RESEARCH

Global, regional, and national burden of inflammatory bowel disease, 1990–2021: Insights from the global burden of disease 2021

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Abstract

Purpose The prevalence of inflammatory bowel disease (IBD) is on the rise worldwide. We utilizes data from the Global Burden of Diseases (GBD) 2021 to analyze the national-level burden of IBD, trends in disease incidence, and epidemiological characteristics.

Methods Detailed information on IBD was gathered from 204 countries and territories spanning 1990 to 2021, sourced from the GBD 2021. Calculations were performed for incidence rates, mortality rates, disease-adjusted life years (DALYs), and estimated annual percentage changes (EAPCs). These trends were analyzed based on region, nationality, age, gender, and World Bank income level stratifications.

Results The global age-standardised incident rate (ASIR) of IBD increased from 4.22 per 100000 in 1990 to 4.45 per 100000 in 2021. However, the age-standardised mortality rate (ASMR) decreased from 0.60 per 100000 in 1990 to 0.52 per 100000 in 2021. Similarly, the age-standardised DALYs rate decreased from 21.55 per 100000 in 1990 to 18.07 per 100000 in 2021. Gender comparisons showed negligible differences in disease burden. The greatest increase in IBD-associated ASIR and ASMR occurred in World Bank upper-middle income region (EAPCs, 1.25) and World Bank high-income region (EAPCs, 1.00), respectively. Regionally, East Asia experienced the largest increase in ASIR (EAPCs, 2.89). Among 204 countries, China had the greatest increases in ASIR (EAPCs, 2.93), Netherlands had the highest ASMR in 2021 (2.21 per 100000).

Conclusions Global incidence rate of IBD have been increasing from 1990 to 2021, while the DALYs and mortality have been decreasing. The escalating incident rates in select Asian regions deserves further attention.

Keywords Inflammatory bowel disease · Epidemiology · Global Burden of Diseases

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Introduction

Inflammatory bowel disease (IBD) is a long-lasting, untreatable condition that is expensive to manage, and is characterized by recurring symptoms and impairment [1]. There is still a substantial proportion of patients who do not achieve or maintain remission despite the increasingly diverse therapeutic options available [2]. The dynamics of these diseases, which affect patients and their families, are becoming a global public health concern.

IBD has traditionally been more prevalent in high-income countries, however, a shift in the epidemiological landscape has been observed, with incidence rates plateauing in high-income nations and escalating in newly industrialized countries across South America, Eastern Europe, Asia, and Africa [3]. These developing regions will confront a rising burden of disease and must adjust their healthcare infrastructure

to address the challenges posed by this costly and intricate condition. Furthermore, elucidating the divergent incidence, prevalence, and outcomes of IBD in various geographic areas may offer valuable insights into its etiology.

According to the Global Burden of Disease (GBD) study, there was a notable increase of 175904 individuals diagnosed with IBD from 1990 to 2021. This underscores the importance of targeting IBD in strategies aimed at reducing the burden of noncommunicable diseases. Early diagnosis of IBD can play a crucial role in prevention and control efforts [4], as the epidemiology of IBD is subject to ongoing changes in environmental factors and levels of industrialization worldwide [5]. Therefore, regular reassessment of GBD in patients with IBD is imperative for mitigating long-term complications associated with the disease.

Methods

Overview

In the GBD 2021, multiple methods were used to integrate a wide variety of available data sources with the specific epidemiology of each disease. The primary approach utilized for estimating the impact of each disease was Bayesian meta-regression [6]. There has been previous reporting on data resources, definitions, statistical modeling, and efforts to improve data quality [6, 7].

Data on the incidence of IBD, mortality related to IBD, and IBD-associated Disability-Adjusted Life Years (DALYs) were gathered in this research, including their rates at global, regional, and national scales. From these data, variables such as year, age, sex, and location were derived. Incidence rate (per 100000) was calculated by dividing the number of new cases by the population size; mortality rate (per 100000) was defined as the number of annual deaths divided by the total population size; The impact of IBD was quantified using DALYs [8], which represents the number of healthy years lost each year per 100,000 people; this allows for consistent assessment of the disease burden in different regions.

The World Bank categorizes economies into four income groups: low, lower-middle, upper-middle, and high. To achieve this goal, it relies on gross national income per capita figures in U.S. dollars, adjusted from local currency using the World Bank Atlas approach to mitigate currency fluctuations. In this study, we used the World Bank classification of economies to explore the association between the burden of IBD and socioeconomic development.

Statistical analysis

Incidence, mortality, DALYs, and their corresponding age-standardised rates were utilized as primary indicators to characterize the burden of IBD. Each rate is presented per 100,000 population, accompanied by 95% uncertainty intervals (95%UIs) based on the GBD algorithm. The temporal changes in the disease burden were evaluated by calculating Estimated Annual Percentage Changes (EAPCs), with 95% confidence intervals (CIs) determined through linear modeling. An upward trend is shown in the corresponding rate when the lower limit of both the EAPC and its 95%CI are positive, while a decreasing trend is suggested if both the upper limit of the EAPC and its 95% CI are negative. Gaussian curves were employed to examine the relationships between EAPC, rates, and the Human Development Index of IBD. R Studio (version 4.4.0) was utilized for statistical analysis. Statistical significance was defined as $P < 0.05$ for all two-sided P values.

Results

IBD: global trends

Incidence

As shown in Table 1, the global incident cases of IBD were 375140 (95%UI, 327686–436925) in 2021. From 1990 to 2021, there was an 88.30% increase in global incident cases of IBD, the EAPC was 0.91 (95%CI, 0.81–1.02). The corresponding age-standardised incident rate (ASIR) increased accordingly 4.22 (95%UI, 3.72–4.88) in 1990 to 4.45 (95%UI, 3.87–5.19) in 2021; Over this period, there was a rise in the number of IBD cases across all age groups, with the most significant increase seen in patients aged 50 to 54 years and the smallest increase among patients aged < 5 years. In 1990, the greatest number of patients were in the 35–39 years age group, while in 2021, the greatest number of patients were in the 40–44 years age group (22902 and 39708 patients, respectively). In 2021, the ASIR of IBD was greater in males than in females [4.52 (95%UI, 3.93–5.28) *vs* 4.38 (95%UI, 3.82–5.11)]. There was no significant difference in the incidence rate of IBD between males and females at any age in 2021 (Fig. 1a).

Mortality

In the last thirty years, there has been a 98.07% increase in global deaths associated with IBD, with 21,418 deaths documented in 1990 as opposed to 42,422 deaths in 2021. However, the age-standardised mortality rate (ASMR) associated with IBD dropped from 0.60 (0.52–0.66) per 100,000 in 1990 to 0.52 (0.46–0.58) per 100,000 in 2021,

Table 1 Incident cases and age-standardised rate of Inflammatory bowel disease Between 1990 and 2021 at the Global and Regional Level

Location	All-age cases (95% UI)		Age-standardised incidence rates (95% UI)		EAPCs
	1990	2021	1990	2021	
Global	199236(174584–232676)	375140(327686–436925)	4.22(3.72–4.88)	4.45(3.87–5.19)	0.29(0.20–0.38)
Andean Latin America	399(342–483)	1050(896–1298)	1.36(1.17–1.65)	1.59(1.37–1.96)	0.56(0.49–0.63)
Australasia	4002(3422–4743)	7307(6372–8465)	18.09(15.48–21.37)	19.66(17.07–23.20)	0.48(0.30–0.66)
Caribbean	727(617–881)	1379(1182–1660)	2.27(1.94–2.74)	2.71(2.32–3.27)	0.55(0.49–0.62)
Central Asia	2524(2178 -3067)	5018(4317–6101)	4.40(3.79–5.32)	5.16(4.47–6.22)	0.50(0.47–0.53)
Central Europe	7318(6410–8624)	9297(8128–10754)	5.37(4.68–6.35)	6.48(5.61–7.73)	0.79(0.60–0.98)
Central Latin America	739(626–904)	1502(1263–1849)	0.58(0.50–0.70)	0.57(0.48–0.69)	0.15(0.02–0.27)
Central Sub-Saharan Africa	505(433–616)	1751(1488–2156)	1.37(1.19–1.64)	1.83(1.59–2.22)	1.02(0.99–1.04)
East Asia	8633(7284–10588)	25532(22107–30530)	0.74(0.64–0.90)	1.39(1.20–1.66)	2.89(2.35–3.43)
Eastern Europe	8896(7706–10721)	11229(9681–13550)	3.43(2.98–4.14)	4.10(3.56–4.95)	0.57(0.53–0.62)
Eastern Sub-Saharan Africa	1642(1407–2000)	4903(4178–5999)	1.36(1.18–1.62)	1.68(1.45–1.99)	0.80(0.74–0.86)
High-income Asia Pacific	4179(3633–4948)	6531(5695–7659)	2.15(1.87–2.56)	2.78(2.41–3.33)	1.10(0.61–1.60)
High-income North America	52440(46626–59946)	84757(75246–95386)	16.76(14.89–19.19)	18.51(16.34–21.17)	0.37(0.26–0.48)
North Africa and Middle East	7180(6129–8700)	19656(16586–24187)	2.73(2.35–3.27)	3.18(2.73–3.87)	0.56(0.51–0.60)
Oceania	33(28–41)	90(76–112)	0.65(0.56–0.79)	0.76(0.65–0.93)	0.46(0.41–0.50)
South Asia	40231(34456–48840)	106215(91605–128247)	4.98(4.32–5.97)	6.00(5.21–7.23)	0.66(0.58–0.74)
Southeast Asia	2268(1922–2798)	5035(4271–6181)	0.57(0.49–0.70)	0.68(0.58–0.83)	0.51(0.47–0.55)
Southern Latin America	2152(1853–2632)	3615(3128–4385)	4.50(3.87–5.51)	4.75(4.10–5.81)	0.19(0.13–0.24)
Southern Sub-Saharan Africa	630(539–762)	1285(1101–1551)	1.64(1.42–1.96)	1.72(1.49–2.04)	0.26(0.17–0.36)
Tropical Latin America	2362(2030–2878)	7616(6550–9287)	1.87(1.62–2.26)	2.95(2.54–3.59)	1.03(0.53–1.53)
Western Europe	50598(45346–57683)	66438(58285–76430)	11.66(10.42–13.35)	12.74(11.08–15.02)	0.32(0.16–0.48)
Western Sub-Saharan Africa	1778(1527–2150)	4933(4236–5971)	1.37(1.19–1.64)	1.49(1.30–1.77)	0.11(-0.01–0.22)
World Bank Lower Middle Income	51880(44592–62807)	132894(114380–160720)	3.49(3.04–4.18)	4.15(3.60–4.98)	0.62(0.56–0.68)
World Bank Upper Middle Income	25765(22169–31370)	56908(49335–68255)	1.41(1.23–1.70)	1.87(1.62–2.25)	1.25(1.02–1.48)
World Bank High Income	118331(105573–136104)	176058(155563–200745)	10.33(9.18–11.91)	11.49(10.04–13.31)	0.41(0.27–0.57)
World Bank Low Income	3065(2605–3728)	9004(7636–11042)	1.43(1.24–1.72)	1.78(1.54–2.14)	0.75(0.72–0.78)

with an EAPC of -0.31 (95%CI, − 0.49 to − 0.13) (Supplement Table 1). From 1990 to 2021, while the number of IBD-related deaths decreased among children aged 0 to 14 years, there was an increase in deaths among patients in all other age groups. The most significant increase in the number of IBD-associated deaths was observed in patients aged 85–89 years. The highest number of deaths occurred in patients aged 75–79 years in 1990 and 85–89 years in 2021 (2780 and 6045, respectively). In 2021, the mortality rate among IBD patients under 75 years of age was similar between males and females, while among those aged over 75 years, the rate was greater in females than in males (Fig. 1b).

DALYs

The global number of DALYs associated with IBD exhibited a 59.22% increase from 1990 to 2021, rising from 948861 (95%UI, 808101–1096717) in 1990 to 1510784 (95%UI, 1308508–1750363) in 2021. However, the rate of IBD-associated age-standardised DALYs per 100,000 population decreased from 21.55 (95%UI, 18.47–24.82) in 1990 to 18.07 (95%UI, 15.67–20.91) in 2021; the EAPC was − 0.52 (95%CI, − 0.61 to − 0.43) (Supplement Table 2). Over the same period, the number of IBD-associated DALYs increased across all age groups, except for a decrease observed among children under 14 years. Notably, the most

Fig. 1 Sex- and age-structured analysis of IBD disease burden in 2021. **A** Incident numbers and its corresponding rate; (**B**) deaths and its mortality rate; (**C**) The numbers and rate of Disability-Adjusted Life Years (DALYs)
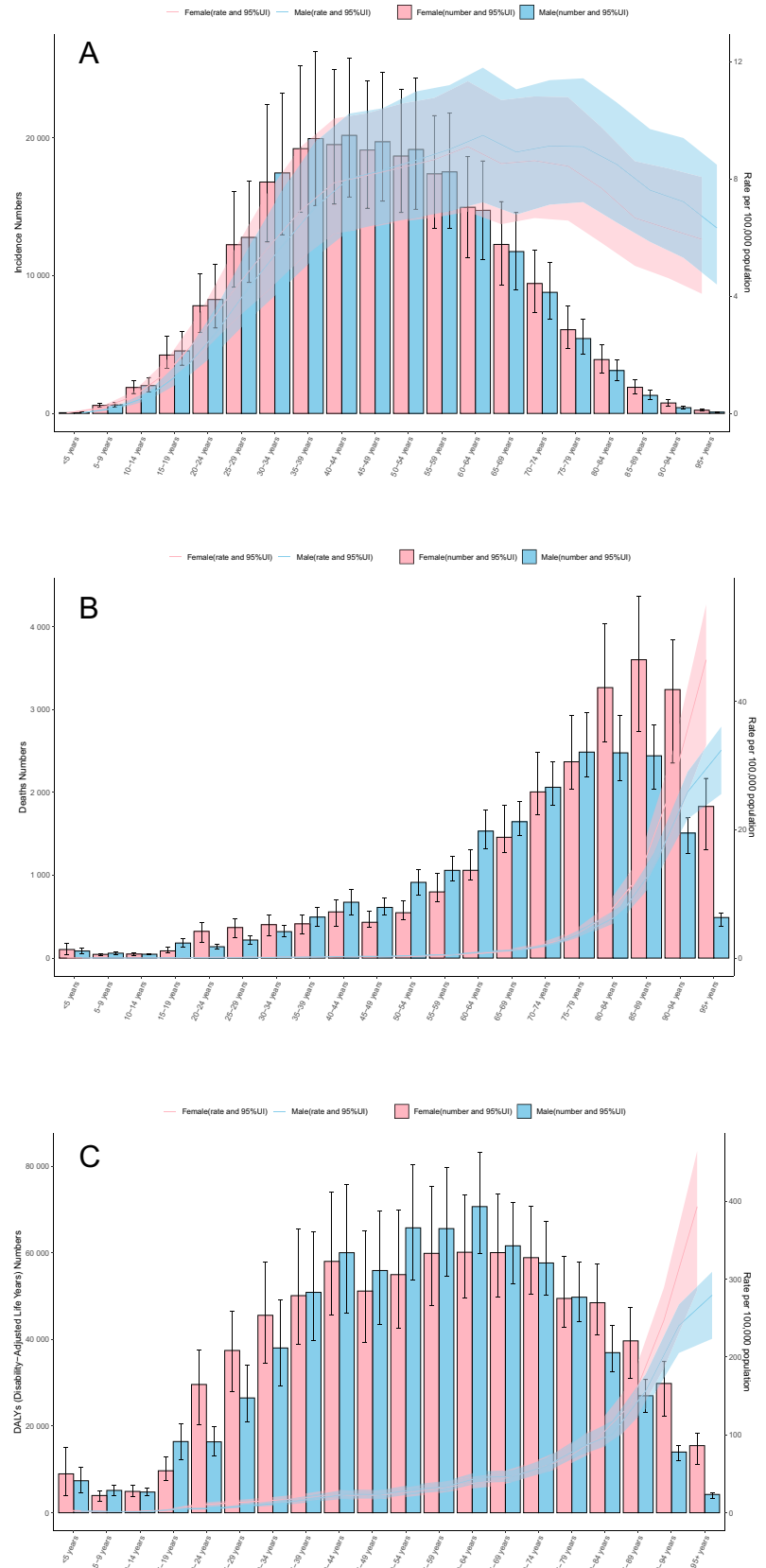
significant increase numbers in IBD-associated DALYs occurred among patients aged 70–74 years. The groups with the highest numbers of DALYs associated with IBD in 1990 and 2021 were patients aged 40–44 years (75,857) and patients aged 60–64 years (130,766), respectively. In 2021, the rate of IBD-associated DALYs among male and female patients under 80 years of age was similar, while among female patients over 80 years of age, the rate was greater than that among male patients (Fig. 1c).

IBD: World Bank income trends

Incidence

The World Bank high-income region exhibited the highest number of cases of IBD patients in 2021 (176058; 95%UI, 155563–200745). From 1990 to 2021, the incident cases in the World Bank low-income region saw a significant increase of 193.77%, the most substantial rise in the ASIR of IBD occurred in the World Bank upper-middle income region (EAPC,1.25; 95%CI, 1.02–1.48) (Table 1 and Supplement Fig. 1).

Mortality

In 2021, the World Bank high-income region recorded the highest number (21580; 95%UI, 18333–23241) and ASMR (0.80; 95%UI, 0.69–0.85) of IBD-associated deaths, while the lowest ASMR were observed in the World Bank upper-middle income region (0.34; 95%UI, 0.29–0.41). Among the 4 regions, the World Bank high-income region also experienced the most significant increase of ASMR from 1990 to 2021 (EAPC,1.00; 95%CI, 0.67–1.34), while the World Bank upper-middle income region had the lowest EAPC in the IBD-associated ASMR (-1.98; 95%UI, − 2.12 to -1.83) (Supplement Table 1 and Supplement Fig. 2).

DALYs

Among the 4 regions, the World Bank upper-middle Income region (EAPC,-1.88; 95%CI, -1.95–1.80) and World Bank lower-middle Income region (EAPC,-0.54; 95%CI, -0.58–0.50) both experienced a decrease in age-standardised DALYs associated with IBD from 1990 to 2021. In 2021, the World Bank high-income region had the highest number of IBD associated DALYs (664515; 95%UI, 556669–787996) showing a dramatic increase of 72.69% from 1990 to 2021 (Supplement Table 2 and Supplement Fig. 3).

IBD geographic regional trends

Incidence

Among 21 geographic regions, South Asia had the most incidence cases of IBD in 2021 (106215; 95%UI, 91605–128247]), whereas Oceania had the fewest (90; 95%UI, 76–112). In 2021, the ASIR of IBD was highest in Australasia (19.67; 95%UI, 17.07–23.20). In contrast, the ASIR of IBD was lowest in Central Latin America (0.57; 95%UI, 0.48–0.70). From 1990 to 2021, East Asia experienced the largest increase in the ASIR of IBD (EAPC, 2.89; 95%CI, 2.35–3.43), whereas the Western Sub-Saharan Africa had the smallest increase (EAPC, 0.11; 95%CI, -0.01–0.22) (Table 1, Fig. 2a and d).

Mortality

In the year 2021, Western Europe reported the highest incidence of deaths associated with IBD, with a total of 12,791 fatalities (95%UI, 10,650–13,952). Additionally, Western Europe exhibited the highest ASMR for IBD at 1.11 (95%UI, 0.95–1.20). Australasia had the highest increase in the IBD-associated ASMR (EAPC, 3.54; 95%CI, 2.58 to 4.50), whereas High-income Asia Pacific had the largest decrease (EAPC, − 3.42; 95%CI, − 3.78 to − 3.05) (Supplement Table 1 and Fig. 2b and e).

DALYs

In 2021, Western Europe exhibited the highest number of IBD-associated DALYs (318237; 95%UI, 270223–372594), whereas Oceania reported the lowest number (884; 95%UI, 631–1235). High-income North America had the highest age-standardised DALYs rate (49.59; 95%UI, 40.23–60.57); Southeast Asia had the age-standardised lowest DALYs rate (6.14; 95%UI, 4.63–7.23). Over the period from 1990 to 2021, Australasia experienced the largest increase in the age-standardised DALYs rate (EAPC, 1.08; 95%CI, 0.74 to 1.43); East Asia had the largest decrease (EAPC, − 2.89; 95%CI, − 3.18 to − 2.61) (Supplement Table 2 and Fig. 2c and f).

IBD: national trends

Incidence

In 2021, Canada exhibited the highest ASIR of IBD among 204 countries (26.83; 95%UI, 23.30–30.76), whereas Mexico had the lowest incidence (0.20; 95%UI, 0.17–0.25) (Fig. 2a). Besides, India had the most cases of IBD in 2021
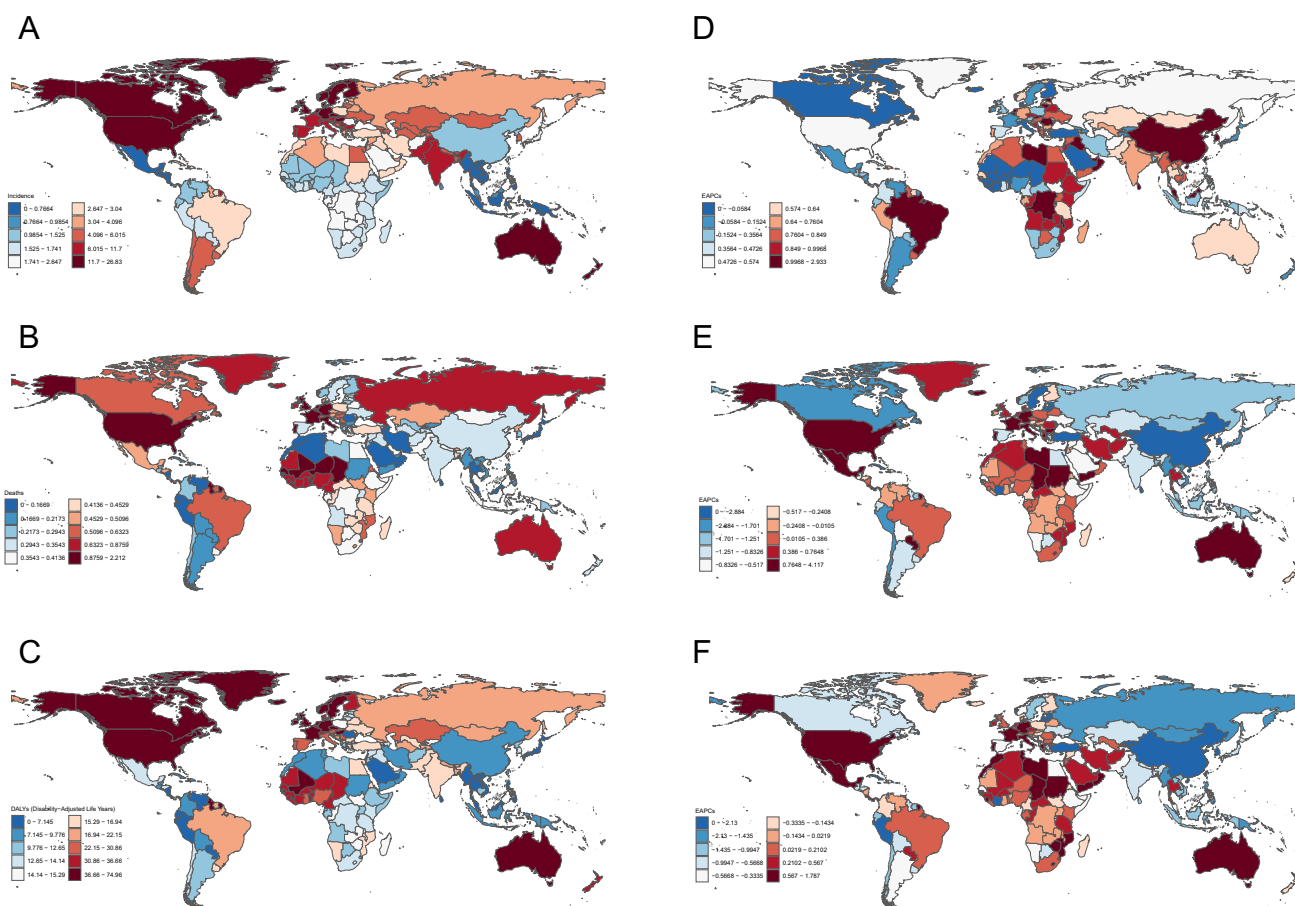
Fig. 2 Age-standardized rate of incidence (**A**), mortality (**B**) and Disability-Adjusted Life Years (DALYs) (**c**) per 100,000 for inflammatory bowel disease by location for both sexes in 2021 and its estimated annual percentage changes (EAPCs) from 1990 to 2021 (**D-F**)

(84479; 95%UI, 102208–72940). China had the greatest increases in the ASIR from 1990 to 2021 (EAPC, 2.93; 95%CI, 2.38–3.49) (Fig. 2d).

Mortality

United States of America had the highest number of IBD-associated deaths in(6193; 95%UI, 5405–6618). Netherlands (2.21; 95%CI, 1.85–2.43) had the highest IBD-associated ASMR (Fig. 2b); Singapore (0.03;95%CI, 0.02–0.03) had the lowest mortality rate. Germany (EAPC, 4.12; 95%CI, 3.49–4.75) exhibited the greatest increases in the ASMR (Fig. 2e); Estonia (EAPC, −6.75; 95%CI, −8.43 to −5.04) had the greatest decreases.

DALYs

In 2021, United States of America had the highest number of IBD-associated DALYs [(235017; 95%UI, 197312–279176)]. Netherlands had the highest age-standardised rate of IBD-associated DALYs (74.96; 95%UI,

60.11–91.48) (Fig. 2c). Libya (EAPC, 1.79; 95%CI, 1.54–2.04) reported the greatest increase in age-standardised DALYs rate (Fig. 2f); the American Aamoa (EAPC, −5.27; 95%CI, −5.72 to 4.82) had the greatest decreases.

Discussion

This study provides an overview of the global disease burden of IBD, indicating a continued increase in incidence rate from 1990 to 2021. However, there was a decrease in IBD-associated mortality rate and DALYs rate, consistent with findings from the GBD 2019 study [9]. The Kaplan et al. prediction model suggests that Western countries are currently experiencing compounding prevalence, characterized by stable incidence rates but a sharp increase in prevalence. In contrast, newly industrialized countries are in the acceleration in incidence stage, with increasing incidence rates and relatively low prevalence levels [10]. Hence, it is imperative to adequately improve the healthcare system to accommodate the escalating burden of IBD and to address

this concern comprehensively in order to enhance overall outcomes and health status. The observed decline in IBD mortality and DALYs may signify advancements in the survival rates of individuals with IBD, potentially attributable to the proliferation of specialized IBD practitioners, the advent of novel biological therapies, timely initiation of biological interventions, refinements in surgical methodologies, and heightened vigilance in monitoring colorectal cancer [11, 12].

The analysis of IBD incidence, mortality, and DALYs was then stratified by age. In 2021, the majority of IBD patients will be in the 40–44 age group, the highest incidence rate and the highest number of DALYs will be among those aged 60–64, the highest death rate will be among those aged 65–69. Given the significant incidence of IBD in the 40–44 age group, early detection and prompt treatment are essential for individuals and their families affected by IBD. Previously, IBD was predominantly associated with younger individuals. Nevertheless, an increasing amount of data indicates the frequency of IBD in the elderly population, consistent with the results of this research [13]. Furthermore, with the global population aging, there is a notable rise in mortality rates and deaths attributed to IBD among individuals aged 60 and older. Conversely, there is a positive trend observed in the reduction of mortality rates, deaths, and DALYs in children under the age of 14. Subsequently, an analysis was conducted to compare the incidence rates, mortality rates, and DALYs among different genders worldwide. The incidence rate of IBD is slightly higher in men compared to women, aligning with existing epidemiological data [14]. The higher smoking rate among men in comparison to women may contribute to the observed disparity in IBD incidence [15]. Nonetheless, given the multifactorial nature of IBD [16], including genetic, immune, and environmental influences, further investigation is warranted to fully understand the gender differences.

We then analyzed the data based on World Bank income levels and found that World Bank high-income regions have the highest incidence, mortality rate, and DALYs. This suggests that the burden of IBD remains significant in countries with a high development index. Additionally, it indicates that populations in high-income areas may be more susceptible to IBD and require early screening. Due to the comprehensive diagnosis of IBD involving clinical manifestations, endoscopy, pathology, etc. [17], a higher level of medical expertise is required in these developed countries, which may result in higher diagnostic rates. While in low and low-middle income countries, delays in the diagnosis of IBD are attributed to limited access to medical resources and coverage. Additionally, a lack of knowledge about IBD among healthcare providers and patients contributes to the delay in diagnosis. Furthermore, environmental factors, such as the adoption of a Western dietary pattern characterized by low fiber, high fat, and high

sugar intake in high-income regions, may also play a role in reducing microbial diversity in the human intestines, potentially exacerbating the risk of IBD [18, 19]. Furthermore, the incidence of the disease in World Bank high-income countries can be attributed to factors such as smoking habits, reduced breastfeeding, increased exposure to antibiotics, and improved hygiene practices [20]. Additionally, residing in high-income regions such as North America and Western Europe, which are situated in high latitude areas with limited sunlight exposure, may also pose a risk due to potential vitamin D deficiency [21]. The globalization of Western cultures in newly industrialized countries in recent decades has further facilitated the adoption of Western lifestyles in these upper-middle income regions. Consistently, we observed the greatest increase of incidence in upper-middle income region. And the lower number of deaths from IBD in World Bank low-income areas may be due to a lack of high-quality basic healthcare infrastructure, resulting in insufficient detection and low quality of death registration for IBD-related deaths.

We then stratified 21 regions globally to explore regional differences in the epidemiology of IBD. In some developed regions such as Australia and North America, the incidence rates are at a higher level globally. It is worth noting that all four Asian regions have higher incidence EAPCs than the global average. As Asia has the largest population share globally [22], countries in this region need to pay more attention to early diagnosis and treatment of IBD. At the national level, India had the highest number of cases of IBD in 2021, while China experienced the greatest increase in ASIR from 1990 to 2021. Over the past 30 years, China has undergone rapid economic and social development, which has accelerated industrialization and health policy development, including its social medical insurance program [13, 23]. With these developments, the general population had enough public health insurance, leading to pay more attention to their own health. In addition, increasing clinicians had been trained to have adequate experience in the diagnosis and treatment of IBD [24].

This study had several significant limitations. Firstly, the analysis is heavily dependent on the GBD database, which is limited by the availability of national registry data and the prevalence of undiagnosed cases of IBD [25]. Secondly, there is currently no standardized system in place for classifying different types of IBD; therefore, it is recommended that future research on IBD incorporate data that could aid in the development of such a classification system.

Conclusion

The global incidence rate of IBD has been increasing from 1990 to 2021, while the DALYs and mortality have been decreasing. It is important to note that even in some

high-income areas according to the World Bank, both the incidence rate and mortality rates remain high. In Asian countries, the burden of IBD may rapidly increase along with the fast-growing prevalence. Therefore, there is an urgent need for healthcare professionals to develop more cost-effective and targeted strategies that can mitigate morbidity and mortality associated with IBD, reduce its socioeconomic burden, and prevent corresponding risks.

Abbreviations ASIR: Age-standardised incident rate; ASMR: Age-standardised mortality rate; CI: Confidence interval; DALYs: Disease-adjusted life years; EAPCs: Estimated annual percentage changes; GBD: Global Burden of Diseases; IBD: Inflammatory bowel disease; UI: Uncertainty interval

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00384-024-04711-x.

Data availability No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate This study did not require ethical approval.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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