 years. Despite substantial decreases in mortality over the past three decades, disability has remained mostly unchanged over this time,

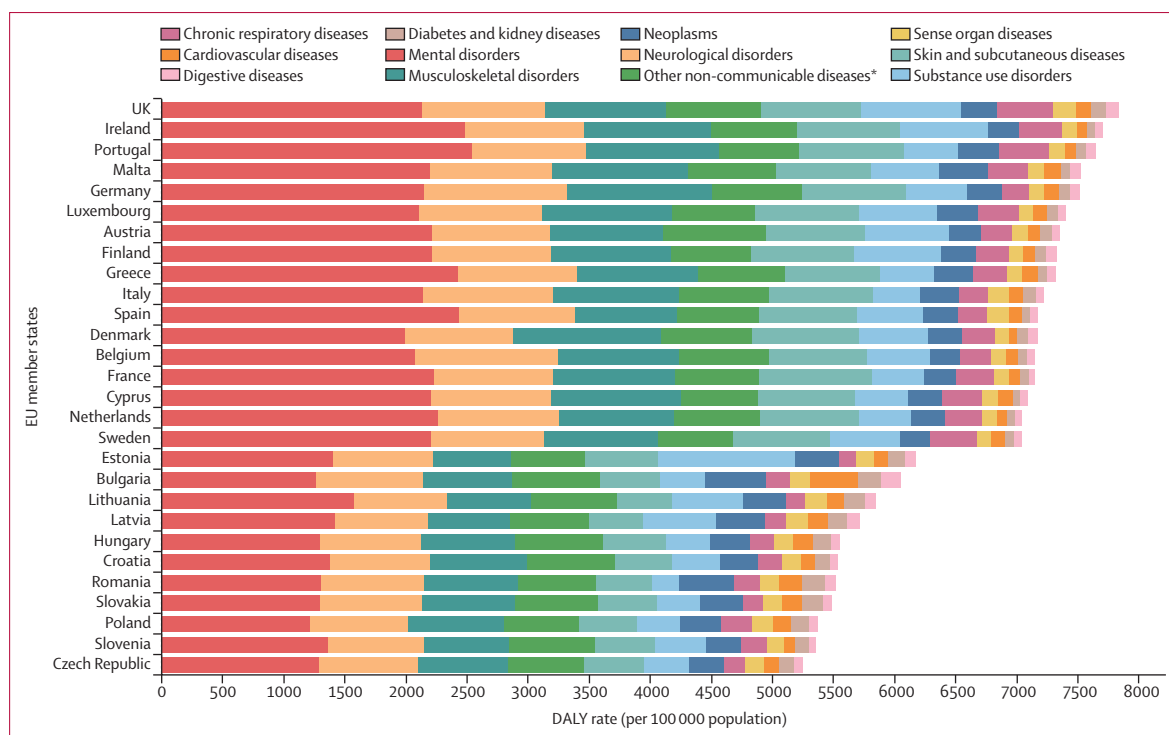


Figure 3: DALY rate per 100 000 population due to level 2 non-communicable diseases in adolescents aged 10–24 years in both sexes, by country, 2019
 DALY=disability-adjusted life-year. *This aggregate cause contains the following level 3 causes: congenital birth defects; urinary diseases; gynaecological diseases; haemoglobinopathies and haemolytic anaemias; endocrine, metabolic, blood, and immune disorders; oral disorders.

and the rising trend of YLLs attributed to mental disorders and their YLD burden are concerning. In line with previous evidence reporting that sex differences tend to increase with age,^{4,17} our findings show that sex differences are wider in young adults. Furthermore, although males have a higher mortality and a major burden attributed to substance use disorders, females present a higher disability burden, particularly attributable to mental disorders, with an emerging mortality burden of eating disorders. Substantial variations of the NCD burden by country were also found. Mortality and YLLs from NCDs predominated in eastern European countries (Bulgaria, Estonia, Latvia, Lithuania, and Romania), in comparison to greater prominence from disability in western European countries (the UK, Portugal, Ireland, Germany, and Luxembourg).

This study highlights the need to scale up wide-ranging interventions to address the challenge of NCDs in adolescents in EU Member States, particularly aiming in reducing the disability burden of these diseases. These interventions comprise holistic multilevel public health approaches,⁹ including evidence-based preventive interventions, investments in dedicated primary and specialist health-care services including specialist training in adolescent medicine,¹⁸ and health-promoting school programmes.¹⁹ Effective interventions should also consider structural and proximal social and environmental determinants of

health, such as improving access to education and employment, as well as commercial determinants that shape ill health.^{20,21}

Within the EU, despite the fifth European Youth Goal¹⁰ to promote social inclusion of all young people, to achieve better mental health and wellbeing and end stigmatisation of mental health issues, mental disorders were the major contributors of the NCD burden in all EU Member States and in adolescents. Previous studies have reported mental disorders as leading causes of disability among adolescents,⁸ and that the onset of the first mental disorder emerges in a third of individuals before the age of 14 years, in almost half by 18 years, and nearly two-thirds before 25 years.²² Yet only 20–40% of adolescents with mental health problems are diagnosed by health services and only 25% receive appropriate treatment.²³ This problem is compounded by low help-seeking behaviour²⁴ and is probably exacerbated by barriers to accessing mental health services,²⁵ such as stigma, service cost, the absence of health services, or the requirement for parental consent. Gender inequalities in health primarily emerge during adolescence,²⁶ and this difference reinforces the importance of prioritising adolescents of all genders as an age group for targeted gender-sensitive health policies, indicators, and programmes. Examples include mainstreaming gender in health service delivery and access, in medical research,

in health planning processes, and in the training of health-care professionals, which would be expected to enhance the effectiveness of actions to address the burden of NCDs. Moreover, the correlation between DALY rates and SDI of each EU Member State also confirms the need to address underlying determinants of health and suggests that country-specific approaches are needed.²⁷ For example, Bulgaria and Romania, which have the lowest expenditure on health in the EU,²⁸ would benefit from greater investments to improve access to and quality of health services, including for adolescents,²⁹ national health system monitoring or quality assurance systems, and prevention,²⁸ whereas Estonia, with the highest burden of substance use disorder in adolescents, would benefit from increased drug-related expenditure, including for tackling gaps in data collection, which accounted for only 0.02% of gross domestic product in 2011, well below the EU average.³⁰

Understanding and responding to these barriers is particularly urgent given the impact of the COVID-19 pandemic on adolescent health and health-related quality of life.¹² In this context, besides mental disorders,³¹ there are also concerns about the impact of the COVID-19 pandemic on reducing access to health services for other NCDs, such as cancer. Despite significant improvements in mortality reduction due to neoplasms in EU Member States, these gains might be jeopardised by the disruptions to cancer care services faced during COVID-19 pandemic.³² Additionally, considering the rising trend of disability due to diabetes, the alarming increase of type 2 diabetes in adolescents,^{33,34} and long-term effects of COVID-19 on obesity and type 1 diabetes, reasonable prevention strategies and health system responses should be prioritised.

GBD 2019 has some key limitations, such as availability of primary data, the uncertainty for some estimates represented by a wide 95% UIs, as well as in the determination and classification of some non-fatal disorders. Further details in GBD 2019 limits are described elsewhere.¹⁴ Our analysis has several limitations related to variation in the availability and quality of primary data for adolescent health, including paucity of data for some age groups (especially 10–14 years), for many health outcomes during adolescence,³⁵ and some EU Member States, particularly in central and eastern Europe. These estimates of disease burden are surrounded by considerable uncertainties and different data availability between countries can generate difficulties in the interpretation of comparisons. Additionally, not all sources of uncertainty could be routinely captured in either the epidemiological or cause-of-death modelling processes. It is important to note that both disability and mortality rates of mental disorders will have been underestimated as self-harm and interpersonal and sexual violence were excluded from the analysis (due to GBD 2019 grouping these

within injures group). In addition, mental disorders and self-harm are often underdiagnosed or misdiagnosed, among other reasons, due to implicit stigma affecting both patients and clinicians. Reporting bias might be relevant as well in stigmatised disorders such as mental disorders and substance use disorders. Finally, although we used SDI to describe socioeconomic differences among countries, other indicators might be more relevant for adolescents, and further disaggregation, such as ethnicity, could provide additional information.

Despite two decades of attention to adolescent-friendly health services that consider the context of adolescent's biological and social development,³⁶ these data on NCDs are consistent with concerns that the quality of health care currently provided to adolescents in the EU is less than optimal.¹⁸ Addressing NCDs in adolescents is complex, as adolescence is a period in which both NCDs begin and many NCD risk behaviours start, with the related burden of diseases becoming visible only in adulthood, as it is estimated that about 70% of premature deaths occurring during adulthood result from health-related behaviours initiated in childhood and adolescence.⁶ Although various plans and strategies are in place at the regional level (ie, the EU level), with some evidence of national plans, the high disability burden due to adolescent NCDs indicates inadequate implementation of key policies and severe underfunding in many countries. NCDs in adolescents have been largely ignored in global targets for the UN Sustainable Development Goals (SDGs).³⁷ Yet responses are urgently needed as these data on adolescents in 2019 will be reflected in national adult targets for NCDs within the 2030 UN SDGs.

Contributors

BA, DB, LM, and SS conceptualised the study. BA drafted the manuscript. BA and LM had access to and verified the data. BA provided the analysis, DB, LM, and SS helped in the interpretation of results. MP and SH contributed to the overall generation of GBD estimates. SS, FB, GS, GC, LR, MP, SH, and PP contributed to reviewing and finalising the manuscript. BA, DB, and LM had final responsibility for the decision to submit for publication. All other authors provided data, developed models, reviewed results, provided guidance on methods, or reviewed and contributed to the manuscript. All authors approved the final version of the manuscript (appendix pp 45–46).

GBD 2019 Europe NCDs in Adolescents Collaborators

Benedetta Armocida, Lorenzo Monasta, Susan M Sawyer, Flavia Bustreo, Giulia Segafredo, Giulio Castelpietra, Luca Ronfani, Maja Pasovic, Simon I Hay, Derrick Bary Abila, Hassan Abolhassani, Manfred Mario Kokou Accrombessi, Victor Adekanmbi, Keivan Ahmadi, Hanadi Al Hamad, Mamoon A Aldeyab, Adel Al-Jumaili, Robert Ancuceanu, Catalina Liliana Andrei, Tudorel Andrei, Ashokan Arumugam, Sameh Attia, Avinash Aujayeb, Marcel Ausloos, Jennifer L Baker, Francesco Barone-Adesi, Fabio Barra, Sandra Barteit, Sanjay Basu, Bernhard T Baune, Yannick Béjot, Luis Belo, Derrick A Bennett, Boris Bikbov, Andras Bikov, Oleg Blyuss, Susanne Breitner, Hermann Brenner, Giulia Carreras, Márcia Carvalho, Alberico L Catapano, Joht Singh Chandan, Periklis Charalampous, Simiao Chen, Joao Conde, Natália Cruz-Martins, Giovanni Damiani, Anna Dastiridou, Alejandro de la Torre-Luque, Mostafa Dianatinasab, Diana Dias da Silva, Abdel Douiri, Elena Dragioti, Luchuo Engelbert Bain, Adeniyi Francis Fagbamigbe, Seyed-Mohammad Fereshtehnejad, Pietro Ferrara,

José Miguel P Ferreira de Oliveira, Simone Ferrero, Lorenzo Ferro Desideri, Florian Fischer, Diogo A Fonseca, Piyada Gaewkhiew, Santosh Gaihre, Silvano Gallus, Mariana Gaspar Fonseca, Paramjit Singh Gill, James C Glasbey, Giuseppe Gorini, Vijai Kumar Gupta, Mekdes Kondale Gurara, Josep Maria Haro, M Tasdik Hasan, Rasmus J Havmoeller, Behzad Heibati, Merel E Hellemons, Claudiu Herteliu, Salman Hussain, Gaetano Isola, Olatunji Johnson, Jost B Jonas, Jacek Jerzy Jozwiak, Mikko Jürisson, Zubair Kabir, André Karch, Joonas H Kauppila, Gbenga A Kayode, Moien AB Khan, Khaled Khatib, Mika Kivimäki, Miloslav Klugar, Jitka Klugarová, Kamrun Nahar Koly, Ai Koyanagi, Om P Kurmi, Dian Kusuma, Carlo La Vecchia, Ben Lacey, Tea Lallukka, Demetris Lamnisos, Berthold Langguth, Anders O Larsson, Paolo Lauriola, Paul H Lee, Matilde Leonardi, An Li, Christine Linehan, Rubén López-Bueno, Stefan Lorkowski, Joana A Loureiro, Raimundas Lunevicius, Laura A Magee, Francesca Giulia Magnani, Azeem Majeed, Konstantinos Christos Makris, Alexander G Mathioudakis, Manu Raj Mathur, John J McGrath, Ritesh G Menezes, Alexios-Fotios A Mentis, Atte Meretoja, Tomislav Mestrovic, Junmei Miao Jonasson, Tomasz Miazgowski, Andreea Mirica, Marcello Moccia, Shafiu Mohammed, Mariam Molokhia, Stefania Mondello, Ulrich Otto Mueller, Francesk Multa, Daniel Munblit, Ionut Negoii, Ruxandra Irina Negoii, Evangelia Nena, Nurulamin N Moor, Christoph Nowak, George Ntaios, Vincent Ebuka Nwatah, Bogdan Oancea, Ayodipupo Sikiru Oguntade, Alberto Ortiz, Adrian Otoiu, Alicia Padron-Monedero, Raffaele Palladino, Adrian Pana, Demosthenes Panagiotakos, Songhomitra Panda-Jonas, Shahina Pardhan, Jay Patel, Paolo Pedersini, José L Peñalvo, Umberto Pensato, Renato B Pereira, Norberto Perico, Ionela-Roxana Petcu, Suzanne Polinder, Maarten J Postma, Mohammad Rabiee, Navid Rabiee, Alberto Raggi, Shadi Rahimzadeh, David Laith Rawaf, Salman Rawaf, Faizan Ur Rehman, Giuseppe Remuzzi, Abanoub Riad, Alina Rodriguez, Simona Sacco, Mohammad Reza Saeb, Mahdi Safdarian, Brijesh Sathian, Davide Sattin, Sonia Saxena, Nikolaos Scarmeas, Winfried Schlee, Falk Schwendicke, Morteza Shamsizadeh, Nigusie Tadesse Sharew, Rahman Shiri, Siddharudha Shivalli, Velizar Shivarov, João Pedro Silva, Colin R Simpson, Soren T Skou, Bogdan Socea, Ireneous N Soyiri, Paschalis Steiropoulos, Kurt Straif, Xiaohui Sun, Rafael Tabarés-Seisdedos, Arulmani Thiagarajan, Fotis Topouzis, Marcos Roberto Tovani-Palone, Thomas Clement Truelsen, Brigid Unim, Jef Van den Eynde, Tommi Juhani Vasankari, Massimiliano Veroux, Santos Villafaina, Matej Vinko, Francesco S Violante, Victor Volovici, Yanzhong Wang, Ronny Westerman, Mohammad Esmaeil Yadegarfar, Sanni Yaya, Vesna Zadnik, Alimuddin Zumla, Pablo Perel, and David Beran.

Affiliations

Division of Tropical and Humanitarian Medicine (B Armocida MD), University of Geneva, Geneva, Switzerland; Clinical Epidemiology and Public Health Research Unit (B Armocida MD, L Monasta DSc, L Ronfani PhD), Burlo Garofolo Institute for Maternal and Child Health, Trieste, Italy; Department of Paediatrics (Prof S M Sawyer MD), University of Melbourne, Parkville, VIC, Australia; Centre for Adolescent Health (Prof S M Sawyer MD), Murdoch Children's Research Institute, Parkville, VIC, Australia; Fondation Botnar, Basel, Switzerland (F Bustreo MD); Governance and Ethics Committee (F Bustreo MD), Partnership for Maternal Newborn and Child Health (PMNCH), Geneva, Switzerland; Policy Department (G Segafredo PhD), Medicines Patent Pool, Geneva, Switzerland; Outpatient and Inpatient Care Service, (G Castelpetra PhD), Central Health Directorate, Friuli Venezia Giulia Region, Trieste, Italy; Institute for Health Metrics and Evaluation (M Pasovic MEd, Prof S I Hay FMedSci), Department of Health Metrics Sciences, School of Medicine (Prof S I Hay FMedSci), University of Washington, Seattle, WA, USA; Division of Tropical and Humanitarian Medicine (D Beran PhD), University of Geneva and Geneva University Hospitals, Geneva, Switzerland; Department of Pathology (D B Abila BSc), Makerere University, Kampala, Uganda; Faculty of Biology, Medicine, and Health (D B Abila BSc), Division of Infection, Immunity and Respiratory Medicine (A Bikov PhD), A G Mathioudakis MD), Department of Mathematics (O Johnson PhD), University of Manchester, Manchester, UK; Research Center for

Immunodeficiencies (H Abolhassani PhD), Tehran University of Medical Sciences, Tehran, Iran; Department of Biosciences and Nutrition (H Abolhassani PhD), Karolinska University Hospital, Huddinge, Sweden; Department of Disease Control (M M K Accrombessi PhD), Center for Global Mental Health (K N Koly MSc), Medical Statistics Department (S Shivalli MD), Department of Non-communicable Disease Epidemiology (Prof P Perel PhD), London School of Hygiene & Tropical Medicine, London, UK; Department of Clinical Research (M M K Accrombessi PhD), Clinical Research Institute of Benin, Abomey-Calavi, Benin; Department of Population Medicine (V Adekanmbi PhD), Cardiff University, Cardiff, UK; Lincoln Medical School (K Ahmadi PhD), Universities of Nottingham & Lincoln, Lincoln, UK; Geriatric and Long Term Care Department (H Al Hamad MD, B Sathian PhD), Rumailah Hospital (H Al Hamad MD), Hamad Medical Corporation, Doha, Qatar; Department of Pharmacy (M A Aldeyab PhD), University of Huddersfield, Huddersfield, UK; School of Computing, Mathematics and Engineering (Prof A Al-Jumaily PhD), Charles Sturt University, Waga Waga, NSW, Australia; Information and Communication Sciences and Technologies Pole, Mathematics, Algorithms and Decision Team (Prof A Al-Jumaily PhD), ENSTA Bretagne, Brest, France; Pharmacy Department (Prof R Ancuceanu PhD), Cardiology Department (C Andrei PhD), Department of General Surgery (I Negoii PhD, B Socea PhD), Department of Anatomy and Embryology (R I Negoii PhD), Carol Davila University of Medicine and Pharmacy, Bucharest, Romania; Department of Statistics and Econometrics (Prof T Andrei PhD, Prof M Ausloos PhD, Prof C Herteliu PhD, A Mirica PhD, A Otoiu PhD, A Pana MD, I Petcu PhD), Bucharest University of Economic Studies, Bucharest, Romania; Department of Physiotherapy (A Arumugam PhD), University of Sharjah, Sharjah, United Arab Emirates; Department of Community Medicine and Rehabilitation (A Arumugam PhD), Umeå University, Umeå, Sweden; Oral and Maxillofacial Surgery (S Attia MSc), Justus Liebig University of Giessen, Giessen, Germany; Northumbria HealthCare NHS Foundation Trust (A Aujaieb MBBS), National Health Service (NHS) Scotland, Newcastle upon Tyne, UK; School of Business (Prof M Ausloos PhD), Department of Health Sciences (P H Lee PhD), University of Leicester, Leicester, UK; Center for Clinical Research and Prevention (J L Baker PhD), Bispebjerg University Hospital, Frederiksberg, Denmark; Department of Translational Medicine (F Barone-Adesi PhD), University of Eastern Piedmont, Novara, Italy; Academic Unit of Obstetrics and Gynecology (F Barra MD), Department of Neurosciences, Rehabilitation, Ophthalmology, Genetics, Maternal and Child Health (DINOGLI) (Prof S Ferrero PhD), University Eye Clinic (L Ferro Desideri MD), University of Genoa, Genoa, Italy; Heidelberg Institute of Global Health (S Barteit PhD), Heidelberg University Hospital, Heidelberg, Germany; Center for Primary Care (S Basu PhD), Harvard University, Boston, MA, USA; School of Public Health (S Basu PhD, Prof S Saxena MD), Imperial College Business School (D Kusuma DSc), Department of Primary Care and Public Health (Prof A Majeed MD, R Palladino MD, Prof S Rawaf MD), National Heart & Lung Institute (Prof D Munblit PhD), WHO Collaborating Centre for Public Health Education and Training (D L Rawaf MD), Department of Epidemiology and Biostatistics (Prof A Rodriguez PhD), Imperial College London, London, UK; Department of Psychiatry (Prof B T Baune PhD), Institute for Epidemiology and Social Medicine (A Karch MD), University of Münster, Münster, Germany; Department of Psychiatry (Prof B T Baune PhD), Melbourne Medical School, Melbourne, VIC, Australia; Department of Neurology (Prof Y Béjot PhD), University Hospital of Dijon, Dijon, France; Dijon Stroke Registry - UFR Sciences Santé (Prof Y Béjot PhD), University of Burgundy, Dijon, France; Biological Sciences Department (L Belo PhD), Research Unit on Applied Molecular Biosciences (UCIBIO) (L Belo PhD, M Carvalho PhD, J P Silva PhD), Department of Medicine (Prof N Cruz-Martins PhD), Laboratory of Toxicology (Prof D Dias da Silva PhD), Associated Laboratory for Green Chemistry (LAQV) (J P Ferreira de Oliveira PhD), Laboratory for Process Engineering, Environment, Biotechnology and Energy (LEPABE) (J Loureiro PhD), Department of Chemistry (R B Pereira PhD), University of Porto, Porto, Portugal; Nuffield Department of Population Health (D A Bennett PhD, B Lacey PhD), The George Institute for Global Health (Prof S Yaya PhD), University of Oxford, Oxford, UK; Mario Negri Institute for Pharmacological Research,

Ranica, Italy (B Bikbov MD); Department of Pulmonology (A Bikov PhD), Semmelweis University, Budapest, Hungary; Wolfson Institute of Population Health (O Blyuss PhD, Prof A Rodriguez PhD), Queen Mary University of London, London, UK; Department of Pediatrics and Pediatric Infectious Diseases (O Blyuss PhD), Department of Paediatrics and Paediatric Infectious Diseases (Prof D Munblit PhD), I.M. Sechenov First Moscow State Medical University, Moscow, Russia; Institute for Medical Information Processing, Biometry, and Epidemiology (S Breitner DSc), Ludwig Maximilian University of Munich, Munich, Germany; Institute of Epidemiology (S Breitner DSc), German Research Center for Environmental Health, Neuherberg, Germany; Division of Clinical Epidemiology and Aging Research (Prof H Brenner MD), German Cancer Research Center, Heidelberg, Germany; Oncological Network, Prevention and Research Institute (G Gorini MD), Institute for Cancer Research, Prevention and Clinical Network, Florence, Italy (G Carreras PhD); Faculty of Health Sciences (M Carvalho PhD), University Fernando Pessoa, Porto, Portugal; Department of Pharmacological and Biomolecular Sciences (Prof A L Catapano PhD), IRCCS Istituto Ortopedico Galeazzi (Galeazzi Orthopedic Institute IRCCS) (G Damiani MD), Department of Clinical Sciences and Community Health (Prof C La Vecchia MD), University of Milan, Milan, Italy; MultiMedica (Prof A L Catapano PhD), IRCCS, Sesto San Giovanni, Italy; Institute of Applied Health Research (J S Chandan MFPH), NIHR Global Health Research Unit on Global Surgery (J C Glasbey MSc), University of Birmingham, Birmingham, UK; Public Health Epidemiology (P Charalampous MSc), Department of Pulmonary Medicine (M E Hellemons PhD), Department of Public Health (S Polinder PhD), Department of Neurosurgery (V Volovici PhD), Erasmus University Medical Center, Rotterdam, Netherlands; Heidelberg Institute of Global Health (HIGH) (S Chen DSc), Heidelberg University, Heidelberg, Germany; Nova Medical School (J Conde PhD), Nova University of Lisbon, Lisbon, Portugal; Department of Health Sciences (Prof N Cruz-Martins PhD), Institute of Research and Advanced Training in Health Sciences and Technologies (CESPU), Famacão, Portugal; Department of Dermatology (G Damiani MD), Case Western Reserve University, Cleveland, OH, USA; 2nd University Ophthalmology Department (A Dastiridou MD), 1st Department of Ophthalmology (Prof F Topouzis PhD), Aristotle University of Thessaloniki, Thessaloniki, Greece; Ophthalmology Department (A Dastiridou MD), Medical School (F Multa MD), Department of Internal Medicine (G Ntaios PhD), University of Thessaly, Larissa, Greece; Department of Legal Medicine, Psychiatry and Pathology (A de la Torre-Luque PhD), Complutense University of Madrid (Universidad Complutense de Madrid), Madrid, Spain; Department of Epidemiology (M Dianatinasab MSc), Maastricht University, Maastricht, Netherlands; Department of Epidemiology (M Dianatinasab MSc), Shiraz University of Medical Sciences, Shiraz, Iran; School of Population Health and Environmental Sciences (A Douiri PhD, X Sun MPH, Y Wang PhD), Population and Patient Health Group (P Gaewkhiew PhD), Department of Women and Children's Health (Prof L A Magee MD), Faculty of Life Sciences and Medicine (M Molokhia PhD), School of Population Health & Environmental Sciences (M E Yadegarfar PhD), King's College London, London, UK; Pain and Rehabilitation Centre (E Dragioti PhD), Department of Health, Medicine and Caring Sciences (E Dragioti PhD), Linköping University, Linköping, Sweden; Lincoln International Institute for Rural Health (L Engelbert Bain PhD), University of Lincoln, Lincoln, UK; Epidemiology and Medical Statistics (A F Fagbamigbe PhD), University of Ibadan, Ibadan, Nigeria; Population and Behavioural Sciences (A F Fagbamigbe PhD), University of St Andrews, St Andrews, UK; Department of Neurobiology (S Fereshtehnejad PhD), Department of Molecular Medicine and Surgery (J H Kauppila MD), Karolinska Institute, Stockholm, Sweden; Division of Neurology (S Fereshtehnejad PhD), School of International Development and Global Studies (Prof S Yaya PhD), University of Ottawa, Ottawa, ON, Canada; Research Center on Public Health (P Ferrara MD), University of Milan Bicocca, Monza, Italy; Institute of Public Health (F Fischer PhD), Charité Medical University Berlin (Charité Universitätsmedizin Berlin), Berlin, Germany; Faculty of Pharmacy (D A Fonseca PhD), Centre for Innovative Biomedicine and Biotechnology (CIBB) (D A Fonseca PhD), University of Coimbra, Coimbra, Portugal; Department of Community Dentistry (P Gaewkhiew PhD), Mahidol University, Ratchathewi, Thailand; Nutrition Innovation Centre for Food and Health (NICHE) (S Gaihre PhD), Ulster University, Coleraine, UK; Department of Environmental Health Sciences (S Gallus DSc), Mario Negri Institute for Pharmacological Research, Milan, Italy; National Health Service, London, UK (M Gaspar Fonseca PhD); Warwick Medical School (Prof P S Gill DM), University of Warwick, Coventry, UK; Center for Safe and Improved Food (V Gupta PhD), Biorefining and Advanced Materials Research Center (V Gupta PhD), Scotland's Rural College, Edinburgh, UK; School of Public Health (M K Gurara MPH), Arba Minch University, Arba Minch, Ethiopia; Faculty of Social Sciences (M K Gurara MPH), Department of Cardiovascular Sciences (J Van den Eynde BSc), Katholieke Universiteit Leuven, Leuven, Belgium; Research Unit (J M Haro MD), University of Barcelona, Barcelona, Spain; Biomedical Research Networking Center for Mental Health Network (CiberSAM), Barcelona, Spain (J M Haro MD); Department of Primary Care and Mental Health (M Hasan MSc), Department of Surgery (Prof R Lunevicius DSc), Institute of Population Health Sciences (M R Mathur PhD), Department of International Public Health (V E Nwatah MD), University of Liverpool, Liverpool, UK; Skaane University Hospital (R J Havmoeller PhD), Skaane County Council, Malmö, Sweden; Center for Environmental and Respiratory Health Research (B Heibati PhD), Surgery Research Unit (J H Kauppila MD), University of Oulu, Oulu, Finland; School of Business (Prof C Herteliu PhD), London South Bank University, London, UK; Czech National Centre for Evidence-Based Healthcare and Knowledge Translation (S Hussain PhD, M Klugar PhD, J Klugarová PhD, A Riad DDS), Department of Public Health (A Riad DDS), Masaryk University, Brno, Czech Republic; Department of General Surgery and Surgical-Medical Specialties (Prof G Isola PhD), Department of Medical and Surgical Sciences and Advanced Technologies (Prof M Veroux PhD), University of Catania, Catania, Italy; Institute of Molecular and Clinical Ophthalmology Basel, Switzerland, Basel, Switzerland (Prof J B Jonas MD); Department of Ophthalmology (Prof J B Jonas MD), Heidelberg University, Mannheim, Germany; Department of Family Medicine and Public Health (J J Jozwiak PhD), University of Opole, Opole, Poland; Institute of Family Medicine and Public Health (M Jürissin PhD), University of Tartu, Tartu, Estonia; School of Public Health (Z Kabir PhD), University College Cork, Cork, Ireland; International Research Center of Excellence (G A Kayode PhD), Institute of Human Virology Nigeria, Abuja, Nigeria; Julius Centre for Health Sciences and Primary Care (G A Kayode PhD), Utrecht University, Utrecht, Netherlands; Family Medicine Department (M A Khan MSc), United Arab Emirates University, Al Ain, United Arab Emirates; Primary Care Department (M A Khan MSc), NHS North West London, London, UK; Faculty of Health and Wellbeing (K Khatab PhD), Sheffield Hallam University, Sheffield, UK; College of Arts and Sciences (K Khatab PhD), Ohio University, Zanesville, OH, USA; Department of Epidemiology and Public Health (Prof M Kivimäki PhD), Medical Research Council Clinical Trials Unit (N M Noor MRCPU), Institute of Cardiovascular Science (A S Oguntade MSc), Department of Infection (Prof A Zumla PhD), University College London, London, UK; Department of Public Health (Prof M Kivimäki PhD, Prof T Lallukka PhD), University of Helsinki, Helsinki, Finland; Institute for Health Information and Statistics of the Czech Republic, Prague, Czech Republic (M Klugar PhD); Faculty of Health and Medical Sciences (J Klugarová PhD), University of Adelaide, Adelaide, SA, Australia; Health System and Population Studies Divisions (K N Koly MSc), International Centre for Diarrhoeal Disease Research, Bangladesh, Dhaka, Bangladesh; Biomedical Research Networking Center for Mental Health Network (CIBERSAM) (A Koyanagi MD), San Juan de Dios Sanitary Park, Sant Boi de Llobregat, Spain; Catalan Institution for Research and Advanced Studies (ICREA), Barcelona, Spain (A Koyanagi MD); Faculty of Health and Life Sciences (O P Kurmi PhD), Coventry University, Coventry, UK; Department of Medicine (O P Kurmi PhD), McMaster University, Hamilton, ON, Canada; Faculty of Public Health (D Kusuma DSc), University of Indonesia, Depok, Indonesia; National Institute for Health Research (NIHR) Oxford Biomedical Research Centre, Oxford, UK (B Lacey PhD); Department of Health Sciences (D Lamnisos PhD), European University Cyprus, Nicosia, Cyprus; Department of Psychiatry and Psychotherapy (B Langguth PhD), Psychiatry and Psychotherapy (W Schlee PhD), University of Regensburg, Regensburg, Germany; Department of

Medical Sciences (Prof A O Larsson PhD), Uppsala University, Uppsala, Sweden; Department of Clinical Chemistry and Pharmacology (Prof A O Larsson PhD), Uppsala University Hospital, Uppsala, Sweden; International Society Doctors for the Environment, Arezzo, Italy (P Lauriola MD); UO Neurologia, Salute Pubblica e Disabilità (M Leonardi MD, F G Magnani PhD, A Raggi PhD), Fondazione IRCCS Istituto Neurologico Carlo Besta (Neurology, Public Health and Disability Unit, Carlo Besta Neurological Institute), Milan, Italy; Center for Dentistry and Oral Hygiene (A Li PhD), University Medical Center Groningen (Prof M J Postma PhD), School of Economics and Business (Prof M J Postma PhD), Interdisciplinary Centre Psychopathology and Emotion regulation (ICPE) (N T Sharew MSc), University of Groningen, Groningen, Netherlands; Stomatological Hospital (A Li PhD), Southern Medical University, Guangzhou, China; UCD Centre for Disability Studies (C Linehan PhD), University College Dublin, Dublin, Ireland; Department of Physical Medicine and Nursing (R López-Buena PhD), University of Zaragoza, Zaragoza, Spain; Department of Musculoskeletal Disorders (R López-Buena PhD), National Research Centre for the Working Environment, Copenhagen, Denmark; Institute of Nutritional Sciences (Prof S Lorkowski PhD), Friedrich Schiller University Jena, Jena, Germany; Competence Cluster for Nutrition and Cardiovascular Health (nutriCARD), Jena, Germany (Prof S Lorkowski PhD); School of Health (J Loureiro PhD), Polytechnic Institute of Porto, Portugal; Department of General Surgery (Prof R Lunevicius DSc), Liverpool University Hospitals NHS Foundation Trust, Liverpool, UK; Department of Obstetrics and Gynaecology (Prof L A Magee MD), University of British Columbia, Vancouver, BC, Canada; Cyprus International Institute for Environmental and Public Health (K C Makris PhD), Cyprus University of Technology, Limassol, Cyprus; North West Lung Centre (A G Mathioudakis MD), Manchester University NHS Foundation Trust, Manchester, UK; Health Policy Research (M R Mathur PhD), Public Health Foundation of India, Gurugram, India; Queensland Brain Institute (Prof J J McGrath MD), The University of Queensland, Brisbane, QLD, Australia; National Centre for Register-based Research (Prof J J McGrath MD), Aarhus University, Aarhus, Denmark; Forensic Medicine Division (Prof R G Menezes MD), Imam Abdulrahman Bin Faisal University, Dammam, Saudi Arabia; University Research Institute (A A Mentis MD), Department of Neurology (Prof N Scarmeas PhD), National and Kapodistrian University of Athens, Athens, Greece; Neurology Unit (A Meretoja MD), Helsinki University Hospital, Helsinki, Finland; School of Health Sciences (A Meretoja MD), University of Melbourne, Melbourne, VIC, Australia; Clinical Microbiology and Parasitology Unit (T Mestrovic PhD), Dr. Zora Profozic Polyclinic, Zagreb, Croatia; University Centre Varazdin (T Mestrovic PhD), University North, Varazdin, Croatia; School of Public Health and Community Medicine (J Miao Jonasson PhD), University of Gothenburg, Gothenburg, Sweden; Department of Propedeutics of Internal Diseases & Arterial Hypertension (Prof T Miazgowski MD), Pomeranian Medical University, Szczecin, Poland; Department of Neurosciences (M Moccia PhD), Federico II University, Naples, Italy; Health Systems and Policy Research Unit (S Mohammed PhD), Ahmadu Bello University, Zaria, Nigeria; Department of Health Care Management (S Mohammed PhD), Technical University of Berlin, Berlin, Germany; Department of Biomedical and Dental Sciences and Morphofunctional Imaging (Prof S Mondello MD), Messina University, Messina, Italy; Competence Center of Mortality-Follow-Up of the German National Cohort (R Westerman DSc), Federal Institute for Population Research, Wiesbaden, Germany (Prof U O Mueller MD); Center for Population and Health, Wiesbaden, Germany (Prof U O Mueller MD); Department of Surgery (F Mulita MD), General University Hospital of Patras, Patras, Greece; Department of General Surgery (I Negroi PhD), Emergency Hospital of Bucharest, Bucharest, Romania; Cardio-Aid, Bucharest, Romania (R I Negroi PhD); Department of Medicine (E Nena MD, P Steiropoulos MD), Democritus University of Thrace, Alexandroupolis, Greece; Department of Gastroenterology (N M Noor MRCP), Cambridge University Hospitals, Cambridge, UK; Department of Neurobiology, Care Sciences and Society (C Nowak PhD), Karolinska Institute, Huddinge, Sweden; Department of Pediatrics (V E Nwatah MD), National Hospital, Abuja, Nigeria; Administrative and Economic Sciences Department (Prof B Oancea PhD), University of Bucharest, Bucharest, Romania; Department of Medicine (A S Oguntade MSc), University College Hospital, Ibadan, Ibadan, Nigeria; Department of Medicine (Prof A Ortiz MD), Autonomous University of Madrid, Madrid, Spain; Department of Nephrology and Hypertension (Prof A Ortiz MD), The Institute for Health Research Foundation Jiménez Díaz University Hospital, Madrid, Spain; National School of Public Health (A Padron-Monedero PhD), Institute of Health Carlos III, Madrid, Spain; Department of Public Health (R Palladino MD), University of Naples Federico II, Naples, Italy; Department of Health Metrics (A Pana MD), Center for Health Outcomes & Evaluation, Bucharest, Romania; Nutrition - Dietetics (Prof D Panagiotakos PhD), Athens, Greece; Board of Directors (Prof D Panagiotakos PhD), National Public Health Organization, Athens, Greece; Privatpraxis, Heidelberg, Germany (S Panda-Jonas MD); Vision and Eye Research Institute (Prof S Pardhan PhD), Anglia Ruskin University, Cambridge, UK; Global Health Governance Programme (J Patel), Usher Institute (Prof C R Simpson PhD), University of Edinburgh, Edinburgh, UK; School of Dentistry (J Patel), University of Leeds, Leeds, UK; Clinical Research Department (P Pedersini MSc), IRCCS Fondazione Don Carlo Gnocchi, Milan, Italy; Department of Public Health (Prof J L Peñalvo PhD), Institute of Tropical Medicine, Antwerp, Belgium; Friedman School of Nutrition Science and Policy (Prof J L Peñalvo PhD), Tufts University, Boston, MA, USA; Department of Biomedical and Neuromotor sciences (U Pensato MD), Department of Medical and Surgical Sciences (Prof F S Violante MD), University of Bologna, Bologna, Italy; Mario Negri Institute for Pharmacological Research, Bergamo, Italy (N Perico MD, Prof G Remuzzi MD); Biomedical Engineering Department (Prof M Rabiee PhD), AmirKabir University of Technology, Tehran, Iran; Department of Physics (N Rabiee PhD), Sharif University of Technology, Tehran, Iran; Department of Natural Science (S Rahimzadeh MSc), Middlesex University, London, UK; NIHR-Biomedical Research Centre (NIHR-BRC) (Prof A Zumla PhD), University College London Hospitals, London, UK (D L Rawaf MD); Academic Public Health England (Prof S Rawaf MD), Public Health England, London, UK; Grenoble Computer Science Laboratory (LIG) (F Rehman PhD), University of Grenoble Alpes, Grenoble, France; Institute of Center and Research Studies (F Rehman PhD), Umm Al-Qura University, Makkah, Saudi Arabia; Department of Neurology (Prof S Sacco MD), University of L'Aquila, L'Aquila, Italy; Department of Polymer Technology (Prof M R Saeb PhD), Independent Consultant, Gdansk, Poland; Department of Neurology (M Safdarian MD), Christian-Doppler University Hospital, Salzburg, Austria; Spinal Cord Injury and Tissue Regeneration Center Salzburg (SCI-TRECS) (M Safdarian MD), Paracelsus Medical University, Salzburg, Austria; Faculty of Health & Social Sciences (B Sathian PhD), Bournemouth University, Bournemouth, UK; IRCCS Istituti Clinici Scientifici Maugeri (IRCCS Maugeri Scientific Clinical Institute), Milan, Italy (D Sattin PsyD); Department of Neurology (Prof N Scarmeas PhD), Columbia University, New York, NY, USA; Oral Diagnosis, Digital Health and Health Services Research (Prof F Schwendicke PhD), Charité University Medical Center Berlin, Berlin, Germany; Faculty of Caring Science, Work Life, and Social Welfare (M Shamsizadeh MSc), University of Borås, Borås, Sweden; Department of Nursing (N T Sharew MSc), Debre Berhan University, Debre Berhan, Ethiopia; Finnish Institute of Occupational Health, Helsinki, Finland (R Shiri PhD); Clinical Immunology and Hematology (V Shivarov PhD), Sofamed University Hospital, Sofia, Bulgaria; Department of Genetics (V Shivarov PhD), Sofia University "St. Kliment Ohridski", Sofia, Bulgaria; School of Health (Prof C R Simpson PhD), Victoria University of Wellington, Wellington, New Zealand; Department of Sports Science and Clinical Biomechanics (Prof S T Skou PhD), University of Southern Denmark, Odense, Denmark; Department of Physiotherapy and Occupational Therapy (Prof S T Skou PhD), Næstved-Slagelse-Ringsted Hospitals, Slagelse, Denmark; Department of Surgery (B Socea PhD), Sf Pantelimon Emergency Clinical Hospital Bucharest, Bucharest, Romania; Hull York Medical School (I N Soyiri PhD), University of Hull, Hull City, UK; Schiller Institute (Prof K Straif PhD), Boston College, Boston, MA, USA; Barcelona Institute for Global Health, Barcelona, Spain (Prof K Straif PhD); Department of Medicine (Prof R Tabarés-Seisdedos PhD), University of Valencia, Valencia, Spain; Carlos III Health Institute (Prof R Tabarés-Seisdedos PhD), Biomedical Research Networking Center for Mental Health Network (CiberSAM),

Madrid, Spain; Clinical Epidemiology (A Thiyagarajan MPH), Leibniz Institute for Prevention Research and Epidemiology, Bremen, Germany; Department of Pathology and Legal Medicine (M R Tovani-Palone PhD), University of São Paulo, Ribeirão Preto, Brazil; Modestum LTD, London, UK (M R Tovani-Palone PhD); Rigshospitalet (T C Truelsen PhD), University of Copenhagen, Copenhagen, Denmark; Department of Cardiovascular, Endocrine-metabolic Diseases and Aging (B Unim PhD), National Institute of Health, Rome, Italy; UKK Institute, Tampere, Finland (Prof T J Vasankari MD); Faculty of Medicine and Health Technology (Prof T J Vasankari MD), Tampere University, Tampere, Finland; Sport Science Department (S Villafaina MSc), University of Extremadura, Cáceres, Spain; Center for Analysis and Development of Health (M Vinko MD), National Institute of Public Health of Slovenia, Ljubljana, Slovenia; Occupational Health Unit (Prof F S Violante MD), Sant'Orsola Malpighi Hospital, Bologna, Italy; Center for Experimental Microsurgery (V Volovici PhD), Iuliu Hațieganu University of Medicine and Pharmacy, Cluj-Napoca, Romania; Epidemiology and Cancer Registry Sector (Prof V Zadnik PhD), Institute of Oncology Ljubljana, Ljubljana, Slovenia.

Declaration of interests

We declare no competing interests.

Data sharing

To download the data used in these analyses, please visit the Global Health Data Exchange at <http://ghdx.healthdata.org/gbd-results-tool>.

Acknowledgments

This study was funded by the Bill & Melinda Gates Foundation.

References

- Sawyer SM, Azzopardi PS, Wickremarathne D, Patton GC. The age of adolescence. *Lancet Child Adolesc Health* 2018; 2: 223–28.
- Temmerman M, Khosla R, Bhutta ZA, Bustreo F. Towards a new Global Strategy for Women's, Children's and Adolescents' Health. *BMJ* 2015; 351: h4414.
- Boerma T, Requejo J, Victora C, et al. Countdown to 2030: tracking progress towards universal coverage for reproductive, maternal, newborn, and child health. *Lancet* 2018; 391: 1538–48.
- Ward J, Azzopardi P, Francis K, et al. Global, regional, and national mortality among young people aged 10–24 years, 1950–2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet* 2021; 398: 1593–618.
- The Lancet Child & Adolescent Health. Universal health coverage and the forgotten generation. *Lancet Child Adolesc Health* 2019; 3: 749.
- Sawyer SM, Afifi RA, Bearinger LH, et al. Adolescence: a foundation for future health. *Lancet* 2012; 379: 1630–40.
- WHO. Noncommunicable diseases. April 13, 2021. <https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases> (accessed Jan 18, 2022).
- Akseer N, Mehta S, Wigle J, et al. Non-communicable diseases among adolescents: current status, determinants, interventions and policies. *BMC Public Health* 2020; 20: 1908.
- Patton GC, Sawyer SM, Santelli JS, et al. Our future: a Lancet commission on adolescent health and wellbeing. *Lancet* 2016; 387: 2423–78.
- Council of the European Union, Representatives of the Governments of the Member States (The Member States). Resolution of the Council of the European Union and the Representatives of the Governments of the Member States meeting within the Council on a framework for European cooperation in the youth field: the European Union Youth Strategy 2019–2027. Dec 18, 2018. [https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:42018Y1218\(01\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:42018Y1218(01)) (accessed Jan 19, 2022).
- European Chronic Disease Alliance. Towards an EU Strategic Framework for the Prevention of Non-communicable Diseases (NCDs). May, 2019. <https://eas.eu/wp-content/uploads/2019/05/Final-NCD-Paper-full-version.pdf> (accessed Jan 18, 2022).
- UN. Policy brief: the impact of COVID-19 on children. April 15, 2020. https://unsdg.un.org/sites/default/files/2020-04/160420_Covid_Children_Policy_Brief.pdf (accessed Jan 18, 2022).
- Palmer K, Monaco A, Kivipelto M, et al. The potential long-term impact of the COVID-19 outbreak on patients with non-communicable diseases in Europe: consequences for healthy ageing. *Aging Clin Exp Res* 2020; 32: 1189–94.
- 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.
- Stevens GA, Alkema L, Black RE, et al. Guidelines for Accurate and Transparent Health Estimates Reporting: the GATHER statement. *PLoS Med* 2016; 13: e1002056.
- Wang H, Abbas KM, Abbasifard M, et al. 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.
- WHO. Regional Office for Europe. Growing up unequal: gender and socioeconomic differences in young people's health and well-being. 2016. <https://apps.who.int/iris/handle/10665/326320> (accessed Jan 18, 2022).
- Michaud PA, Weber MW, Namazova-Baranova L, Ambresin AE. Improving the quality of care delivered to adolescents in Europe: a time to invest. *Arch Dis Child* 2019; 104: 214–16.
- WHO, UNESCO, UNICEF, WFP, eds. Making every school a health-promoting school: implementation guidance. June 22, 2021. <https://www.who.int/publications/i/item/9789240025073> (accessed Jan 19, 2022).
- Viner RM, Ozer EM, Denny S, et al. Adolescence and the social determinants of health. *Lancet* 2012; 379: 1641–52.
- Kickbusch I, Allen L, Franz C. The commercial determinants of health. *Lancet Glob Health* 2016; 4: e895–96.
- Solmi M, Radua J, Olivola M, et al. Age at onset of mental disorders worldwide: large-scale meta-analysis of 192 epidemiological studies. *Mol Psychiatry* 2021; published online June 2. <https://doi.org/10.1038/s41380-021-01161-7>.
- Sanci L, Lewis D, Patton G. Detecting emotional disorder in young people in primary care. *Curr Opin Psychiatry* 2010; 23: 318–23.
- Kaess M, Brunner R, Parzer P, et al. Risk-behaviour screening for identifying adolescents with mental health problems in Europe. *Eur Child Adolesc Psychiatry* 2014; 23: 611–20.
- Tylee A, Haller DM, Graham T, Churchill R, Sanci LA. Youth-friendly primary-care services: how are we doing and what more needs to be done? *Lancet* 2007; 369: 1565–73.
- Kennedy E, Binder G, Humphries-Waa K, et al. Gender inequalities in health and wellbeing across the first two decades of life: an analysis of 40 low-income and middle-income countries in the Asia-Pacific region. *Lancet Glob Health* 2020; 8: e1473–88.
- Azzopardi PS, Hearps SJC, Francis KL, et al. Progress in adolescent health and wellbeing: tracking 12 headline indicators for 195 countries and territories, 1990–2016. *Lancet* 2019; 393: 1101–18.
- OECD/European Observatory on Health Systems and Policies. State of Health in the EU. Belgium: country health profile 2021. Dec 13, 2021. <https://doi.org/10.1787/57e3abb5-en> (accessed Jan 18, 2022).
- Saloustros E, Stark DP, Michailidou K, et al. The care of adolescents and young adults with cancer: results of the ESMO/SIOPE survey. *ESMO Open* 2017; 2: e000252.
- European Monitoring Centre for Drugs and Drug Addiction. Estonia, country drug report 2019. 2019. https://www.emcdda.europa.eu/system/files/publications/11337/estonia-cdr-2019_0.pdf (accessed Jan 18, 2022).
- Racine N, McArthur BA, Cooke JE, Eirich R, Zhu J, Madigan S. Global prevalence of depressive and anxiety symptoms in children and adolescents during COVID-19: a meta-analysis. *JAMA Pediatr* 2021; 175: 1142–50.
- Graetz D, Agulnik A, Ranadive R, et al. Global effect of the COVID-19 pandemic on paediatric cancer care: a cross-sectional study. *Lancet Child Adolesc Health* 2021; 5: 332–40.
- Liu J, Ren ZH, Qiang H, et al. Trends in the incidence of diabetes mellitus: results from the Global Burden of Disease Study 2017 and implications for diabetes mellitus prevention. *BMC Public Health* 2020; 20: 1415.

-
- 34 Lascar N, Brown J, Pattison H, Barnett AH, Bailey CJ, Bellary S. Type 2 diabetes in adolescents and young adults. *Lancet Diabetes Endocrinol* 2018; **6**: 69–80.
- 35 Patton G, Azzopardi P, Kennedy E, Coffey C, Mokdad A. Global measures of health risks and disease burden in adolescents. Disease control priorities, vol 8, 3rd edn. Child and adolescent health and development. Washington, DC: The International Bank for Reconstruction and Development/The World Bank, 2017: 57–72.
- 36 Ambresin AE, Bennett K, Patton GC, Sanci LA, Sawyer SM. Assessment of youth-friendly health care: a systematic review of indicators drawn from young people's perspectives. *J Adolesc Health* 2013; **52**: 670–81.
- 37 UN. Transforming our world: the 2030 Agenda for Sustainable Development. 2015. <https://sdgs.un.org/2030agenda> (accessed Jan 18, 2022).