




Global trends in incidence, death, burden and risk factors of early-onset cancer from 1990 to 2019

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To cite: Zhao J, Xu L, Sun J, *et al.* Global trends in incidence, death, burden and risk factors of early-onset cancer from 1990 to 2019. *BMJ Oncology* 2023;2:e000049. doi:10.1136/bmjonc-2023-000049

Received 14 February 2023
Accepted 18 May 2023

ABSTRACT

Objective This study aimed to explore the global burden of early-onset cancer based on the Global Burden of Disease (GBD) 2019 study for 29 cancers worldwide.

Methods and analysis Incidence, deaths, disability-adjusted life years (DALYs) and risk factors for 29 early-onset cancer groups were obtained from GBD.

Results Global incidence of early-onset cancer increased by 79.1% and the number of early-onset cancer deaths increased by 27.7% between 1990 and 2019. Early-onset breast, tracheal, bronchus and lung, stomach and colorectal cancers showed the highest mortality and DALYs in 2019. Globally, the incidence rates of early-onset nasopharyngeal and prostate cancer showed the fastest increasing trend, whereas early-onset liver cancer showed the sharpest decrease. Early-onset colorectal cancers had high DALYs within the top five ranking for both men and women. High-middle and middle Sociodemographic Index (SDI) regions had the highest burden of early-onset cancer. The morbidity of early-onset cancer increased with the SDI, and the mortality rate decreased considerably when SDI increased from 0.7 to 1. The projections indicated that the global number of incidence and deaths of early-onset cancer would increase by 31% and 21% in 2030, respectively. Dietary risk factors (diet high in red meat, low in fruits, high in sodium and low in milk, etc), alcohol consumption and tobacco use are the main risk factors underlying early-onset cancers.

Conclusion Early-onset cancer morbidity continues to increase worldwide with notable variances in mortality and DALYs between areas, countries, sex and cancer types. Encouraging a healthy lifestyle could reduce early-onset cancer disease burden.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Previous studies have suggested that the incidence of cancers of various organs diagnosed in adults <50 years of age has been rising in many parts of the world since the 1990s. The global disease burden and secular trend of early onset cancers, and the variations in different socioeconomic categories, have not been described. The pattern of attributable risk factors for burdensome early onset cancers has not been investigated.

WHAT THIS STUDY ADDS

⇒ Since 1990, the incidence and deaths of early onset cancers have substantially increased globally. Early-onset breast, tracheal, bronchus and lung, stomach and colorectal cancers showed the highest mortality and burden in 2019. Countries with a high-middle and middle Sociodemographic Index and individuals aged 40–49 years were particularly affected. Dietary risk factors (diet high in red meat, low in fruits, high in sodium and low in milk, etc), alcohol consumption and tobacco use are the main risk factors underlying early-onset cancers.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ This study suggests that it is necessary to conduct prospective life-course cohort studies to explore the aetiologies of early-onset cancers, and each country should adjust their prevention strategies based on the characteristics of early-onset cancer. Meanwhile, encouraging a healthy lifestyle could reduce early-onset cancer disease burden.

INTRODUCTION

Globally, cancer is a significant cause of morbidity and mortality, resulting in a large disease burden.¹ According to Global Cancer Statistics 2020, breast cancer with the largest number of 2.3 million new cases accounted for 11.7% of all cancers, followed by lung cancer (11.4%), colorectal cancer (CRC) (10.0%), while lung cancer was the main cause of cancer death (1.8 million deaths,

18%), followed by CRC (9.4%), liver (8.3%) cancer.¹ Cancer is generally more prevalent in adults over 50 years, but the incidence of early-onset cancer (<50 years) has increased worldwide.² In comparison to later-onset cancer, the increase of early-onset cancer has significant personal and societal ramifications. Moreover, early-onset cancer and the adverse impacts of some corresponding cancer treatments may result in additional



► <http://dx.doi.org/10.1136/bmjonc-2023-000106>



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health issues during subsequent life cycle,³ which would considerably increase the disease burden associated with early-onset cancers.

Currently, it was reported that the promotion of cancer screening strategies and the exposure to risk factors in early life or young adulthood may increase incidence of early-onset cancer.⁴ For example, increasing the proportion of cervical cancer screening among women aged 21–65 years was a Healthy People 2020 objective for use of cancer screening tests in the USA,⁵ and the American Cancer Society (ACS) has recommended initiating CRC screening at age 45 years instead of 50 years.⁶ For breast cancer, in countries with favourable healthcare conditions, it is recommended that women between the ages of 40 and 49 undergo a screening test for breast cancer every 1–2 years.^{7–11} Furthermore, changes in diet, lifestyle and environment since the turn of the 20th century, resulting in increased rates of obesity, physical inactivity, westernised diets and environmental pollution, may have affected the incidence of early-onset cancer.¹² Additionally, alcohol, smoking and detrimental pregnancy exposures may have also affected the incidence of early-onset cancer.^{2 13}

The majority of previous studies focused on regional and national variations in the incidence and death of all-age cancer,¹⁴ and only a small number of studies examined the worldwide epidemiology and disease burden of early-onset cancer. A systematic examination on the global epidemiology of early-onset cancer can aid in the efficient implementation of prevention, early detection, diagnosis and treatment initiatives. Thus, we conducted this study to describe the global burden of early-onset cancer based on the Global Burden of Disease (GBD) 2019 study for 29 cancers in 204 countries and regions with the aim of shedding light on early-onset global cancer prevention and control.

MATERIAL AND METHODS

Data source, definition of early-onset cancer and risk factors

We obtained the data from the GBD 2019 database (<http://ghdx.healthdata.org/gbd-2019>). The incidence, deaths, disability-adjusted life years (DALYs) and risk factor proportion were extracted directly from GBD 2019. All rates are reported per 100k population. A total of 29 early-onset cancers were ascertained from administrative data according to International Classification of Disease 9th revision (ICD-9) and 10th revision (ICD-10) codes, the ICD codes of 29 cancers are shown in online supplemental table S1. Early-onset cancer was defined as cancer cases diagnosed from 14 to 49 years.¹⁵ In total, 204 countries were divided into five-level regions based on the Sociodemographic Index (SDI). The Human Development Index (HDI) data were obtained at the national level from the World Bank. Definitions of risk factors and method for calculating the proportions of their attribution in GBD 2019 were detailedly described in online supplemental methods.

Statistical analysis

The incidence rate, death rate and estimated annual percentage change (EAPC) were used to quantify the epidemic trends of 29 early-onset cancers. The EAPC formulas were as follows:

$$y = \alpha + \beta x + \varepsilon$$

$$\text{EAPC} = 100 \times (\exp(\beta) - 1)$$

The age-standardised rate (ASR)/100k population, including age-standardised incidence rate (ASIR) and age-standardised death rate (ASDR), was estimated with the following formula:

$$\text{ASR} = \frac{\sum_{i=1}^A a_i W_i}{\sum_{i=1}^A W_i} \times 100k$$

The selected reference standard population was presented in online supplemental table S2. We explored the associations between EAPCs and HDI in 2019 using Spearman correlation analysis. Additionally, the Bayesian age-period-cohort (BAPC) model integrating nested Laplace approximations was used to project the morbidity and mortality of the disease burden attributable to early-onset cancer from 2020 to 2030.¹⁶ The BAPC model is widely used in analysing and projecting age-stratified cancer incidence and mortality rates, particularly considering the significant demographic changes taking place. The primary advantage of developing the BAPC package is to create efficient Markov chain Monte Carlo-free software specifically designed for routine utilisation in epidemiological applications. This package simplifies the implementation of the BAPC model, enabling the generation of well-calibrated probabilistic forecasts with reasonably narrow ranges of uncertainty. The formula was as follow:

$$R_{ijk} = \mu + \alpha_i \text{Age} + \beta_j \text{Period} + \gamma_k$$

To avoid over dispersion, an independent random effect, $z_{ij} \sim (0, k_z^{-1})$, was added into the model:

$$R_{ijk} = \mu + \alpha_i \text{Age} + \beta_{j+t} \text{Period} + \gamma_{k+t} \text{Cohort} + z_{ij+t}$$

Data analysis and graphics were conducted using R V.4.2.1 (Lucent Technologies, Jasmine Mountain, USA). P value < 0.05 was considered to be statistically significant. All parameters were detailedly described in the online supplemental methods.

Patient and public involvement statement

The GBD Study is a global collaborative scientific effort involving more than 7500 people from about 150 countries. We did not consider involving patients when designing the study and no patients were involved in setting the specific research question, collecting and analysing the data, interpreting the results, or writing up the manuscript. The research findings will be disseminated to the wider community by press releases, social media platforms such as WeChat, presentations at international fora, reports to relevant government agencies and academic societies.

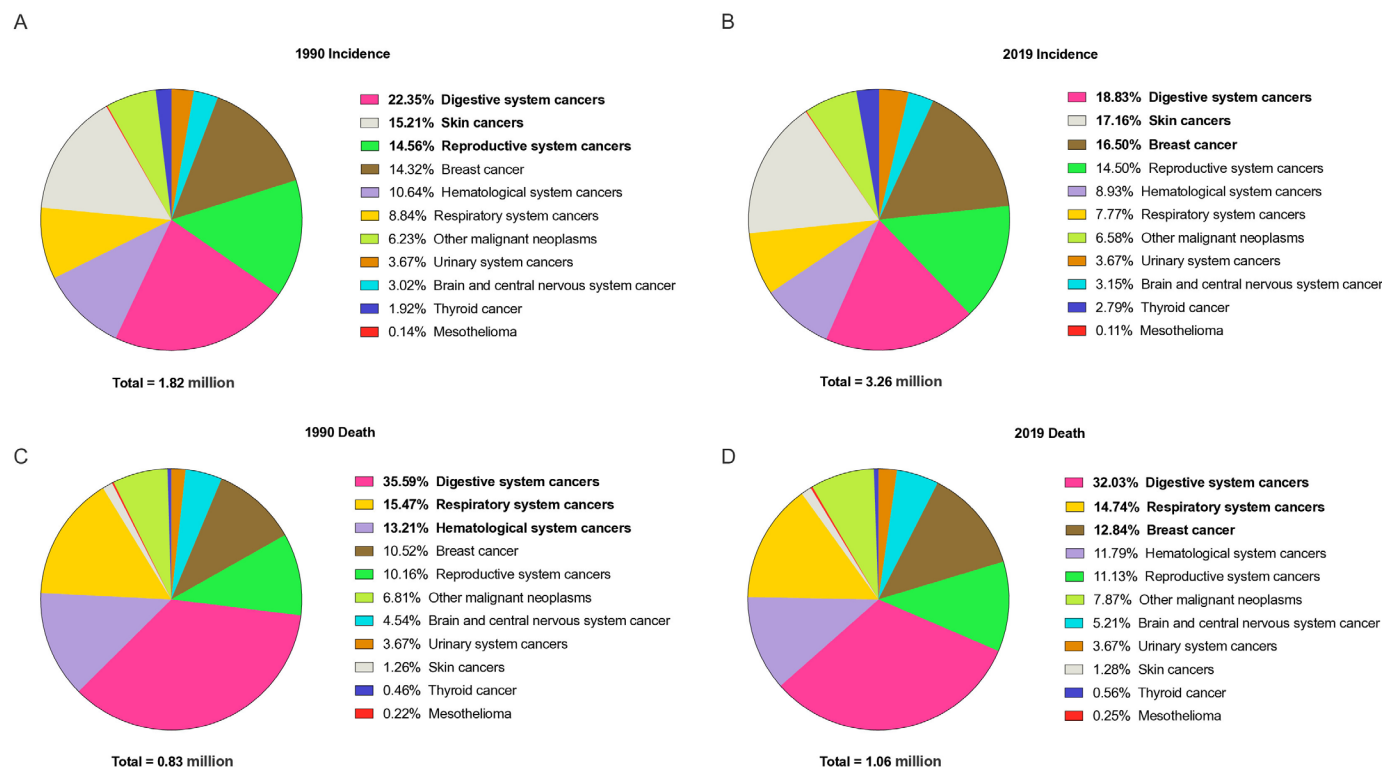


Figure 1 Distribution of cases and deaths for the early-onset cancers of different systems in 1990 and 2019. The early-onset cancer types in bold are the top three. Respiratory system cancers include larynx cancer, nasopharynx cancer, other pharynx cancer and tracheal, bronchus, and lung cancer; digestive system cancers include colon and rectum cancer, oesophageal cancer, gallbladder and biliary tract cancer, lip and oral cavity cancer, liver cancer, pancreatic cancer and stomach cancer; haematological system cancers include Hodgkin's lymphoma, leukaemia, multiple myeloma and non-Hodgkin's lymphoma; reproductive system cancers include cervical cancer, ovarian cancer, testicular cancer and uterine cancer; urinary system cancer include bladder cancer, kidney cancer and prostate cancer; skin cancers include malignant skin melanoma and non-melanoma skin cancer.

RESULTS

Trends in incidence, death and DALYs of 29 early-onset cancers from 1990 to 2019

In 2019, the incidence number of early-onset cancer was 3.26 million, a 79.1% increase from 1990 (figure 1A,B). Among them, the early-onset breast cancer had the highest incidence (13.7, 95% uncertainty interval (UI): 12.5 to 15 per 100k) and mortality (3.5, 95% CI: 3.2 to 3.8 per 100k) rates (online supplemental tables S3 and S4). Globally, the morbidity of early-onset nasopharyngeal cancer (EAPC=2.28%, 95% CI: 2.1% to 2.47%) and prostate cancer (EAPC=2.23%, 95% CI: 1.97% to 2.49%) showed the fastest increasing trends, whereas early-onset liver cancer (EAPC=-2.88%, 95% CI: -3.46% to -2.3%) showed the sharpest decline (online supplemental table S3). Besides, the number of early-onset cancer deaths in 2019 was 1.06 million, which was an increase of 27.7% from 1990 (figure 1C,D). The top four early-onset cancers with the highest mortality and DALYs rates were early-onset breast, tracheal, bronchus and lung (TBL), stomach and CRC cancers (online supplemental tables S4 and S5). The mortality of early-onset kidney cancer (EAPC=0.81%, 95% CI: 0.70% to 0.92%) and ovarian cancer (EAPC=0.59%, 95% CI: 0.49% to 0.69%) showed the fastest increasing trends, whereas

early-onset liver cancer (EAPC=-3.39%, 95% CI: -4.00% to -2.77%) showed the sharpest decline (online supplemental table S4). In 2019, early-onset breast cancer had the highest ASIR in regions with high SDI, while early-onset TBL cancer had the highest ASIR in high-middle SDI regions (online supplemental table S6). Early-onset CRC had the highest ASIR in high SDI regions, and stomach cancer had the highest ASIR in high-middle SDI regions in 2019. On the other hand, the highest ASDR for early-onset breast cancer were observed in regions with low and low-middle SDI in 2019. Early-onset TBL cancer had the highest ASDR in high-middle SDI regions in 2019, while early-onset CRC and stomach cancer had the highest ASDR in high-middle and low-middle SDI regions, respectively. As depicted in online supplemental figure S1, the morbidities, mortality and DALYs rates of early-onset breast cancer and CRC increased simultaneously from 1990 to 2019.

Early-onset cancer burden differed by sex

In 2019, the early-onset cancers with the greatest disease burden in women and men were breast cancer (348.1, 95% UI: 316.7 to 378.7 per 100k) and TBL cancer (167.6, 95% UI: 149.9 to 186.5 per 100k), respectively (figure 2). The men/women ratios of morbidity, mortality and

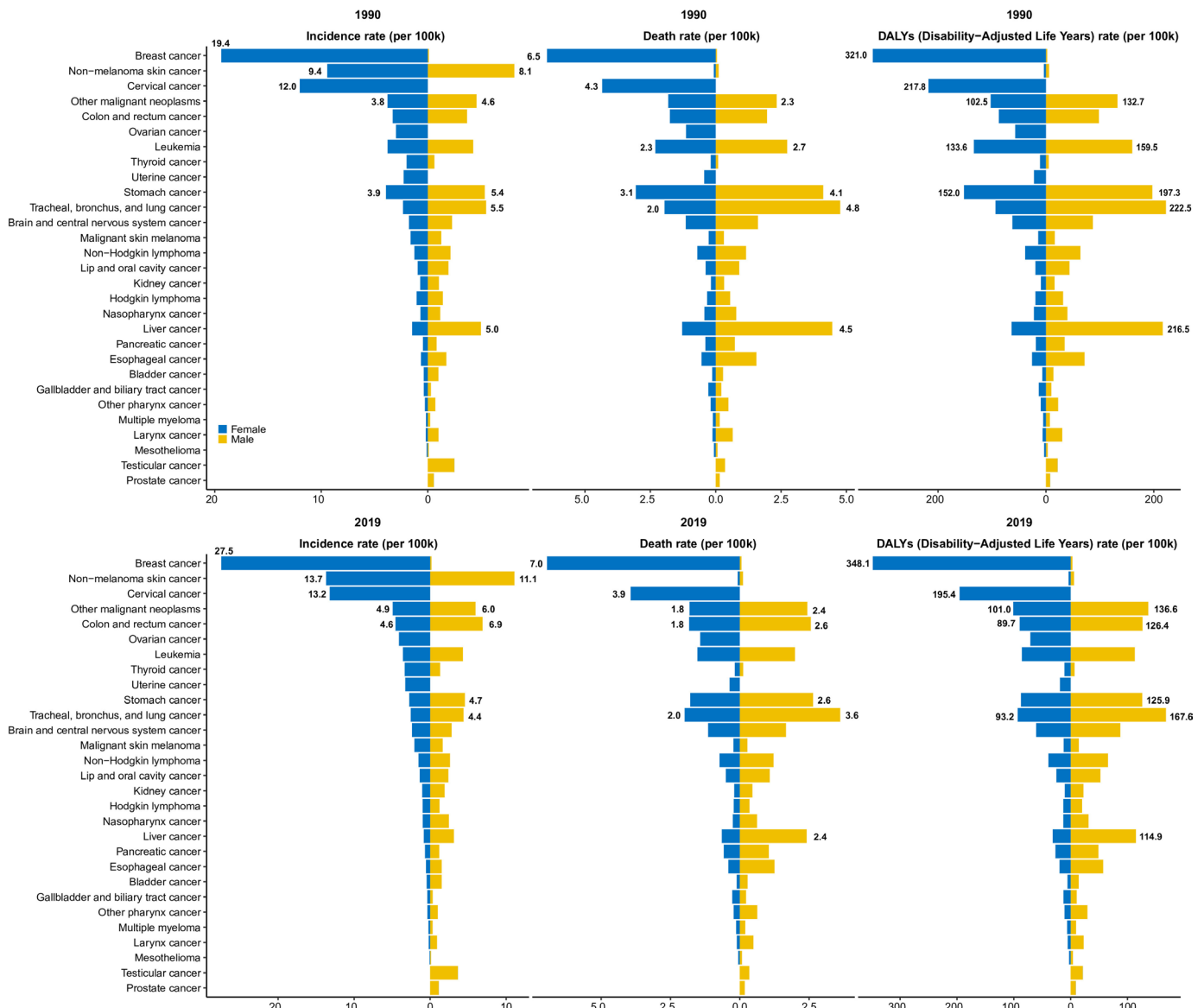


Figure 2 The global incidence, death and DALYs rates of 29 specified early-onset cancers in 1990 and 2019 by sex. DALYs, disability-adjusted life years.

DALYs below 1 meant higher burden in women, while the men/women ratios above 1 meant higher burden in men. For morbidity, the men/women ratios in five SDI regions were consistently below 1 from 1990 to 2019 and showed a downward trend (online supplemental figure S2A), which suggested that the general morbidity of early-onset cancer in men was lower than women from 1990 to 2019. And men/women ratios of mortalities and DALYs were close to 1 in high, high-middle and middle SDI regions, 2019, while were far less than 1 in low-middle and low SDI regions (online supplemental figure S2B and S2C). The results above indicated that, in low-middle and low SDI regions, early-onset cancer had a significantly higher impact on women than on men in terms of both mortality and disease burden.

Early-onset cancer burden in different world regions

In 2019, the highest ASIR of early-onset cancer were in high-income North America (273.2 per 100k), while the

lowest ASIR were in Western Sub-Saharan Africa (37.4 per 100k) (online supplemental table S7). The regions with the highest ASDR were Oceania (39.1 per 100k), Eastern Europe (33.7 per 100k) and Central Asia (31.8 per 100k), whereas the lowest were in high-income Asia Pacific (16.3 per 100k) (online supplemental table S7). Of note, East Asia's incident and death numbers of early-onset cancer were 814749 and 268709, respectively, ranking first among all regions. The greatest age-standardised DALYs rates were in Oceania (1952.6 per 100k), while the lowest were in high-income Asia Pacific (840.6 per 100k) in 2019 (online supplemental table S7).

ASIR, ASDR and age-standardised DALYs in 2019, and relative change in incident, death and DALYs cases of early-onset cancers from 1990 to 2019

Globally, the incident and death cases of early-onset cancers increased by 79.0% and 28.5% in 2019, respectively (figure 1). The United Arab Emirates (1127.6%),

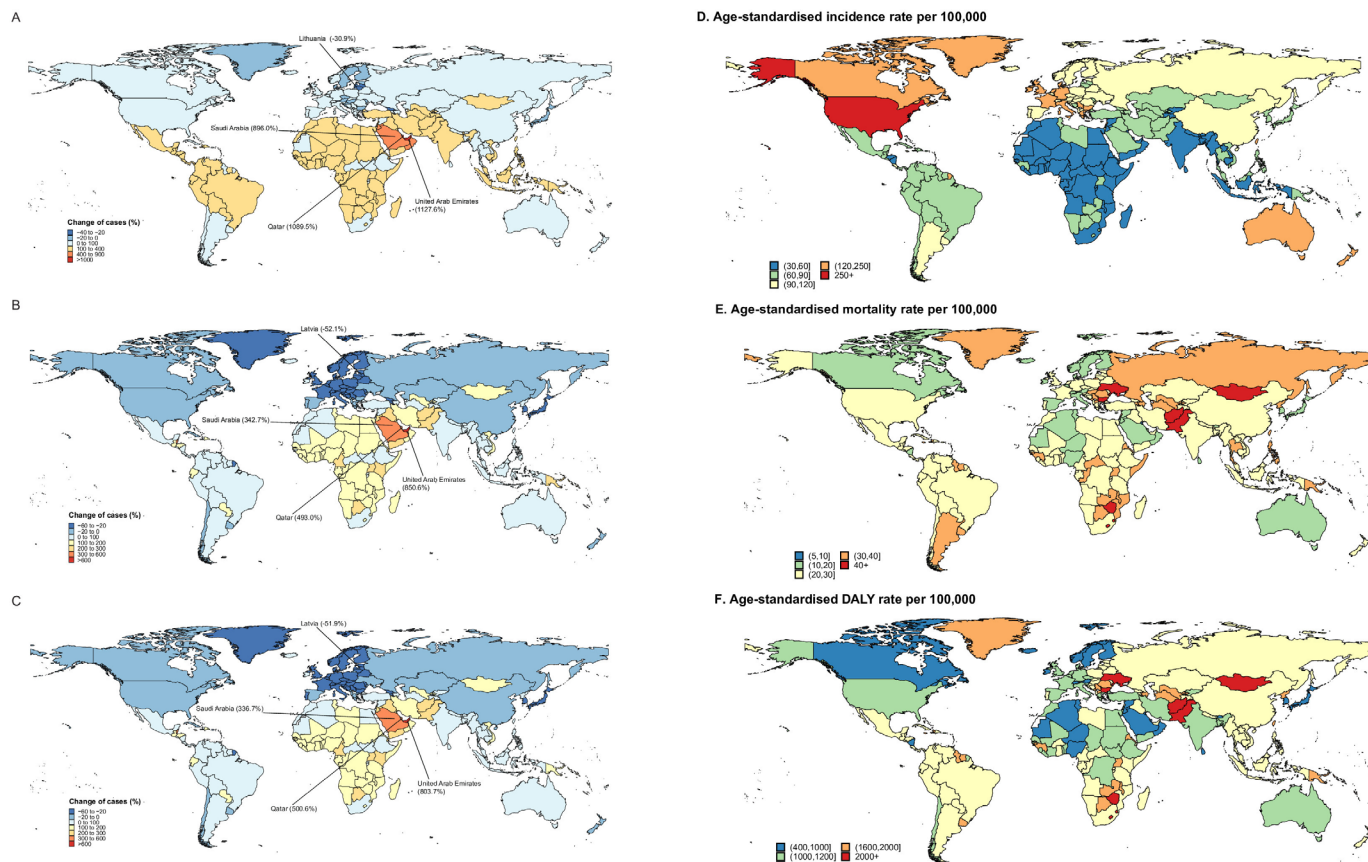


Figure 3 Among 204 countries and territories, the relative change of incident (A), death (B) and DALYs (C) cases of early-onset cancers from 1990 to 2019, and ASIR (D), ASDR (E), age-standardised DALYs rate (F) in 2019. ASIR, age-standardised incidence rate; ASDR, age-standardised death rate; DALYs, disability-adjusted life years.

Qatar (1089.5%) and Saudi Arabia (896.0%) exhibited the sharpest increases in the number of incident cases from 1990 to 2019, while Lithuania decreased by 30.9%, followed by Georgia (−30.0%) and Latvia (−29.0%) (figure 3A). Besides, the most pronounced change in the number of death and DALYs cases was observed in the United Arab Emirates (850.6% and 803.7%), while Latvia (−52.1% and −51.9%) experienced the greatest decline (figure 3B,C). In 2019, the highest ASIR and ASDR of early-onset cancer were in the USA (282.1 per 100k) and Solomon Islands (82.9 per 100k) and the lowest ASIR and ASDR were in Niger (31.0 per 100k) and Kuwait (9.5 per 100k) (figure 3D,E). Moreover, 20 countries have an age-standardised DALYs of more than 2000 per 100k (figure 3F).

Furthermore, the global and regional proportions of death number among 29 early-onset cancers in 2019 are described in online supplemental figure S3.

The trend of ASIR, ASDR and DALY rate of all early-onset cancers in regions and countries with different SDI levels

The overall trend indicated that the morbidity of all early-onset cancers gradually increased with the SDI (online supplemental figure S4A). When SDI was below 0.7, the ASDR and DALYs of all early-onset cancers increased with the SDI value and the ASDR and DALYs then decreased considerably when SDI kept increasing after 0.7 (online

supplemental figure S4B and S4C). At the national level, the association between SDI and the ASIR of all early-onset cancers was similar to the regional level (online supplemental figure S5).

Composition and trend of early-onset cancer incident cases in the digestive and respiratory system

In 2019, after breast cancer, the digestive and respiratory systems of early-onset cancer were mainly responsible for the deaths (figure 1). In digestive system globally, early-onset stomach cancer (30.9%) was the largest proportion of early cancer in 1990, follow by early-onset CRC (23.3%) and liver cancer (21.6%); however, in 2019, early-onset CRC (36.8%) has surpassed stomach cancer as the most numerous form of early cancer (online supplemental figure S6A). In addition, although TBL cancer has been the most important early-onset cancer of the respiratory system from 1990 to 2019, early-onset nasopharyngeal cancer increased from 15.7% in 1990 to 26.8% in 2019, particularly in high-middle SDI region (online supplemental figure S6B).

The association between EAPC and HDI in the most burdensome early-onset cancers

As shown in online supplemental figure S7A, significant association was observed among EAPC_{morbidity}, EAPC_{mortality} and HDI (in 2019) for early-onset breast cancer,

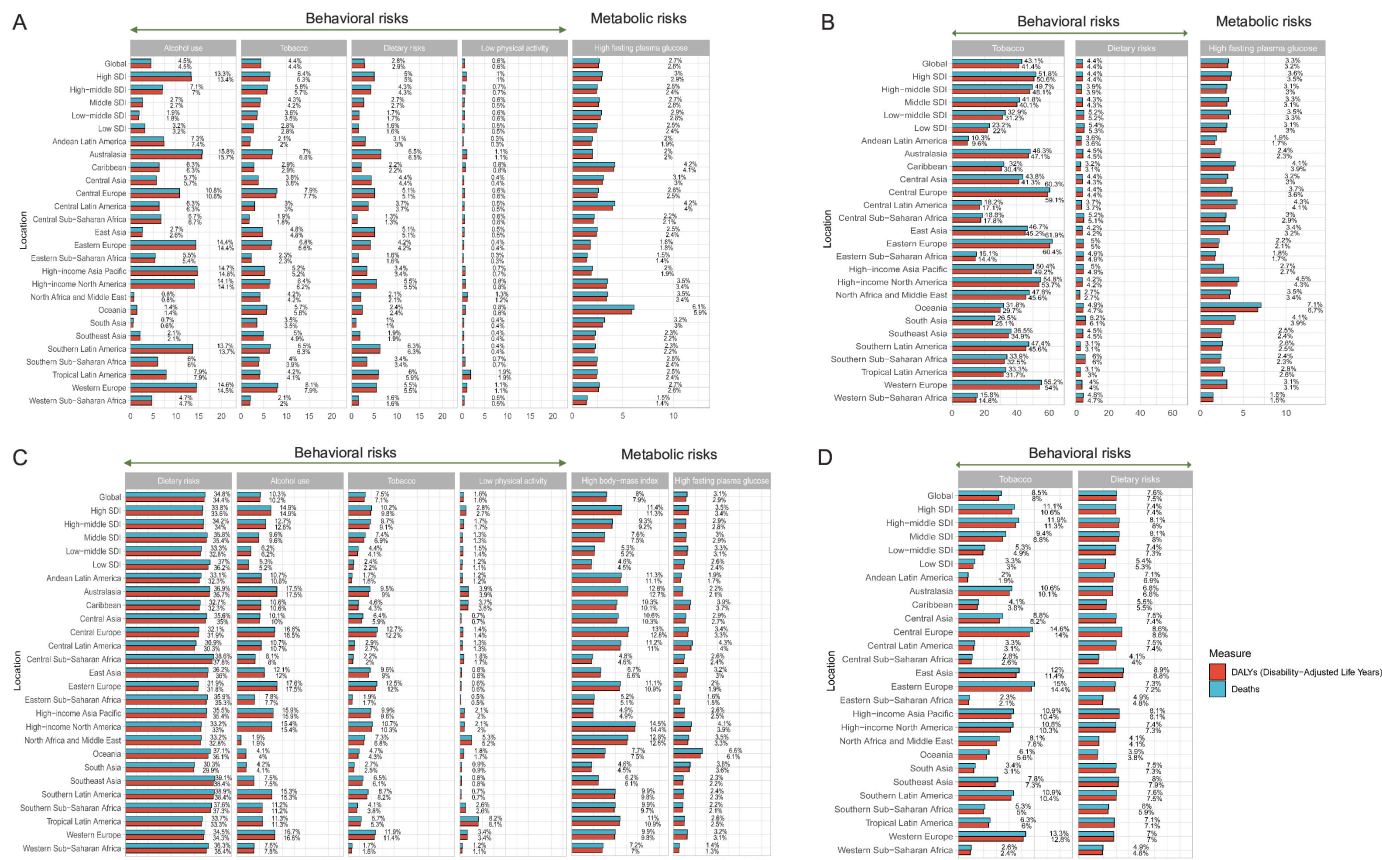


Figure 4 The risk factors of early-onset breast cancer (A), TBL cancer (B), CRC (C) and stomach cancer (D) worldwide, in 21 GBD and 5 SDI regions, 2019. CRC, colorectal cancer; DALYs, disability-adjusted life years; GBD, Global Burden of Disease; SDI, Sociodemographic Index; TBL, tracheal, bronchus and lung.

TBL cancer, CRC and stomach cancer, respectively. For EAPC_{morbidity} and EAPC_{mortality} in these early-onset cancers, a significant positive association was found between EAPC and HDI when the HDI was limited to below 0.6 or 0.7; a significant negative relation was detected between EAPC and HDI when the HDI was greater than 0.6 or 0.7 (online supplemental figure S7).

Risk factors for early-onset breast cancer, TBL cancer, CRC and stomach cancer

We explored the behaviour and metabolic risk factors for death and DALYs of early-onset cancers with the highest disease burden in 2019 (figure 4). Globally, the leading risk factors for early-onset breast cancer DALYs were alcohol use (4.5%, 95% UI: 3.7% to 5.5%), tobacco smoking (4.4%, 95% UI: 1.9% to 6.6%), diet high in red meat (2.9%, 95% UI: 1.4% to 3.8%), physical inactivity (0.6%, 95% UI: 0.3% to 1.2%) and high fasting plasma glucose (2.6%, 95% UI: 0.5% to 6.4%) (figure 4A and online supplemental figure S8A). For early-onset TBL cancer DALYs, tobacco smoking (41.4%, 95% UI: 37.7% to 45.5%) was the most important risk factor, followed by diet low in fruits (4.4%) and high fasting plasma glucose (3.2%) (figure 4B and online supplemental figure S8B). Six risk factors were identified for early-onset CRC, including dietary risks, alcohol use, tobacco smoking, low physical activity, high body mass index (BMI) and high

fasting plasma glucose. Dietary risks for DALYs globally reached 34.4%, mainly consisting of a diet low in milk (16.5%), low in whole grains (15.2%) and low in calcium (14.3%) (figure 4C and online supplemental figure S8C). The percentage trends of diet low in milk, low in calcium and low in whole grains-attributable DALYs in early-onset CRC from 1990 to 2019 are shown in online supplemental figure S9. Tobacco smoking (8.0%) and a diet high in sodium (7.5%) were the risk factors for early-onset stomach cancer globally (figure 4D and online supplemental figure S8D). The ranking change of DALYs risk factors for early-onset cancer from 1990 to 2019 among women and men is presented in online supplemental figure S10. The results indicated that the ranking of risk factors in 2019 for early-onset breast cancer (online supplemental figure S10A), cervical cancer (online supplemental figure S10B) and stomach cancer (online supplemental figure S10C) in women has not altered, compared with 1990. For early-onset CRC in women, the ranking of alcohol use, tobacco, a diet low in fibre and low physical activity in 2019 downgraded compared with 1990, while a diet high in red meat, high BMI and high fasting plasma glucose upgraded (online supplemental figure S10D). The ranking of risk factors for early-onset TBL cancer (online supplemental figure S10E) and stomach cancer in men (online supplemental figure S10G) did not

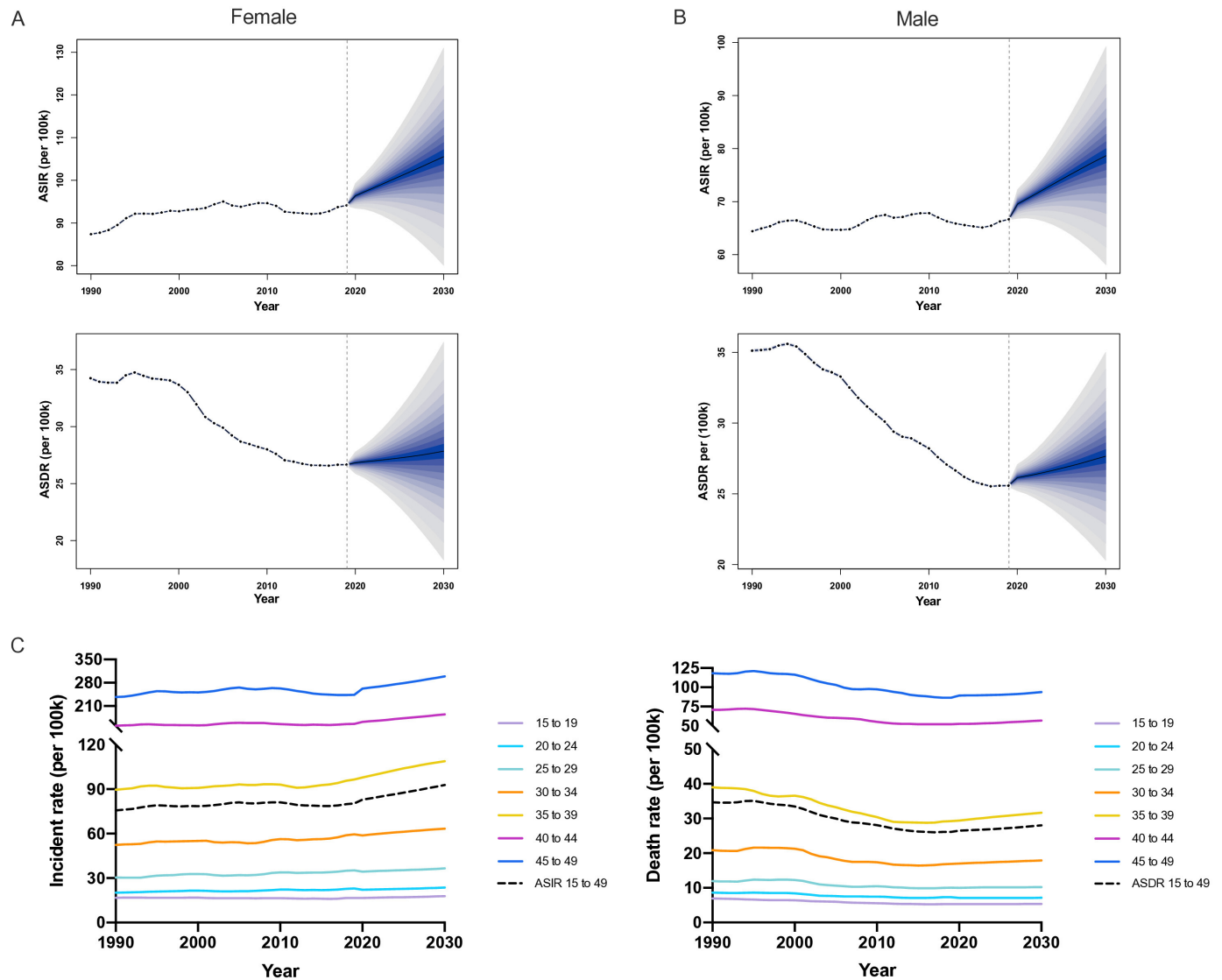


Figure 5 Trends of ASIR and ASDR in the early-onset cancer in female (A), male (B) and both sex (C): observed (1990–2019) and predicted rates (2020–2030). The blue region in (A) and (B) shows the upper and lower limits of the 95% uncertainty intervals (95% UI). ASIR, age-standardised incidence rate; ASDR, age-standardised death rate.

change. In 2019, the ranking of dietary factors associated with early-onset CRC in men underwent some changes when compared with the rankings in 1990. Specifically, a diet low in calcium and fibre was downgraded, while a diet low in milk and whole grains, along with high BMI and high fasting plasma glucose, were upgraded (online supplemental figure S10F). Meanwhile, for early-onset liver cancer in men, the rankings of tobacco and alcohol use had been interchanged in 2019 (online supplemental figure S10H).

Prediction of the incidence and death of early-onset cancers from 2020–2030 worldwide

The ASIR of early-onset cancer in women were higher than in men in 2020–2030, the increasing trend in ASIR and ASDR of early-onset cancer for men were similar to women (figure 5A,B and online supplemental figure S11). Furthermore, the 40–44 and 45–49 age groups were substantially the major population of early-onset cancer

morbidity and mortality from 1990 to 2030 (figure 5C). The ASIR of early-onset cancer would continue to increase globally from 2020 to 2030. The ASDR showed a slight increase compared with 2019 (figure 5C), especially in men.

DISCUSSION

The study systematically evaluated the global burden of 29 cancers with early onset in 2019. The analysis of incidence, death and DALYs by location, country and sex revealed that the spectrum of early-onset cancer varied significantly among the regions and nations across the world. Although the global early-onset cancer incidence surpassed 3.26 million in 2019, a 79.1% increase of the incidence in 1990, the mortality number of early-onset cancer only increased by 27.7%. Notably, the prediction model indicated that the age brackets of 40–44 and 45–49

will represent a significant proportion of the population affected by early-onset cancer morbidity and mortality in the next 10 years.

Significant regional variations in the early-onset cancer spectrum can be ascribed to the local environment, lifestyle and level of available medical treatment. For example, in high-income North America, Australasia and Western Europe with high degree of development, the ASIRs in 2019 were higher than 125 per 100k, while the lowest were in Western Sub-Saharan Africa and Central Sub-Saharan Africa (<50 per 100k), which were similar to the ASIR of all-age cancer.¹⁴ At present, cancer control efforts, preventive measures and strategies in Africa are inadequate, and the majority of Africa countries have limited cancer registries, and their cancer reporting systems are poorly organised.¹⁷ Besides, most countries in Africa do not have well established health insurance systems to cover the cost of cancer screening.¹⁸ The aforementioned factors could be contributing factors to the Africa's low ASIRs for early-onset cancer. On the whole, the more developed the country and region, the higher the incidence of early-onset cancer. The rising incidence of early-onset cancers may partially attribute to increasing uptake of screening and early detection in developed regions and countries²; however, only a small number of countries and certain types of cancer (including cervical cancer, breast cancer and CRC¹⁹) have implemented a screening strategy for individuals with cancer who are under the age of 50. Beyond this, western diet risk and lifestyle risk factors promoted the incidence rate of early-onset cancers.¹ However, as SDI values increased, there was a sharp decrease in ASDR for early-onset cancer in Western Europe, high-income Asia Pacific and high-income North America regions. Furthermore, the projections indicated that the global morbidity and ASIR from early-onset cancer would increase over the next 10 years, while there would be a slight increase in mortality and ASDR compared to 2019 due to changing demographics over the following 10 years. Our results suggested that the incidences of early-onset nasopharynx cancer and prostate cancer displayed the most rapid upward trends in morbidity from 1990 to 2019. Despite the regional clustering and ethnic susceptibility of nasopharynx cancer, its underlying causes are currently unknown. While genetic factors, Epstein-Barr virus (EBV) infection and environmental factors are thought to be significant contributors to the development of nasopharynx cancer, more research is required to establish exact aetiological roles of early-onset nasopharynx cancer.²⁰ Prostate-specific antigen (PSA) screening, which began in developed countries in the 1990s, contributed to the incidence of early-onset prostate cancer.²⁰ However, it would be incorrect to solely attribute the entire increase in early-onset prostate cancer since 1986 to PSA screening. Besides advancements in screenings and diagnostics, other possible reasons for variations in health outcomes could be differences in age demographics and the presence of genetic and lifestyle risk factors.²⁰

Among 29 early-onset cancers, breast cancer had the highest morbidity, mortality and DALYs. In 1990, North America regions with high-income levels had the highest rate of early-onset breast cancer (30.6 per 100k), but by 2019, the incidence of early-onset breast cancer (23.1 per 100k) had decreased, although it still remained in third place. It may benefit from the application of early screening programmes of breast cancer in North America regions. In contrast, over the same time period, Asia regions experienced a significant increase in the incidence of early-onset breast cancer, rising from 4.9 to 13.1 per 100k in 1990 to 8.7–15.6 per 100k in 2019. The growing prevalence of a westernised lifestyle could be among the factors contributing to the upward trend observed in Asian countries.^{21 22} Recently, a case-control study of Asian American women (diagnosed at age≤55 years) from the San Francisco Bay Area found that breast cancer risk was marginally increased among foreign-born women (OR=1.40) and twofold among foreign-born Chinese women.²³ Thus, the factors (including genetic susceptibility) driving the increasing burden of breast cancer in women of Asian are still unclear. Furthermore, the death of early-onset breast cancer accounted for 32% and 20% among all early-onset cancers in the Oceania and Southeast Asia, respectively. The extensive application and promotion of mammography screening worldwide from 2005 to 2015²⁴ has led to an earlier age of breast cancer screening and higher rates of early-onset breast cancer detection. The most typical country is the USA,²⁵ which began to introduce and promote mammography screening from 1980s. The ACS suggests that women be given the chance to commence yearly screening between the ages of 40–44, and to undergo routine screening mammography from the age of 45 onwards.²⁰ More importantly, it is noteworthy that the incidence of early-onset breast cancer also increased in some countries without the introduction of routine screening,²⁶ suggesting that the change of reproductive factors (younger age at menarche, oral contraceptive use, nulliparity, older age at first birth and never breast feeding), physical indicators (higher BMI) and behaviour factors (physical inactivity and alcohol consumption) during recent decades may have contributed to the increasing incidence of early-onset breast cancer.² Globally, we found that alcohol use and tobacco were always the leading risk factors for early-onset breast cancer DALYs during 1990–2019. Several previous studies also found that both tobacco use and alcohol consumption increase the risk of developing breast cancer, with tobacco use specifically linked to premenopausal breast cancer²⁷ and alcohol consumption linked to increased risk regardless of menopausal status.²⁸ The above evidences highlights that limiting and quitting alcohol and tobacco may serve as a promising strategy to reduce the growing burden of early-onset breast cancer.

Early-onset TBL cancer had the highest burden in men and secondary cause of death for the overall population. Generally, the incidence of early-onset TBL cancer dropped during 1990–2019, which benefited from

tobacco control in recent decades.²⁹ In 1990, the regions of Central Europe, Eastern Europe, Central Asia, high-income North America and East Asia had the highest ASIR of early-onset TBL cancer among all regions. However, ASIR of early-onset TBL cancer in these regions decreased by 2019. Notably, lung adenocarcinoma in East Asia, especially among those who have never smoked, tends to have an early onset, which sets it apart from cases observed in other regions.³⁰ The differences in incidence rates may be due to various risk factors, such as genetics and exposure to environmental pollution.^{31 32} Thus, by examining the molecular characteristics and defining the hallmarks of tumour progression in early-onset TBL cancer, precision medicine and prevention may be a viable approach for managing non-smoking early-onset TBL cancer in East Asia. Globally, the morbidity and mortality of early-onset TBL cancer in men was 1.7 and 1.8 times higher than that of women, respectively, which was mainly attributed to the higher tobacco consumption in men.³³ Notably, between 1990 and 2019, smoking continued to be the most significant risk factor for lung cancer among men. Currently, the definition of high-risk or moderate-risk individuals in National Comprehensive Cancer Network (NCCN) Clinical Practice Guidelines in Oncology for lung cancer screening was restricted to those aged 50 years or older.³⁴ However, it is still to be assessed if lung cancer screening is necessary for populations with a history of long-term and high-dose smoking who are younger than 50 years old. TBL cancer is similarly caused by passive exposure to tobacco smoking, environmental pollution and indoor lampblack pollution,³⁵ particularly in women. And outdoor air pollution may be emerging as an important risk factor for early-onset TBL cancer.^{36 37} In addition to tobacco, we identified two risk factors for early-onset TBL cancer: high fasting plasma glucose and a diet low in fruits. Recently, a meta-analysis of prospective cohort studies demonstrated high glycaemic index diet increased risks of lung cancer.³⁸ Therefore, it is necessary to implement a planned programme of measures, including preventing indoor and outdoor air pollution, promoting balanced diet and blood glucose control for diabetic, to further reduce the burden of early-onset TBL cancer.

Early-onset CRC also had high DALYs for both sexes and was the most common form of digestive system early-onset cancer in 2019 globally, accounting for 36.8%. It was reported that greater proportions of patients younger than 50 years were diagnosed with advanced-stage tumours than older patients, thus promoting diagnosis of early-onset CRC patients and identification of potential risk factor were important to improving prevention and therapy of early-onset CRC.³⁹ In 1990, Australasia had the highest occurrence of early-onset CRC. By 2019, this incidence had further increased. However, it is important to highlight that in East Asia, the ASIR of early-onset CRC rose from 4.2 per 100k in 1990 to 10.0 per 100k in 2019, making it the top-ranked region. Besides, the results of risk factors analysis indicated that a diet low in milk, low in

whole grains and low in calcium were the top risk factors for early-onset CRC in both women and men. Although diet low in calcium were the top risk factors for early-onset CRC in 2019, its risk proportion showed a general downward trend from 1990 to 2019 across all SDI regions, which may benefit from calcium fortification programme since 1990.⁴⁰ Interestingly, as one source of calcium intake, an obvious downward trend of risk proportion of diet low in milk of early-onset CRC from 1990 to 2019 was only observed in high SDI region, but an upward or flat trend in other SDI regions. For a diet low in whole grains, the risk proportion in high SDI region has been on an upward trend from 1990 to 2019. The above results suggest that calcium and milk fortification should be taken into reducing the risk of early-onset CRC in the population, especially in non-high SDI regions. Furthermore, diet in whole grains should be promoted, especially in high SDI regions. Except for dietary risk factors, alcohol use, high BMI, tobacco consumption, high fasting plasma glucose and low physical activity contributed to early-onset CRC. Of these risk factors, high BMI, particularly obesity, has been identified as a strong risk factor for early-onset CRC. The increasing prevalence of obesity in younger generations has led to a substantial increase in early-onset CRC cases.⁴¹ According to research, obesity is associated with an OR of 1.4 for early-onset CRC.⁴² Besides, individuals with high fasting plasma glucose and diabetes have a higher risk of developing early-onset CRC, as demonstrated by previous studies,⁴³ and it was recommended to conduct CRC screening earlier for those with diabetes than for the general population.⁴⁴ Taken together, in addition to focusing on traditional lifestyle risk factors, dietary modifications will have a positive impact on lowering the incidence burden of early-onset CRC.

The ASIR of early-onset stomach cancer in 2019 was highest in East Asia, high-income Asia Pacific, and Eastern Europe, whereas Oceania had the highest ASDR. Generally, stomach non-cardia cancer was common in Eastern Asia and Eastern Europe where the prevalence of *Helicobacter pylori* infection is quite high.⁴⁵ Overall, the morbidity and mortality of early-onset stomach cancer in the most regions showed a downward trend from 1990 to 2019, which suggests that the prevention and treatment of stomach cancer has achieved a remarkable success in recent decades. Undoubtedly, the decrease in mortality of early-onset stomach cancer mainly attributed to the control of risk factors, screening, and treatment methods. For instance, the prevalence of *H. pylori* infection, associated with early-onset stomach cancer, has declined in the USA, most European countries and several East Asian countries.⁴⁶ More importantly, surgical resection combined with neoadjuvant/perioperative chemotherapy is a highly effective treatment for stomach cancer in early stage, which gives a substantial support to the prevention and treatment of early stomach cancer. Additionally, our result indicated that tobacco and a diet high in sodium were the main risk factors for early-onset stomach cancer. Therefore, the morbidity of early-onset

stomach cancer might benefit from the decrease in salt intake and tobacco control.

As the SDI increased, there was a rise in the ASIR of early-onset cancer; yet in regions with a high SDI (>0.7), there was a reduction in both early-onset cancer ASDR and DALYs rate as the SDI increased. The high of ASDR and DALYs rate concentrated on middle and middle-high SDI regions. Despite the fact that the ASIR remained elevated in high SDI regions, advancements in medical technology and treatments had substantially alleviated the mortality and overall impact of early-onset cancer. Conversely, it appeared that the middle SDI region was afflicted by the issue of early-onset cancer with high deaths and DALYs. Meanwhile, our findings indicated that the relationship between the HDI and the EAPC of incidence and death rates for early-onset breast cancer, TBL cancer, CRC and stomach cancer follows an inverted U-shaped curve, and the highest EAPC was observed in regions with low-middle and middle HDI, ranging from 0.5 to 0.7. Therefore, it could be concluded that in countries with a low-middle and middle HDI, burdensome early-onset cancers were displaying the most rapid increase in incidence, mortality and DALYs rates. As a result, enhancing the monitoring and prevention of early-onset cancers in these regions is crucial.

Genetic screening has become an indispensable tool due to its emphasis on the prevention of early-stage cancer. For example, current research indicated that breast and ovarian cancer were associated with variants in the *BRCA1* and *BRCA2* genes.⁴⁷ Besides, approximately 10% of CRC cases have been found to be associated with pathogenic variants according to research studies.²⁰ Research studies have revealed that these pathogenic variants were detected in 15%–33% of individuals who were diagnosed with CRC before the age of 50, regardless of their family history of the disease.²⁰ More importantly, next-generation sequencing has led to improvements in the accessibility and affordability of genetic testing for cancer susceptibility genes. Therefore, genetic screening is expected to have a significant impact on the identification and anticipation of early-onset cancers in the near future.

However, the study still has several limitations due to GBD 2019's intrinsic drawbacks. First, the accuracy of GBD data was compromised by the quality of cancer registry data in different countries. Thus, the under-reporting and under-diagnosis in undeveloped countries may result in underestimation of the incidences and deaths of early-onset cancer. Second, the increasing trend of early-onset cancer burden is still unclear, which may be related to early screening intervention and early-life exposures. Third, the estimation of risk factor exposure was conducted on data with sparse investigation time nodes and different sources, which may affect influence accuracy and introduce potential measurement bias. Fourth, it is inevitable that implementing a dichotomy at 50 years

of age has drawbacks because pathological, molecular and biological characteristics are unlikely to change considerably at that age.

CONCLUSIONS

Our study showed that the global morbidity of early-onset cancer increased from 1990 to 2019, while mortality and DALYs slightly decreased. The rate of incidence, mortality and DALY varied widely across regions, countries and cancer types. The highest-burden regions and cancer types were high-middle and middle SDI regions and early-onset breast cancer, TBL cancer, CRC and stomach cancer, respectively. Dietary risk factors, alcohol use and tobacco consumption were the main risk factors for top early-onset cancers in 2019. Additionally, it is necessary to conduct prospective life-course cohort studies to explore the aetiologies of early-onset cancers. Encouraging a healthy lifestyle, including a healthy diet, the restriction of tobacco and alcohol consumption and appropriate outdoor activity, could reduce the burden of early-onset cancer. It is worth exploring whether early screening and prevention programmes for early-onset cancer should be expanded to include individuals aged 40–44 and 45–49, but further systematic studies and randomised trials are necessary to make a definitive determination.

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Acknowledgements We appreciate the comprehensive and systematic work by the Global Burden of Disease study 2019 members.

Contributors XL, JZ and KD conceptualised the project. JZ performed the data analyses and wrote the first draft. All authors critically reviewed the manuscript for important intellectual content. XL is the study guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

Funding XL: the Natural Science Fund for Distinguished Young Scholars of Zhejiang Province (LR22H260001) and the National Nature Science Foundation of China (82204019). ET: CRUK Career Development Fellowship (C31250/A22804). SL: the Swedish Heart Lung Foundation (Hjärt-Lungfonden, 20210351), the Swedish Research Council (Vetenskapsrådet, 2019-00977) and the Swedish Cancer Society (Cancerfonden). KD: Project of the regional diagnosis and treatment center of the Health Planning Committee (No. JBZX-201903).

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Material and methods section for further details.

Patient consent for publication Not applicable.

Ethics approval Not applicable.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available in a public, open access repository. To access the citations for the data utilized in this study, please visit the data input sources tool on the Global Health Data Exchange website (<http://ghdx.healthdata.org/gbd-2019/data-input-sources>). Complete files containing all GBD 2019 estimates can be obtained from the Global Health Data Exchange website (<http://ghdx.healthdata.org/gbd-2019>) or downloaded using the Global Health Data Exchange results tool (<http://healthdata.org/gbd-results-tool>). Reference: GBD 2019 Cancer Risk Factors Collaborators. The global burden of cancer attributable to risk factors, 2010-19: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet*. 2022;400(10352):563-591. doi:10.1016/S0140-6736(22)01438-6.

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Supplementary Methods

Data source, definition of early-onset cancer and risk factors

We extracted metadata on the burden of 29 early-onset cancers at the global, regional and national levels from the GBD 2019 database, which is accessible via the GBD citation tool online (<http://ghdx.healthdata.org/gbd-2019>)¹. Twenty-nine early-onset cancers were ascertained from administrative data according to International Classification of Disease version 9 (ICD-9) and 10 (ICD-10) codes, the ICD codes of 29 cancers are shown in Supplementary Table S1. Early-onset cancer was defined as cancer cases diagnosed from 14 to 49 years². In total, 204 countries were divided into five-level regions based on the socio-demographic index (SDI), the SDI comprehensively represents development status in different regions³. It was calculated based on lag distributed income per capita, mean years of schooling for individuals 15 years and older, and total fertility rate for individuals younger than 25 years, ranging 0 to 1⁴. The human development index (HDI) data were obtained at the national level from the World Bank. The GBD database in 2019 estimated the population (including a comprehensive update on fertility and migration), mortality and life expectancy for a total of 990 locations, in 204 countries and territories based on a total of 1250 censuses and 747 location-years of population registry data. In addition, the Bayesian population model was used to reconcile censuses and registry data¹. We considered morbidity and mortality, defined as the number of incident cases and deaths per 100k individuals. The burden of early-onset

cancer expressed by DALYs was retrieved to represent healthy years lost annually per 100k individuals)⁵. The DALY equation is as follows: $DALYs = \text{years lived with disability (YLDs)} + \text{years of life lost (YLLs)}$. YLDs was estimated by diagnosis or treatment, remission, metastatic disseminate, and terminal phase modules, and each module prevalence multiplied by a disability weight was to calculate YLDs. YLLs was calculated by multiplying the number of deaths in the specific age with the corresponding standard life expectancy.

GBD 2019 examined three groups risk factors (environmental and occupational, behavioural, and metabolic), including 23 cancer types and 34 risk factors, with risk factors identified with the World Cancer Research Fund (WCRF) criteria⁶. Behavioral (including dietary risk factors) and metabolic risk factors were examined for their attributable risk to the burden of early-onset cancer in this study. Definitions of these risk factors and method for calculating the proportions of their attribution are described and reported in the previous study⁷. Briefly, to evaluate the burden associated with each risk factor, the GBD 2019 adopted the basic framework developed for comparative risk assessment, including six main steps for each risk–outcome pair^{7,8}. First, risk factors with persuasive or likely evidence of a causal connection were identified using the World Cancer Research Fund criteria. For GBD 2019, systematic reviews were revised to ensure that risk factors were appropriately included⁷. Second, existing systematic reviews were updated and meta-analyses of relative risks were performed using GBD’s meta-regression-Bayesian, regularised, trimmed

tool in order to estimate relative risks for each risk–outcome pair as a function of exposure. Third, risk factor exposure levels and distributions were modeled with Bayesian meta-regression modelling (DisMod-MR 2.1) or spatiotemporal Gaussian process regression for every age, sex, location, and year combination using data from published studies. Fourth, the theoretical minimum risk exposure level of risk factor was confirmed. Fifth, the population attributable fraction of corresponding risk factor was calculated across age, sex, location, and year, based on the risk function, exposure level and the theoretical minimum risk exposure level. Sixth, mediation was considered for some risk factor to estimate the population attributable fraction ⁷.

Statistical analysis

The incidence rate, death rate and estimated annual percentage change (EAPC) were used to quantify the epidemic trends of 29 early-onset cancers. EAPC was applied to depict the trends of morbidity and mortality, which has been widely used in public health studies ^{9,10}. A regression line was fitted to the natural logarithm of the rates, and the EAPC and its 95% confidence intervals (CIs) were calculated by the linear regression model. The formulas were as follows:

$$y = \alpha + \beta x + \varepsilon$$

$$EAPC = 100 \times (\exp(\beta) - 1)$$

Thereinto, $y = \ln(\text{rate})$ and $x = \text{calendar year}$. Meanwhile, we conducted the age-standardization to balance multiple population with different age structures

or for the same population over time to facilitate the comparison between different regions and nations. The age-standardized rate (ASR)/100k population, including age-standardized incidence rate (ASIR) and age-standardized death rate (ASDR), were estimated with the following formula:

$$ASR = \frac{\sum_{i=1}^A a_i W_i}{\sum_{i=1}^A W_i} \times 100k$$

For above formula, α_i meant the age-specific rate in the i^{th} age group, w meant the number of population (or the weight) in the corresponding i^{th} age group from among the selected reference standard population (global populations from 1990 to 2019 used in this study from GBD) (Table S2), and A meant the number of age groups. The age groups for age-standardized included 15-19 years, 20-24 years, 25-29 years, 30-34 years, 35-39 years, 40-44 years and 45-49 years. We explored the associations between EAPCs and HDI in 2019 using Spearman correlation analysis. Additionally, the Bayesian age-period-cohort (BAPC) model integrating nested Laplace approximations was used to project the morbidity and mortality of the disease burden attributable to early-onset cancer from 2020 to 2030¹¹, and the formula was as follow:

$$R_{ijk} = \mu + \alpha_i \text{ Age} + \beta_j \text{ Period} + \gamma_k$$

Among the parameters of the formula, μ as a constant, R_{ijk} represents the incidence or mortality rate in the i^{th} age group, j^{th} time period, and k^{th} birth cohort. α_i , β_j , and γ_k are the effects of age, time period, and birth cohort. In the BAPC model, the prior probability distribution of time period and birth cohort

effects were the prior information, and the effects of age, period, and cohort through a random walk of different orders were estimated¹¹. To avoid over dispersion, an independent random effect, $z_{ij} \sim (0, k_z^{-1})$, was added into the model:

$$R_{ijk} = \mu + \alpha_i \text{Age} + \beta_{j+t} \text{Period} + \gamma_{k+t} \text{Cohort} + z_{ij+t}$$

Data analysis and graphics were conducted using R 4.2.1 (Lucent Technologies, Jasmine Mountain, USA). *P*-value < 0.05 was considered to be statistically significant.

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Table S1. The International Classification of Disease version 9 and 10 codes of 29 early-onset cancers

Cause	ICD10	ICD10 Used in Hospital/Claims Analyses	ICD9	ICD9 Used in Hospital/Claims Analyses
Bladder cancer	C67-C67.9, Z12.6-Z12.79, Z80.52, Z85.51		188-188.9, V10.51, V16.52, V76.3	
Brain and central nervous system cancer	C70-C70.1, C70.9-C72.9, Z85.841-Z85.848, Z86.011		191-191.9	
Breast cancer	C50-C50.629, C50.8-C50.929, Z12.3-Z12.39, Z80.3, Z85.3, Z86.000		174-175.9, V10.3, V16.3	
Cervical cancer	C53-C53.9, Z12.4, Z85.41		180-180.9, V10.41, V72.32	
Colon and rectum cancer	C18-C19.0, C20, C21-C21.8, Z12.1-Z12.13, Z85.03-Z85.048, Z86.010		153-154.9, 209.1-209.17, V10.05-V10.06, V76.41, V76.5-V76.52	
Esophageal cancer	C15-C15.9, Z85.01		150-150.9	
Gallbladder and biliary tract cancer	C23, C24-C24.9		156-156.9	
Hodgkin lymphoma	C81-C81.49, C81.7-C81.79, C81.9-C81.99, Z85.71-Z85.72		201-201.98, V10.72	
Kidney cancer	C64-C64.2, C64.9-C65.9, Z80.51, Z85.52-Z85.54		189-189.1, 189.5-189.6, 209.24	
Larynx cancer	C32-C32.9, Z85.21		161-161.9, V10.21	
Leukemia	C91-C93.7, C93.9-C95.2, C95.7-C95.92, Z80.6, Z85.6		204-208.92, V10.59-V10.69, V16.6	
Lip and oral cavity cancer	C00-C07, C08-C08.9, Z85.81-Z85.810		140-145.9, V76.42	
Liver cancer	C22-C22.4, C22.7-C22.9, Z85.05		155-155.9, V10.07	
Malignant skin melanoma	C43-C43.9, Z85.82-Z85.828		172-172.9	

Mesothelioma	C45-C45.2, C45.7, C45.9			
Multiple myeloma	C88-C90.32		203-203.9	
Nasopharynx cancer	C11-C11.9		147-147.9	
Non-Hodgkin lymphoma	C82-C85.29, C85.7-C86.6, C96-C96.9		200-200.9, 202-202.98	
Non-melanoma skin cancer	C44.01-C44.99	C44.01-C44.92	173-173.99	173.01-173.92
Other malignant neoplasms				
Other pharynx cancer	C09-C10.9, C12-C13.9		146-146.9, 148-148.9	
Ovarian cancer	C56-C56.2, C56.9, Z80.41, Z85.43		183-183.0, 183.8-183.9, V10.43, V16.41	
Pancreatic cancer	C25-C25.9, Z85.07		157-157.9	
Prostate cancer	C61-C61.9, Z12.5, Z80.42, Z85.46		185-185.9, V10.46, V16.42, V76.44	
Stomach cancer	C16-C16.9, Z12.0, Z85.02-Z85.028		151-151.9, 209.23, V10.04	
Testicular cancer	C62-C62.92, Z80.43, Z85.47-Z85.48		186-186.9, V10.47-V10.48, V16.43	
Thyroid cancer	C73, Z85.850		193-193.9	
Tracheal, bronchus, and lung cancer	C33, C34-C34.92, Z12.2, Z80.1-Z80.2, Z85.1-Z85.20		162-162.9, 209.21, V10.1-V10.20, V16.1-V16.2, V16.4-V16.40	
Uterine cancer	C54-C54.3, C54.8-C54.9, Z85.42, Z86.001		182-182.9	

Table S2. The global populations from 1990 to 2019 from Global Burden of Disease database.

Age group	Year	Population (Number)		
		value	95% UI upper	95% UI lower
15 to 19	1990	519603412.1	530680498.1	508300320.3
20 to 24	1990	492675757.3	503896044.6	481582093.4
25 to 29	1990	442843296.3	452298683.7	433270420.5
30 to 34	1990	385628936.3	393643207.2	377634667.2
35 to 39	1990	352742337.2	360428575.9	345093616.7
40 to 44	1990	286291792.8	292117447.4	280385026.7
45 to 49	1990	232409454.8	237083522.7	227751425.8
total	1990	2712194987	2770147980	2654017571
15 to 19	1991	518431189.8	529625669	506685286
20 to 24	1991	497721431.6	509107338.8	485392189.6
25 to 29	1991	455832152.7	466284103.7	444935393.9
30 to 34	1991	391230084.1	399372571.7	382820363.8
35 to 39	1991	361169652.2	369328193	352730424
40 to 44	1991	300417868	306725084.9	293732738.6
45 to 49	1991	235818955.1	240649046.4	230624980.1
total	1991	2760621334	2821092008	2696921376
15 to 19	1992	517752112.3	529645040.2	505664457.5
20 to 24	1992	501355296.6	513963392.1	488822164.2
25 to 29	1992	467066293.3	478885507.3	455232836.3
30 to 34	1992	399751499.4	408609391.4	390772117.8
35 to 39	1992	368327533.8	377433002.9	359401450.8
40 to 44	1992	310706133.5	317936104	303474218.7
45 to 49	1992	244256904	249728441	238590364.2
total	1992	2809215773	2876200879	2741957610
15 to 19	1993	518331320.9	530589982.8	505383791.4
20 to 24	1993	503737367.1	516634043	490381654.2
25 to 29	1993	475498861.8	488308914.1	462208164.3
30 to 34	1993	412123993.8	422123959.6	401912314.7
35 to 39	1993	373316483.4	382820829.4	363520327.1
40 to 44	1993	321665708.5	329832878.7	313297659.4
45 to 49	1993	253832429.9	259866960.1	247418735.3
total	1993	2858506166	2930177568	2784122646
15 to 19	1994	520867528.1	534036366.2	507564349.3
20 to 24	1994	505044168.7	519205490	490995146.2
25 to 29	1994	481852637	496002910.9	467594339.3
30 to 34	1994	426649539.2	438369965	415004429.2
35 to 39	1994	376959573.7	387075630.1	366693145.6
40 to 44	1994	331572772.1	340918924.3	322309246.9
45 to 49	1994	266054126.5	273106002.2	258906637.1
total	1994	2909000345	2988715289	2829067294

15 to 19	1995	525627131.5	539810121.8	511786579.1
20 to 24	1995	505533844.6	520435296.8	490792209.9
25 to 29	1995	487044565.9	502559413.8	471506826
30 to 34	1995	441148313.6	454486155.5	427714659.1
35 to 39	1995	380779750.6	391656066.8	370221444.8
40 to 44	1995	344801865.7	355292420.6	334523992.1
45 to 49	1995	276148943.3	283980606.7	268285253.1
total	1995	2961084415	3048220082	2874830964
15 to 19	1996	532746680	546959076.7	518596772.5
20 to 24	1996	505332329.5	519527208.4	491141002.5
25 to 29	1996	492230166	507261276.7	477324491.6
30 to 34	1996	453915291.6	467610171.6	440183343.3
35 to 39	1996	386716603.9	397485130.6	376108907.7
40 to 44	1996	352517513.3	362937302.1	342178577.8
45 to 49	1996	289621233.1	297893216.6	281474561.1
total	1996	3013079817	3099673383	2927007656
15 to 19	1997	541569409.9	555217526.3	527501869.3
20 to 24	1997	505471466.9	518641456.4	491842204.4
25 to 29	1997	496413797.2	510280881	481685530.6
30 to 34	1997	464801665.8	478011948.4	450670088.8
35 to 39	1997	395709386.2	405717465.2	385116111.9
40 to 44	1997	359075632.2	368936016.8	348777035.7
45 to 49	1997	299324118	307157744	290953335.5
total	1997	3062365476	3143963038	2976546176
15 to 19	1998	551433118.6	564737008	538525999.1
20 to 24	1998	506664550.5	519038997.2	494424129.5
25 to 29	1998	499486643.4	512639674.3	486328469.7
30 to 34	1998	472793184.4	485686479.5	459824502.3
35 to 39	1998	408547814.3	418487971.6	398427069.2
40 to 44	1998	363613013.4	372858162.5	354162295.9
45 to 49	1998	309743148.6	317472961.4	301744625.7
total	1998	3112281473	3190921254	3033437091
15 to 19	1999	561765793.9	573840530.8	549514415.4
20 to 24	1999	509518057.1	520480382.6	498385100.7
25 to 29	1999	501514045.8	513289855	489588813.4
30 to 34	1999	478748391	490504854.8	466591931.9
35 to 39	1999	423428022.5	433120590.9	413526445.3
40 to 44	1999	366896556.8	375162052.1	358369381.9
45 to 49	1999	319090325.7	326456829.8	311442125.9
total	1999	3160961193	3232855096	3087418214
15 to 19	2000	572711000.5	584570505.3	560653361.1
20 to 24	2000	514381490.6	524841210.7	503645582
25 to 29	2000	502647111.1	513618289.9	491343042.8
30 to 34	2000	483765873.5	494906930.3	472250617

35 to 39	2000	438184947.2	447954574.6	427994194.1
40 to 44	2000	370461890.2	378141421.5	362426860.2
45 to 49	2000	331717054.9	338950651.7	324152892.5
total	2000	3213869368	3282983584	3142466550
15 to 19	2001	584931684.8	597054315.5	572619149.4
20 to 24	2001	521426557	531907452.8	510553254.1
25 to 29	2001	502778255.8	513825110.4	491695869.7
30 to 34	2001	489107892	500472869.5	477631548.2
35 to 39	2001	450910563.8	461444044.9	440234900.5
40 to 44	2001	376209318	384124036.5	368094930.6
45 to 49	2001	339226508.3	347002229.8	331428893
total	2001	3264590780	3335830059	3192258546
15 to 19	2002	597719508.8	611699883	584089197.3
20 to 24	2002	530224078.1	542057890.2	518438411.4
25 to 29	2002	503038577.1	514865407.1	491191485.6
30 to 34	2002	493665792.2	506053212.6	480975927.6
35 to 39	2002	461626087.8	473611387.3	449411890.2
40 to 44	2002	385026319.7	393866389.2	376014046
45 to 49	2002	345682300.8	354306020.6	337032389.8
total	2002	3316982664	3396460190	3237153348
15 to 19	2003	609967034.5	625187073.2	594795523.5
20 to 24	2003	540129344.8	552899935.6	527393988.4
25 to 29	2003	504273518.2	516656822.7	491991160.6
30 to 34	2003	497207785.2	510054168.9	483941892.8
35 to 39	2003	469474307.6	482259520.7	456384977.4
40 to 44	2003	397639384.8	407361471	387558433.6
45 to 49	2003	350246132.1	359252998.1	341021192.2
total	2003	3368937507	3453671990	3283087168
15 to 19	2004	620429802	637255911.9	603658073.6
20 to 24	2004	550457476.5	564531386.4	536483664.2
25 to 29	2004	507068043.7	520080083.6	493802524.9
30 to 34	2004	499698985.9	513656569.5	485432029.9
35 to 39	2004	475388405.9	489074818.6	461195035.5
40 to 44	2004	412265186.6	423386424.4	400795939.6
45 to 49	2004	353640784.9	362892312.4	343999007.9
total	2004	3418948685	3510877507	3325366276
15 to 19	2005	627746727.5	645910118.8	610174954.4
20 to 24	2005	561336218.8	576549848.6	546265825.3
25 to 29	2005	511675130.1	525377586.9	497735936.5
30 to 34	2005	501153714.4	515877113.7	486530733.2
35 to 39	2005	480401874.4	495932256.1	465451537.8
40 to 44	2005	426776464.4	439847183.5	414157740.4
45 to 49	2005	357325169.5	367414504.9	347377902.8
total	2005	3466415299	3566908613	3367694630

15 to 19	2006	630491830.2	649229178.7	612304102.7
20 to 24	2006	573821690	590337130.4	557843963.4
25 to 29	2006	518507526.2	533235102.8	504281929.5
30 to 34	2006	501610073	516516227.9	486810121.4
35 to 39	2006	485831409.2	500998980.5	470589625.1
40 to 44	2006	439314572.4	452820313.7	425661215.2
45 to 49	2006	363172616.8	372941316.5	352857966.5
total	2006	3512749718	3616078251	3410348924
15 to 19	2007	629442031.1	646295218.8	612499765.7
20 to 24	2007	587350039.5	602610301.3	571694341
25 to 29	2007	527232718.6	540698208.5	513836038.1
30 to 34	2007	502257145.1	515603020.5	488928549.6
35 to 39	2007	490575061.2	504677852.9	476275453.3
40 to 44	2007	449989584.1	462861877.1	436648140.7
45 to 49	2007	372071189.2	381575480.7	362348132.8
total	2007	3558917769	3654321960	3462230421
15 to 19	2008	625501004.8	640328892.5	610271163.4
20 to 24	2008	600238491.1	614894853	585371297
25 to 29	2008	536869167.1	549331310.9	524396861.2
30 to 34	2008	503719503.2	515663033.6	491411781.7
35 to 39	2008	494258405.8	507040715.4	481382118.5
40 to 44	2008	457844356.2	469781842.6	445508393.3
45 to 49	2008	384677767.3	393677275.7	375189293.5
total	2008	3603108696	3690717924	3513530909
15 to 19	2009	620182568.5	634270507.2	606911715
20 to 24	2009	610877828	625020486.3	597067578.1
25 to 29	2009	546596215.5	558505271.1	534922972.6
30 to 34	2009	506437833.9	517785005.9	495277724.2
35 to 39	2009	496779149.6	508371538.2	485216706.2
40 to 44	2009	463763007.9	475093496.9	452442257.9
45 to 49	2009	399220279.3	408242252.7	390258823
total	2009	3643856883	3727288558	3562097777
15 to 19	2010	614905315.7	627682461.7	602455449.2
20 to 24	2010	618197109.4	631506402.2	605083502
25 to 29	2010	556937766.6	568257932.8	545572491.3
30 to 34	2010	510863945.2	521349257.2	500365347.5
35 to 39	2010	498339906.9	509133871.4	487396308.4
40 to 44	2010	468870865.8	479379365.3	458374062.7
45 to 49	2010	413683324.9	422481082.2	404810524.7
total	2010	3681798235	3759790373	3604057686
15 to 19	2011	611004326.6	623438739	598700918.6
20 to 24	2011	621004896	634923308	607743528.1
25 to 29	2011	568854206.8	580965354.5	557091388.1
30 to 34	2011	517307082.1	528239970.6	506892697.2

35 to 39	2011	498831665.9	510054449.4	487894843.3
40 to 44	2011	474428276.4	486099984.6	463196920.3
45 to 49	2011	426164043	436631599.7	416101956.1
total	2011	3717594497	3800353406	3637622252
15 to 19	2012	608599249.6	621623994.2	595771283.9
20 to 24	2012	619902721.6	634185027	605447816.4
25 to 29	2012	581549897.1	594815688.9	568439583.8
30 to 34	2012	525336993.4	536676719.7	513823571.9
35 to 39	2012	499285168.6	510948734.5	487300751
40 to 44	2012	479203061.1	491142019.8	466882896.6
45 to 49	2012	436828062.3	448305890.5	425072911.3
total	2012	3750705154	3837698075	3662738815
15 to 19	2013	607448157.1	621183643.3	593654916.9
20 to 24	2013	616102175.2	631308923.7	601259565.3
25 to 29	2013	593849144.7	608648508.2	579034752.6
30 to 34	2013	534426345	546818918.7	521774076.2
35 to 39	2013	500574699.6	512891450.5	488059434.1
40 to 44	2013	482984401.2	495903478.9	469744193
45 to 49	2013	444807473.5	457482128.2	432033962.4
total	2013	3780192396	3874237052	3685560901
15 to 19	2014	607279470.4	621922154.5	592278065.3
20 to 24	2014	611104444.2	626705120	595244495.2
25 to 29	2014	604446564.9	620120233.1	587965973.5
30 to 34	2014	544030593.2	557351969.7	530070906.2
35 to 39	2014	503338810.4	515992995.6	490067180
40 to 44	2014	485771436.6	499226313.9	471956896.2
45 to 49	2014	450968489.8	464249991.4	437468017
total	2014	3806939810	3905568778	3705051533
15 to 19	2015	608218087.6	623622681.7	592376348.4
20 to 24	2015	606112142.2	622744675.2	589837526.6
25 to 29	2015	612012137	628815900.7	594577158.7
30 to 34	2015	554407501.9	569269450.1	539122605.6
35 to 39	2015	507892129.9	521330451.5	493847217.8
40 to 44	2015	487612069.2	501695247.2	473185523.3
45 to 49	2015	456297755.8	470321181.9	441780065.7
total	2015	3832551824	3937799588	3724726446
15 to 19	2016	610093992.1	626604794	592844022.2
20 to 24	2016	602557005.1	620090585.6	585352846
25 to 29	2016	614984761.6	633145816.8	596184994.3
30 to 34	2016	566303551.5	582918522.1	549474113.7
35 to 39	2016	514363495.7	529328722.3	499336052.5
40 to 44	2016	488320878	503226274.7	473000968.3
45 to 49	2016	462025193.2	477592660.6	446919426.9
total	2016	3858648877	3972907376	3743112424

15 to 19	2017	612577366.2	630504939	594845461.4
20 to 24	2017	600599320.1	619121599.8	582944860.2
25 to 29	2017	614004651	634481806.8	594512501.1
30 to 34	2017	578913277.4	598037280.6	560584333.7
35 to 39	2017	522346015.5	538808826.4	506174465.6
40 to 44	2017	488978593.4	505035158.4	472768963.1
45 to 49	2017	466917924.3	483082675.1	449912324.5
total	2017	3884337148	4009072286	3761742910
15 to 19	2018	615767495.4	633590404.6	596886100.5
20 to 24	2018	599885085.9	618055364.1	581519599.2
25 to 29	2018	610283133.9	630271788.3	590563763.3
30 to 34	2018	591133850.7	610761189.7	571645816.6
35 to 39	2018	531387014.5	548149258.5	514538370.3
40 to 44	2018	490465267.1	506372984.1	474366524.5
45 to 49	2018	470841955.4	487805016.7	454027560.5
total	2018	3909763803	4035006006	3783547735
15 to 19	2019	619540978.1	639410643.1	600449626
20 to 24	2019	600144464.9	619566711.2	581021870.5
25 to 29	2019	605470102.4	626202183.3	584989358.8
30 to 34	2019	601732453.7	623410373.9	580098350.7
35 to 39	2019	540976121.5	559170147.5	522534368.2
40 to 44	2019	493443132.4	510303392	476222491.8
45 to 49	2019	473801065.3	491190698.2	455039768.8
total	2019	3935108318	4069254149	3800355835

Table S3. Incidence and corresponding EAPC of 29 early-onset cancer types in 1990 and 2019.

Early-onset cancer types	1990 Incidence		2019 Incidence		1990-2019 Incidence
	Cases No. (95% UI)	Rate per 100k No. (95% UI)	Cases No. (95% UI)	Rate per 100k No. (95% UI)	EAPC No. (95% CI)
Bladder cancer	18851.7 (17877.6-19937)	0.7 (0.7-0.7)	38922.2 (34991.5-43223.9)	1 (0.9-1.1)	1 (0.92, 1.08)
Brain and central nervous system cancer	54922.8 (47514.5-66711.4)	2 (1.8-2.5)	102687.2 (80889.9-115093.7)	2.6 (2.1-2.9)	0.8 (0.74, 0.86)
Breast cancer	260836.3 (250473.6-271710.5)	9.6 (9.2-10)	537979.6 (490640.8-588711.2)	13.7 (12.5-15)	1.01 (0.9, 1.12)
Cervical cancer	160770.2 (141427.6-186580.3)	5.9 (5.2-6.9)	256902.2 (215920.8-289544.9)	6.5 (5.5-7.4)	0.28 (0.22, 0.34)
Colorectal cancer	94707.1 (90420.5-99416.4)	3.5 (3.3-3.7)	225736 (207658-246755.7)	5.7 (5.3-6.3)	1.73 (1.65, 1.8)
Esophageal cancer	32454.9 (25094.2-36124.1)	1.2 (0.9-1.3)	40818.9 (36352.6-46025.9)	1 (0.9-1.2)	-0.86 (-1.25, -0.48)
Gallbladder and biliary tract cancer	9006.6 (8136.5-10218.2)	0.3 (0.3-0.4)	13722.5 (11736.3-15194.5)	0.3 (0.3-0.4)	0.18 (0.1, 0.26)
Hodgkin lymphoma	33409.6 (26787.6-36176.5)	1.2 (1-1.3)	43574.3 (39046.3-52320.7)	1.1 (1-1.3)	-0.47 (-0.54, -0.41)
Kidney cancer	23875.5 (22848.6-24856.1)	0.9 (0.8-0.9)	57999.5 (52884.9-63376.5)	1.5 (1.3-1.6)	1.75 (1.62, 1.87)
Larynx cancer	16296.6 (15544.1-17094.1)	0.6 (0.6-0.6)	21549.1 (19780.8-23591)	0.5 (0.5-0.6)	-0.71 (-0.84, -0.58)
Leukemia	109042 (96043.9-120420.4)	4 (3.5-4.4)	155420.8 (139380.4-169956.2)	3.9 (3.5-4.3)	-0.25 (-0.33, -0.16)
Lip and oral cavity cancer	39319.9 (37399.9-41418.2)	1.4 (1.4-1.5)	74344.2 (66884.1-81548.6)	1.9 (1.7-2.1)	0.76 (0.69, 0.83)
Liver cancer	88117.2 (76723.3-101492.9)	3.2 (2.8-3.7)	78299.4 (68668-89097.7)	2 (1.7-2.3)	-2.88 (-3.46, -2.3)
Malignant skin melanoma	38988.2 (29130.2-44281.6)	1.4 (1.1-1.6)	72968.4 (59581.3-91447.6)	1.9 (1.5-2.3)	0.68 (0.51, 0.84)
Mesothelioma	2615.4 (1948.1-3556.7)	0.1 (0.1-0.1)	3740.3 (3161.6-4272.1)	0.1 (0.1-0.1)	-0.32 (-0.43, -0.21)
Multiple myeloma	5277.4 (4704.1-6325)	0.2 (0.2-0.2)	10740.8 (8964.2-12044.2)	0.3 (0.2-0.3)	0.94 (0.76, 1.13)
Nasopharynx cancer	25238.2 (22682.8-27620.8)	0.9 (0.8-1)	67915.2 (59442.4-77614.4)	1.7 (1.5-2)	2.28 (2.1, 2.47)
Non-Hodgkin lymphoma	46087.4 (42095.1-51252.4)	1.7 (1.6-1.9)	81586.8 (74019-90533.3)	2.1 (1.9-2.3)	0.51 (0.42, 0.6)
Non-melanoma skin cancer	238054.1 (186397-300376.3)	8.8 (6.9-11.1)	486545 (401341.6-586406.2)	12.4 (10.2-14.9)	1.59 (1.21, 1.98)

Other malignant neoplasms	113396.4 (100921.9-123848)	4.2 (3.7-4.6)	214565.8 (195583-232245.1)	5.5 (5-5.9)	0.89 (0.85, 0.92)
Other pharynx cancers	13257.5 (12364.8-14312.9)	0.5 (0.5-0.5)	26987.7 (24143.1-29674.5)	0.7 (0.6-0.8)	0.9 (0.78, 1.01)
Ovarian cancer	39872 (34417.7-48766.4)	1.5 (1.3-1.8)	79671.9 (68572.8-90845)	2 (1.7-2.3)	0.91 (0.82, 1)
Pancreatic cancer	17479.4 (16587.8-18435.7)	0.6 (0.6-0.7)	36851.2 (33756.6-40329.9)	0.9 (0.9-1)	1.14 (1.04, 1.24)
Prostate cancer	7831.4 (6374.4-9087.1)	0.3 (0.2-0.3)	22581.2 (19175.2-27761)	0.6 (0.5-0.7)	2.23 (1.97, 2.49)
Stomach cancer	125974.3 (118139.9-133955.5)	4.6 (4.4-4.9)	144321.2 (130472.9-158788.9)	3.7 (3.3-4)	-0.84 (-0.99, -0.7)
Testicular cancer	34332.8 (27953.8-37230.1)	1.3 (1-1.4)	72597.2 (64977.7-81950)	1.8 (1.7-2.1)	1.23 (1.18, 1.27)
Thyroid cancer	35055.2 (31179.3-37947)	1.3 (1.1-1.4)	91032.5 (80018.5-99250.1)	2.3 (2-2.5)	1.96 (1.76, 2.15)
Tracheal, bronchus, and lung cancer	106306.3 (100111.4-113467.8)	3.9 (3.7-4.2)	136946.2 (123422.3-150290.4)	3.5 (3.1-3.8)	-0.7 (-0.9, -0.5)
Uterine cancer	30231.6 (25409.9-32988)	1.1 (0.9-1.2)	63585.2 (54747.7-71083)	1.6 (1.4-1.8)	1.32 (1.03, 1.62)

Abbreviations: EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval.

Table S4. Death and corresponding EAPC of 29 early-onset cancer types in 1990 and 2019.

Early-onset cancer types	1990 Death		2019 Death		1990-2019 Death
	Cases No. (95% UI)	Rate per 100k No. (95% UI)	Cases No. (95% UI)	Rate per 100k No. (95% UI)	EAPC No. (95% CI)
Bladder cancer	5598.6 (5227.7-6015.6)	0.2 (0.2-0.2)	7784 (7090.9-8593.1)	0.2 (0.2-0.2)	-0.42 (-0.53, -0.32)
Brain and central nervous system cancer	37501 (31997.3-45876.4)	1.4 (1.2-1.7)	55346.1 (43753.7-61463.2)	1.4 (1.1-1.6)	-0.09 (-0.19, 0.01)
Breast cancer	86957.8 (82562.6-92106.1)	3.2 (3-3.4)	136448.7 (124894.9-149068.5)	3.5 (3.2-3.8)	0 (-0.12, 0.12)
Cervical cancer	58081.3 (50008.7-68379)	2.1 (1.8-2.5)	76549.5 (64144.3-86516.1)	1.9 (1.6-2.2)	-0.42 (-0.5, -0.34)
Colorectal cancer	50436.5 (47475-53367.8)	1.9 (1.8-2)	86545.6 (80162-93431.1)	2.2 (2-2.4)	0.48 (0.4, 0.55)
Esophageal cancer	28632.6 (22111.7-31956.5)	1.1 (0.8-1.2)	32955.9 (29538-37482.2)	0.8 (0.8-1)	-1.19 (-1.57, -0.8)

Gallbladder and biliary tract cancer	6664.5 (5955.8-7687.5)	0.2 (0.2-0.3)	9761.2 (8321.2-10715)	0.2 (0.2-0.3)	0.05 (-0.03, 0.13)
Hodgkin lymphoma	11982.8 (9385-13204.9)	0.4 (0.3-0.5)	11183.8 (9517.9-13128.8)	0.3 (0.2-0.3)	-1.73 (-1.83, -1.63)
Kidney cancer	6845.8 (6485.6-7172.3)	0.3 (0.2-0.3)	12957.9 (11916.3-14161.8)	0.3 (0.3-0.4)	0.81 (0.7, 0.92)
Larynx cancer	10561.8 (9928.2-11154.6)	0.4 (0.4-0.4)	11834 (10813.4-13097.7)	0.3 (0.3-0.3)	-1.28 (-1.42, -1.15)
Leukemia	68426.4 (59766.5-75746.6)	2.5 (2.2-2.8)	69298.4 (62141-75429.3)	1.8 (1.6-1.9)	-1.44 (-1.54, -1.35)
Lip and oral cavity cancer	17492.9 (16405.1-18751.3)	0.6 (0.6-0.7)	31258.4 (27932.4-34762.2)	0.8 (0.7-0.9)	0.58 (0.5, 0.66)
Liver cancer	78416.1 (67900.6-90532.2)	2.9 (2.5-3.3)	60602.5 (53310-68336.1)	1.5 (1.4-1.7)	-3.39 (-4, -2.77)
Malignant skin melanoma	7892 (6189.7-9560.7)	0.3 (0.2-0.4)	9880.3 (8113-12023.4)	0.3 (0.2-0.3)	-0.78 (-0.89, -0.68)
Mesothelioma	1820.9 (1377-2457.6)	0.1 (0.1-0.1)	2707.8 (2318.1-3058.3)	0.1 (0.1-0.1)	-0.14 (-0.24, -0.03)
Multiple myeloma	3539.4 (3127.3-4353.6)	0.1 (0.1-0.2)	6418.1 (5369.8-7111.9)	0.2 (0.1-0.2)	0.52 (0.36, 0.67)
Nasopharynx cancer	16563.7 (14922.1-18246.7)	0.6 (0.6-0.7)	17237.5 (15774.7-18851.4)	0.4 (0.4-0.5)	-1.44 (-1.57, -1.3)
Non-Hodgkin lymphoma	25306.5 (23603.2-27119)	0.9 (0.9-1)	38451.3 (35770.2-41630.3)	1 (0.9-1.1)	0 (-0.08, 0.08)
Non-melanoma skin cancer	2517.8 (2321.6-2736.7)	0.1 (0.1-0.1)	3748.6 (3450-4020.7)	0.1 (0.1-0.1)	0.07 (-0.03, 0.17)
Other malignant neoplasms	56333.1 (50107.6-60578.5)	2.1 (1.8-2.2)	83689 (75459.7-91529.7)	2.1 (1.9-2.3)	-0.06 (-0.1, -0.01)
Other pharynx cancers	9215.2 (8498.4-10176.1)	0.3 (0.3-0.4)	16843.5 (14816.9-18804.9)	0.4 (0.4-0.5)	0.56 (0.46, 0.66)
Ovarian cancer	15138.9 (12927.3-18976.1)	0.6 (0.5-0.7)	27759.2 (23923-31721.7)	0.7 (0.6-0.8)	0.59 (0.49, 0.69)
Pancreatic cancer	15285.8 (14453.1-16200.3)	0.6 (0.5-0.6)	32004 (29401.6-34968.4)	0.8 (0.7-0.9)	1.11 (1.01, 1.21)
Prostate cancer	2110.1 (1706.7-2332.4)	0.1 (0.1-0.1)	3574.1 (3008.8-4281.9)	0.1 (0.1-0.1)	0.33 (0.23, 0.44)
Stomach cancer	97382.7 (90808.2-104061.7)	3.6 (3.3-3.8)	87333.5 (79904.3-95000.1)	2.2 (2-2.4)	-1.78 (-1.99, -1.58)
Testicular cancer	4917.3 (4639.3-5178.3)	0.2 (0.2-0.2)	6867.7 (6306.5-7457.3)	0.2 (0.2-0.2)	-0.19 (-0.28, -0.1)
Thyroid cancer	3795.8 (3246-4304)	0.1 (0.1-0.2)	5925.5 (5262.9-6473.7)	0.2 (0.1-0.2)	0.11 (0, 0.22)
Tracheal, bronchus, and lung cancer	91573.6 (85931-98019.2)	3.4 (3.2-3.6)	110729.4 (101076.6-120624.3)	2.8 (2.6-3.1)	-0.94 (-1.14, -0.74)
Uterine cancer	5878.3 (4443.6-6749.3)	0.2 (0.2-0.2)	7120.6 (5825.5-7914.1)	0.2 (0.1-0.2)	-0.83 (-1.13, -0.52)

Abbreviations: EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval.

Table S5. Disability-adjusted life years (DALYs) and corresponding EAPC of 29 early-onset cancers in 1990 and 2019.

Early-onset cancer types	1990 DALYs		2019 DALYs		1990-2019 DALYs
	Cases No. (95% UI)	Rate per 100k No. (95% UI)	Cases No. (95% UI)	Rate per 100k No. (95% UI)	EAPC No. (95% CI)
Bladder cancer	279920.4 (260428.6-301617.8)	10.3 (9.6-11.1)	390740.7 (357671.3-429267.4)	9.9 (9.1-10.9)	-0.41 (-0.51, -0.31)
Brain and central nervous system cancer	2027034.2 (1731600.3-2486867.8)	74.7 (63.8-91.7)	2917783.9 (2305065.6-3247570.8)	74.1 (58.6-82.5)	-0.17 (-0.26, -0.08)
Breast cancer	4327460.9 (4102075.4-4590967.7)	159.6 (151.2-169.3)	6832262.2 (6219746.4-7431400.4)	173.6 (158.1-188.8)	0.02 (-0.1, 0.14)
Cervical cancer	2913442.6 (2504657.5-3437397.7)	107.4 (92.3-126.7)	3801241.7 (3175065.5-4285528.7)	96.6 (80.7-108.9)	-0.47 (-0.55, -0.38)
Colorectal cancer	2516720.9 (2368905.6-2663625.4)	92.8 (87.3-98.2)	4259922 (3942849.9-4590979.2)	108.3 (100.2-116.7)	0.42 (0.35, 0.49)
Esophageal cancer	1327637 (1026867.4-1476512.8)	49 (37.9-54.4)	1516319 (1361708.2-1720376.2)	38.5 (34.6-43.7)	-1.22 (-1.59, -0.84)
Gallbladder and biliary tract cancer	315792.5 (282111.5-364221.4)	11.6 (10.4-13.4)	456165.2 (388506.3-500980.1)	11.6 (9.9-12.7)	-0.01 (-0.09, 0.07)
Hodgkin lymphoma	696643.2 (547556.6-767547.2)	25.7 (20.2-28.3)	650560.1 (554149-764527.6)	16.5 (14.1-19.4)	-1.71 (-1.81, -1.61)
Kidney cancer	341994.9 (323772.6-359870.6)	12.6 (11.9-13.3)	646339.9 (594759.4-706070)	16.4 (15.1-17.9)	0.82 (0.72, 0.93)
Larynx cancer	496236.2 (467216.1-524227.7)	18.3 (17.2-19.3)	555495.2 (508685.9-611840.7)	14.1 (12.9-15.5)	-1.29 (-1.42, -1.15)
Leukemia	3984968.1 (3463513.2-4416809.9)	146.9 (127.7-162.9)	3913497.7 (3502797.6-4267249.9)	99.5 (89-108.4)	-1.54 (-1.64, -1.45)
Lip and oral cavity cancer	858787.6 (804949.5-919796.6)	31.7 (29.7-33.9)	1527398 (1366591.5-1697046.4)	38.8 (34.7-43.1)	0.55 (0.48, 0.63)
Liver cancer	3826682 (3314993-4420259.5)	141.1 (122.2-163)	2898076.8 (2554655.9-3261451.2)	73.6 (64.9-82.9)	-3.46 (-4.06, -2.86)
Malignant skin melanoma	415705.6 (327380.4-506830.2)	15.3 (12.1-18.7)	524345.1 (427761.5-639655.8)	13.3 (10.9-16.3)	-0.74 (-0.84, -0.65)
Mesothelioma	91409.1 (67711.5-125083.1)	3.4 (2.5-4.6)	132402.6 (112421-150038.2)	3.4 (2.9-3.8)	-0.25 (-0.35, -0.14)
Multiple myeloma	169068.4 (150052.6-209555.5)	6.2 (5.5-7.7)	306838.9 (256087.6-340491.4)	7.8 (6.5-8.7)	0.51 (0.35, 0.67)
Nasopharynx cancer	844065.6 (760336.6-928015.4)	31.1 (28-34.2)	874186.4 (804883.7-952901.8)	22.2 (20.5-24.2)	-1.47 (-1.61, -1.33)
Non-Hodgkin lymphoma	1392131.7 (1294870.8-1494921)	51.3 (47.7-55.1)	2066163.5 (1924546.4-2237846.4)	52.5 (48.9-56.9)	-0.08 (-0.16, -0.01)
Non-melanoma skin cancer	128327.7 (118778.6-139250.1)	4.7 (4.4-5.1)	187302.7 (172963.6-200586.2)	4.8 (4.4-5.1)	-0.01 (-0.1, 0.08)

Other malignant neoplasms	3194375 (2838849.1-3437705)	117.8 (104.7-126.7)	4682788.6 (4222113.3-5113396.2)	119 (107.3-129.9)	-0.1 (-0.14, -0.05)
Other pharynx cancers	436024.6 (401114.7-484058.5)	16.1 (14.8-17.8)	795774.7 (700405.9-888018.6)	20.2 (17.8-22.6)	0.55 (0.45, 0.65)
Ovarian cancer	760870.4 (645441.4-960212.7)	28.1 (23.8-35.4)	1379355.3 (1183284.2-1574161.6)	35.1 (30.1-40)	0.55 (0.45, 0.64)
Pancreatic cancer	723474.5 (682646.9-767793.3)	26.7 (25.2-28.3)	1489527.7 (1368667.3-1627198.3)	37.9 (34.8-41.4)	1.04 (0.95, 1.13)
Prostate cancer	105476.6 (84960.1-115605.9)	3.9 (3.1-4.3)	182131.6 (154399-217655.1)	4.6 (3.9-5.5)	0.41 (0.3, 0.51)
Stomach cancer	4743785.3 (4423216.2-5063886)	174.9 (163.1-186.7)	4206556.7 (3853720.9-4566426.9)	106.9 (97.9-116)	-1.84 (-2.04, -1.64)
Testicular cancer	297954.5 (280555.7-314734.3)	11 (10.3-11.6)	424469.8 (388485.7-462990)	10.8 (9.9-11.8)	-0.11 (-0.2, -0.02)
Thyroid cancer	215255.2 (182182.9-244090.3)	7.9 (6.7-9)	347975.8 (306330.9-384509.9)	8.8 (7.8-9.8)	0.23 (0.12, 0.34)
Tracheal, bronchus, and lung cancer	4308319.8 (4042416-4611324.6)	158.8 (149-170)	5147912.6 (4703827.5-5611862.2)	130.8 (119.5-142.6)	-1 (-1.19, -0.8)
Uterine cancer	295925.1 (223759.1-340039.8)	10.9 (8.3-12.5)	365187 (300719.7-406309.7)	9.3 (7.6-10.3)	-0.76 (-1.05, -0.47)

Abbreviations: EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval.

Table S6. Incidence and death of early-onset breast cancer, TBL cancer, CRC and stomach cancer by region and sociodemographic index level in 1990 and 2019.

Cancers	SDI regions	1990 Incidence		2019 Incidence		1990 Death		2019 Death	
		Cases (95% UI)	ASR per 100k (95% UI)	Cases (95% UI)	ASR per 100k (95% UI)	Cases (95% UI)	ASR per 100k (95% UI)	Cases (95% UI)	ASR per 100k (95% UI)
Breast cancer	Global	260836.3 (250473.6-271710.5)	11.2 (11.2, 11.3)	537979.6 (490640.8-588711.2)	13.2 (13.1, 13.2)	86957.8 (82562.6-92106.1)	3.7 (3.7, 3.8)	136448.7 (124894.9-149068.5)	3.3 (3.3, 3.4)
	Low SDI	9363.7 (8001.9-10797.6)	5.2 (5.1, 5.3)	32559.2 (27874.8-37975.8)	7.6 (7.5, 7.7)	6211.2 (5321.9-7235.5)	3.5 (3.4, 3.6)	17240.6 (14793.9-20021.6)	4.1 (4, 4.1)
	Low-middle SDI	26776.6 (23729.1-30345.5)	6.1 (6, 6.2)	83499.4 (72485-95330.3)	9.6 (9.6, 9.7)	15570.4 (13780.3-17711.6)	3.6 (3.5, 3.6)	35253.3 (30234.7-40788.5)	4.1 (4, 4.1)
	Middle SDI	52827.9 (48220.2-57995.7)	7.3 (7.2, 7.3)	167017.6 (147164.1-187948)	12.3 (12.2, 12.3)	23883.3 (22021.3-26229.8)	3.3 (3.3, 3.4)	44643.9 (39988.6-49854.2)	3.3 (3.2, 3.3)
	High-middle SDI	68200.6 (65207.6-71583)	12.4 (12.4, 12.5)	134512.5 (119061.7-151755.1)	15.4 (15.3, 15.5)	21200.8 (20171.9-22417)	3.9 (3.8, 3.9)	24208 (22152-26662)	2.8 (2.7, 2.8)
	High SDI	103495.7 (100980.7-105995.3)	22.9 (22.8, 23.1)	120000.7 (106168.2-134790.7)	21.1 (21, 21.2)	20026.5 (19713.9-20347.4)	4.4 (4.4, 4.5)	14976.3 (14320.5-15639.6)	2.6 (2.6, 2.7)
	High-income Asia Pacific	13747.9 (12553.4-15103)	13.5 (13.3, 13.7)	20642.6 (17076.9-24966.4)	18.4 (18.2, 18.7)	2497 (2441.6-2555.3)	2.4 (2.4, 2.5)	2237.2 (2117.6-2376.8)	2 (1.9, 2)

	Central Asia	3310.1 (3141.5-3491.5)	13.1 (12.6, 13.6)	6164.1 (5336.9-7078.8)	12.8 (12.5, 13.1)	1265.5 (1213.4-1323.7)	5.1 (4.8, 5.4)	1816.9 (1584.2-2085)	3.8 (3.6, 4)
	East Asia	34620.3 (27994.9-42038.5)	6 (6, 6.1)	112508.6 (86987.1-140589.7)	12.2 (12.1, 12.2)	13253.6 (10745.4-16007.2)	2.3 (2.3, 2.4)	17176.3 (13618-21402)	1.8 (1.8, 1.9)
	South Asia	21947.2 (18713.6-25110.8)	4.9 (4.9, 5)	78582.1 (64308.5-94610.5)	8.7 (8.6, 8.7)	13489.2 (11514.3-15394.2)	3.1 (3, 3.1)	35091.7 (28704.5-42380.8)	3.9 (3.9, 3.9)
	Southeast Asia	21600 (18378.9-25278.5)	11.4 (11.2, 11.5)	59060.6 (49804.5-69732.6)	15.6 (15.5, 15.7)	11368.3 (9772.4-13411.8)	6.1 (5.9, 6.2)	20994.5 (17773.5-24976.1)	5.5 (5.5, 5.6)
	Australasia	2775.8 (2597.1-2951)	25 (24.1, 26)	3720.3 (2886.9-4754.8)	23.4 (22.7, 24.2)	562.2 (540.5-583.5)	5.1 (4.7, 5.5)	451.3 (410.4-491.2)	2.8 (2.6, 3.1)
	Caribbean	2003.3 (1825.4-2178.9)	13.3 (12.7, 13.9)	4010.5 (3175.3-4897.6)	16.4 (15.9, 16.9)	700.7 (622-793.4)	4.7 (4.3, 5)	1194.9 (910.4-1502.5)	4.9 (4.6, 5.2)
	Central Europe	10220.4 (9804.4-10641.4)	15.9 (15.6, 16.2)	11795.2 (9939.4-14053)	17.2 (16.9, 17.6)	3053.8 (2973-3136.4)	4.8 (4.6, 4.9)	2088.7 (1773.9-2451.5)	3 (2.9, 3.2)
	Eastern Europe	17469.4 (16717.9-18417.5)	15.8 (15.6, 16.1)	21674.3 (17985.3-26158.4)	17.6 (17.4, 17.9)	5338.2 (5140.1-5589)	4.9 (4.7, 5)	4333.2 (3601.4-5238.4)	3.5 (3.4, 3.6)
	Western Europe	52039.6 (50419.1-53777.5)	25.4 (25.1, 25.6)	59394.1 (50003.8-69938.6)	24.7 (24.5, 24.9)	11030.7 (10835-11242.2)	5.4 (5.3, 5.5)	7185.5 (6867.5-7509.9)	3 (2.9, 3)
	Andean Latin America	896.3 (788.8-1018.1)	6.2 (5.8, 6.6)	2954.3 (2246.2-3790.5)	9.2 (8.9, 9.6)	451.8 (401.4-513.4)	3.1 (2.9, 3.5)	843.3 (648.7-1083.5)	2.6 (2.5, 2.8)
	Central Latin America	4907.4 (4734-5086.4)	7.9 (7.7, 8.1)	16076.5 (13150.9-19567.4)	12.3 (12.1, 12.5)	1868.4 (1815.7-1920.1)	3 (2.9, 3.2)	3786.9 (3135.7-4558.6)	2.9 (2.8, 3)
	Southern Latin America	3060.1 (2860.6-3275.4)	13.2 (12.7, 13.6)	5524.5 (4019-7322.8)	15.3 (14.9, 15.8)	1232 (1179.3-1287.7)	5.3 (5, 5.6)	1381.4 (1264.8-1497.8)	3.8 (3.6, 4)
	Tropical Latin America	6303.1 (6045.5-6593.2)	9.8 (9.5, 10)	16561.4 (15390.9-17848.8)	13 (12.8, 13.2)	2559 (2464.2-2657.4)	4 (3.8, 4.1)	4356.7 (4078.1-4673.5)	3.4 (3.3, 3.5)
	North Africa and Middle East	8993.3 (8063.8-10137.6)	7.3 (7.2, 7.5)	43491.5 (36982-50548.7)	13.2 (13.1, 13.3)	4148.4 (3748.4-4739)	3.4 (3.3, 3.5)	11426.9 (9698-13499.3)	3.5 (3.4, 3.6)
	High-income North America	46972.1 (45578.5-48289.6)	30.6 (30.4, 30.9)	43402.7 (34889.3-53837.4)	23.1 (22.8, 23.3)	7915.9 (7750.9-8074.6)	5.2 (5.1, 5.3)	5359.9 (5078.5-5649.8)	2.8 (2.8, 2.9)
	Oceania	424 (323.3-543.6)	17 (15.4, 18.7)	1528.2 (1139.7-2022)	25.3 (24, 26.6)	239.1 (180.7-305.1)	9.7 (8.5, 11)	768.5 (572.4-1017.4)	12.8 (11.9, 13.7)
	Central Sub-Saharan Africa	1087.7 (813.4-1417.6)	6.1 (5.7, 6.4)	3773.1 (2690.8-5038.6)	7.8 (7.6, 8.1)	726.4 (558.8-928.3)	4.1 (3.8, 4.4)	2143.2 (1535.8-2881.2)	4.5 (4.3, 4.7)
	Eastern Sub-Saharan Africa	3163 (2485-3839.7)	5.3 (5.1, 5.5)	9718.2 (7943.7-11706.5)	6.5 (6.3, 6.6)	2127.5 (1661.3-2563.5)	3.6 (3.4, 3.8)	5252.4 (4293.3-6348.6)	3.5 (3.4, 3.6)
	Southern Sub-Saharan Africa	1797.7 (1585.5-2005.5)	8.9 (8.5, 9.4)	3524.6 (2943.3-4188.6)	9 (8.7, 9.3)	929.6 (824-1033.7)	4.7 (4.4, 5)	1540.9 (1281-1851.8)	3.9 (3.8, 4.2)
	Western Sub-Saharan Africa	3497.8 (2738.5-4452.2)	5.4 (5.2, 5.6)	13872.5 (10392.2-17974.7)	8.5 (8.4, 8.7)	2200.5 (1752.7-2826.1)	3.4 (3.3, 3.6)	7018.5 (5309.3-9219.2)	4.3 (4.2, 4.4)
	Global	106306.3 (100111.4-113467.8)	4.7 (4.6, 4.7)	136946.2 (123422.3-150290.4)	3.3 (3.3, 3.3)	91573.6 (85931-98019.2)	4 (4, 4)	110729.4 (101076.6-120624.3)	2.7 (2.7, 2.7)
TBL	Low SDI	2309.4 (1884.7-2835.5)	1.3 (1.3, 1.4)	5971.9 (5003.9-7231.2)	1.4 (1.4, 1.5)	2091.1 (1717.3-2574.8)	1.2 (1.2, 1.3)	5404.3 (4517.7-6571.7)	1.3 (1.3, 1.4)
cancer	Low-middle SDI	9127.7 (8200.1-10297.6)	2.1 (2.1, 2.2)	18936.2 (16744-21061.4)	2.2 (2.2, 2.2)	8234.6 (7345.2-9340.4)	1.9 (1.9, 2)	16773.6 (14930.5-18639.2)	2 (1.9, 2)
	Middle SDI	31522.5 (28464.1-34800.6)	4.4 (4.4, 4.5)	51333.3 (44548.7-58301)	3.7 (3.7, 3.8)	28262.2 (25418.4-31356.9)	4 (3.9, 4)	42952.5 (37467.1-48693.4)	3.1 (3.1, 3.1)

	High-middle SDI	36355 (33963.5-39300.2)	6.8 (6.7, 6.9)	39890.6 (35596.5-44418.8)	4.5 (4.5, 4.6)	31818.6 (29616.6-34315.3)	6 (5.9, 6)	31370.6 (28381.4-34559.9)	3.5 (3.5, 3.6)
	High SDI	26944.2 (26511.4-27353.1)	6 (6, 6.1)	20741.6 (18643.1-22901.8)	3.5 (3.5, 3.6)	21125.7 (20836.3-21426.2)	4.7 (4.7, 4.8)	14166.8 (13567.6-14792.6)	2.4 (2.4, 2.5)
	High-income Asia Pacific	3882.6 (3763.5-3989.8)	3.8 (3.7, 3.9)	3158.8 (2775.1-3594.9)	2.7 (2.6, 2.8)	2887.7 (2806.7-2958.9)	2.8 (2.7, 2.9)	1747.3 (1648.8-1849.1)	1.5 (1.4, 1.6)
	Central Asia	1853.6 (1778.7-1926.4)	7.6 (7.3, 8)	1671.7 (1479.1-1894.5)	3.5 (3.3, 3.7)	1632.9 (1564.9-1697.4)	6.8 (6.5, 7.2)	1456 (1290.1-1652.2)	3 (2.9, 3.2)
	East Asia	36487.8 (31228.2-42291.2)	6.5 (6.4, 6.5)	54862.4 (45569-65209.5)	5.8 (5.7, 5.8)	32568.6 (27591.2-37929.5)	5.8 (5.7, 5.9)	43343.3 (36305-51578.9)	4.5 (4.5, 4.6)
	South Asia	5726.7 (4881.5-6509.9)	1.3 (1.3, 1.4)	14532.6 (12383.6-16642.7)	1.6 (1.6, 1.7)	5199.6 (4484.3-5959.1)	1.2 (1.2, 1.2)	13004.3 (11016.6-14900.1)	1.5 (1.4, 1.5)
	Southeast Asia	6762.8 (5969.9-7603.6)	3.7 (3.6, 3.8)	13941 (11257-16662.3)	3.7 (3.6, 3.7)	6109.2 (5395.1-6841.4)	3.4 (3.3, 3.5)	12279.2 (9985.2-14491.7)	3.2 (3.2, 3.3)
	Australasia	479.8 (455.9-506.4)	4.4 (4, 4.8)	515.2 (400.3-660.7)	3.2 (2.9, 3.4)	351.4 (334.8-368.6)	3.2 (2.9, 3.6)	328.8 (297.4-362.7)	2 (1.8, 2.2)
	Caribbean	585 (544.1-631.5)	3.9 (3.6, 4.3)	709.3 (568-867.6)	2.9 (2.7, 3.1)	514.6 (477.9-556.6)	3.5 (3.2, 3.8)	602.5 (482.6-734)	2.4 (2.2, 2.6)
	Central Europe	5959.9 (5816.7-6108)	9.5 (9.2, 9.7)	3819 (3280.9-4405.5)	5.5 (5.3, 5.6)	5271.3 (5150.4-5400)	8.4 (8.1, 8.6)	3171.8 (2705-3654.7)	4.5 (4.4, 4.7)
	Eastern Europe	8674.1 (8154.6-9032.5)	8.2 (8.1, 8.4)	5908.5 (5175.6-6758.2)	4.8 (4.7, 4.9)	7429.8 (6991.9-7725.6)	7.1 (6.9, 7.2)	4696.6 (4047.4-5353.6)	3.8 (3.7, 3.9)
	Western Europe	12812.8 (12545.6-13102.5)	6.2 (6.1, 6.3)	10578.7 (8724.1-12465.2)	4.2 (4.1, 4.3)	10396.6 (10201.3-10604.7)	5 (4.9, 5.1)	7431.9 (6968.6-7817.3)	2.9 (2.9, 3)
	Andean Latin America	362.3 (311-412.3)	2.4 (2.2, 2.7)	602.7 (456.3-788.3)	1.9 (1.7, 2)	320.1 (274.4-365.3)	2.2 (2, 2.4)	515.5 (389.2-671.9)	1.6 (1.5, 1.8)
	Central Latin America	1418 (1384.5-1453.9)	2.3 (2.1, 2.4)	2227.5 (1841.5-2671.2)	1.7 (1.6, 1.8)	1248.5 (1218.6-1282.3)	2 (1.9, 2.1)	1877.9 (1553.9-2268)	1.4 (1.4, 1.5)
	Southern Latin America	1449.1 (1379.8-1523.3)	6.3 (6, 6.6)	1095.4 (817.6-1443)	3 (2.9, 3.2)	1301.9 (1238.5-1365.4)	5.6 (5.3, 6)	921.7 (830.4-1031.6)	2.5 (2.4, 2.7)
	Tropical Latin America	1901.2 (1841.3-1968)	3 (2.9, 3.1)	2708.3 (2554.6-2865.1)	2.1 (2.1, 2.2)	1705.9 (1648.1-1766.6)	2.7 (2.6, 2.8)	2353.6 (2222.1-2485.8)	1.9 (1.8, 1.9)
	North Africa and Middle East	3777.1 (2962.8-4633.1)	3.1 (3, 3.2)	8046.6 (7010-9194.7)	2.5 (2.4, 2.5)	3425.3 (2674.6-4212.9)	2.9 (2.8, 3)	7098.2 (6158.6-8155.7)	2.2 (2.1, 2.3)
	High-income North America	11532.9 (11314.8-11759.1)	7.7 (7.6, 7.9)	7013.9 (6002.9-8224.9)	3.6 (3.5, 3.7)	8825.3 (8662.3-8993.5)	5.9 (5.8, 6.1)	4878.8 (4673.9-5083.4)	2.5 (2.4, 2.6)
	Oceania	92.3 (68.9-134.6)	3.7 (3, 4.6)	244.4 (171.1-362)	4 (3.5, 4.6)	81.5 (60.9-118.8)	3.3 (2.6, 4.1)	216.8 (150.7-322)	3.6 (3.1, 4.1)
	Central Sub-Saharan Africa	421.2 (237.3-848.8)	2.5 (2.3, 2.7)	974.6 (606.3-1753.6)	2.1 (2, 2.3)	379.6 (213.8-762.5)	2.3 (2, 2.5)	885.1 (548.8-1601.6)	1.9 (1.8, 2.1)
	Eastern Sub-Saharan Africa	566.9 (466-710.4)	1 (0.9, 1.1)	1425.7 (1126.1-1806.8)	1 (0.9, 1)	511.3 (417.7-640.4)	0.9 (0.8, 1)	1304.6 (1034-1639.8)	0.9 (0.9, 1)
	Southern Sub-Saharan Africa	903.1 (805.3-1029.7)	4.8 (4.5, 5.2)	1074 (929.2-1231.7)	2.8 (2.7, 3)	823.3 (729.1-934.6)	4.4 (4.1, 4.7)	967 (841.2-1105.6)	2.6 (2.4, 2.7)
	Western Sub-Saharan Africa	657 (529.4-796.5)	1 (0.9, 1.1)	1835.8 (1459.4-2241.7)	1.1 (1.1, 1.2)	589.4 (480.4-715.8)	0.9 (0.8, 1)	1648.4 (1312.8-2024.7)	1 (1, 1.1)
CRC	Global	94707.1 (90420.5-99416.4)	4 (4, 4)	225736 (207658-246755.7)	5.5 (5.5, 5.5)	50436.5 (47475-53367.8)	2.1 (2.1, 2.2)	86545.6 (80162-93431.1)	2.1 (2.1, 2.1)
	Low SDI	2777 (2284.1-3327.5)	1.5 (1.5, 1.6)	7716.4 (6643-8911.9)	1.8 (1.8, 1.8)	2225.6 (1836.4-2671)	1.2 (1.2, 1.3)	5693 (4933-6582.5)	1.3 (1.3, 1.4)

Low-middle SDI	8615 (7710.5-9669.5)	1.9 (1.9, 2)	24979.5 (22488.3-27829.7)	2.9 (2.8, 2.9)	6433.1 (5715.1-7231.1)	1.5 (1.4, 1.5)	15376.2 (13666.2-17136.9)	1.8 (1.7, 1.8)
Middle SDI	23377.9 (21458.4-25471.2)	3.1 (3.1, 3.1)	75841.7 (67256.8-85383.6)	5.6 (5.5, 5.6)	15311.1 (13878-16640)	2.1 (2, 2.1)	31223.5 (28190.6-34399.3)	2.3 (2.3, 2.3)
High-middle SDI	27712.9 (26289.2-29502.6)	5 (4.9, 5.1)	69605.6 (62366.1-77641.5)	8.1 (8, 8.1)	14897.7 (14014.1-15826.3)	2.7 (2.7, 2.7)	22183.4 (20248.8-24368.7)	2.6 (2.5, 2.6)
High SDI	32179.4 (31645.5-32734.2)	7.2 (7.1, 7.3)	47489.7 (43601.5-51742.5)	8.4 (8.3, 8.5)	11544 (11365.8-11718.1)	2.6 (2.5, 2.6)	12020.1 (11559.8-12508.9)	2.1 (2.1, 2.1)
High-income Asia Pacific	7952.7 (7713.7-8186.5)	7.8 (7.6, 8)	9294.5 (8006.7-10617.2)	8.3 (8.1, 8.5)	2837.1 (2778.7-2891.7)	2.8 (2.7, 2.9)	2056.4 (1941.2-2159.5)	1.8 (1.7, 1.9)
Central Asia	1297.1 (1243.5-1358.5)	4.8 (4.5, 5.1)	1830.9 (1636.7-2062.3)	3.8 (3.6, 4)	805.5 (773.3-844)	3 (2.8, 3.3)	982.6 (878.4-1113.7)	2 (1.9, 2.2)
East Asia	25347.7 (22184.8-28937.6)	4.2 (4.2, 4.3)	90911 (76318.1-106893.9)	10 (10, 10.1)	15532.2 (13405-17867.5)	2.6 (2.6, 2.7)	27447.4 (23104-32222.8)	3 (3, 3)
South Asia	6135.9 (5396.9-6948.6)	1.4 (1.3, 1.4)	18253.4 (15671.1-21008.5)	2 (2, 2.1)	4824.3 (4265.5-5454.8)	1.1 (1.1, 1.1)	12420.9 (10757.6-14391.2)	1.4 (1.4, 1.4)
Southeast Asia	6101.4 (5194.6-6824)	3.2 (3.1, 3.2)	18976.3 (15675-22334.4)	5 (5, 5.1)	4241 (3616.7-4793)	2.2 (2.2, 2.3)	10550.2 (8800.3-12385.5)	2.8 (2.7, 2.8)
Australasia	941.4 (892.5-992.7)	8.6 (8, 9.2)	1520.4 (1194.1-1932.8)	9.7 (9.2, 10.2)	320.6 (306.9-335.5)	2.9 (2.6, 3.3)	337.1 (308-369.5)	2.1 (1.9, 2.4)
Caribbean	575.4 (540.2-611.4)	3.7 (3.4, 4)	1222 (1005.9-1474)	5 (4.7, 5.3)	314.2 (292.3-338.6)	2 (1.8, 2.3)	561.9 (461.2-681.1)	2.3 (2.1, 2.5)
Central Europe	3846.7 (3736.7-3969.4)	6.1 (5.9, 6.3)	4850.4 (4151.5-5578.9)	7.2 (7, 7.4)	2112.8 (2056.6-2174.4)	3.3 (3.2, 3.5)	1861.5 (1598.2-2134)	2.7 (2.6, 2.9)
Eastern Europe	6810.7 (6347.7-7171.6)	6.2 (6.1, 6.4)	9238.7 (8187.5-10479.7)	7.6 (7.5, 7.8)	3514.6 (3276-3697.7)	3.2 (3.1, 3.3)	3458.8 (3063-3897.6)	2.8 (2.8, 2.9)
Western Europe	13441.6 (13128.9-13761.4)	6.6 (6.5, 6.7)	17020.9 (14619.3-19670.2)	7.1 (7, 7.2)	5082.1 (4991.8-5173.5)	2.5 (2.4, 2.5)	4247 (4053.5-4426.3)	1.8 (1.7, 1.8)
Andean Latin America	351.1 (310.6-399.2)	2.3 (2.1, 2.6)	1507.4 (1159.9-1950.9)	4.7 (4.4, 4.9)	203.3 (181.1-230.3)	1.4 (1.2, 1.6)	525.7 (410.9-669.4)	1.6 (1.5, 1.8)
Central Latin America	1452.3 (1412.9-1490.4)	2.2 (2.1, 2.3)	5782.2 (4916.4-6815)	4.4 (4.3, 4.5)	875.6 (852.8-898)	1.4 (1.3, 1.5)	2564 (2170.9-3008.6)	2 (1.9, 2)
Southern Latin America	949.7 (903.3-999.4)	4.1 (3.8, 4.3)	2233.3 (1694.2-2912.9)	6.2 (6, 6.5)	584.4 (558-613.2)	2.5 (2.3, 2.7)	1021.5 (936.1-1116.3)	2.8 (2.7, 3)
Tropical Latin America	1916.8 (1856.5-1983.1)	2.9 (2.7, 3)	5754.9 (5414.7-6061.3)	4.6 (4.4, 4.7)	1239 (1200.6-1282.7)	1.9 (1.8, 2)	2856.8 (2697.7-3003.1)	2.3 (2.2, 2.3)
North Africa and Middle East	3125.8 (2608.2-3801.4)	2.5 (2.4, 2.5)	11101.1 (9615.5-12783.3)	3.4 (3.3, 3.4)	2179.8 (1816-2650.2)	1.7 (1.7, 1.8)	5485 (4715.8-6362.1)	1.7 (1.6, 1.7)
High-income North America	11664.8 (11348.3-11962.4)	7.7 (7.5, 7.8)	18499.3 (15902.1-21546.9)	9.8 (9.7, 10)	3604.5 (3516.8-3688.1)	2.4 (2.3, 2.5)	4544.6 (4398.5-4709)	2.4 (2.3, 2.5)
Oceania	61 (48.7-76)	2.4 (1.8, 3.1)	164.6 (125.9-215.1)	2.7 (2.3, 3.1)	42.8 (33.7-53.6)	1.7 (1.2, 2.3)	111.8 (84.6-147.5)	1.8 (1.5, 2.2)
Central Sub-Saharan Africa	291.3 (215.4-386.8)	1.6 (1.4, 1.8)	797.7 (566.4-1081.9)	1.6 (1.5, 1.8)	232 (177.1-305.3)	1.3 (1.1, 1.5)	604.2 (427.9-820.8)	1.3 (1.2, 1.4)
Eastern Sub-Saharan Africa	1066.6 (858.1-1310.7)	1.8 (1.6, 1.9)	3089 (2525.8-3770.4)	2 (2, 2.1)	849.7 (678.3-1042.6)	1.4 (1.3, 1.5)	2298.2 (1884.8-2807.8)	1.5 (1.5, 1.6)
Southern Sub-Saharan Africa	565.9 (507.9-631.5)	2.8 (2.6, 3)	1111.1 (955.2-1276.6)	2.8 (2.6, 3)	405.9 (366.2-451.8)	2 (1.8, 2.2)	738 (635-851.9)	1.9 (1.7, 2)
Western Sub-Saharan Africa	811.1 (642.4-1008.6)	1.2 (1.1, 1.3)	2577 (2059.5-3111.6)	1.5 (1.5, 1.6)	635.1 (500.1-791.2)	1 (0.9, 1)	1872 (1493.9-2315.5)	1.1 (1.1, 1.2)

	Global	125974.3 (118139.9-133955.5)	5.4 (5.3, 5.4)	144321.2 (130472.9-158788.9)	3.5 (3.5, 3.6)	97382.7 (90808.2-104061.7)	4.2 (4.1, 4.2)	87333.5 (79904.3-95000.1)	2.1 (2.1, 2.1)
	Low SDI	5835.5 (4920.5-6622.3)	3.2 (3.1, 3.3)	9441.7 (8062-10865.2)	2.2 (2.2, 2.3)	5185.9 (4411-5845.1)	2.9 (2.8, 3)	8351.3 (7187-9592)	2 (1.9, 2)
	Low-middle SDI	18731.3 (16680.3-20403.8)	4.2 (4.2, 4.3)	26153 (23536-28918.2)	3 (3, 3)	16458.5 (14722.8-17964.3)	3.8 (3.7, 3.8)	21408.6 (19236-23771.6)	2.5 (2.4, 2.5)
	Middle SDI	41707 (37519.7-46081.8)	5.7 (5.7, 5.8)	54281.9 (47258.6-61911.5)	4 (3.9, 4)	34945.5 (31453.6-38870.9)	4.8 (4.8, 4.9)	31097.3 (27804.1-34949.7)	2.3 (2.2, 2.3)
	High-middle SDI	35029.6 (32514.5-37646.2)	6.4 (6.3, 6.5)	40349.1 (35304.3-45650.3)	4.7 (4.6, 4.7)	27950.4 (25910.2-30134)	5.1 (5.1, 5.2)	20715.7 (18484-22953.5)	2.4 (2.3, 2.4)
	High SDI	24633 (24088.8-25166.5)	5.5 (5.4, 5.6)	14041.5 (12929.2-15275.4)	2.5 (2.5, 2.5)	12811 (12569-13027.3)	2.9 (2.8, 2.9)	5717.8 (5462.9-5995.2)	1 (1, 1)
	High-income Asia Pacific	16694.8 (16188.1-17189.8)	16.5 (16.3, 16.8)	6407.9 (5627.8-7282.8)	5.9 (5.8, 6.1)	7715.8 (7482.3-7894.4)	7.7 (7.5, 7.8)	2069 (1943.4-2212.1)	1.9 (1.8, 2)
	Central Asia	2161.1 (2076.7-2244.2)	8.5 (8.1, 8.8)	1974.4 (1764.8-2229.9)	4.1 (3.9, 4.3)	1875 (1799-1947.7)	7.5 (7.1, 7.8)	1679.7 (1497.9-1900)	3.5 (3.3, 3.7)
	East Asia	49304.8 (42924.4-56327.8)	8.6 (8.6, 8.7)	68382.2 (56611.1-81594.8)	7.4 (7.4, 7.5)	40658 (34888.9-46565.6)	7.2 (7.1, 7.3)	32211.4 (26787.3-38306)	3.4 (3.4, 3.5)
	South Asia	14580.2 (12911.5-16083.5)	3.2 (3.2, 3.3)	21127.2 (18261.3-24233.1)	2.3 (2.3, 2.4)	12915.2 (11397-14184.9)	2.9 (2.8, 2.9)	18314.2 (15927.6-21109.5)	2 (2, 2.1)
	Southeast Asia	5693.3 (4809.9-6436.8)	3 (2.9, 3.1)	6354.4 (5397.3-7406.5)	1.7 (1.6, 1.7)	4947.9 (4220.1-5516.7)	2.6 (2.5, 2.7)	5019.6 (4323.5-5812.6)	1.3 (1.3, 1.4)
Stomach cancer	Australasia	210.7 (198.4-225.6)	1.9 (1.7, 2.2)	241.8 (185.8-310.1)	1.5 (1.4, 1.8)	118.3 (112.2-124.7)	1.1 (0.9, 1.3)	102.1 (90.4-115.2)	0.6 (0.5, 0.8)
	Caribbean	409.5 (348.7-452.6)	2.7 (2.4, 2.9)	534.8 (432.1-643.9)	2.2 (2, 2.4)	346.8 (292.9-385.5)	2.3 (2, 2.5)	436.6 (348.7-528.9)	1.8 (1.6, 2)
	Central Europe	2511.2 (2452.4-2570.1)	3.9 (3.8, 4.1)	1460.4 (1262.4-1678.1)	2.2 (2, 2.3)	2128.3 (2076.8-2181)	3.3 (3.2, 3.5)	1086.3 (933.4-1254.5)	1.6 (1.5, 1.7)
	Eastern Europe	9947.9 (9280.4-10297.7)	9.1 (8.9, 9.3)	6053.2 (5378.7-6793.4)	5 (4.9, 5.1)	7650.9 (7151.3-7922.7)	7 (6.9, 7.2)	3706.9 (3262.8-4180.3)	3 (2.9, 3.1)
	Western Europe	6142.6 (6007.9-6269.8)	3 (2.9, 3.1)	4611.8 (3923.7-5399)	1.9 (1.9, 2)	4002.3 (3924.6-4072)	2 (1.9, 2)	2168.7 (2043-2296.1)	0.9 (0.9, 0.9)
	Andean Latin America	985.2 (889-1095.8)	6.5 (6.1, 7)	1510.6 (1177.3-1917.6)	4.7 (4.5, 4.9)	857.4 (773.2-951)	5.8 (5.4, 6.2)	1185.4 (924.7-1503.6)	3.7 (3.5, 3.9)
	Central Latin America	2590.3 (2514.5-2662.7)	4 (3.9, 4.2)	4706.9 (3923.5-5598.5)	3.6 (3.5, 3.7)	2136.9 (2072.6-2197.9)	3.4 (3.2, 3.5)	3253.4 (2730.4-3876.7)	2.5 (2.4, 2.6)
	Southern Latin America	845.1 (809.6-885.2)	3.6 (3.4, 3.9)	916 (704.2-1196.6)	2.6 (2.4, 2.7)	694.9 (666.7-726.7)	3 (2.8, 3.2)	642.9 (591.4-700.2)	1.8 (1.6, 1.9)
	Tropical Latin America	2493.3 (2410-2578.5)	3.8 (3.7, 4)	3064.3 (2911-3226.3)	2.4 (2.3, 2.5)	2154.1 (2077.5-2231)	3.3 (3.2, 3.5)	2408.9 (2287.8-2525.5)	1.9 (1.8, 2)
	North Africa and Middle East	4441 (3842.7-4988.3)	3.5 (3.4, 3.6)	7272.1 (6170.9-8484)	2.2 (2.2, 2.3)	3858.9 (3342.9-4340.6)	3.1 (3, 3.2)	5676.5 (4740.1-6694.7)	1.7 (1.7, 1.8)
	High-income North America	2492.6 (2423.1-2554.1)	1.6 (1.6, 1.7)	2785.3 (2404.8-3259.4)	1.5 (1.4, 1.6)	1370.1 (1335.5-1400.6)	0.9 (0.9, 0.9)	1226.3 (1174.3-1282.5)	0.7 (0.6, 0.7)
	Oceania	126.4 (95.4-158.4)	4.9 (4.1, 5.9)	293.5 (212-392.5)	4.8 (4.2, 5.3)	108.7 (82.1-136.5)	4.3 (3.5, 5.2)	252.2 (182.5-337.9)	4.1 (3.6, 4.7)
	Central Sub-Saharan Africa	544.3 (412-697.8)	3 (2.8, 3.3)	905.5 (672.9-1187.3)	1.9 (1.8, 2)	480.4 (369.3-599)	2.7 (2.5, 3)	805.2 (598.7-1067.4)	1.7 (1.6, 1.8)

Eastern Sub-Saharan Africa	1916.8 (1532.4-2213.4)	3.2 (3, 3.3)	2711.2 (2256.9-3264.7)	1.8 (1.7, 1.9)	1694.9 (1349.6-1954)	2.8 (2.7, 3)	2432.5 (2017.1-2917)	1.6 (1.6, 1.7)
Southern Sub-Saharan Africa	562.1 (514.3-608.5)	2.8 (2.6, 3.1)	618.6 (522.2-727.8)	1.6 (1.5, 1.7)	492.3 (450.7-533.2)	2.5 (2.3, 2.7)	535 (454.6-630.1)	1.4 (1.3, 1.5)
Western Sub-Saharan Africa	1320.8 (1108.7-1516.4)	2 (1.9, 2.1)	2389.2 (1933.4-2896)	1.4 (1.4, 1.5)	1175.6 (999.6-1359.9)	1.8 (1.7, 1.9)	2120.4 (1707.2-2570)	1.3 (1.2, 1.3)

Abbreviations: ASR, age-standardized rate; TBL, tracheal, bronchus, and lung; CRC, colorectal cancer.

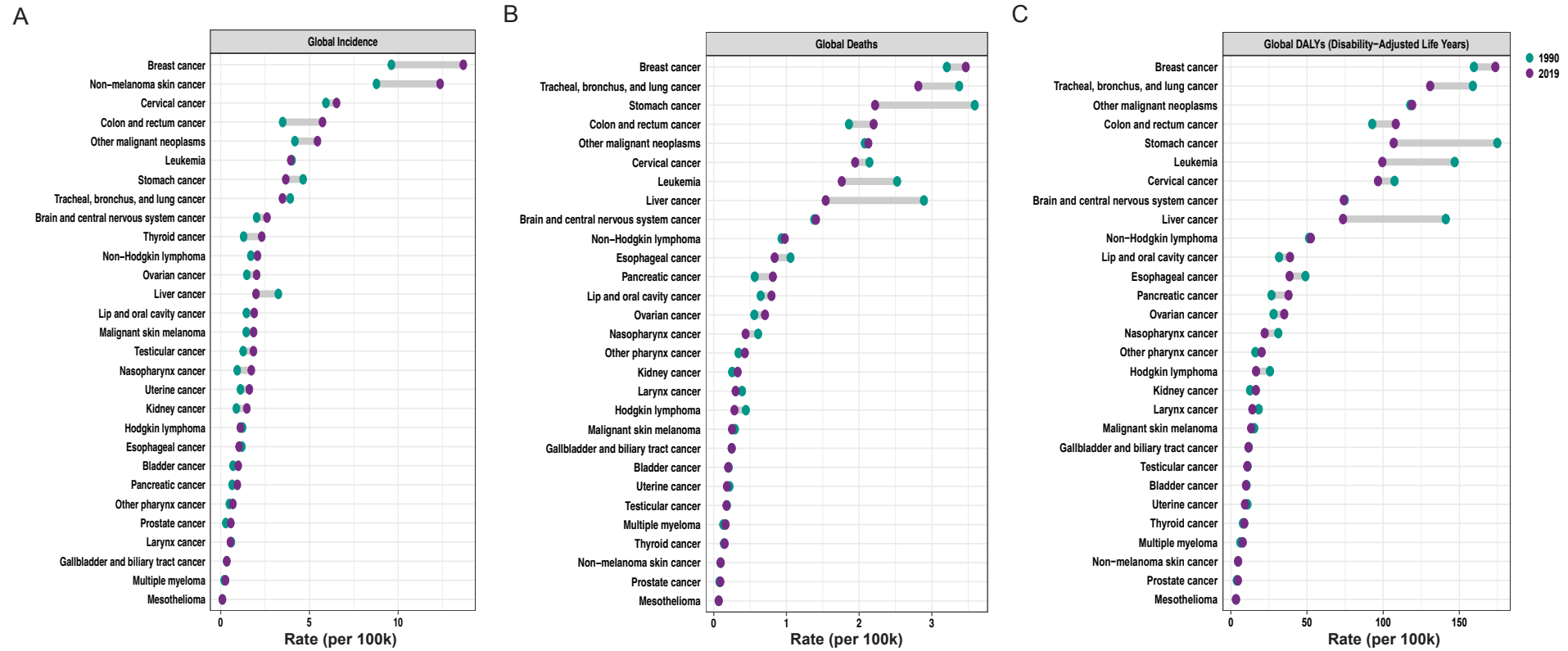
Table S7. Incidence and and death of all early-onset cancers in 1990 and 2019 by region and sociodemographic index level.

Location	Incidence		Death		DALYs	
	1990 ASR per 100k	2019 ASR per 100k	1990 ASR per 100k	2019 ASR per 100k	1990 ASR per 100k	2019 ASR per 100k
Global	75.7 (75.6, 75.8)	80.3 (80.2, 80.4)	34.7 (34.6, 34.8)	26.1 (26.1, 26.2)	1727.9 (1727.3, 1728.4)	1321.7 (1321.4, 1322.1)
Low SDI	43.2 (42.9, 43.5)	45.3 (45.1, 45.5)	28.4 (28.2, 28.7)	26.8 (26.6, 26.9)	1409 (1407.3, 1410.8)	1334.7 (1333.7, 1335.8)
Low-middle SDI	45.5 (45.3, 45.7)	52.8 (52.6, 52.9)	29.5 (29.3, 29.6)	27.7 (27.6, 27.8)	1473.8 (1472.7, 1475)	1392.9 (1392.1, 1393.7)
Middle SDI	59 (58.8, 59.2)	68.9 (68.8, 69.1)	37 (36.9, 37.2)	26.8 (26.7, 26.9)	1841.2 (1840.2, 1842.2)	1356.1 (1355.5, 1356.7)
High-middle SDI	81.5 (81.3, 81.7)	94.5 (94.3, 94.7)	40.5 (40.3, 40.7)	26.9 (26.8, 27)	2007.1 (2006, 2008.3)	1368.5 (1367.7, 1369.3)
High SDI	139.1 (138.8, 139.5)	159.7 (159.4, 160)	31.2 (31, 31.3)	19.8 (19.7, 20)	1563.2 (1562, 1564.3)	1023 (1022.1, 1023.8)
High-income Asia Pacific	82.2 (81.6, 82.8)	86.1 (85.5, 86.7)	29.5 (29.2, 29.9)	16.3 (16, 16.5)	1486.6 (1484.2, 1489)	840.6 (838.7, 842.4)
Central Asia	78.8 (77.7, 79.9)	72.5 (71.7, 73.2)	42.3 (41.5, 43.2)	31.8 (31.3, 32.3)	2115.5 (2109.9, 2121.2)	1609.7 (1606.1, 1613.3)
East Asia	69.1 (68.9, 69.3)	92.5 (92.3, 92.7)	46.6 (46.4, 46.8)	29.6 (29.5, 29.7)	2301.7 (2300.5, 2302.9)	1502.2 (1501.3, 1503)
South Asia	38.3 (38.1, 38.5)	46.3 (46.1, 46.4)	25.6 (25.4, 25.7)	25.9 (25.8, 26)	1281.6 (1280.5, 1282.6)	1301.7 (1300.9, 1302.4)
Southeast Asia	53.8 (53.5, 54.1)	61.1 (60.8, 61.3)	32.5 (32.3, 32.8)	28.4 (28.3, 28.6)	1631.2 (1629.4, 1633)	1437.3 (1436, 1438.5)
Australasia	146.2 (144, 148.5)	157.7 (155.7, 159.7)	28.6 (27.6, 29.6)	20 (19.3, 20.7)	1456.1 (1448.9, 1463.2)	1044.3 (1039.1, 1049.5)
Caribbean	69.3 (68, 70.6)	75.3 (74.3, 76.4)	32.4 (31.5, 33.3)	30.3 (29.6, 31)	1626.8 (1620.5, 1633.1)	1529.7 (1524.8, 1534.6)
Central Europe	98.3 (97.5, 99.1)	103.7 (102.9, 104.5)	44.8 (44.3, 45.3)	29.8 (29.4, 30.2)	2201.6 (2197.9, 2205.3)	1484.7 (1481.7, 1487.8)
Eastern Europe	93.5 (92.9, 94.1)	108.8 (108.1, 109.4)	43.4 (43, 43.8)	33.7 (33.4, 34)	2146.1 (2143.3, 2148.9)	1698.6 (1696.2, 1701)
Western Europe	118.1 (117.6, 118.6)	125.6 (125.1, 126.1)	32.6 (32.3, 32.8)	20.4 (20.2, 20.6)	1633.7 (1631.9, 1635.4)	1057.2 (1055.8, 1058.6)
Andean Latin America	57.9 (56.7, 59.1)	68.8 (67.9, 69.7)	32.1 (31.2, 33)	26.2 (25.6, 26.8)	1620.7 (1614.4, 1627.1)	1349.9 (1345.9, 1353.9)

Central Latin America	60.8 (60.2, 61.4)	72.7 (72.3, 73.2)	27.7 (27.3, 28.1)	24.2 (23.9, 24.5)	1405.2 (1402.3, 1408.1)	1249.9 (1248, 1251.8)
Southern Latin America	86.8 (85.6, 88)	94.5 (93.5, 95.5)	39.8 (39, 40.6)	28.5 (27.9, 29)	1977.4 (1971.7, 1983.1)	1452.6 (1448.6, 1456.5)
Tropical Latin America	75.8 (75.1, 76.5)	83.8 (83.3, 84.3)	31.9 (31.4, 32.3)	26.1 (25.8, 26.3)	1579.9 (1576.9, 1582.9)	1316.8 (1314.8, 1318.8)
North Africa and Middle East	44.8 (44.4, 45.1)	58.9 (58.7, 59.2)	26.4 (26.2, 26.7)	22.2 (22.1, 22.4)	1325.4 (1323.4, 1327.3)	1128.8 (1127.6, 1129.9)
High-income North America	215.6 (214.8, 216.3)	273.2 (272.5, 274)	30.7 (30.4, 31)	20.3 (20.1, 20.5)	1551.6 (1549.6, 1553.6)	1048.1 (1046.6, 1049.6)
Oceania	59.8 (56.8, 62.9)	69.6 (67.5, 71.7)	36.4 (34.1, 38.9)	39.1 (37.6, 40.7)	1814.7 (1798.2, 1831.3)	1952.6 (1941.6, 1963.7)
Central Sub-Saharan Africa	45 (44, 46)	42.5 (41.9, 43.1)	29.2 (28.4, 30)	25.5 (25, 25.9)	1430.1 (1424.6, 1435.6)	1253.4 (1250.3, 1256.6)
Eastern Sub-Saharan Africa	49.7 (49.2, 50.3)	46.9 (46.6, 47.3)	31.9 (31.5, 32.4)	27.6 (27.3, 27.8)	1578.6 (1575.5, 1581.8)	1373.1 (1371.2, 1374.9)
Southern Sub-Saharan Africa	70.3 (69.2, 71.5)	63.3 (62.5, 64.1)	38.9 (38, 39.8)	30.4 (29.9, 31)	1919.4 (1913.3, 1925.5)	1506.9 (1503.1, 1510.7)
Western Sub-Saharan Africa	33.4 (33, 33.8)	37.4 (37.1, 37.7)	20.9 (20.5, 21.2)	21.2 (21, 21.4)	1033.1 (1030.6, 1035.5)	1052.5 (1050.9, 1054)

Abbreviations: ASR, age-standardized rate.

Figure S1



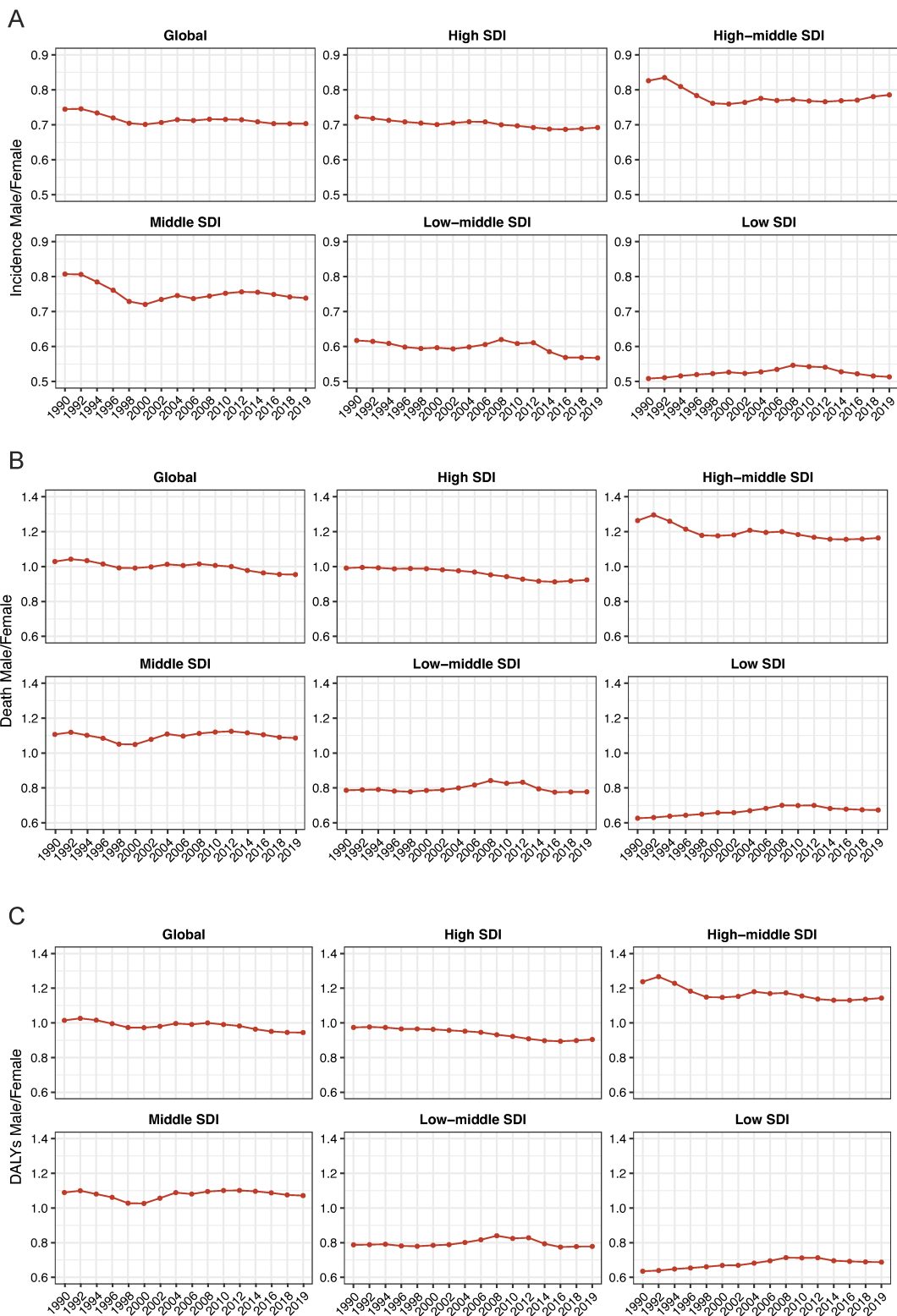
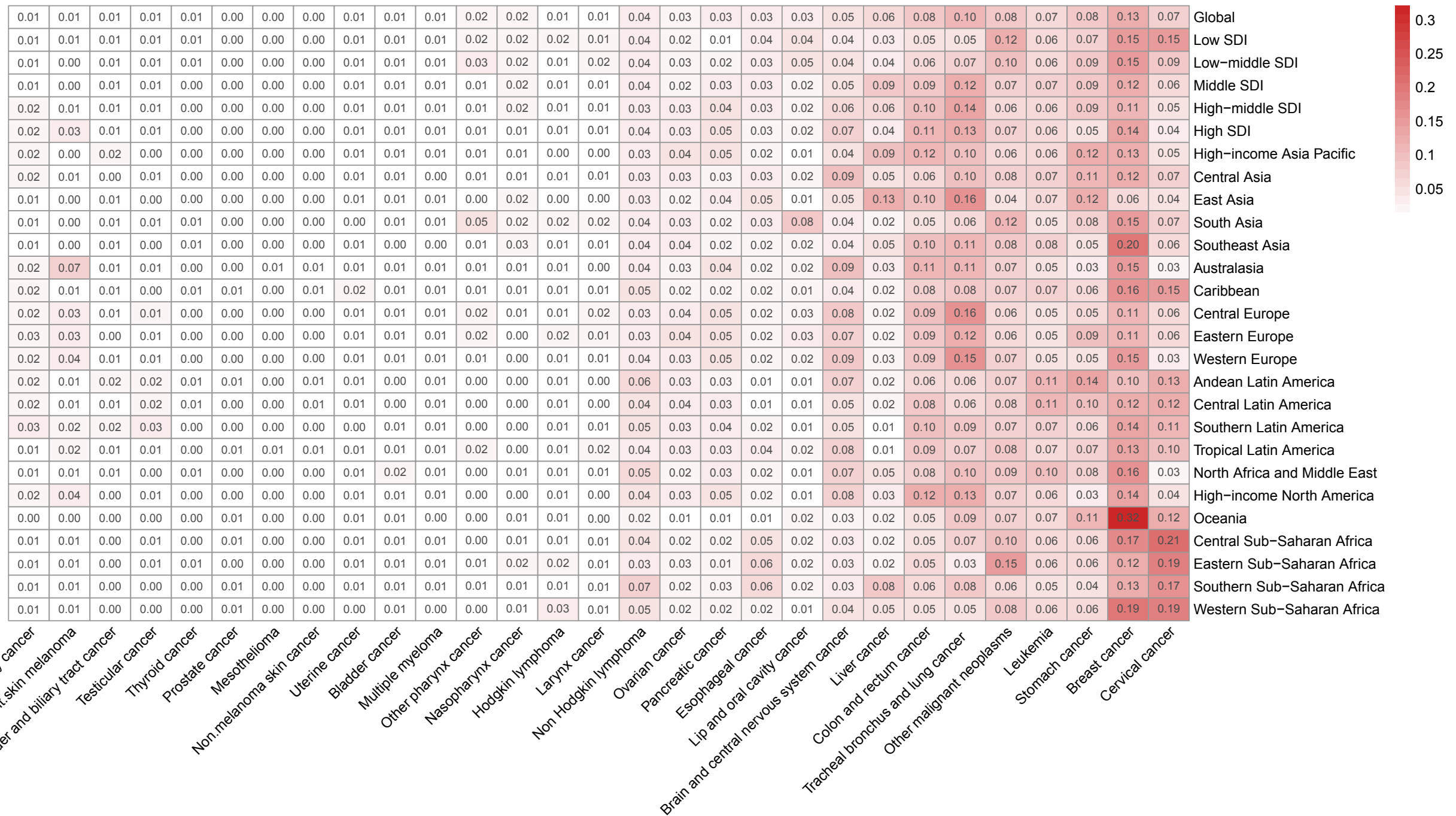
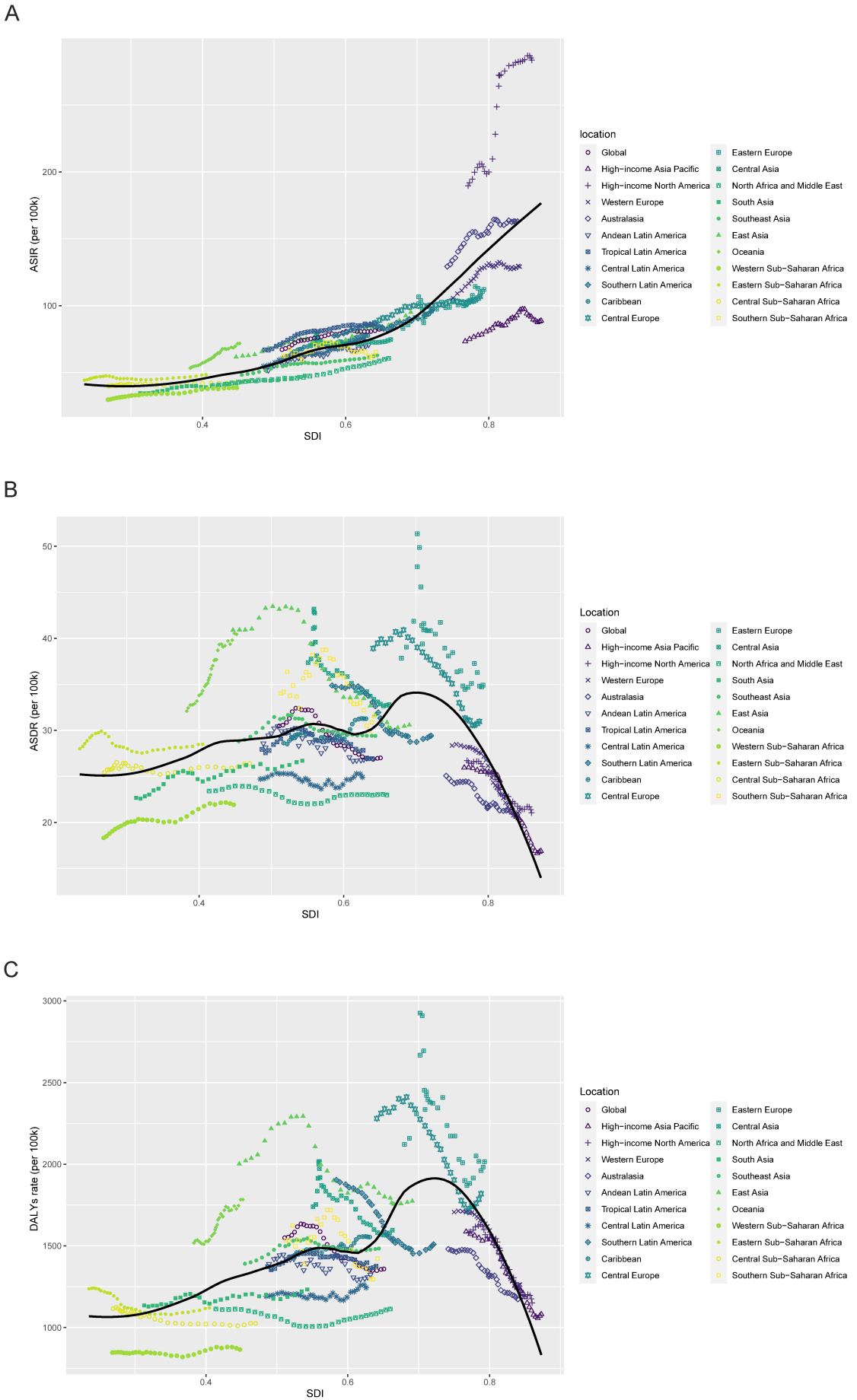
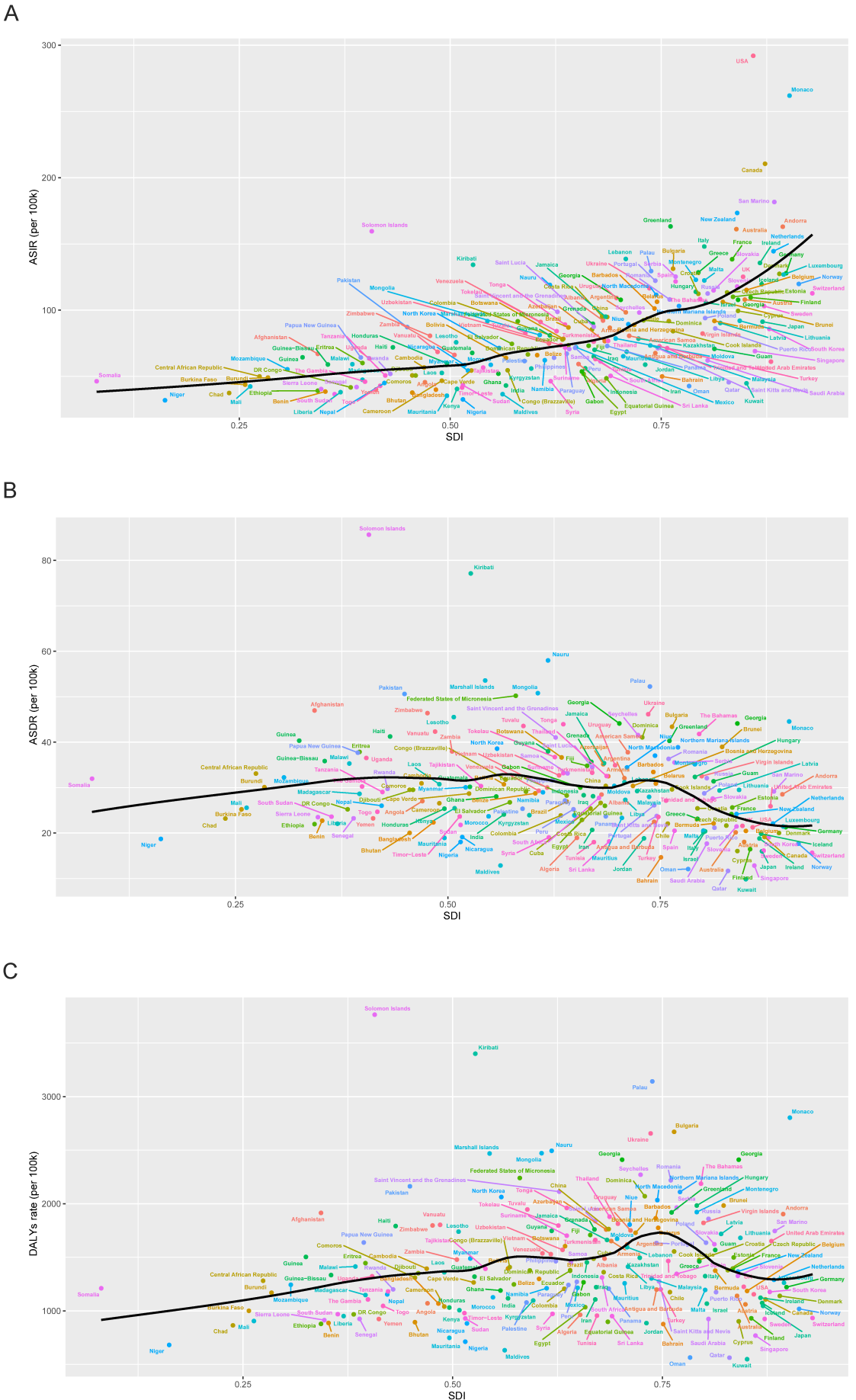


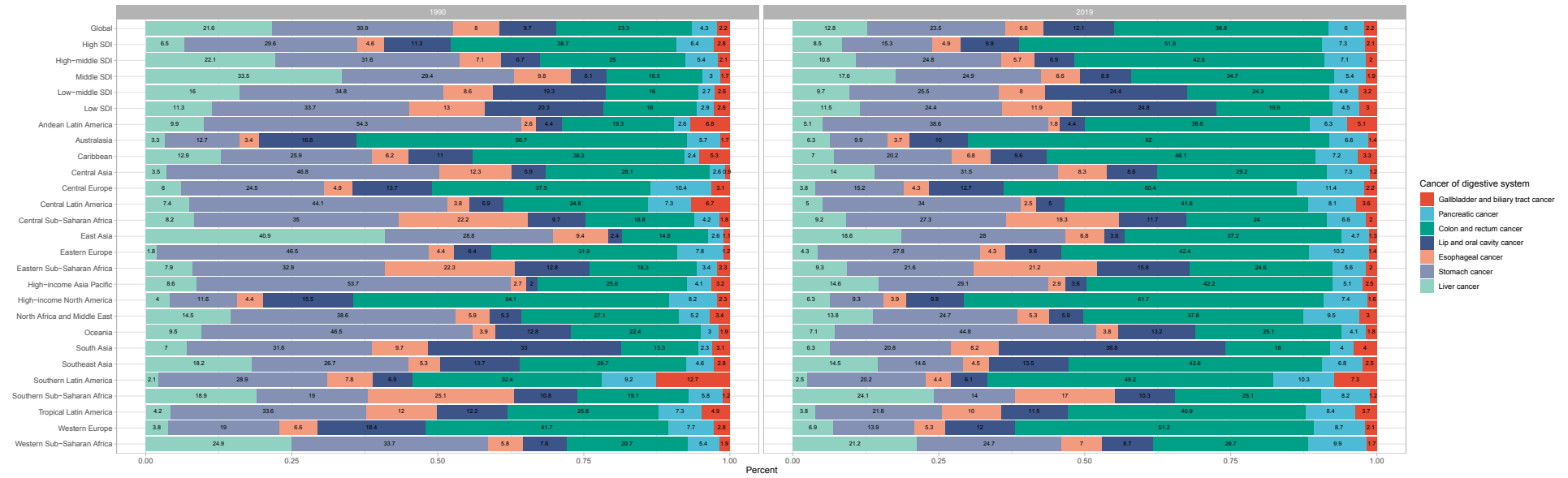
Figure S3



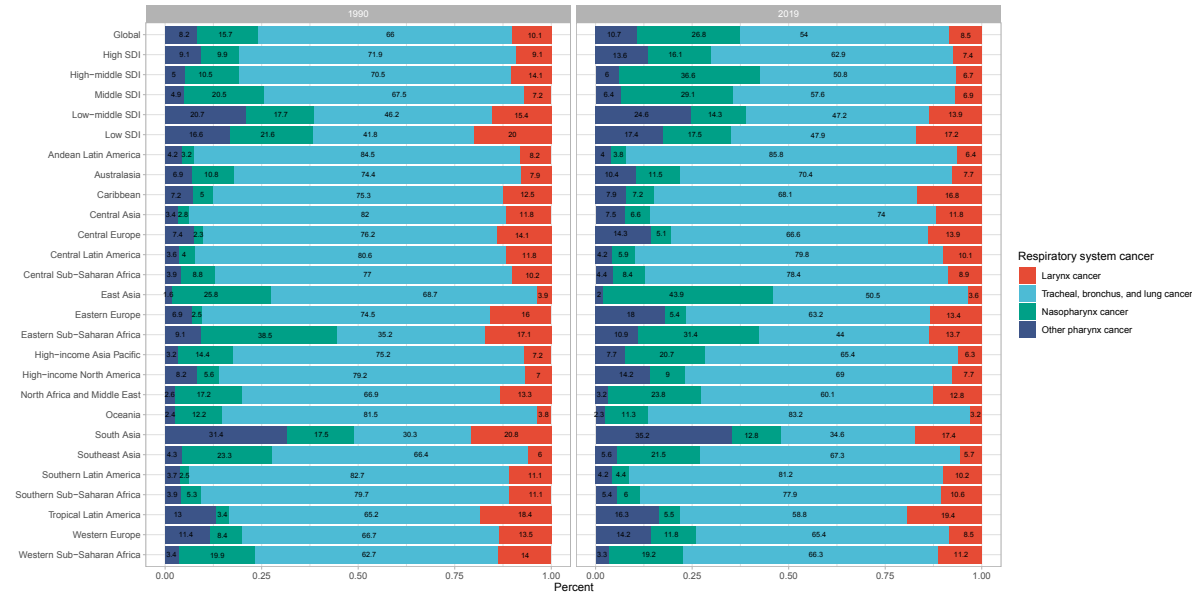




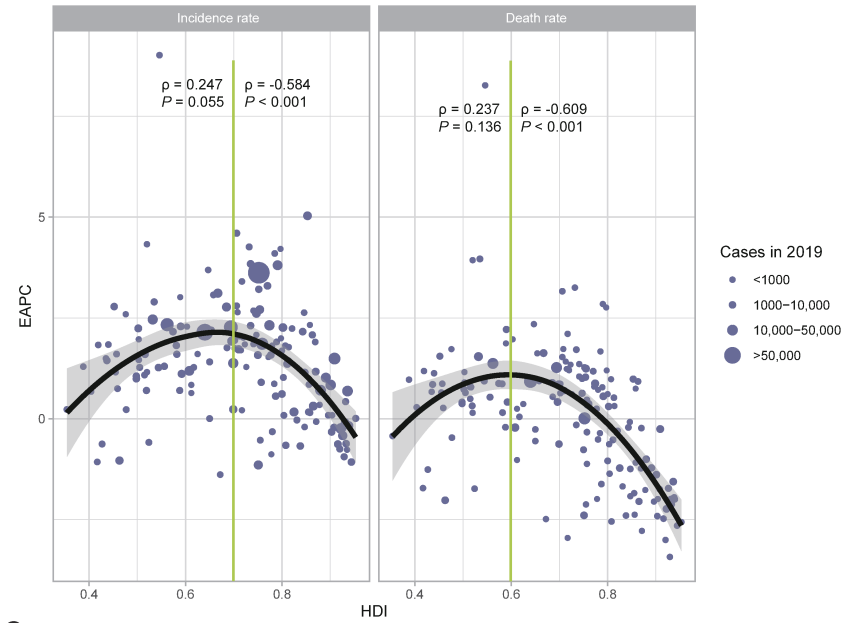
A Figure S6



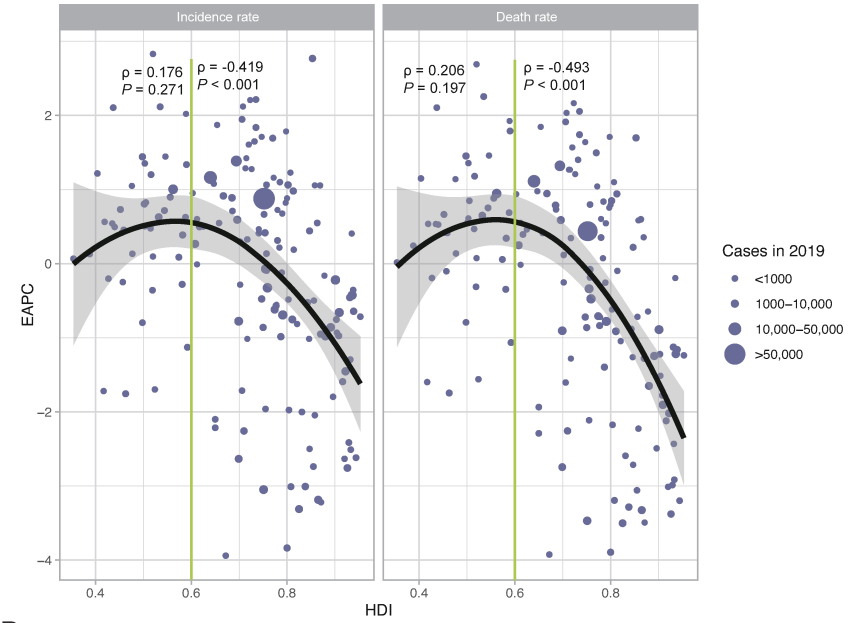
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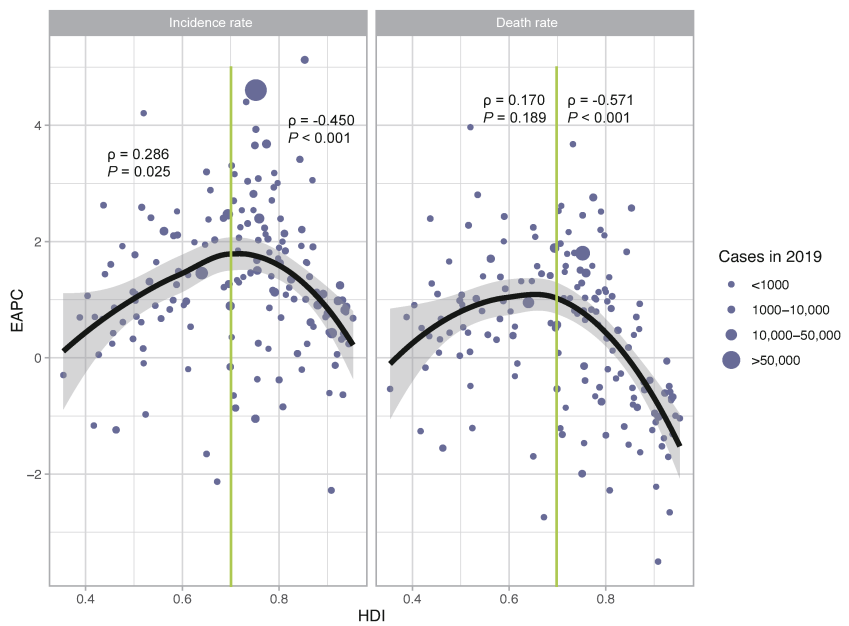
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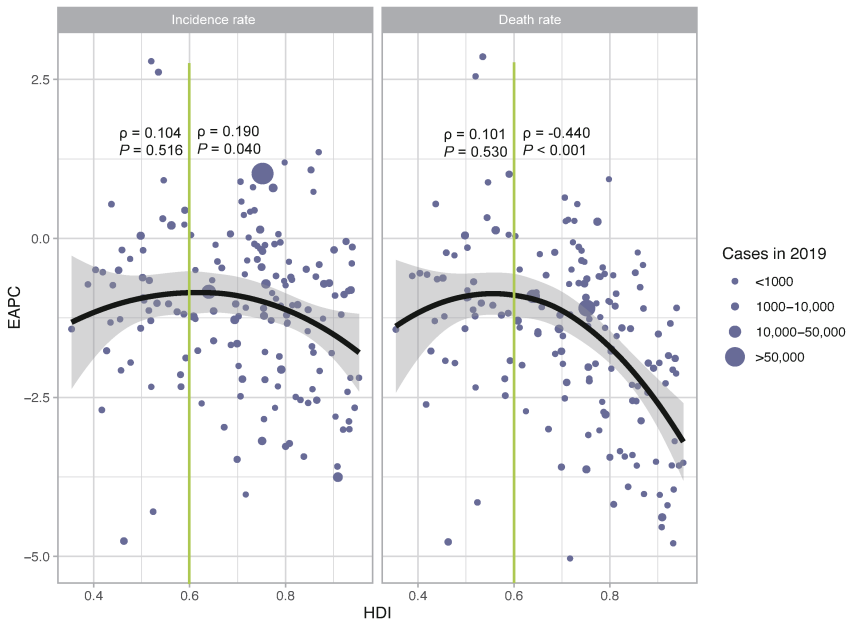
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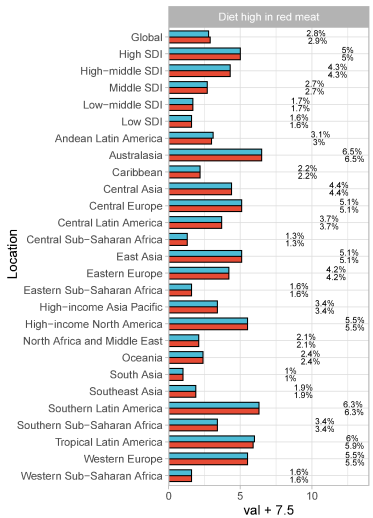
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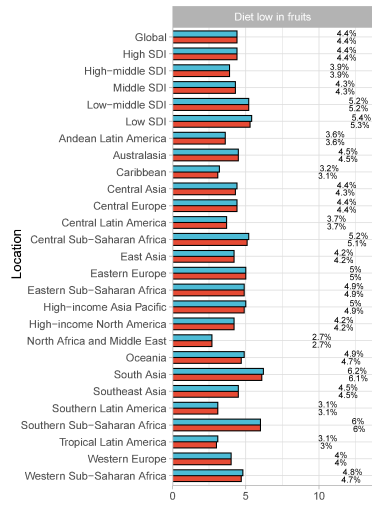
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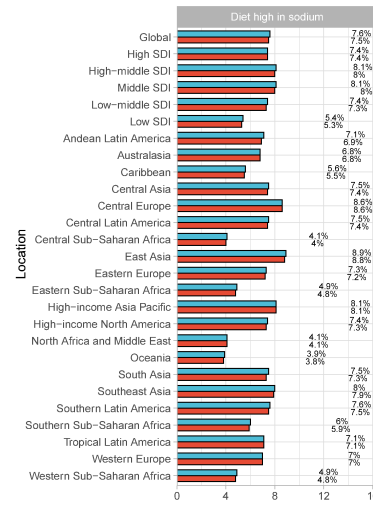
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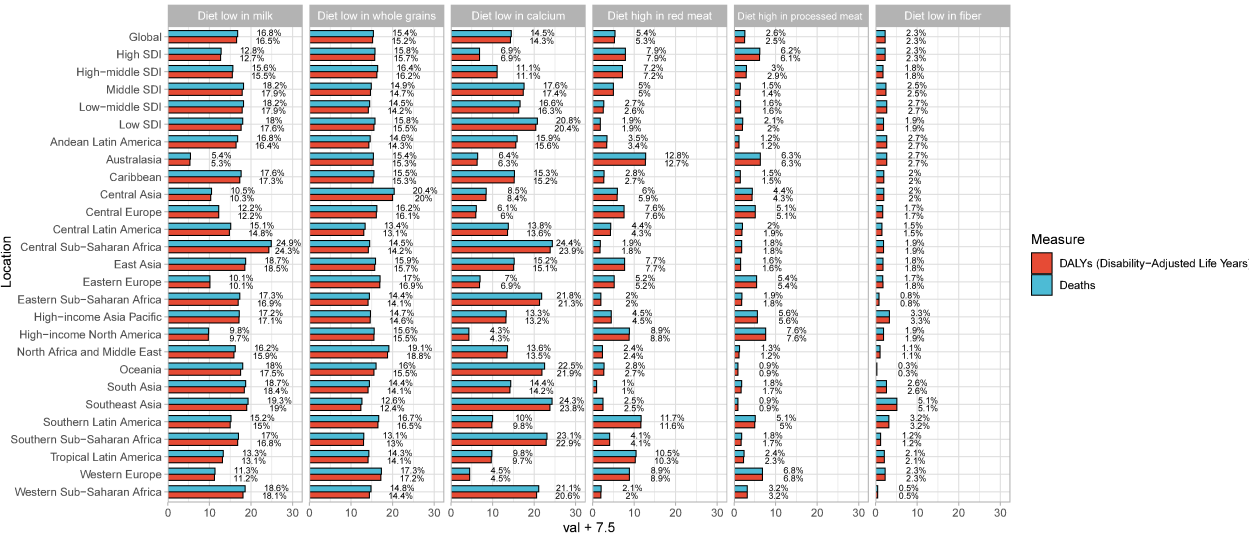
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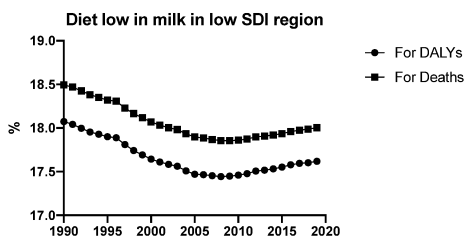
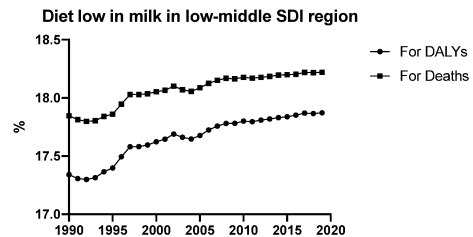
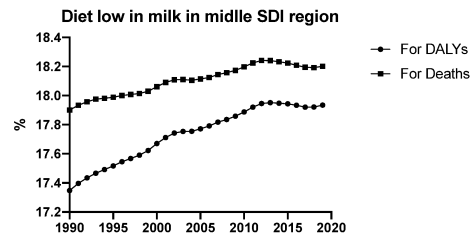
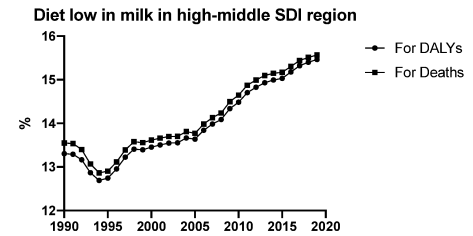
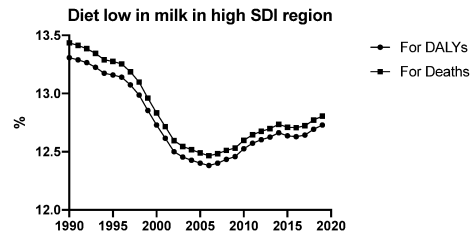


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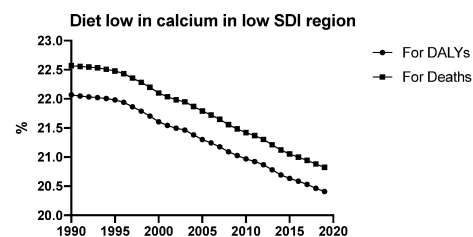
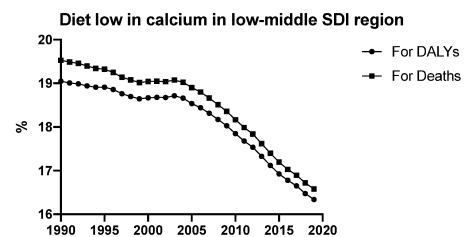
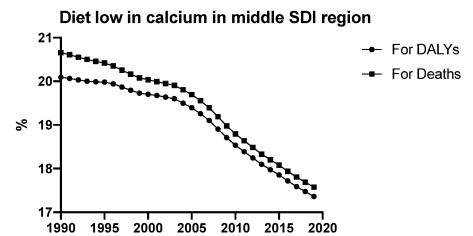
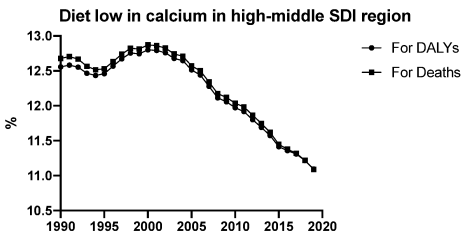
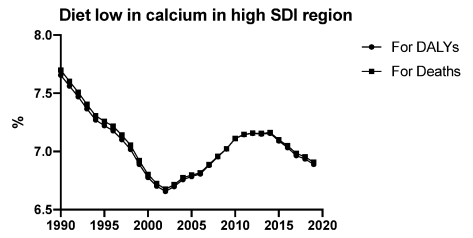


Measure
 DALYs (Disability-Adjusted Life Years)
 Deaths

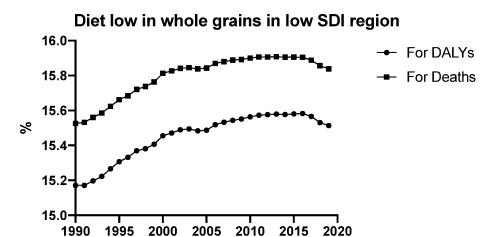
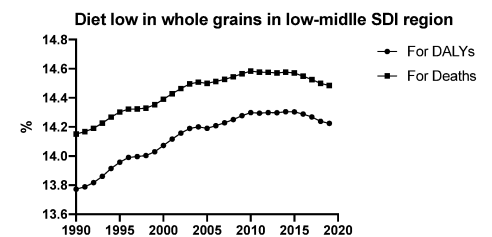
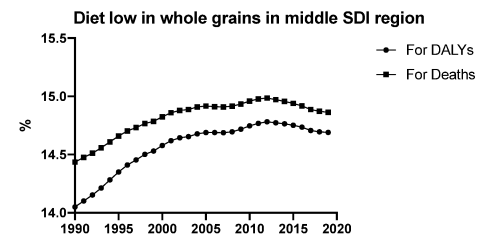
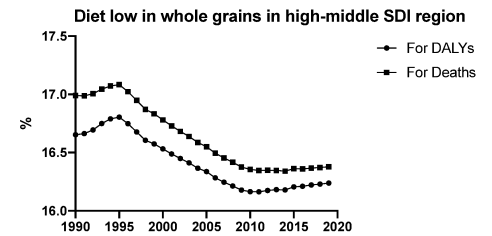
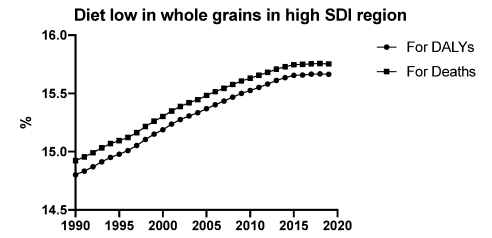
A

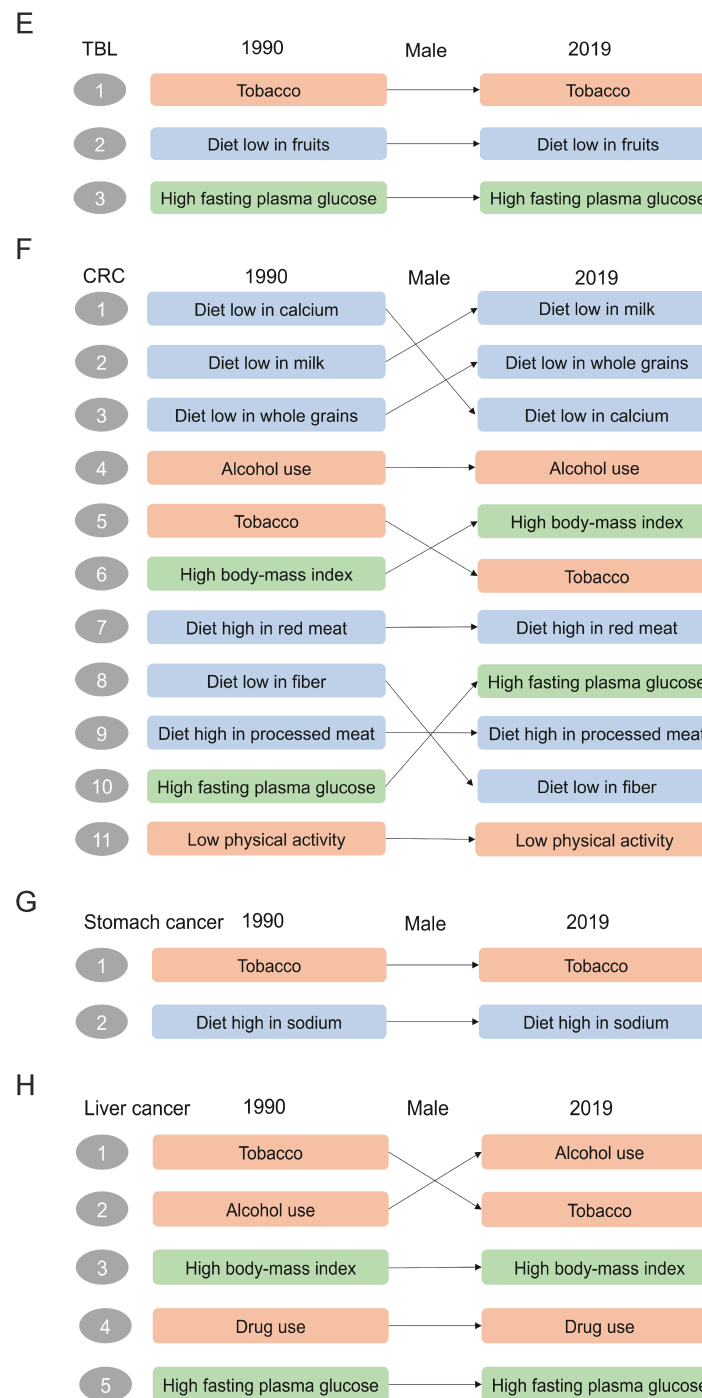
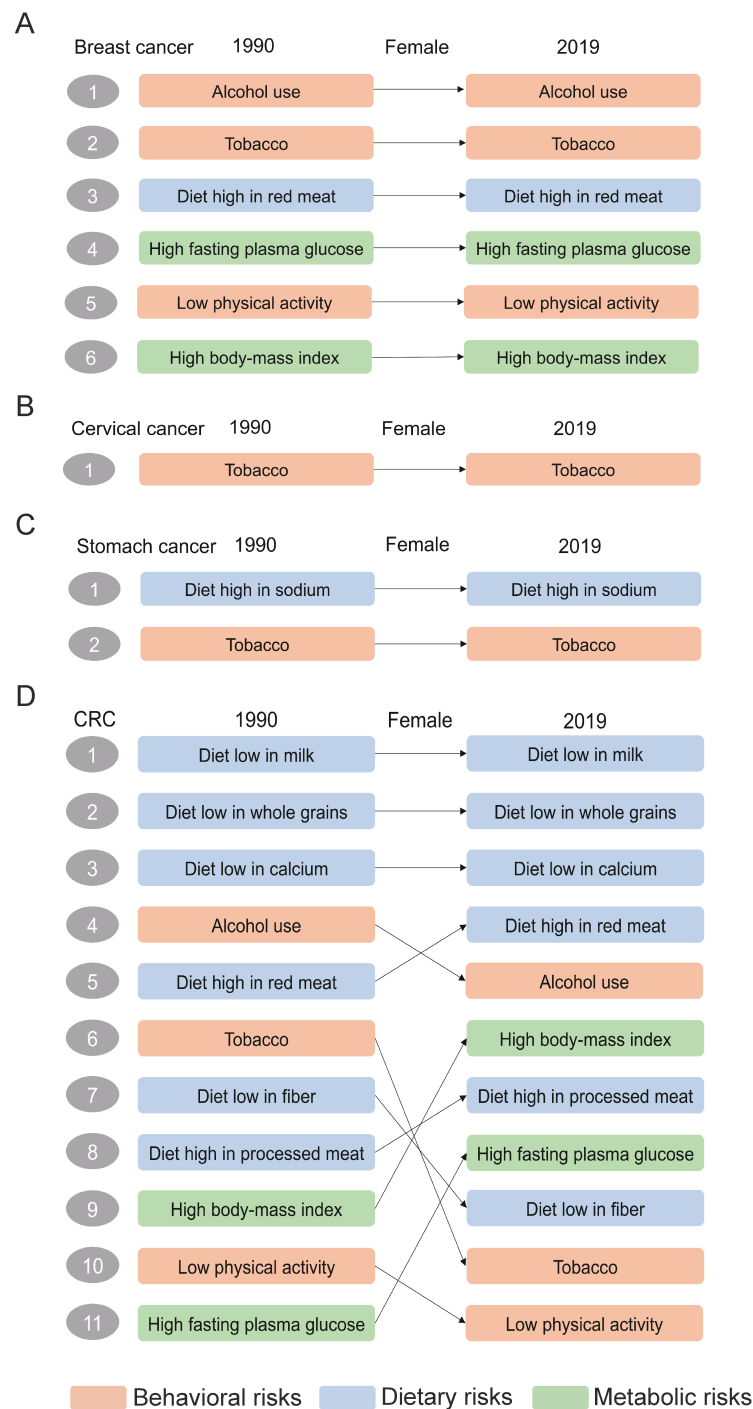


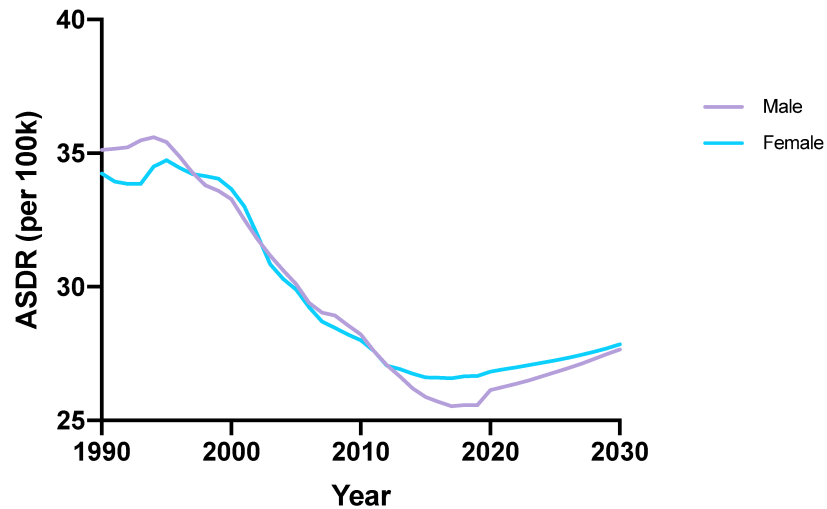
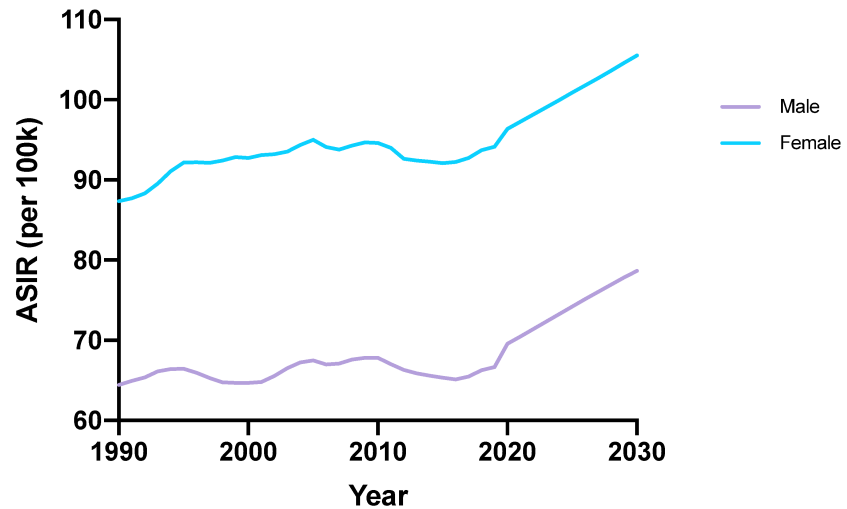
B



C







Supplementary Methods

Data source, definition of early-onset cancer and risk factors

We extracted metadata on the burden of 29 early-onset cancers at the global, regional and national levels from the GBD 2019 database, which is accessible via the GBD citation tool online (<http://ghdx.healthdata.org/gbd-2019>)¹. Twenty-nine early-onset cancers were ascertained from administrative data according to International Classification of Disease version 9 (ICD-9) and 10 (ICD-10) codes, the ICD codes of 29 cancers are shown in Supplementary Table S1. Early-onset cancer was defined as cancer cases diagnosed from 14 to 49 years². In total, 204 countries were divided into five-level regions based on the socio-demographic index (SDI), the SDI comprehensively represents development status in different regions³. It was calculated based on lag distributed income per capita, mean years of schooling for individuals 15 years and older, and total fertility rate for individuals younger than 25 years, ranging 0 to 1⁴. The human development index (HDI) data were obtained at the national level from the World Bank. The GBD database in 2019 estimated the population (including a comprehensive update on fertility and migration), mortality and life expectancy for a total of 990 locations, in 204 countries and territories based on a total of 1250 censuses and 747 location-years of population registry data. In addition, the Bayesian population model was used to reconcile censuses and registry data¹. We considered morbidity and mortality, defined as the number of incident cases and deaths per 100k individuals. The burden of early-onset

cancer expressed by DALYs was retrieved to represent healthy years lost annually per 100k individuals)⁵. The DALY equation is as follows: $DALYs = \text{years lived with disability (YLDs)} + \text{years of life lost (YLLs)}$. YLDs was estimated by diagnosis or treatment, remission, metastatic disseminate, and terminal phase modules, and each module prevalence multiplied by a disability weight was to calculate YLDs. YLLs was calculated by multiplying the number of deaths in the specific age with the corresponding standard life expectancy.

GBD 2019 examined three groups risk factors (environmental and occupational, behavioural, and metabolic), including 23 cancer types and 34 risk factors, with risk factors identified with the World Cancer Research Fund (WCRF) criteria⁶. Behavioral (including dietary risk factors) and metabolic risk factors were examined for their attributable risk to the burden of early-onset cancer in this study. Definitions of these risk factors and method for calculating the proportions of their attribution are described and reported in the previous study⁷. Briefly, to evaluate the burden associated with each risk factor, the GBD 2019 adopted the basic framework developed for comparative risk assessment, including six main steps for each risk–outcome pair^{7,8}. First, risk factors with persuasive or likely evidence of a causal connection were identified using the World Cancer Research Fund criteria. For GBD 2019, systematic reviews were revised to ensure that risk factors were appropriately included⁷. Second, existing systematic reviews were updated and meta-analyses of relative risks were performed using GBD's meta-regression-Bayesian, regularised, trimmed

tool in order to estimate relative risks for each risk–outcome pair as a function of exposure. Third, risk factor exposure levels and distributions were modeled with Bayesian meta-regression modelling (DisMod-MR 2.1) or spatiotemporal Gaussian process regression for every age, sex, location, and year combination using data from published studies. Fourth, the theoretical minimum risk exposure level of risk factor was confirmed. Fifth, the population attributable fraction of corresponding risk factor was calculated across age, sex, location, and year, based on the risk function, exposure level and the theoretical minimum risk exposure level. Sixth, mediation was considered for some risk factor to estimate the population attributable fraction ⁷.

Statistical analysis

The incidence rate, death rate and estimated annual percentage change (EAPC) were used to quantify the epidemic trends of 29 early-onset cancers. EAPC was applied to depict the trends of morbidity and mortality, which has been widely used in public health studies ^{9,10}. A regression line was fitted to the natural logarithm of the rates, and the EAPC and its 95% confidence intervals (CIs) were calculated by the linear regression model. The formulas were as follows:

$$y = \alpha + \beta x + \varepsilon$$

$$EAPC = 100 \times (\exp(\beta) - 1)$$

Thereinto, $y = \ln(\text{rate})$ and $x = \text{calendar year}$. Meanwhile, we conducted the age-standardization to balance multiple population with different age structures

or for the same population over time to facilitate the comparison between different regions and nations. The age-standardized rate (ASR)/100k population, including age-standardized incidence rate (ASIR) and age-standardized death rate (ASDR), were estimated with the following formula:

$$ASR = \frac{\sum_{i=1}^A a_i W_i}{\sum_{i=1}^A W_i} \times 100k$$

For above formula, α_i meant the age-specific rate in the i^{th} age group, w meant the number of population (or the weight) in the corresponding i^{th} age group from among the selected reference standard population (global populations from 1990 to 2019 used in this study from GBD) (Table S2), and A meant the number of age groups. The age groups for age-standardized included 15-19 years, 20-24 years, 25-29 years, 30-34 years, 35-39 years, 40-44 years and 45-49 years. We explored the associations between EAPCs and HDI in 2019 using Spearman correlation analysis. Additionally, the Bayesian age-period-cohort (BAPC) model integrating nested Laplace approximations was used to project the morbidity and mortality of the disease burden attributable to early-onset cancer from 2020 to 2030¹¹, and the formula was as follow:

$$R_{ijk} = \mu + \alpha_i \text{ Age} + \beta_j \text{ Period} + \gamma_k$$

Among the parameters of the formula, μ as a constant, R_{ijk} represents the incidence or mortality rate in the i^{th} age group, j^{th} time period, and k^{th} birth cohort. α_i , β_j , and γ_k are the effects of age, time period, and birth cohort. In the BAPC model, the prior probability distribution of time period and birth cohort

effects were the prior information, and the effects of age, period, and cohort through a random walk of different orders were estimated¹¹. To avoid over dispersion, an independent random effect, $z_{ij} \sim (0, k_z^{-1})$, was added into the model:

$$R_{ijk} = \mu + \alpha_i \text{Age} + \beta_{j+t} \text{Period} + \gamma_{k+t} \text{Cohort} + z_{ij+t}$$

Data analysis and graphics were conducted using R 4.2.1 (Lucent Technologies, Jasmine Mountain, USA). *P*-value < 0.05 was considered to be statistically significant.

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Table S1. The International Classification of Disease version 9 and 10 codes of 29 early-onset cancers

Cause	ICD10	ICD10 Used in Hospital/Claims Analyses	ICD9	ICD9 Used in Hospital/Claims Analyses
Bladder cancer	C67-C67.9, Z12.6-Z12.79, Z80.52, Z85.51		188-188.9, V10.51, V16.52, V76.3	
Brain and central nervous system cancer	C70-C70.1, C70.9-C72.9, Z85.841-Z85.848, Z86.011		191-191.9	
Breast cancer	C50-C50.629, C50.8-C50.929, Z12.3-Z12.39, Z80.3, Z85.3, Z86.000		174-175.9, V10.3, V16.3	
Cervical cancer	C53-C53.9, Z12.4, Z85.41		180-180.9, V10.41, V72.32	
Colon and rectum cancer	C18-C19.0, C20, C21-C21.8, Z12.1-Z12.13, Z85.03-Z85.048, Z86.010		153-154.9, 209.1-209.17, V10.05-V10.06, V76.41, V76.5-V76.52	
Esophageal cancer	C15-C15.9, Z85.01		150-150.9	
Gallbladder and biliary tract cancer	C23, C24-C24.9		156-156.9	
Hodgkin lymphoma	C81-C81.49, C81.7-C81.79, C81.9-C81.99, Z85.71-Z85.72		201-201.98, V10.72	
Kidney cancer	C64-C64.2, C64.9-C65.9, Z80.51, Z85.52-Z85.54		189-189.1, 189.5-189.6, 209.24	
Larynx cancer	C32-C32.9, Z85.21		161-161.9, V10.21	
Leukemia	C91-C93.7, C93.9-C95.2, C95.7-C95.92, Z80.6, Z85.6		204-208.92, V10.59-V10.69, V16.6	
Lip and oral cavity cancer	C00-C07, C08-C08.9, Z85.81-Z85.810		140-145.9, V76.42	
Liver cancer	C22-C22.4, C22.7-C22.9, Z85.05		155-155.9, V10.07	
Malignant skin melanoma	C43-C43.9, Z85.82-Z85.828		172-172.9	

Mesothelioma	C45-C45.2, C45.7, C45.9			
Multiple myeloma	C88-C90.32		203-203.9	
Nasopharynx cancer	C11-C11.9		147-147.9	
Non-Hodgkin lymphoma	C82-C85.29, C85.7-C86.6, C96-C96.9		200-200.9, 202-202.98	
Non-melanoma skin cancer	C44.01-C44.99	C44.01-C44.92	173-173.99	173.01-173.92
Other malignant neoplasms				
Other pharynx cancer	C09-C10.9, C12-C13.9		146-146.9, 148-148.9	
Ovarian cancer	C56-C56.2, C56.9, Z80.41, Z85.43		183-183.0, 183.8-183.9, V10.43, V16.41	
Pancreatic cancer	C25-C25.9, Z85.07		157-157.9	
Prostate cancer	C61-C61.9, Z12.5, Z80.42, Z85.46		185-185.9, V10.46, V16.42, V76.44	
Stomach cancer	C16-C16.9, Z12.0, Z85.02-Z85.028		151-151.9, 209.23, V10.04	
Testicular cancer	C62-C62.92, Z80.43, Z85.47-Z85.48		186-186.9, V10.47-V10.48, V16.43	
Thyroid cancer	C73, Z85.850		193-193.9	
Tracheal, bronchus, and lung cancer	C33, C34-C34.92, Z12.2, Z80.1-Z80.2, Z85.1-Z85.20		162-162.9, 209.21, V10.1-V10.20, V16.1-V16.2, V16.4-V16.40	
Uterine cancer	C54-C54.3, C54.8-C54.9, Z85.42, Z86.001		182-182.9	

Table S2. The global populations from 1990 to 2019 from Global Burden of Disease database.

Age group	Year	Population (Number)		
		value	95% UI upper	95% UI lower
15 to 19	1990	519603412.1	530680498.1	508300320.3
20 to 24	1990	492675757.3	503896044.6	481582093.4
25 to 29	1990	442843296.3	452298683.7	433270420.5
30 to 34	1990	385628936.3	393643207.2	377634667.2
35 to 39	1990	352742337.2	360428575.9	345093616.7
40 to 44	1990	286291792.8	292117447.4	280385026.7
45 to 49	1990	232409454.8	237083522.7	227751425.8
total	1990	2712194987	2770147980	2654017571
15 to 19	1991	518431189.8	529625669	506685286
20 to 24	1991	497721431.6	509107338.8	485392189.6
25 to 29	1991	455832152.7	466284103.7	444935393.9
30 to 34	1991	391230084.1	399372571.7	382820363.8
35 to 39	1991	361169652.2	369328193	352730424
40 to 44	1991	300417868	306725084.9	293732738.6
45 to 49	1991	235818955.1	240649046.4	230624980.1
total	1991	2760621334	2821092008	2696921376
15 to 19	1992	517752112.3	529645040.2	505664457.5
20 to 24	1992	501355296.6	513963392.1	488822164.2
25 to 29	1992	467066293.3	478885507.3	455232836.3
30 to 34	1992	399751499.4	408609391.4	390772117.8
35 to 39	1992	368327533.8	377433002.9	359401450.8
40 to 44	1992	310706133.5	317936104	303474218.7
45 to 49	1992	244256904	249728441	238590364.2
total	1992	2809215773	2876200879	2741957610
15 to 19	1993	518331320.9	530589982.8	505383791.4
20 to 24	1993	503737367.1	516634043	490381654.2
25 to 29	1993	475498861.8	488308914.1	462208164.3
30 to 34	1993	412123993.8	422123959.6	401912314.7
35 to 39	1993	373316483.4	382820829.4	363520327.1
40 to 44	1993	321665708.5	329832878.7	313297659.4
45 to 49	1993	253832429.9	259866960.1	247418735.3
total	1993	2858506166	2930177568	2784122646
15 to 19	1994	520867528.1	534036366.2	507564349.3
20 to 24	1994	505044168.7	519205490	490995146.2
25 to 29	1994	481852637	496002910.9	467594339.3
30 to 34	1994	426649539.2	438369965	415004429.2
35 to 39	1994	376959573.7	387075630.1	366693145.6
40 to 44	1994	331572772.1	340918924.3	322309246.9
45 to 49	1994	266054126.5	273106002.2	258906637.1
total	1994	2909000345	2988715289	2829067294

15 to 19	1995	525627131.5	539810121.8	511786579.1
20 to 24	1995	505533844.6	520435296.8	490792209.9
25 to 29	1995	487044565.9	502559413.8	471506826
30 to 34	1995	441148313.6	454486155.5	427714659.1
35 to 39	1995	380779750.6	391656066.8	370221444.8
40 to 44	1995	344801865.7	355292420.6	334523992.1
45 to 49	1995	276148943.3	283980606.7	268285253.1
total	1995	2961084415	3048220082	2874830964
15 to 19	1996	532746680	546959076.7	518596772.5
20 to 24	1996	505332329.5	519527208.4	491141002.5
25 to 29	1996	492230166	507261276.7	477324491.6
30 to 34	1996	453915291.6	467610171.6	440183343.3
35 to 39	1996	386716603.9	397485130.6	376108907.7
40 to 44	1996	352517513.3	362937302.1	342178577.8
45 to 49	1996	289621233.1	297893216.6	281474561.1
total	1996	3013079817	3099673383	2927007656
15 to 19	1997	541569409.9	555217526.3	527501869.3
20 to 24	1997	505471466.9	518641456.4	491842204.4
25 to 29	1997	496413797.2	510280881	481685530.6
30 to 34	1997	464801665.8	478011948.4	450670088.8
35 to 39	1997	395709386.2	405717465.2	385116111.9
40 to 44	1997	359075632.2	368936016.8	348777035.7
45 to 49	1997	299324118	307157744	290953335.5
total	1997	3062365476	3143963038	2976546176
15 to 19	1998	551433118.6	564737008	538525999.1
20 to 24	1998	506664550.5	519038997.2	494424129.5
25 to 29	1998	499486643.4	512639674.3	486328469.7
30 to 34	1998	472793184.4	485686479.5	459824502.3
35 to 39	1998	408547814.3	418487971.6	398427069.2
40 to 44	1998	363613013.4	372858162.5	354162295.9
45 to 49	1998	309743148.6	317472961.4	301744625.7
total	1998	3112281473	3190921254	3033437091
15 to 19	1999	561765793.9	573840530.8	549514415.4
20 to 24	1999	509518057.1	520480382.6	498385100.7
25 to 29	1999	501514045.8	513289855	489588813.4
30 to 34	1999	478748391	490504854.8	466591931.9
35 to 39	1999	423428022.5	433120590.9	413526445.3
40 to 44	1999	366896556.8	375162052.1	358369381.9
45 to 49	1999	319090325.7	326456829.8	311442125.9
total	1999	3160961193	3232855096	3087418214
15 to 19	2000	572711000.5	584570505.3	560653361.1
20 to 24	2000	514381490.6	524841210.7	503645582
25 to 29	2000	502647111.1	513618289.9	491343042.8
30 to 34	2000	483765873.5	494906930.3	472250617

35 to 39	2000	438184947.2	447954574.6	427994194.1
40 to 44	2000	370461890.2	378141421.5	362426860.2
45 to 49	2000	331717054.9	338950651.7	324152892.5
total	2000	3213869368	3282983584	3142466550
15 to 19	2001	584931684.8	597054315.5	572619149.4
20 to 24	2001	521426557	531907452.8	510553254.1
25 to 29	2001	502778255.8	513825110.4	491695869.7
30 to 34	2001	489107892	500472869.5	477631548.2
35 to 39	2001	450910563.8	461444044.9	440234900.5
40 to 44	2001	376209318	384124036.5	368094930.6
45 to 49	2001	339226508.3	347002229.8	331428893
total	2001	3264590780	3335830059	3192258546
15 to 19	2002	597719508.8	611699883	584089197.3
20 to 24	2002	530224078.1	542057890.2	518438411.4
25 to 29	2002	503038577.1	514865407.1	491191485.6
30 to 34	2002	493665792.2	506053212.6	480975927.6
35 to 39	2002	461626087.8	473611387.3	449411890.2
40 to 44	2002	385026319.7	393866389.2	376014046
45 to 49	2002	345682300.8	354306020.6	337032389.8
total	2002	3316982664	3396460190	3237153348
15 to 19	2003	609967034.5	625187073.2	594795523.5
20 to 24	2003	540129344.8	552899935.6	527393988.4
25 to 29	2003	504273518.2	516656822.7	491991160.6
30 to 34	2003	497207785.2	510054168.9	483941892.8
35 to 39	2003	469474307.6	482259520.7	456384977.4
40 to 44	2003	397639384.8	407361471	387558433.6
45 to 49	2003	350246132.1	359252998.1	341021192.2
total	2003	3368937507	3453671990	3283087168
15 to 19	2004	620429802	637255911.9	603658073.6
20 to 24	2004	550457476.5	564531386.4	536483664.2
25 to 29	2004	507068043.7	520080083.6	493802524.9
30 to 34	2004	499698985.9	513656569.5	485432029.9
35 to 39	2004	475388405.9	489074818.6	461195035.5
40 to 44	2004	412265186.6	423386424.4	400795939.6
45 to 49	2004	353640784.9	362892312.4	343999007.9
total	2004	3418948685	3510877507	3325366276
15 to 19	2005	627746727.5	645910118.8	610174954.4
20 to 24	2005	561336218.8	576549848.6	546265825.3
25 to 29	2005	511675130.1	525377586.9	497735936.5
30 to 34	2005	501153714.4	515877113.7	486530733.2
35 to 39	2005	480401874.4	495932256.1	465451537.8
40 to 44	2005	426776464.4	439847183.5	414157740.4
45 to 49	2005	357325169.5	367414504.9	347377902.8
total	2005	3466415299	3566908613	3367694630

15 to 19	2006	630491830.2	649229178.7	612304102.7
20 to 24	2006	573821690	590337130.4	557843963.4
25 to 29	2006	518507526.2	533235102.8	504281929.5
30 to 34	2006	501610073	516516227.9	486810121.4
35 to 39	2006	485831409.2	500998980.5	470589625.1
40 to 44	2006	439314572.4	452820313.7	425661215.2
45 to 49	2006	363172616.8	372941316.5	352857966.5
total	2006	3512749718	3616078251	3410348924
15 to 19	2007	629442031.1	646295218.8	612499765.7
20 to 24	2007	587350039.5	602610301.3	571694341
25 to 29	2007	527232718.6	540698208.5	513836038.1
30 to 34	2007	502257145.1	515603020.5	488928549.6
35 to 39	2007	490575061.2	504677852.9	476275453.3
40 to 44	2007	449989584.1	462861877.1	436648140.7
45 to 49	2007	372071189.2	381575480.7	362348132.8
total	2007	3558917769	3654321960	3462230421
15 to 19	2008	625501004.8	640328892.5	610271163.4
20 to 24	2008	600238491.1	614894853	585371297
25 to 29	2008	536869167.1	549331310.9	524396861.2
30 to 34	2008	503719503.2	515663033.6	491411781.7
35 to 39	2008	494258405.8	507040715.4	481382118.5
40 to 44	2008	457844356.2	469781842.6	445508393.3
45 to 49	2008	384677767.3	393677275.7	375189293.5
total	2008	3603108696	3690717924	3513530909
15 to 19	2009	620182568.5	634270507.2	606911715
20 to 24	2009	610877828	625020486.3	597067578.1
25 to 29	2009	546596215.5	558505271.1	534922972.6
30 to 34	2009	506437833.9	517785005.9	495277724.2
35 to 39	2009	496779149.6	508371538.2	485216706.2
40 to 44	2009	463763007.9	475093496.9	452442257.9
45 to 49	2009	399220279.3	408242252.7	390258823
total	2009	3643856883	3727288558	3562097777
15 to 19	2010	614905315.7	627682461.7	602455449.2
20 to 24	2010	618197109.4	631506402.2	605083502
25 to 29	2010	556937766.6	568257932.8	545572491.3
30 to 34	2010	510863945.2	521349257.2	500365347.5
35 to 39	2010	498339906.9	509133871.4	487396308.4
40 to 44	2010	468870865.8	479379365.3	458374062.7
45 to 49	2010	413683324.9	422481082.2	404810524.7
total	2010	3681798235	3759790373	3604057686
15 to 19	2011	611004326.6	623438739	598700918.6
20 to 24	2011	621004896	634923308	607743528.1
25 to 29	2011	568854206.8	580965354.5	557091388.1
30 to 34	2011	517307082.1	528239970.6	506892697.2

35 to 39	2011	498831665.9	510054449.4	487894843.3
40 to 44	2011	474428276.4	486099984.6	463196920.3
45 to 49	2011	426164043	436631599.7	416101956.1
total	2011	3717594497	3800353406	3637622252
15 to 19	2012	608599249.6	621623994.2	595771283.9
20 to 24	2012	619902721.6	634185027	605447816.4
25 to 29	2012	581549897.1	594815688.9	568439583.8
30 to 34	2012	525336993.4	536676719.7	513823571.9
35 to 39	2012	499285168.6	510948734.5	487300751
40 to 44	2012	479203061.1	491142019.8	466882896.6
45 to 49	2012	436828062.3	448305890.5	425072911.3
total	2012	3750705154	3837698075	3662738815
15 to 19	2013	607448157.1	621183643.3	593654916.9
20 to 24	2013	616102175.2	631308923.7	601259565.3
25 to 29	2013	593849144.7	608648508.2	579034752.6
30 to 34	2013	534426345	546818918.7	521774076.2
35 to 39	2013	500574699.6	512891450.5	488059434.1
40 to 44	2013	482984401.2	495903478.9	469744193
45 to 49	2013	444807473.5	457482128.2	432033962.4
total	2013	3780192396	3874237052	3685560901
15 to 19	2014	607279470.4	621922154.5	592278065.3
20 to 24	2014	611104444.2	626705120	595244495.2
25 to 29	2014	604446564.9	620120233.1	587965973.5
30 to 34	2014	544030593.2	557351969.7	530070906.2
35 to 39	2014	503338810.4	515992995.6	490067180
40 to 44	2014	485771436.6	499226313.9	471956896.2
45 to 49	2014	450968489.8	464249991.4	437468017
total	2014	3806939810	3905568778	3705051533
15 to 19	2015	608218087.6	623622681.7	592376348.4
20 to 24	2015	606112142.2	622744675.2	589837526.6
25 to 29	2015	612012137	628815900.7	594577158.7
30 to 34	2015	554407501.9	569269450.1	539122605.6
35 to 39	2015	507892129.9	521330451.5	493847217.8
40 to 44	2015	487612069.2	501695247.2	473185523.3
45 to 49	2015	456297755.8	470321181.9	441780065.7
total	2015	3832551824	3937799588	3724726446
15 to 19	2016	610093992.1	626604794	592844022.2
20 to 24	2016	602557005.1	620090585.6	585352846
25 to 29	2016	614984761.6	633145816.8	596184994.3
30 to 34	2016	566303551.5	582918522.1	549474113.7
35 to 39	2016	514363495.7	529328722.3	499336052.5
40 to 44	2016	488320878	503226274.7	473000968.3
45 to 49	2016	462025193.2	477592660.6	446919426.9
total	2016	3858648877	3972907376	3743112424

15 to 19	2017	612577366.2	630504939	594845461.4
20 to 24	2017	600599320.1	619121599.8	582944860.2
25 to 29	2017	614004651	634481806.8	594512501.1
30 to 34	2017	578913277.4	598037280.6	560584333.7
35 to 39	2017	522346015.5	538808826.4	506174465.6
40 to 44	2017	488978593.4	505035158.4	472768963.1
45 to 49	2017	466917924.3	483082675.1	449912324.5
total	2017	3884337148	4009072286	3761742910
15 to 19	2018	615767495.4	633590404.6	596886100.5
20 to 24	2018	599885085.9	618055364.1	581519599.2
25 to 29	2018	610283133.9	630271788.3	590563763.3
30 to 34	2018	591133850.7	610761189.7	571645816.6
35 to 39	2018	531387014.5	548149258.5	514538370.3
40 to 44	2018	490465267.1	506372984.1	474366524.5
45 to 49	2018	470841955.4	487805016.7	454027560.5
total	2018	3909763803	4035006006	3783547735
15 to 19	2019	619540978.1	639410643.1	600449626
20 to 24	2019	600144464.9	619566711.2	581021870.5
25 to 29	2019	605470102.4	626202183.3	584989358.8
30 to 34	2019	601732453.7	623410373.9	580098350.7
35 to 39	2019	540976121.5	559170147.5	522534368.2
40 to 44	2019	493443132.4	510303392	476222491.8
45 to 49	2019	473801065.3	491190698.2	455039768.8
total	2019	3935108318	4069254149	3800355835

Table S3. Incidence and corresponding EAPC of 29 early-onset cancer types in 1990 and 2019.

Early-onset cancer types	1990 Incidence		2019 Incidence		1990-2019 Incidence
	Cases No. (95% UI)	Rate per 100k No. (95% UI)	Cases No. (95% UI)	Rate per 100k No. (95% UI)	EAPC No. (95% CI)
Bladder cancer	18851.7 (17877.6-19937)	0.7 (0.7-0.7)	38922.2 (34991.5-43223.9)	1 (0.9-1.1)	1 (0.92, 1.08)
Brain and central nervous system cancer	54922.8 (47514.5-66711.4)	2 (1.8-2.5)	102687.2 (80889.9-115093.7)	2.6 (2.1-2.9)	0.8 (0.74, 0.86)
Breast cancer	260836.3 (250473.6-271710.5)	9.6 (9.2-10)	537979.6 (490640.8-588711.2)	13.7 (12.5-15)	1.01 (0.9, 1.12)
Cervical cancer	160770.2 (141427.6-186580.3)	5.9 (5.2-6.9)	256902.2 (215920.8-289544.9)	6.5 (5.5-7.4)	0.28 (0.22, 0.34)
Colorectal cancer	94707.1 (90420.5-99416.4)	3.5 (3.3-3.7)	225736 (207658-246755.7)	5.7 (5.3-6.3)	1.73 (1.65, 1.8)
Esophageal cancer	32454.9 (25094.2-36124.1)	1.2 (0.9-1.3)	40818.9 (36352.6-46025.9)	1 (0.9-1.2)	-0.86 (-1.25, -0.48)
Gallbladder and biliary tract cancer	9006.6 (8136.5-10218.2)	0.3 (0.3-0.4)	13722.5 (11736.3-15194.5)	0.3 (0.3-0.4)	0.18 (0.1, 0.26)
Hodgkin lymphoma	33409.6 (26787.6-36176.5)	1.2 (1-1.3)	43574.3 (39046.3-52320.7)	1.1 (1-1.3)	-0.47 (-0.54, -0.41)
Kidney cancer	23875.5 (22848.6-24856.1)	0.9 (0.8-0.9)	57999.5 (52884.9-63376.5)	1.5 (1.3-1.6)	1.75 (1.62, 1.87)
Larynx cancer	16296.6 (15544.1-17094.1)	0.6 (0.6-0.6)	21549.1 (19780.8-23591)	0.5 (0.5-0.6)	-0.71 (-0.84, -0.58)
Leukemia	109042 (96043.9-120420.4)	4 (3.5-4.4)	155420.8 (139380.4-169956.2)	3.9 (3.5-4.3)	-0.25 (-0.33, -0.16)
Lip and oral cavity cancer	39319.9 (37399.9-41418.2)	1.4 (1.4-1.5)	74344.2 (66884.1-81548.6)	1.9 (1.7-2.1)	0.76 (0.69, 0.83)
Liver cancer	88117.2 (76723.3-101492.9)	3.2 (2.8-3.7)	78299.4 (68668-89097.7)	2 (1.7-2.3)	-2.88 (-3.46, -2.3)
Malignant skin melanoma	38988.2 (29130.2-44281.6)	1.4 (1.1-1.6)	72968.4 (59581.3-91447.6)	1.9 (1.5-2.3)	0.68 (0.51, 0.84)
Mesothelioma	2615.4 (1948.1-3556.7)	0.1 (0.1-0.1)	3740.3 (3161.6-4272.1)	0.1 (0.1-0.1)	-0.32 (-0.43, -0.21)
Multiple myeloma	5277.4 (4704.1-6325)	0.2 (0.2-0.2)	10740.8 (8964.2-12044.2)	0.3 (0.2-0.3)	0.94 (0.76, 1.13)
Nasopharynx cancer	25238.2 (22682.8-27620.8)	0.9 (0.8-1)	67915.2 (59442.4-77614.4)	1.7 (1.5-2)	2.28 (2.1, 2.47)
Non-Hodgkin lymphoma	46087.4 (42095.1-51252.4)	1.7 (1.6-1.9)	81586.8 (74019-90533.3)	2.1 (1.9-2.3)	0.51 (0.42, 0.6)
Non-melanoma skin cancer	238054.1 (186397-300376.3)	8.8 (6.9-11.1)	486545 (401341.6-586406.2)	12.4 (10.2-14.9)	1.59 (1.21, 1.98)

Other malignant neoplasms	113396.4 (100921.9-123848)	4.2 (3.7-4.6)	214565.8 (195583-232245.1)	5.5 (5-5.9)	0.89 (0.85, 0.92)
Other pharynx cancers	13257.5 (12364.8-14312.9)	0.5 (0.5-0.5)	26987.7 (24143.1-29674.5)	0.7 (0.6-0.8)	0.9 (0.78, 1.01)
Ovarian cancer	39872 (34417.7-48766.4)	1.5 (1.3-1.8)	79671.9 (68572.8-90845)	2 (1.7-2.3)	0.91 (0.82, 1)
Pancreatic cancer	17479.4 (16587.8-18435.7)	0.6 (0.6-0.7)	36851.2 (33756.6-40329.9)	0.9 (0.9-1)	1.14 (1.04, 1.24)
Prostate cancer	7831.4 (6374.4-9087.1)	0.3 (0.2-0.3)	22581.2 (19175.2-27761)	0.6 (0.5-0.7)	2.23 (1.97, 2.49)
Stomach cancer	125974.3 (118139.9-133955.5)	4.6 (4.4-4.9)	144321.2 (130472.9-158788.9)	3.7 (3.3-4)	-0.84 (-0.99, -0.7)
Testicular cancer	34332.8 (27953.8-37230.1)	1.3 (1-1.4)	72597.2 (64977.7-81950)	1.8 (1.7-2.1)	1.23 (1.18, 1.27)
Thyroid cancer	35055.2 (31179.3-37947)	1.3 (1.1-1.4)	91032.5 (80018.5-99250.1)	2.3 (2-2.5)	1.96 (1.76, 2.15)
Tracheal, bronchus, and lung cancer	106306.3 (100111.4-113467.8)	3.9 (3.7-4.2)	136946.2 (123422.3-150290.4)	3.5 (3.1-3.8)	-0.7 (-0.9, -0.5)
Uterine cancer	30231.6 (25409.9-32988)	1.1 (0.9-1.2)	63585.2 (54747.7-71083)	1.6 (1.4-1.8)	1.32 (1.03, 1.62)

Abbreviations: EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval.

Table S4. Death and corresponding EAPC of 29 early-onset cancer types in 1990 and 2019.

Early-onset cancer types	1990 Death		2019 Death		1990-2019 Death
	Cases No. (95% UI)	Rate per 100k No. (95% UI)	Cases No. (95% UI)	Rate per 100k No. (95% UI)	EAPC No. (95% CI)
Bladder cancer	5598.6 (5227.7-6015.6)	0.2 (0.2-0.2)	7784 (7090.9-8593.1)	0.2 (0.2-0.2)	-0.42 (-0.53, -0.32)
Brain and central nervous system cancer	37501 (31997.3-45876.4)	1.4 (1.2-1.7)	55346.1 (43753.7-61463.2)	1.4 (1.1-1.6)	-0.09 (-0.19, 0.01)
Breast cancer	86957.8 (82562.6-92106.1)	3.2 (3-3.4)	136448.7 (124894.9-149068.5)	3.5 (3.2-3.8)	0 (-0.12, 0.12)
Cervical cancer	58081.3 (50008.7-68379)	2.1 (1.8-2.5)	76549.5 (64144.3-86516.1)	1.9 (1.6-2.2)	-0.42 (-0.5, -0.34)
Colorectal cancer	50436.5 (47475-53367.8)	1.9 (1.8-2)	86545.6 (80162-93431.1)	2.2 (2-2.4)	0.48 (0.4, 0.55)
Esophageal cancer	28632.6 (22111.7-31956.5)	1.1 (0.8-1.2)	32955.9 (29538-37482.2)	0.8 (0.8-1)	-1.19 (-1.57, -0.8)

Gallbladder and biliary tract cancer	6664.5 (5955.8-7687.5)	0.2 (0.2-0.3)	9761.2 (8321.2-10715)	0.2 (0.2-0.3)	0.05 (-0.03, 0.13)
Hodgkin lymphoma	11982.8 (9385-13204.9)	0.4 (0.3-0.5)	11183.8 (9517.9-13128.8)	0.3 (0.2-0.3)	-1.73 (-1.83, -1.63)
Kidney cancer	6845.8 (6485.6-7172.3)	0.3 (0.2-0.3)	12957.9 (11916.3-14161.8)	0.3 (0.3-0.4)	0.81 (0.7, 0.92)
Larynx cancer	10561.8 (9928.2-11154.6)	0.4 (0.4-0.4)	11834 (10813.4-13097.7)	0.3 (0.3-0.3)	-1.28 (-1.42, -1.15)
Leukemia	68426.4 (59766.5-75746.6)	2.5 (2.2-2.8)	69298.4 (62141-75429.3)	1.8 (1.6-1.9)	-1.44 (-1.54, -1.35)
Lip and oral cavity cancer	17492.9 (16405.1-18751.3)	0.6 (0.6-0.7)	31258.4 (27932.4-34762.2)	0.8 (0.7-0.9)	0.58 (0.5, 0.66)
Liver cancer	78416.1 (67900.6-90532.2)	2.9 (2.5-3.3)	60602.5 (53310-68336.1)	1.5 (1.4-1.7)	-3.39 (-4, -2.77)
Malignant skin melanoma	7892 (6189.7-9560.7)	0.3 (0.2-0.4)	9880.3 (8113-12023.4)	0.3 (0.2-0.3)	-0.78 (-0.89, -0.68)
Mesothelioma	1820.9 (1377-2457.6)	0.1 (0.1-0.1)	2707.8 (2318.1-3058.3)	0.1 (0.1-0.1)	-0.14 (-0.24, -0.03)
Multiple myeloma	3539.4 (3127.3-4353.6)	0.1 (0.1-0.2)	6418.1 (5369.8-7111.9)	0.2 (0.1-0.2)	0.52 (0.36, 0.67)
Nasopharynx cancer	16563.7 (14922.1-18246.7)	0.6 (0.6-0.7)	17237.5 (15774.7-18851.4)	0.4 (0.4-0.5)	-1.44 (-1.57, -1.3)
Non-Hodgkin lymphoma	25306.5 (23603.2-27119)	0.9 (0.9-1)	38451.3 (35770.2-41630.3)	1 (0.9-1.1)	0 (-0.08, 0.08)
Non-melanoma skin cancer	2517.8 (2321.6-2736.7)	0.1 (0.1-0.1)	3748.6 (3450-4020.7)	0.1 (0.1-0.1)	0.07 (-0.03, 0.17)
Other malignant neoplasms	56333.1 (50107.6-60578.5)	2.1 (1.8-2.2)	83689 (75459.7-91529.7)	2.1 (1.9-2.3)	-0.06 (-0.1, -0.01)
Other pharynx cancers	9215.2 (8498.4-10176.1)	0.3 (0.3-0.4)	16843.5 (14816.9-18804.9)	0.4 (0.4-0.5)	0.56 (0.46, 0.66)
Ovarian cancer	15138.9 (12927.3-18976.1)	0.6 (0.5-0.7)	27759.2 (23923-31721.7)	0.7 (0.6-0.8)	0.59 (0.49, 0.69)
Pancreatic cancer	15285.8 (14453.1-16200.3)	0.6 (0.5-0.6)	32004 (29401.6-34968.4)	0.8 (0.7-0.9)	1.11 (1.01, 1.21)
Prostate cancer	2110.1 (1706.7-2332.4)	0.1 (0.1-0.1)	3574.1 (3008.8-4281.9)	0.1 (0.1-0.1)	0.33 (0.23, 0.44)
Stomach cancer	97382.7 (90808.2-104061.7)	3.6 (3.3-3.8)	87333.5 (79904.3-95000.1)	2.2 (2-2.4)	-1.78 (-1.99, -1.58)
Testicular cancer	4917.3 (4639.3-5178.3)	0.2 (0.2-0.2)	6867.7 (6306.5-7457.3)	0.2 (0.2-0.2)	-0.19 (-0.28, -0.1)
Thyroid cancer	3795.8 (3246-4304)	0.1 (0.1-0.2)	5925.5 (5262.9-6473.7)	0.2 (0.1-0.2)	0.11 (0, 0.22)
Tracheal, bronchus, and lung cancer	91573.6 (85931-98019.2)	3.4 (3.2-3.6)	110729.4 (101076.6-120624.3)	2.8 (2.6-3.1)	-0.94 (-1.14, -0.74)
Uterine cancer	5878.3 (4443.6-6749.3)	0.2 (0.2-0.2)	7120.6 (5825.5-7914.1)	0.2 (0.1-0.2)	-0.83 (-1.13, -0.52)

Abbreviations: EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval.

Table S5. Disability-adjusted life years (DALYs) and corresponding EAPC of 29 early-onset cancers in 1990 and 2019.

Early-onset cancer types	1990 DALYs		2019 DALYs		1990-2019 DALYs
	Cases No. (95% UI)	Rate per 100k No. (95% UI)	Cases No. (95% UI)	Rate per 100k No. (95% UI)	EAPC No. (95% CI)
Bladder cancer	279920.4 (260428.6-301617.8)	10.3 (9.6-11.1)	390740.7 (357671.3-429267.4)	9.9 (9.1-10.9)	-0.41 (-0.51, -0.31)
Brain and central nervous system cancer	2027034.2 (1731600.3-2486867.8)	74.7 (63.8-91.7)	2917783.9 (2305065.6-3247570.8)	74.1 (58.6-82.5)	-0.17 (-0.26, -0.08)
Breast cancer	4327460.9 (4102075.4-4590967.7)	159.6 (151.2-169.3)	6832262.2 (6219746.4-7431400.4)	173.6 (158.1-188.8)	0.02 (-0.1, 0.14)
Cervical cancer	2913442.6 (2504657.5-3437397.7)	107.4 (92.3-126.7)	3801241.7 (3175065.5-4285528.7)	96.6 (80.7-108.9)	-0.47 (-0.55, -0.38)
Colorectal cancer	2516720.9 (2368905.6-2663625.4)	92.8 (87.3-98.2)	4259922 (3942849.9-4590979.2)	108.3 (100.2-116.7)	0.42 (0.35, 0.49)
Esophageal cancer	1327637 (1026867.4-1476512.8)	49 (37.9-54.4)	1516319 (1361708.2-1720376.2)	38.5 (34.6-43.7)	-1.22 (-1.59, -0.84)
Gallbladder and biliary tract cancer	315792.5 (282111.5-364221.4)	11.6 (10.4-13.4)	456165.2 (388506.3-500980.1)	11.6 (9.9-12.7)	-0.01 (-0.09, 0.07)
Hodgkin lymphoma	696643.2 (547556.6-767547.2)	25.7 (20.2-28.3)	650560.1 (554149-764527.6)	16.5 (14.1-19.4)	-1.71 (-1.81, -1.61)
Kidney cancer	341994.9 (323772.6-359870.6)	12.6 (11.9-13.3)	646339.9 (594759.4-706070)	16.4 (15.1-17.9)	0.82 (0.72, 0.93)
Larynx cancer	496236.2 (467216.1-524227.7)	18.3 (17.2-19.3)	555495.2 (508685.9-611840.7)	14.1 (12.9-15.5)	-1.29 (-1.42, -1.15)
Leukemia	3984968.1 (3463513.2-4416809.9)	146.9 (127.7-162.9)	3913497.7 (3502797.6-4267249.9)	99.5 (89-108.4)	-1.54 (-1.64, -1.45)
Lip and oral cavity cancer	858787.6 (804949.5-919796.6)	31.7 (29.7-33.9)	1527398 (1366591.5-1697046.4)	38.8 (34.7-43.1)	0.55 (0.48, 0.63)
Liver cancer	3826682 (3314993-4420259.5)	141.1 (122.2-163)	2898076.8 (2554655.9-3261451.2)	73.6 (64.9-82.9)	-3.46 (-4.06, -2.86)
Malignant skin melanoma	415705.6 (327380.4-506830.2)	15.3 (12.1-18.7)	524345.1 (427761.5-639655.8)	13.3 (10.9-16.3)	-0.74 (-0.84, -0.65)
Mesothelioma	91409.1 (67711.5-125083.1)	3.4 (2.5-4.6)	132402.6 (112421-150038.2)	3.4 (2.9-3.8)	-0.25 (-0.35, -0.14)
Multiple myeloma	169068.4 (150052.6-209555.5)	6.2 (5.5-7.7)	306838.9 (256087.6-340491.4)	7.8 (6.5-8.7)	0.51 (0.35, 0.67)
Nasopharynx cancer	844065.6 (760336.6-928015.4)	31.1 (28-34.2)	874186.4 (804883.7-952901.8)	22.2 (20.5-24.2)	-1.47 (-1.61, -1.33)
Non-Hodgkin lymphoma	1392131.7 (1294870.8-1494921)	51.3 (47.7-55.1)	2066163.5 (1924546.4-2237846.4)	52.5 (48.9-56.9)	-0.08 (-0.16, -0.01)
Non-melanoma skin cancer	128327.7 (118778.6-139250.1)	4.7 (4.4-5.1)	187302.7 (172963.6-200586.2)	4.8 (4.4-5.1)	-0.01 (-0.1, 0.08)

Other malignant neoplasms	3194375 (2838849.1-3437705)	117.8 (104.7-126.7)	4682788.6 (4222113.3-5113396.2)	119 (107.3-129.9)	-0.1 (-0.14, -0.05)
Other pharynx cancers	436024.6 (401114.7-484058.5)	16.1 (14.8-17.8)	795774.7 (700405.9-888018.6)	20.2 (17.8-22.6)	0.55 (0.45, 0.65)
Ovarian cancer	760870.4 (645441.4-960212.7)	28.1 (23.8-35.4)	1379355.3 (1183284.2-1574161.6)	35.1 (30.1-40)	0.55 (0.45, 0.64)
Pancreatic cancer	723474.5 (682646.9-767793.3)	26.7 (25.2-28.3)	1489527.7 (1368667.3-1627198.3)	37.9 (34.8-41.4)	1.04 (0.95, 1.13)
Prostate cancer	105476.6 (84960.1-115605.9)	3.9 (3.1-4.3)	182131.6 (154399-217655.1)	4.6 (3.9-5.5)	0.41 (0.3, 0.51)
Stomach cancer	4743785.3 (4423216.2-5063886)	174.9 (163.1-186.7)	4206556.7 (3853720.9-4566426.9)	106.9 (97.9-116)	-1.84 (-2.04, -1.64)
Testicular cancer	297954.5 (280555.7-314734.3)	11 (10.3-11.6)	424469.8 (388485.7-462990)	10.8 (9.9-11.8)	-0.11 (-0.2, -0.02)
Thyroid cancer	215255.2 (182182.9-244090.3)	7.9 (6.7-9)	347975.8 (306330.9-384509.9)	8.8 (7.8-9.8)	0.23 (0.12, 0.34)
Tracheal, bronchus, and lung cancer	4308319.8 (4042416-4611324.6)	158.8 (149-170)	5147912.6 (4703827.5-5611862.2)	130.8 (119.5-142.6)	-1 (-1.19, -0.8)
Uterine cancer	295925.1 (223759.1-340039.8)	10.9 (8.3-12.5)	365187 (300719.7-406309.7)	9.3 (7.6-10.3)	-0.76 (-1.05, -0.47)

Abbreviations: EAPC, estimated annual percentage change; UI, uncertainty interval; CI, confidence interval.

Table S6. Incidence and death of early-onset breast cancer, TBL cancer, CRC and stomach cancer by region and sociodemographic index level in 1990 and 2019.

Cancers	SDI regions	1990 Incidence		2019 Incidence		1990 Death		2019 Death	
		Cases (95% UI)	ASR per 100k (95% UI)	Cases (95% UI)	ASR per 100k (95% UI)	Cases (95% UI)	ASR per 100k (95% UI)	Cases (95% UI)	ASR per 100k (95% UI)
Breast cancer	Global	260836.3 (250473.6-271710.5)	11.2 (11.2, 11.3)	537979.6 (490640.8-588711.2)	13.2 (13.1, 13.2)	86957.8 (82562.6-92106.1)	3.7 (3.7, 3.8)	136448.7 (124894.9-149068.5)	3.3 (3.3, 3.4)
	Low SDI	9363.7 (8001.9-10797.6)	5.2 (5.1, 5.3)	32559.2 (27874.8-37975.8)	7.6 (7.5, 7.7)	6211.2 (5321.9-7235.5)	3.5 (3.4, 3.6)	17240.6 (14793.9-20021.6)	4.1 (4, 4.1)
	Low-middle SDI	26776.6 (23729.1-30345.5)	6.1 (6, 6.2)	83499.4 (72485-95330.3)	9.6 (9.6, 9.7)	15570.4 (13780.3-17711.6)	3.6 (3.5, 3.6)	35253.3 (30234.7-40788.5)	4.1 (4, 4.1)
	Middle SDI	52827.9 (48220.2-57995.7)	7.3 (7.2, 7.3)	167017.6 (147164.1-187948)	12.3 (12.2, 12.3)	23883.3 (22021.3-26229.8)	3.3 (3.3, 3.4)	44643.9 (39988.6-49854.2)	3.3 (3.2, 3.3)
	High-middle SDI	68200.6 (65207.6-71583)	12.4 (12.4, 12.5)	134512.5 (119061.7-151755.1)	15.4 (15.3, 15.5)	21200.8 (20171.9-22417)	3.9 (3.8, 3.9)	24208 (22152-26662)	2.8 (2.7, 2.8)
	High SDI	103495.7 (100980.7-105995.3)	22.9 (22.8, 23.1)	120000.7 (106168.2-134790.7)	21.1 (21, 21.2)	20026.5 (19713.9-20347.4)	4.4 (4.4, 4.5)	14976.3 (14320.5-15639.6)	2.6 (2.6, 2.7)
	High-income Asia Pacific	13747.9 (12553.4-15103)	13.5 (13.3, 13.7)	20642.6 (17076.9-24966.4)	18.4 (18.2, 18.7)	2497 (2441.6-2555.3)	2.4 (2.4, 2.5)	2237.2 (2117.6-2376.8)	2 (1.9, 2)

	Central Asia	3310.1 (3141.5-3491.5)	13.1 (12.6, 13.6)	6164.1 (5336.9-7078.8)	12.8 (12.5, 13.1)	1265.5 (1213.4-1323.7)	5.1 (4.8, 5.4)	1816.9 (1584.2-2085)	3.8 (3.6, 4)
	East Asia	34620.3 (27994.9-42038.5)	6 (6, 6.1)	112508.6 (86987.1-140589.7)	12.2 (12.1, 12.2)	13253.6 (10745.4-16007.2)	2.3 (2.3, 2.4)	17176.3 (13618-21402)	1.8 (1.8, 1.9)
	South Asia	21947.2 (18713.6-25110.8)	4.9 (4.9, 5)	78582.1 (64308.5-94610.5)	8.7 (8.6, 8.7)	13489.2 (11514.3-15394.2)	3.1 (3, 3.1)	35091.7 (28704.5-42380.8)	3.9 (3.9, 3.9)
	Southeast Asia	21600 (18378.9-25278.5)	11.4 (11.2, 11.5)	59060.6 (49804.5-69732.6)	15.6 (15.5, 15.7)	11368.3 (9772.4-13411.8)	6.1 (5.9, 6.2)	20994.5 (17773.5-24976.1)	5.5 (5.5, 5.6)
	Australasia	2775.8 (2597.1-2951)	25 (24.1, 26)	3720.3 (2886.9-4754.8)	23.4 (22.7, 24.2)	562.2 (540.5-583.5)	5.1 (4.7, 5.5)	451.3 (410.4-491.2)	2.8 (2.6, 3.1)
	Caribbean	2003.3 (1825.4-2178.9)	13.3 (12.7, 13.9)	4010.5 (3175.3-4897.6)	16.4 (15.9, 16.9)	700.7 (622-793.4)	4.7 (4.3, 5)	1194.9 (910.4-1502.5)	4.9 (4.6, 5.2)
	Central Europe	10220.4 (9804.4-10641.4)	15.9 (15.6, 16.2)	11795.2 (9939.4-14053)	17.2 (16.9, 17.6)	3053.8 (2973-3136.4)	4.8 (4.6, 4.9)	2088.7 (1773.9-2451.5)	3 (2.9, 3.2)
	Eastern Europe	17469.4 (16717.9-18417.5)	15.8 (15.6, 16.1)	21674.3 (17985.3-26158.4)	17.6 (17.4, 17.9)	5338.2 (5140.1-5589)	4.9 (4.7, 5)	4333.2 (3601.4-5238.4)	3.5 (3.4, 3.6)
	Western Europe	52039.6 (50419.1-53777.5)	25.4 (25.1, 25.6)	59394.1 (50003.8-69938.6)	24.7 (24.5, 24.9)	11030.7 (10835-11242.2)	5.4 (5.3, 5.5)	7185.5 (6867.5-7509.9)	3 (2.9, 3)
	Andean Latin America	896.3 (788.8-1018.1)	6.2 (5.8, 6.6)	2954.3 (2246.2-3790.5)	9.2 (8.9, 9.6)	451.8 (401.4-513.4)	3.1 (2.9, 3.5)	843.3 (648.7-1083.5)	2.6 (2.5, 2.8)
	Central Latin America	4907.4 (4734-5086.4)	7.9 (7.7, 8.1)	16076.5 (13150.9-19567.4)	12.3 (12.1, 12.5)	1868.4 (1815.7-1920.1)	3 (2.9, 3.2)	3786.9 (3135.7-4558.6)	2.9 (2.8, 3)
	Southern Latin America	3060.1 (2860.6-3275.4)	13.2 (12.7, 13.6)	5524.5 (4019-7322.8)	15.3 (14.9, 15.8)	1232 (1179.3-1287.7)	5.3 (5, 5.6)	1381.4 (1264.8-1497.8)	3.8 (3.6, 4)
	Tropical Latin America	6303.1 (6045.5-6593.2)	9.8 (9.5, 10)	16561.4 (15390.9-17848.8)	13 (12.8, 13.2)	2559 (2464.2-2657.4)	4 (3.8, 4.1)	4356.7 (4078.1-4673.5)	3.4 (3.3, 3.5)
	North Africa and Middle East	8993.3 (8063.8-10137.6)	7.3 (7.2, 7.5)	43491.5 (36982-50548.7)	13.2 (13.1, 13.3)	4148.4 (3748.4-4739)	3.4 (3.3, 3.5)	11426.9 (9698-13499.3)	3.5 (3.4, 3.6)
	High-income North America	46972.1 (45578.5-48289.6)	30.6 (30.4, 30.9)	43402.7 (34889.3-53837.4)	23.1 (22.8, 23.3)	7915.9 (7750.9-8074.6)	5.2 (5.1, 5.3)	5359.9 (5078.5-5649.8)	2.8 (2.8, 2.9)
	Oceania	424 (323.3-543.6)	17 (15.4, 18.7)	1528.2 (1139.7-2022)	25.3 (24, 26.6)	239.1 (180.7-305.1)	9.7 (8.5, 11)	768.5 (572.4-1017.4)	12.8 (11.9, 13.7)
	Central Sub-Saharan Africa	1087.7 (813.4-1417.6)	6.1 (5.7, 6.4)	3773.1 (2690.8-5038.6)	7.8 (7.6, 8.1)	726.4 (558.8-928.3)	4.1 (3.8, 4.4)	2143.2 (1535.8-2881.2)	4.5 (4.3, 4.7)
	Eastern Sub-Saharan Africa	3163 (2485-3839.7)	5.3 (5.1, 5.5)	9718.2 (7943.7-11706.5)	6.5 (6.3, 6.6)	2127.5 (1661.3-2563.5)	3.6 (3.4, 3.8)	5252.4 (4293.3-6348.6)	3.5 (3.4, 3.6)
	Southern Sub-Saharan Africa	1797.7 (1585.5-2005.5)	8.9 (8.5, 9.4)	3524.6 (2943.3-4188.6)	9 (8.7, 9.3)	929.6 (824-1033.7)	4.7 (4.4, 5)	1540.9 (1281-1851.8)	3.9 (3.8, 4.2)
	Western Sub-Saharan Africa	3497.8 (2738.5-4452.2)	5.4 (5.2, 5.6)	13872.5 (10392.2-17974.7)	8.5 (8.4, 8.7)	2200.5 (1752.7-2826.1)	3.4 (3.3, 3.6)	7018.5 (5309.3-9219.2)	4.3 (4.2, 4.4)
	Global	106306.3 (100111.4-113467.8)	4.7 (4.6, 4.7)	136946.2 (123422.3-150290.4)	3.3 (3.3, 3.3)	91573.6 (85931-98019.2)	4 (4, 4)	110729.4 (101076.6-120624.3)	2.7 (2.7, 2.7)
TBL	Low SDI	2309.4 (1884.7-2835.5)	1.3 (1.3, 1.4)	5971.9 (5003.9-7231.2)	1.4 (1.4, 1.5)	2091.1 (1717.3-2574.8)	1.2 (1.2, 1.3)	5404.3 (4517.7-6571.7)	1.3 (1.3, 1.4)
cancer	Low-middle SDI	9127.7 (8200.1-10297.6)	2.1 (2.1, 2.2)	18936.2 (16744-21061.4)	2.2 (2.2, 2.2)	8234.6 (7345.2-9340.4)	1.9 (1.9, 2)	16773.6 (14930.5-18639.2)	2 (1.9, 2)
	Middle SDI	31522.5 (28464.1-34800.6)	4.4 (4.4, 4.5)	51333.3 (44548.7-58301)	3.7 (3.7, 3.8)	28262.2 (25418.4-31356.9)	4 (3.9, 4)	42952.5 (37467.1-48693.4)	3.1 (3.1, 3.1)

	High-middle SDI	36355 (33963.5-39300.2)	6.8 (6.7, 6.9)	39890.6 (35596.5-44418.8)	4.5 (4.5, 4.6)	31818.6 (29616.6-34315.3)	6 (5.9, 6)	31370.6 (28381.4-34559.9)	3.5 (3.5, 3.6)
	High SDI	26944.2 (26511.4-27353.1)	6 (6, 6.1)	20741.6 (18643.1-22901.8)	3.5 (3.5, 3.6)	21125.7 (20836.3-21426.2)	4.7 (4.7, 4.8)	14166.8 (13567.6-14792.6)	2.4 (2.4, 2.5)
	High-income Asia Pacific	3882.6 (3763.5-3989.8)	3.8 (3.7, 3.9)	3158.8 (2775.1-3594.9)	2.7 (2.6, 2.8)	2887.7 (2806.7-2958.9)	2.8 (2.7, 2.9)	1747.3 (1648.8-1849.1)	1.5 (1.4, 1.6)
	Central Asia	1853.6 (1778.7-1926.4)	7.6 (7.3, 8)	1671.7 (1479.1-1894.5)	3.5 (3.3, 3.7)	1632.9 (1564.9-1697.4)	6.8 (6.5, 7.2)	1456 (1290.1-1652.2)	3 (2.9, 3.2)
	East Asia	36487.8 (31228.2-42291.2)	6.5 (6.4, 6.5)	54862.4 (45569-65209.5)	5.8 (5.7, 5.8)	32568.6 (27591.2-37929.5)	5.8 (5.7, 5.9)	43343.3 (36305-51578.9)	4.5 (4.5, 4.6)
	South Asia	5726.7 (4881.5-6509.9)	1.3 (1.3, 1.4)	14532.6 (12383.6-16642.7)	1.6 (1.6, 1.7)	5199.6 (4484.3-5959.1)	1.2 (1.2, 1.2)	13004.3 (11016.6-14900.1)	1.5 (1.4, 1.5)
	Southeast Asia	6762.8 (5969.9-7603.6)	3.7 (3.6, 3.8)	13941 (11257-16662.3)	3.7 (3.6, 3.7)	6109.2 (5395.1-6841.4)	3.4 (3.3, 3.5)	12279.2 (9985.2-14491.7)	3.2 (3.2, 3.3)
	Australasia	479.8 (455.9-506.4)	4.4 (4, 4.8)	515.2 (400.3-660.7)	3.2 (2.9, 3.4)	351.4 (334.8-368.6)	3.2 (2.9, 3.6)	328.8 (297.4-362.7)	2 (1.8, 2.2)
	Caribbean	585 (544.1-631.5)	3.9 (3.6, 4.3)	709.3 (568-867.6)	2.9 (2.7, 3.1)	514.6 (477.9-556.6)	3.5 (3.2, 3.8)	602.5 (482.6-734)	2.4 (2.2, 2.6)
	Central Europe	5959.9 (5816.7-6108)	9.5 (9.2, 9.7)	3819 (3280.9-4405.5)	5.5 (5.3, 5.6)	5271.3 (5150.4-5400)	8.4 (8.1, 8.6)	3171.8 (2705-3654.7)	4.5 (4.4, 4.7)
	Eastern Europe	8674.1 (8154.6-9032.5)	8.2 (8.1, 8.4)	5908.5 (5175.6-6758.2)	4.8 (4.7, 4.9)	7429.8 (6991.9-7725.6)	7.1 (6.9, 7.2)	4696.6 (4047.4-5353.6)	3.8 (3.7, 3.9)
	Western Europe	12812.8 (12545.6-13102.5)	6.2 (6.1, 6.3)	10578.7 (8724.1-12465.2)	4.2 (4.1, 4.3)	10396.6 (10201.3-10604.7)	5 (4.9, 5.1)	7431.9 (6968.6-7817.3)	2.9 (2.9, 3)
	Andean Latin America	362.3 (311-412.3)	2.4 (2.2, 2.7)	602.7 (456.3-788.3)	1.9 (1.7, 2)	320.1 (274.4-365.3)	2.2 (2, 2.4)	515.5 (389.2-671.9)	1.6 (1.5, 1.8)
	Central Latin America	1418 (1384.5-1453.9)	2.3 (2.1, 2.4)	2227.5 (1841.5-2671.2)	1.7 (1.6, 1.8)	1248.5 (1218.6-1282.3)	2 (1.9, 2.1)	1877.9 (1553.9-2268)	1.4 (1.4, 1.5)
	Southern Latin America	1449.1 (1379.8-1523.3)	6.3 (6, 6.6)	1095.4 (817.6-1443)	3 (2.9, 3.2)	1301.9 (1238.5-1365.4)	5.6 (5.3, 6)	921.7 (830.4-1031.6)	2.5 (2.4, 2.7)
	Tropical Latin America	1901.2 (1841.3-1968)	3 (2.9, 3.1)	2708.3 (2554.6-2865.1)	2.1 (2.1, 2.2)	1705.9 (1648.1-1766.6)	2.7 (2.6, 2.8)	2353.6 (2222.1-2485.8)	1.9 (1.8, 1.9)
	North Africa and Middle East	3777.1 (2962.8-4633.1)	3.1 (3, 3.2)	8046.6 (7010-9194.7)	2.5 (2.4, 2.5)	3425.3 (2674.6-4212.9)	2.9 (2.8, 3)	7098.2 (6158.6-8155.7)	2.2 (2.1, 2.3)
	High-income North America	11532.9 (11314.8-11759.1)	7.7 (7.6, 7.9)	7013.9 (6002.9-8224.9)	3.6 (3.5, 3.7)	8825.3 (8662.3-8993.5)	5.9 (5.8, 6.1)	4878.8 (4673.9-5083.4)	2.5 (2.4, 2.6)
	Oceania	92.3 (68.9-134.6)	3.7 (3, 4.6)	244.4 (171.1-362)	4 (3.5, 4.6)	81.5 (60.9-118.8)	3.3 (2.6, 4.1)	216.8 (150.7-322)	3.6 (3.1, 4.1)
	Central Sub-Saharan Africa	421.2 (237.3-848.8)	2.5 (2.3, 2.7)	974.6 (606.3-1753.6)	2.1 (2, 2.3)	379.6 (213.8-762.5)	2.3 (2, 2.5)	885.1 (548.8-1601.6)	1.9 (1.8, 2.1)
	Eastern Sub-Saharan Africa	566.9 (466-710.4)	1 (0.9, 1.1)	1425.7 (1126.1-1806.8)	1 (0.9, 1)	511.3 (417.7-640.4)	0.9 (0.8, 1)	1304.6 (1034-1639.8)	0.9 (0.9, 1)
	Southern Sub-Saharan Africa	903.1 (805.3-1029.7)	4.8 (4.5, 5.2)	1074 (929.2-1231.7)	2.8 (2.7, 3)	823.3 (729.1-934.6)	4.4 (4.1, 4.7)	967 (841.2-1105.6)	2.6 (2.4, 2.7)
	Western Sub-Saharan Africa	657 (529.4-796.5)	1 (0.9, 1.1)	1835.8 (1459.4-2241.7)	1.1 (1.1, 1.2)	589.4 (480.4-715.8)	0.9 (0.8, 1)	1648.4 (1312.8-2024.7)	1 (1, 1.1)
CRC	Global	94707.1 (90420.5-99416.4)	4 (4, 4)	225736 (207658-246755.7)	5.5 (5.5, 5.5)	50436.5 (47475-53367.8)	2.1 (2.1, 2.2)	86545.6 (80162-93431.1)	2.1 (2.1, 2.1)
	Low SDI	2777 (2284.1-3327.5)	1.5 (1.5, 1.6)	7716.4 (6643-8911.9)	1.8 (1.8, 1.8)	2225.6 (1836.4-2671)	1.2 (1.2, 1.3)	5693 (4933-6582.5)	1.3 (1.3, 1.4)

Low-middle SDI	8615 (7710.5-9669.5)	1.9 (1.9, 2)	24979.5 (22488.3-27829.7)	2.9 (2.8, 2.9)	6433.1 (5715.1-7231.1)	1.5 (1.4, 1.5)	15376.2 (13666.2-17136.9)	1.8 (1.7, 1.8)
Middle SDI	23377.9 (21458.4-25471.2)	3.1 (3.1, 3.1)	75841.7 (67256.8-85383.6)	5.6 (5.5, 5.6)	15311.1 (13878-16640)	2.1 (2, 2.1)	31223.5 (28190.6-34399.3)	2.3 (2.3, 2.3)
High-middle SDI	27712.9 (26289.2-29502.6)	5 (4.9, 5.1)	69605.6 (62366.1-77641.5)	8.1 (8, 8.1)	14897.7 (14014.1-15826.3)	2.7 (2.7, 2.7)	22183.4 (20248.8-24368.7)	2.6 (2.5, 2.6)
High SDI	32179.4 (31645.5-32734.2)	7.2 (7.1, 7.3)	47489.7 (43601.5-51742.5)	8.4 (8.3, 8.5)	11544 (11365.8-11718.1)	2.6 (2.5, 2.6)	12020.1 (11559.8-12508.9)	2.1 (2.1, 2.1)
High-income Asia Pacific	7952.7 (7713.7-8186.5)	7.8 (7.6, 8)	9294.5 (8006.7-10617.2)	8.3 (8.1, 8.5)	2837.1 (2778.7-2891.7)	2.8 (2.7, 2.9)	2056.4 (1941.2-2159.5)	1.8 (1.7, 1.9)
Central Asia	1297.1 (1243.5-1358.5)	4.8 (4.5, 5.1)	1830.9 (1636.7-2062.3)	3.8 (3.6, 4)	805.5 (773.3-844)	3 (2.8, 3.3)	982.6 (878.4-1113.7)	2 (1.9, 2.2)
East Asia	25347.7 (22184.8-28937.6)	4.2 (4.2, 4.3)	90911 (76318.1-106893.9)	10 (10, 10.1)	15532.2 (13405-17867.5)	2.6 (2.6, 2.7)	27447.4 (23104-32222.8)	3 (3, 3)
South Asia	6135.9 (5396.9-6948.6)	1.4 (1.3, 1.4)	18253.4 (15671.1-21008.5)	2 (2, 2.1)	4824.3 (4265.5-5454.8)	1.1 (1.1, 1.1)	12420.9 (10757.6-14391.2)	1.4 (1.4, 1.4)
Southeast Asia	6101.4 (5194.6-6824)	3.2 (3.1, 3.2)	18976.3 (15675-22334.4)	5 (5, 5.1)	4241 (3616.7-4793)	2.2 (2.2, 2.3)	10550.2 (8800.3-12385.5)	2.8 (2.7, 2.8)
Australasia	941.4 (892.5-992.7)	8.6 (8, 9.2)	1520.4 (1194.1-1932.8)	9.7 (9.2, 10.2)	320.6 (306.9-335.5)	2.9 (2.6, 3.3)	337.1 (308-369.5)	2.1 (1.9, 2.4)
Caribbean	575.4 (540.2-611.4)	3.7 (3.4, 4)	1222 (1005.9-1474)	5 (4.7, 5.3)	314.2 (292.3-338.6)	2 (1.8, 2.3)	561.9 (461.2-681.1)	2.3 (2.1, 2.5)
Central Europe	3846.7 (3736.7-3969.4)	6.1 (5.9, 6.3)	4850.4 (4151.5-5578.9)	7.2 (7, 7.4)	2112.8 (2056.6-2174.4)	3.3 (3.2, 3.5)	1861.5 (1598.2-2134)	2.7 (2.6, 2.9)
Eastern Europe	6810.7 (6347.7-7171.6)	6.2 (6.1, 6.4)	9238.7 (8187.5-10479.7)	7.6 (7.5, 7.8)	3514.6 (3276-3697.7)	3.2 (3.1, 3.3)	3458.8 (3063-3897.6)	2.8 (2.8, 2.9)
Western Europe	13441.6 (13128.9-13761.4)	6.6 (6.5, 6.7)	17020.9 (14619.3-19670.2)	7.1 (7, 7.2)	5082.1 (4991.8-5173.5)	2.5 (2.4, 2.5)	4247 (4053.5-4426.3)	1.8 (1.7, 1.8)
Andean Latin America	351.1 (310.6-399.2)	2.3 (2.1, 2.6)	1507.4 (1159.9-1950.9)	4.7 (4.4, 4.9)	203.3 (181.1-230.3)	1.4 (1.2, 1.6)	525.7 (410.9-669.4)	1.6 (1.5, 1.8)
Central Latin America	1452.3 (1412.9-1490.4)	2.2 (2.1, 2.3)	5782.2 (4916.4-6815)	4.4 (4.3, 4.5)	875.6 (852.8-898)	1.4 (1.3, 1.5)	2564 (2170.9-3008.6)	2 (1.9, 2)
Southern Latin America	949.7 (903.3-999.4)	4.1 (3.8, 4.3)	2233.3 (1694.2-2912.9)	6.2 (6, 6.5)	584.4 (558-613.2)	2.5 (2.3, 2.7)	1021.5 (936.1-1116.3)	2.8 (2.7, 3)
Tropical Latin America	1916.8 (1856.5-1983.1)	2.9 (2.7, 3)	5754.9 (5414.7-6061.3)	4.6 (4.4, 4.7)	1239 (1200.6-1282.7)	1.9 (1.8, 2)	2856.8 (2697.7-3003.1)	2.3 (2.2, 2.3)
North Africa and Middle East	3125.8 (2608.2-3801.4)	2.5 (2.4, 2.5)	11101.1 (9615.5-12783.3)	3.4 (3.3, 3.4)	2179.8 (1816-2650.2)	1.7 (1.7, 1.8)	5485 (4715.8-6362.1)	1.7 (1.6, 1.7)
High-income North America	11664.8 (11348.3-11962.4)	7.7 (7.5, 7.8)	18499.3 (15902.1-21546.9)	9.8 (9.7, 10)	3604.5 (3516.8-3688.1)	2.4 (2.3, 2.5)	4544.6 (4398.5-4709)	2.4 (2.3, 2.5)
Oceania	61 (48.7-76)	2.4 (1.8, 3.1)	164.6 (125.9-215.1)	2.7 (2.3, 3.1)	42.8 (33.7-53.6)	1.7 (1.2, 2.3)	111.8 (84.6-147.5)	1.8 (1.5, 2.2)
Central Sub-Saharan Africa	291.3 (215.4-386.8)	1.6 (1.4, 1.8)	797.7 (566.4-1081.9)	1.6 (1.5, 1.8)	232 (177.1-305.3)	1.3 (1.1, 1.5)	604.2 (427.9-820.8)	1.3 (1.2, 1.4)
Eastern Sub-Saharan Africa	1066.6 (858.1-1310.7)	1.8 (1.6, 1.9)	3089 (2525.8-3770.4)	2 (2, 2.1)	849.7 (678.3-1042.6)	1.4 (1.3, 1.5)	2298.2 (1884.8-2807.8)	1.5 (1.5, 1.6)
Southern Sub-Saharan Africa	565.9 (507.9-631.5)	2.8 (2.6, 3)	1111.1 (955.2-1276.6)	2.8 (2.6, 3)	405.9 (366.2-451.8)	2 (1.8, 2.2)	738 (635-851.9)	1.9 (1.7, 2)
Western Sub-Saharan Africa	811.1 (642.4-1008.6)	1.2 (1.1, 1.3)	2577 (2059.5-3111.6)	1.5 (1.5, 1.6)	635.1 (500.1-791.2)	1 (0.9, 1)	1872 (1493.9-2315.5)	1.1 (1.1, 1.2)

	Global	125974.3 (118139.9-133955.5)	5.4 (5.3, 5.4)	144321.2 (130472.9-158788.9)	3.5 (3.5, 3.6)	97382.7 (90808.2-104061.7)	4.2 (4.1, 4.2)	87333.5 (79904.3-95000.1)	2.1 (2.1, 2.1)
	Low SDI	5835.5 (4920.5-6622.3)	3.2 (3.1, 3.3)	9441.7 (8062-10865.2)	2.2 (2.2, 2.3)	5185.9 (4411-5845.1)	2.9 (2.8, 3)	8351.3 (7187-9592)	2 (1.9, 2)
	Low-middle SDI	18731.3 (16680.3-20403.8)	4.2 (4.2, 4.3)	26153 (23536-28918.2)	3 (3, 3)	16458.5 (14722.8-17964.3)	3.8 (3.7, 3.8)	21408.6 (19236-23771.6)	2.5 (2.4, 2.5)
	Middle SDI	41707 (37519.7-46081.8)	5.7 (5.7, 5.8)	54281.9 (47258.6-61911.5)	4 (3.9, 4)	34945.5 (31453.6-38870.9)	4.8 (4.8, 4.9)	31097.3 (27804.1-34949.7)	2.3 (2.2, 2.3)
	High-middle SDI	35029.6 (32514.5-37646.2)	6.4 (6.3, 6.5)	40349.1 (35304.3-45650.3)	4.7 (4.6, 4.7)	27950.4 (25910.2-30134)	5.1 (5.1, 5.2)	20715.7 (18484-22953.5)	2.4 (2.3, 2.4)
	High SDI	24633 (24088.8-25166.5)	5.5 (5.4, 5.6)	14041.5 (12929.2-15275.4)	2.5 (2.5, 2.5)	12811 (12569-13027.3)	2.9 (2.8, 2.9)	5717.8 (5462.9-5995.2)	1 (1, 1)
	High-income Asia Pacific	16694.8 (16188.1-17189.8)	16.5 (16.3, 16.8)	6407.9 (5627.8-7282.8)	5.9 (5.8, 6.1)	7715.8 (7482.3-7894.4)	7.7 (7.5, 7.8)	2069 (1943.4-2212.1)	1.9 (1.8, 2)
	Central Asia	2161.1 (2076.7-2244.2)	8.5 (8.1, 8.8)	1974.4 (1764.8-2229.9)	4.1 (3.9, 4.3)	1875 (1799-1947.7)	7.5 (7.1, 7.8)	1679.7 (1497.9-1900)	3.5 (3.3, 3.7)
	East Asia	49304.8 (42924.4-56327.8)	8.6 (8.6, 8.7)	68382.2 (56611.1-81594.8)	7.4 (7.4, 7.5)	40658 (34888.9-46565.6)	7.2 (7.1, 7.3)	32211.4 (26787.3-38306)	3.4 (3.4, 3.5)
	South Asia	14580.2 (12911.5-16083.5)	3.2 (3.2, 3.3)	21127.2 (18261.3-24233.1)	2.3 (2.3, 2.4)	12915.2 (11397-14184.9)	2.9 (2.8, 2.9)	18314.2 (15927.6-21109.5)	2 (2, 2.1)
	Southeast Asia	5693.3 (4809.9-6436.8)	3 (2.9, 3.1)	6354.4 (5397.3-7406.5)	1.7 (1.6, 1.7)	4947.9 (4220.1-5516.7)	2.6 (2.5, 2.7)	5019.6 (4323.5-5812.6)	1.3 (1.3, 1.4)
Stomach cancer	Australasia	210.7 (198.4-225.6)	1.9 (1.7, 2.2)	241.8 (185.8-310.1)	1.5 (1.4, 1.8)	118.3 (112.2-124.7)	1.1 (0.9, 1.3)	102.1 (90.4-115.2)	0.6 (0.5, 0.8)
	Caribbean	409.5 (348.7-452.6)	2.7 (2.4, 2.9)	534.8 (432.1-643.9)	2.2 (2, 2.4)	346.8 (292.9-385.5)	2.3 (2, 2.5)	436.6 (348.7-528.9)	1.8 (1.6, 2)
	Central Europe	2511.2 (2452.4-2570.1)	3.9 (3.8, 4.1)	1460.4 (1262.4-1678.1)	2.2 (2, 2.3)	2128.3 (2076.8-2181)	3.3 (3.2, 3.5)	1086.3 (933.4-1254.5)	1.6 (1.5, 1.7)
	Eastern Europe	9947.9 (9280.4-10297.7)	9.1 (8.9, 9.3)	6053.2 (5378.7-6793.4)	5 (4.9, 5.1)	7650.9 (7151.3-7922.7)	7 (6.9, 7.2)	3706.9 (3262.8-4180.3)	3 (2.9, 3.1)
	Western Europe	6142.6 (6007.9-6269.8)	3 (2.9, 3.1)	4611.8 (3923.7-5399)	1.9 (1.9, 2)	4002.3 (3924.6-4072)	2 (1.9, 2)	2168.7 (2043-2296.1)	0.9 (0.9, 0.9)
	Andean Latin America	985.2 (889-1095.8)	6.5 (6.1, 7)	1510.6 (1177.3-1917.6)	4.7 (4.5, 4.9)	857.4 (773.2-951)	5.8 (5.4, 6.2)	1185.4 (924.7-1503.6)	3.7 (3.5, 3.9)
	Central Latin America	2590.3 (2514.5-2662.7)	4 (3.9, 4.2)	4706.9 (3923.5-5598.5)	3.6 (3.5, 3.7)	2136.9 (2072.6-2197.9)	3.4 (3.2, 3.5)	3253.4 (2730.4-3876.7)	2.5 (2.4, 2.6)
	Southern Latin America	845.1 (809.6-885.2)	3.6 (3.4, 3.9)	916 (704.2-1196.6)	2.6 (2.4, 2.7)	694.9 (666.7-726.7)	3 (2.8, 3.2)	642.9 (591.4-700.2)	1.8 (1.6, 1.9)
	Tropical Latin America	2493.3 (2410-2578.5)	3.8 (3.7, 4)	3064.3 (2911-3226.3)	2.4 (2.3, 2.5)	2154.1 (2077.5-2231)	3.3 (3.2, 3.5)	2408.9 (2287.8-2525.5)	1.9 (1.8, 2)
	North Africa and Middle East	4441 (3842.7-4988.3)	3.5 (3.4, 3.6)	7272.1 (6170.9-8484)	2.2 (2.2, 2.3)	3858.9 (3342.9-4340.6)	3.1 (3, 3.2)	5676.5 (4740.1-6694.7)	1.7 (1.7, 1.8)
	High-income North America	2492.6 (2423.1-2554.1)	1.6 (1.6, 1.7)	2785.3 (2404.8-3259.4)	1.5 (1.4, 1.6)	1370.1 (1335.5-1400.6)	0.9 (0.9, 0.9)	1226.3 (1174.3-1282.5)	0.7 (0.6, 0.7)
	Oceania	126.4 (95.4-158.4)	4.9 (4.1, 5.9)	293.5 (212-392.5)	4.8 (4.2, 5.3)	108.7 (82.1-136.5)	4.3 (3.5, 5.2)	252.2 (182.5-337.9)	4.1 (3.6, 4.7)
	Central Sub-Saharan Africa	544.3 (412-697.8)	3 (2.8, 3.3)	905.5 (672.9-1187.3)	1.9 (1.8, 2)	480.4 (369.3-599)	2.7 (2.5, 3)	805.2 (598.7-1067.4)	1.7 (1.6, 1.8)

Eastern Sub-Saharan Africa	1916.8 (1532.4-2213.4)	3.2 (3, 3.3)	2711.2 (2256.9-3264.7)	1.8 (1.7, 1.9)	1694.9 (1349.6-1954)	2.8 (2.7, 3)	2432.5 (2017.1-2917)	1.6 (1.6, 1.7)
Southern Sub-Saharan Africa	562.1 (514.3-608.5)	2.8 (2.6, 3.1)	618.6 (522.2-727.8)	1.6 (1.5, 1.7)	492.3 (450.7-533.2)	2.5 (2.3, 2.7)	535 (454.6-630.1)	1.4 (1.3, 1.5)
Western Sub-Saharan Africa	1320.8 (1108.7-1516.4)	2 (1.9, 2.1)	2389.2 (1933.4-2896)	1.4 (1.4, 1.5)	1175.6 (999.6-1359.9)	1.8 (1.7, 1.9)	2120.4 (1707.2-2570)	1.3 (1.2, 1.3)

Abbreviations: ASR, age-standardized rate; TBL, tracheal, bronchus, and lung; CRC, colorectal cancer.

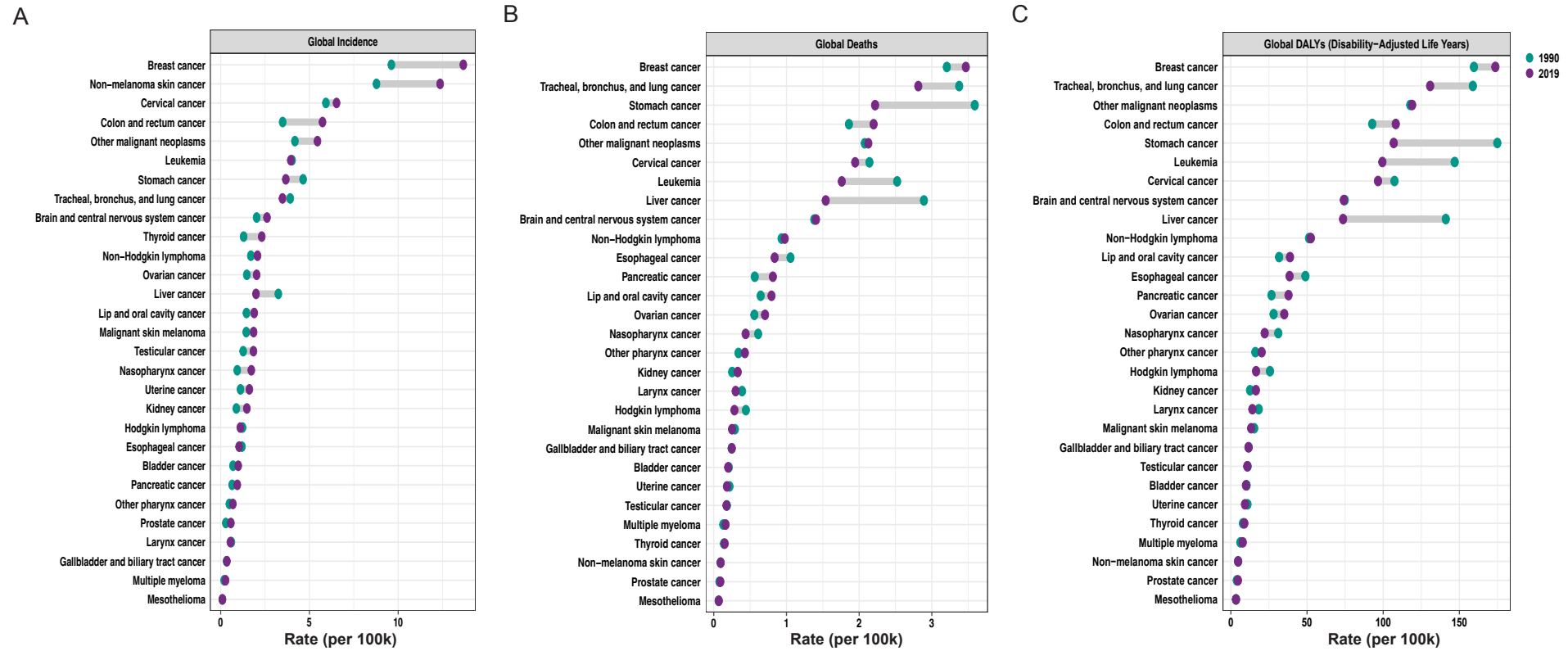
Table S7. Incidence and and death of all early-onset cancers in 1990 and 2019 by region and sociodemographic index level.

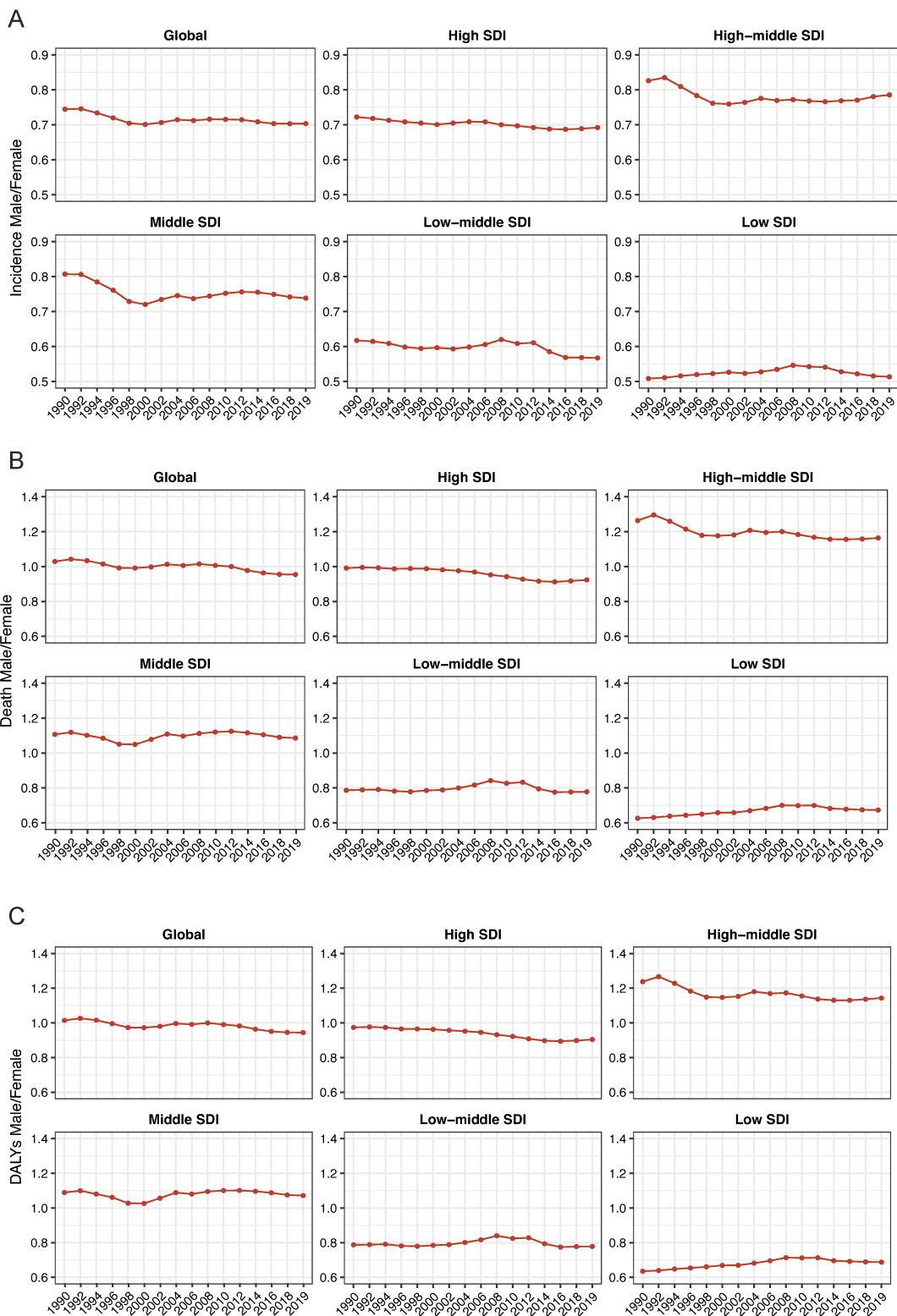
Location	Incidence		Death		DALYs	
	1990 ASR per 100k	2019 ASR per 100k	1990 ASR per 100k	2019 ASR per 100k	1990 ASR per 100k	2019 ASR per 100k
Global	75.7 (75.6, 75.8)	80.3 (80.2, 80.4)	34.7 (34.6, 34.8)	26.1 (26.1, 26.2)	1727.9 (1727.3, 1728.4)	1321.7 (1321.4, 1322.1)
Low SDI	43.2 (42.9, 43.5)	45.3 (45.1, 45.5)	28.4 (28.2, 28.7)	26.8 (26.6, 26.9)	1409 (1407.3, 1410.8)	1334.7 (1333.7, 1335.8)
Low-middle SDI	45.5 (45.3, 45.7)	52.8 (52.6, 52.9)	29.5 (29.3, 29.6)	27.7 (27.6, 27.8)	1473.8 (1472.7, 1475)	1392.9 (1392.1, 1393.7)
Middle SDI	59 (58.8, 59.2)	68.9 (68.8, 69.1)	37 (36.9, 37.2)	26.8 (26.7, 26.9)	1841.2 (1840.2, 1842.2)	1356.1 (1355.5, 1356.7)
High-middle SDI	81.5 (81.3, 81.7)	94.5 (94.3, 94.7)	40.5 (40.3, 40.7)	26.9 (26.8, 27)	2007.1 (2006, 2008.3)	1368.5 (1367.7, 1369.3)
High SDI	139.1 (138.8, 139.5)	159.7 (159.4, 160)	31.2 (31, 31.3)	19.8 (19.7, 20)	1563.2 (1562, 1564.3)	1023 (1022.1, 1023.8)
High-income Asia Pacific	82.2 (81.6, 82.8)	86.1 (85.5, 86.7)	29.5 (29.2, 29.9)	16.3 (16, 16.5)	1486.6 (1484.2, 1489)	840.6 (838.7, 842.4)
Central Asia	78.8 (77.7, 79.9)	72.5 (71.7, 73.2)	42.3 (41.5, 43.2)	31.8 (31.3, 32.3)	2115.5 (2109.9, 2121.2)	1609.7 (1606.1, 1613.3)
East Asia	69.1 (68.9, 69.3)	92.5 (92.3, 92.7)	46.6 (46.4, 46.8)	29.6 (29.5, 29.7)	2301.7 (2300.5, 2302.9)	1502.2 (1501.3, 1503)
South Asia	38.3 (38.1, 38.5)	46.3 (46.1, 46.4)	25.6 (25.4, 25.7)	25.9 (25.8, 26)	1281.6 (1280.5, 1282.6)	1301.7 (1300.9, 1302.4)
Southeast Asia	53.8 (53.5, 54.1)	61.1 (60.8, 61.3)	32.5 (32.3, 32.8)	28.4 (28.3, 28.6)	1631.2 (1629.4, 1633)	1437.3 (1436, 1438.5)
Australasia	146.2 (144, 148.5)	157.7 (155.7, 159.7)	28.6 (27.6, 29.6)	20 (19.3, 20.7)	1456.1 (1448.9, 1463.2)	1044.3 (1039.1, 1049.5)
Caribbean	69.3 (68, 70.6)	75.3 (74.3, 76.4)	32.4 (31.5, 33.3)	30.3 (29.6, 31)	1626.8 (1620.5, 1633.1)	1529.7 (1524.8, 1534.6)
Central Europe	98.3 (97.5, 99.1)	103.7 (102.9, 104.5)	44.8 (44.3, 45.3)	29.8 (29.4, 30.2)	2201.6 (2197.9, 2205.3)	1484.7 (1481.7, 1487.8)
Eastern Europe	93.5 (92.9, 94.1)	108.8 (108.1, 109.4)	43.4 (43, 43.8)	33.7 (33.4, 34)	2146.1 (2143.3, 2148.9)	1698.6 (1696.2, 1701)
Western Europe	118.1 (117.6, 118.6)	125.6 (125.1, 126.1)	32.6 (32.3, 32.8)	20.4 (20.2, 20.6)	1633.7 (1631.9, 1635.4)	1057.2 (1055.8, 1058.6)
Andean Latin America	57.9 (56.7, 59.1)	68.8 (67.9, 69.7)	32.1 (31.2, 33)	26.2 (25.6, 26.8)	1620.7 (1614.4, 1627.1)	1349.9 (1345.9, 1353.9)

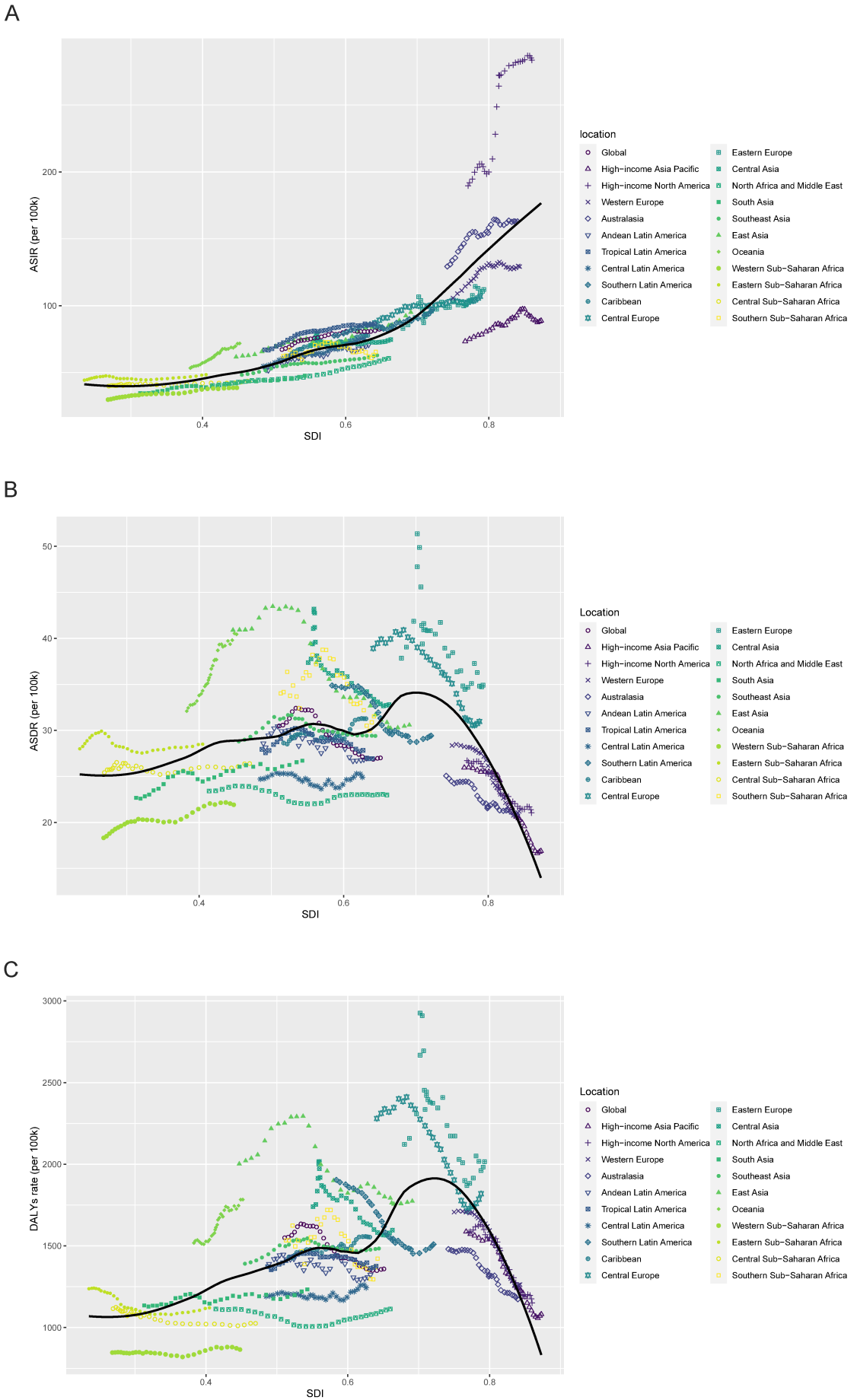
Central Latin America	60.8 (60.2, 61.4)	72.7 (72.3, 73.2)	27.7 (27.3, 28.1)	24.2 (23.9, 24.5)	1405.2 (1402.3, 1408.1)	1249.9 (1248, 1251.8)
Southern Latin America	86.8 (85.6, 88)	94.5 (93.5, 95.5)	39.8 (39, 40.6)	28.5 (27.9, 29)	1977.4 (1971.7, 1983.1)	1452.6 (1448.6, 1456.5)
Tropical Latin America	75.8 (75.1, 76.5)	83.8 (83.3, 84.3)	31.9 (31.4, 32.3)	26.1 (25.8, 26.3)	1579.9 (1576.9, 1582.9)	1316.8 (1314.8, 1318.8)
North Africa and Middle East	44.8 (44.4, 45.1)	58.9 (58.7, 59.2)	26.4 (26.2, 26.7)	22.2 (22.1, 22.4)	1325.4 (1323.4, 1327.3)	1128.8 (1127.6, 1129.9)
High-income North America	215.6 (214.8, 216.3)	273.2 (272.5, 274)	30.7 (30.4, 31)	20.3 (20.1, 20.5)	1551.6 (1549.6, 1553.6)	1048.1 (1046.6, 1049.6)
Oceania	59.8 (56.8, 62.9)	69.6 (67.5, 71.7)	36.4 (34.1, 38.9)	39.1 (37.6, 40.7)	1814.7 (1798.2, 1831.3)	1952.6 (1941.6, 1963.7)
Central Sub-Saharan Africa	45 (44, 46)	42.5 (41.9, 43.1)	29.2 (28.4, 30)	25.5 (25, 25.9)	1430.1 (1424.6, 1435.6)	1253.4 (1250.3, 1256.6)
Eastern Sub-Saharan Africa	49.7 (49.2, 50.3)	46.9 (46.6, 47.3)	31.9 (31.5, 32.4)	27.6 (27.3, 27.8)	1578.6 (1575.5, 1581.8)	1373.1 (1371.2, 1374.9)
Southern Sub-Saharan Africa	70.3 (69.2, 71.5)	63.3 (62.5, 64.1)	38.9 (38, 39.8)	30.4 (29.9, 31)	1919.4 (1913.3, 1925.5)	1506.9 (1503.1, 1510.7)
Western Sub-Saharan Africa	33.4 (33, 33.8)	37.4 (37.1, 37.7)	20.9 (20.5, 21.2)	21.2 (21, 21.4)	1033.1 (1030.6, 1035.5)	1052.5 (1050.9, 1054)

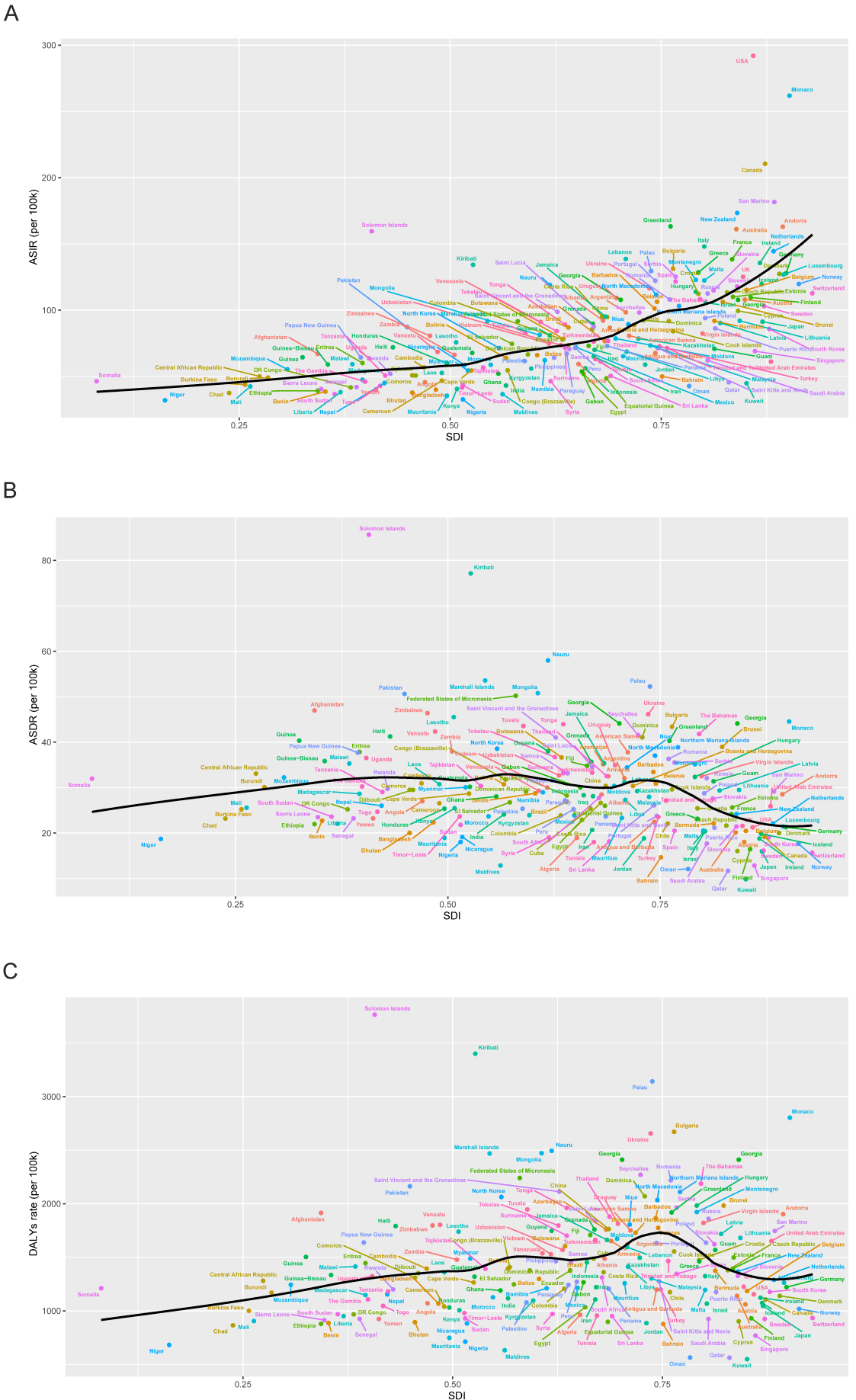
Abbreviations: ASR, age-standardized rate.

Figure S1



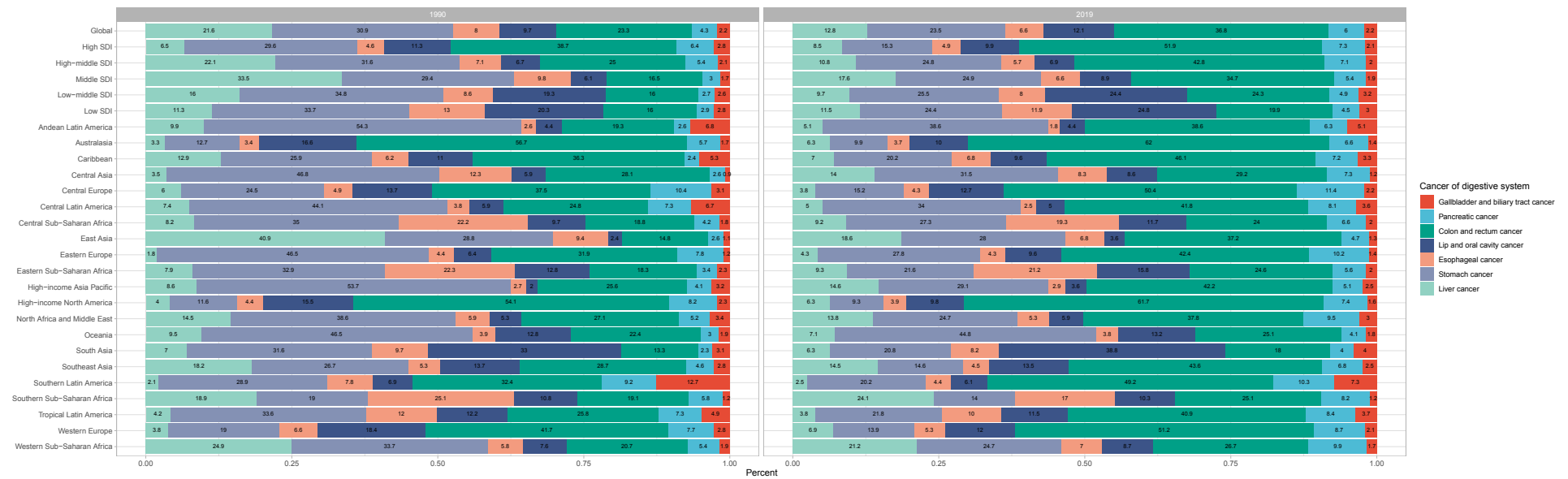






A

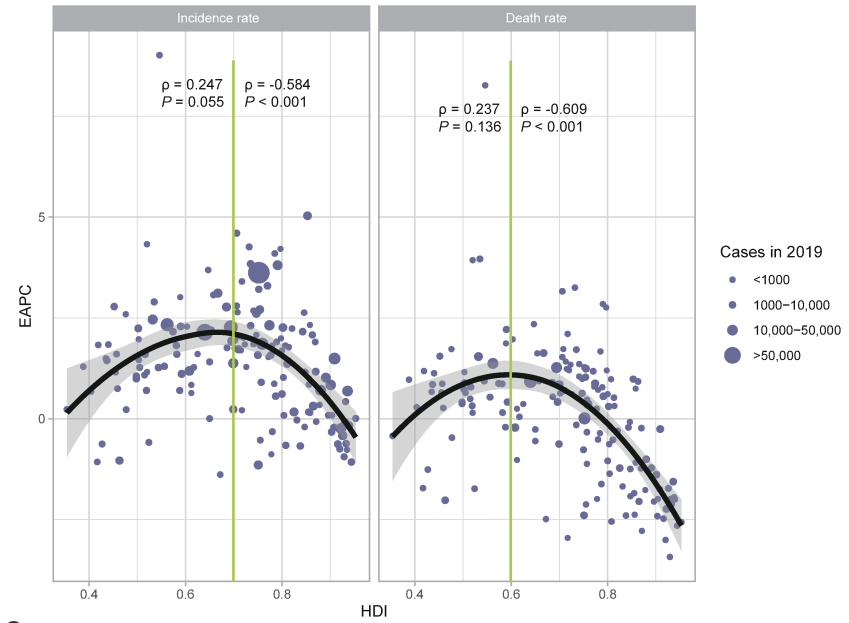
Figure S6



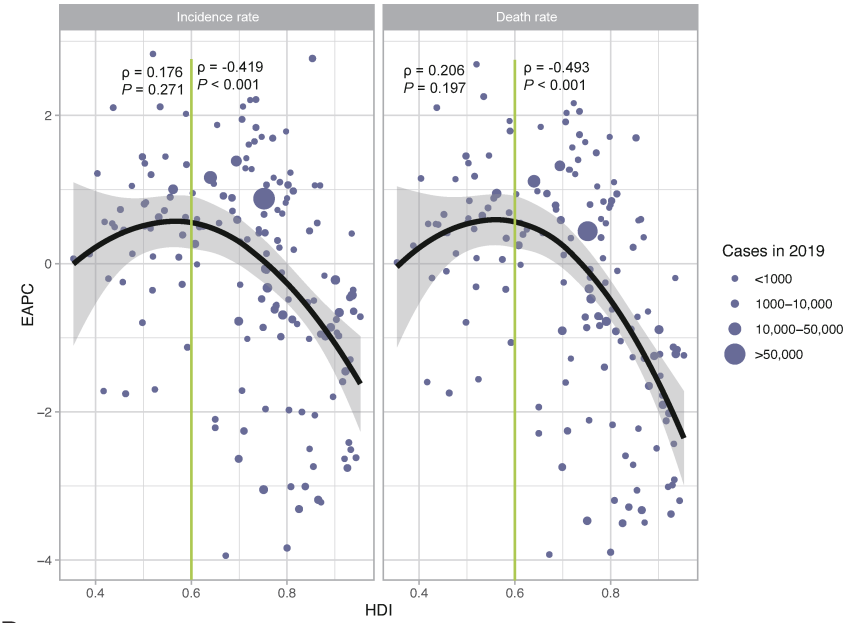
B



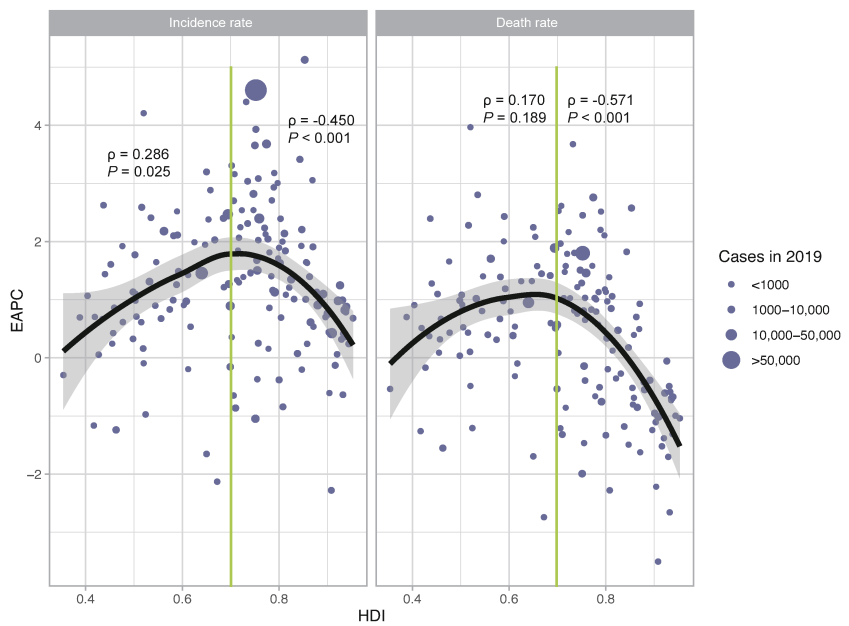
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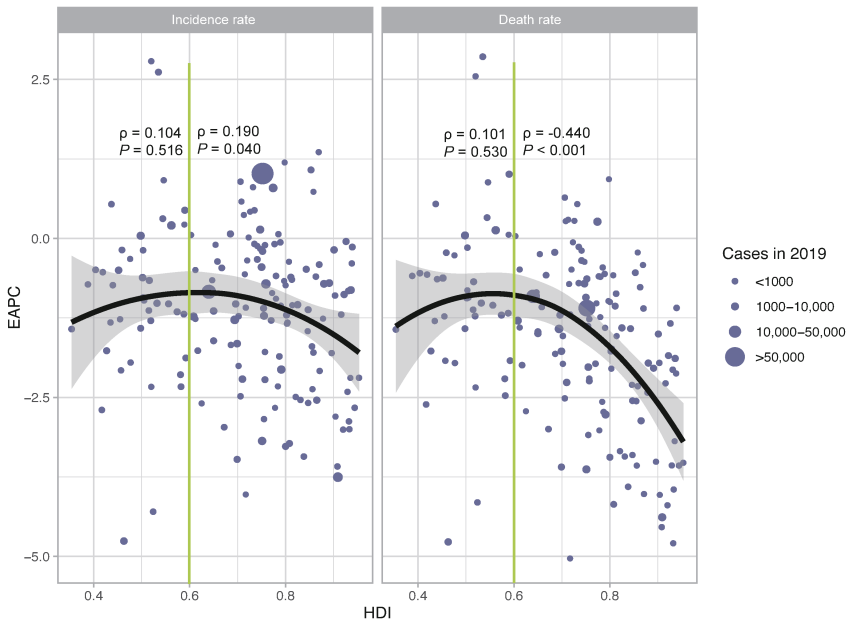
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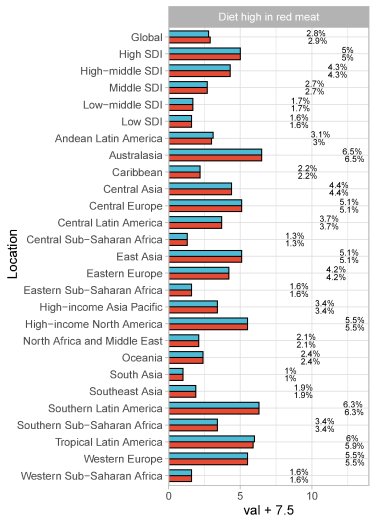
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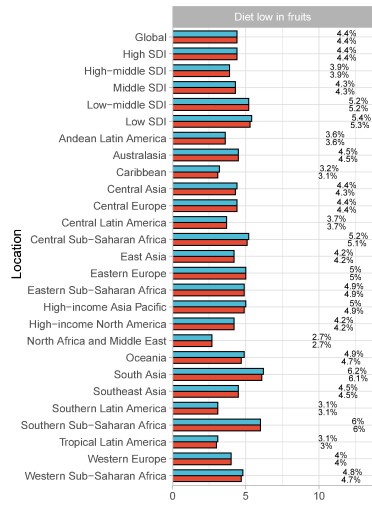
D



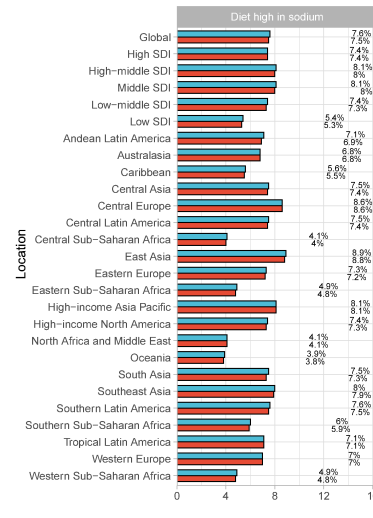
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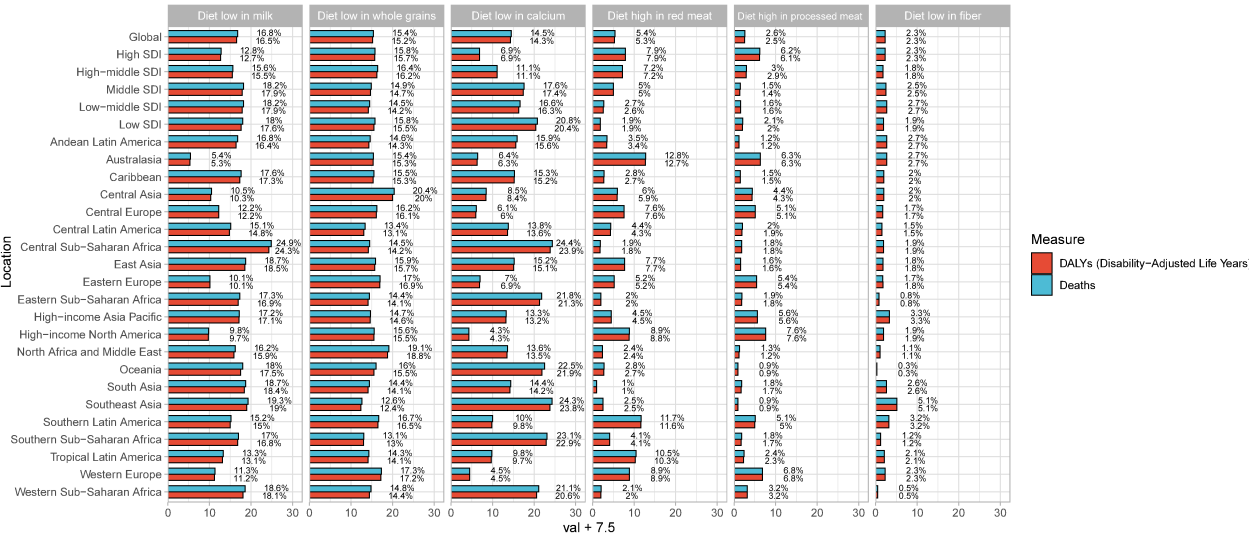
B



D



C



Measure
■ DALYs (Disability-Adjusted Life Years)
■ Deaths

