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Global, regional and national level burden of bulimia nervosa from 1990 to 2021 and their projections to 2030: analysis of the global burden of disease study

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Abstract

Background Bulimia nervosa (BN) is increasingly recognized as a significant public health issue worldwide. This study aims to explore the effects of BN on global, regional, and national scales by analyzing data from the Global Burden of Disease (GBD) Study 2021.

Methods We obtained the age-standardized rates (ASRs) of prevalence, incidence, and disability-adjusted life years rates (DALYs), along with their 95% uncertainty intervals (UIs) for BN from the GBD 2021 dataset, covering the period from 1990 to 2021. And estimated annual percentage changes (EAPCs) was used to represent the changing trend of BN burden. The Long-term trends of the burden of BN were quantified by Age-period-cohort (APC) analysis. Furthermore, an evaluation of inequality and a prospective prediction concerning the worldwide impact of BN is performed.

Results From 1990 to 2021, the global burden of BN showed a continuous increase. In 2021, the highest burden of BN was observed in regions with a high socio-demographic index (SDI), particularly in Australasia (ASPR was 811.9 per 100,000 individuals; 95% UI: 629.68 to 1041.59). The most substantial increase in the burden of BN was observed in Asia. In the national level, Equatorial Guinea experienced the most significant increase in the burden of BN from 1990 to 2021 (EAPC of ASPR was 3.48; 2.86 to 4.11). In contrast, burden of BN in High-income North America recorded a substantial decrease from 1990 to 2021 (EAPC of ASPRs was − 0.26; -0.39 to -0.13). The growth rate of male BN burden was higher than that of female. The relative inequality of the BN burden decreased between 1990 and 2021. Further forecasts from the GBD indicated that the global burden of BN would continue to rise by 2030.

Conclusion These results can help governments across the globe in developing suitable health and medical policies focused on the prevention and early intervention of BN. Moreover, the differences in BN burden should be analyzed based on region, nation, gender, and year when setting international health goals.

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Plain English summary
Analyses of prevalence, incidence, and disability-adjusted life years (DALYs) for bulimia nervosa (BN) revealed a sustained increase in BN's global burden from the year of 1990 to 2021. Regionally and nationally, BN burden correlated positively with socioeconomic development levels, with Australia exhibiting the highest burden in 2021. The most pronounced growth occurred in East and South Asia, while high-income North America experienced a decline. Notably, although females bore a higher burden, males demonstrated faster growth rates in BN cases. Inequality analyses showed widening absolute disparities in BN burden between high- and low-income nations, whereas relative inequality decreased due to accelerated burden growth in lower-income regions. Projections indicate a continuing global rise in BN burden through 2030, underscoring the need for targeted interventions.

Keywords Bulimia nervosa, Inequality, Global burden of disease study, Trend

Introduction

Bulimia nervosa (BN) is a psychiatric disorder characterized by recurrent episodes of binge eating, which involve consuming large quantities of food in a short period while feeling a lack of control over eating, accompanied by compensatory behaviors [1]. Conditions of depression and anxiety frequently co-occur with BN [2]. Research indicates that approximately 80–90% of individuals with BN experience at least one episode of a mood disorder during their lifetime, with depressive episodes being the most prevalent [3]. Long-term BN significantly impacts the health and quality of life of individuals, their caregivers, and society as a whole; however, it receives limited resources and attention [4, 5]. Therefore, accurate epidemiology and burden estimates are therefore critical to understanding the impact of BN on population health, designing health system responses to preventive interventions, and improving access to optimal treatment.

The Global Burden of Disease (GBD) Study methodically measures health loss across 369 diseases, categorized by age, gender, year, and geographic area, enabling comparisons of the burden between different diseases [6]. Eating disorders in the GBD database include BN and anorexia nervosa [7]. Scholars have previously evaluated the burden of eating disorders based on GBD. However, most of these assessments have concentrated on the burden associated with all eating disorder categories [8], or have been limited to a specific region or country [9], or have focused on a particular population [10]. Consequently, there are currently no global, regional, or national epidemiological studies on BN based on the GBD framework.

In this research, we discuss the national, regional, and worldwide impact of BN, providing updates to the earlier reports on the specificity of BN for GBD 2010, GBD 2017, and GBD 2019. We present data on burden for the year 2021, analyze trends spanning from 1990 to 2021, examine cross-country health inequality related to BN in both 1990 and 2021, and forecast the burden of BN up to the year 2030.

Methods

Data source

Our analysis of BN burden is based on the GBD 2021 database. This comprehensive dataset encompasses nationally representative surveys, census data, and results of meta-analyses, providing a clear epidemiological overview of 371 diseases and injuries, along with 88 risk factors [11]. The examination encompasses 27 regions and incorporates information from 204 nations and territories, spanning the years 1990 to 2021 [12]. The GBD 2021 relied on data obtained from various sources, including peer-reviewed research, survey results, disease registries, and hospital admission records, to ensure a comprehensive and high-quality analysis of eating disorders.

We gathered estimates of incidence, prevalence, and disability-adjusted life years (DALYs) for BN, stratified by sex, age, and location, with the associated 95% uncertainty intervals (UIs), from 1990 to 2021. Data from regional and national levels have been included in our analysis. Additionally, we utilized the socio-demographic index (SDI), a composite measure for evaluating socioeconomic development levels [13]. In addition, we obtained demographic projection data from the GBD database and age-adjusted structural information from the official website of the World Health Organization.

Burden description

The yearly age-standardized rates (ASRs) (rates per 100,000 populations) along with the estimated annual percentage changes (EAPCs) were used to assess the long-term trends in the incidence, prevalence, and DALYs related to BN. A growing trend in ASR was identified when the estimation of EAPC was greater than 0 and the 95% UI was also greater than 0. In contrast, a declining trend in ASR was observed when the estimation of EAPC was less than 0, with the 95% confidence interval (CI) not exceeding 0 [14]. In other cases, ASR was considered stable throughout the period [15].

Age-period-cohort model

The APC model frequently incorporates a multifaceted framework that addresses the impacts of age categories, time periods, and birth cohorts [16]. The age effect reflects the impact of age relative factors on prevalence, DALYs and incidence. The period effect shows changes in the risk of illness or injury caused by measurable factors. Meanwhile, the cohort effect examines how exposure levels to risk factors in different birth cohorts affect prevalence, DALYs and incidence. The APC model can be expressed as a linear equation in the following manner: In (Refg) = α + Ae + Pf + Cg [17]. In this analysis, Refg represents the burden of BN, g represents the birth cohort, e represents discrete age groups and f corresponds to time periods. The variables Ae, Pf, and Cg represent the effect of age, period, and cohort, respectively.

Cross-country inequality analysis

The Slope Inequality Index (SII) and the Concentration Index are standardized indicators used to quantify inequality in global burden for BN [18]. The SII serves as a metric that measures absolute disparities in health indicators between the most and least privileged subgroups of the population, while the relative concentration index (RCI) measures relative disparities by depicting how health indicators are distributed between advantaged and disadvantaged groups [19]. The SII measures absolute inequality by fitting a regression model to the country-specific burden of BN, weighted by each country's relative position on the SDI scale. The SDI is defined as the average point within the range of the population, organized based on the cumulative SDI rankings. The RCI quantifies the cumulative burden of BN relative to the cumulative population distribution, with countries ranked by their SDI. A subtractive value of SII or RCI suggests that an increase in SDI correlates with a diminished burden, and vice versa. A higher absolute value of the SII or RCI signifies a more substantial level of inequality [20].

Predicting incidence, prevalence, and DALYs

Nordpred prediction models can effectively forecast future trends in the incidence, prevalence, and DALYs associated with diseases or injuries [21]. Nordpred prediction models examine the connection between demographic features and time series, focusing on alterations in population structure, trends in diseases, and effects across generations [22].

Statistical analysis

Statistical analyses were performed utilizing R software version 4.4.0. The APC model was constructed using tools from the APC website (https://analysistools.cancer.gov/apc/) and estimated rates specific to age for each period and cohort based on RR. The analysis and visualization of inequality across countries were performed utilizing the Health Equity Assessment Toolkit provided by WHO, along with R software (version R-4.4.1). Forecasting was conducted using the 'Nordpred' package within the R software environment. A p-value of less than 0.05 was deemed statistically significant.

Results

Burden of BN at the global level

Notably, from the year of 1990 to 2021, the ASRs for BN of prevalence, incidence, and DALYs all showed significant increases at the global level, with EAPCs of 0.66 (0.61 to 0.71), 0.55 (0.52 to 0.58), and 0.67 (0.62 to 0.72), respectively (Fig. 1a-c and Additional file 1). In addition, it was reported that the prevalent cases, incident cases, and DALYs cases of BN increased significantly worldwide. Specifically, in 1990, the total count of BN incident cases was 5,595,035, which rose to 8,227,657 by 2021, reflecting a percentage increase of 47%. During the period from 1990 to 2021, the number of individuals affected by BN increased by 67%, rising from 7,416,420 cases to 12,367,024 cases. Furthermore, the number of DALYs cases for BN rose from 1,564,211 in 1990 to 2,604,702 in 2021, showing a percentage change of 67% (Additional file 1 and Additional file 5). In summary, the global burden of BN has shown a persistent increasing trend from 1990 to 2021.

Burden of BN at the SDI regional level

The global burden of BN exhibited significant regional disparities, with age-standardized incidence rates (ASIRs), age-standardized prevalence rates (ASPRs), and age-standardized DALYs closely associated with SDI levels. For example, the ASPRs for BN in 2021 demonstrated significant disparities. High SDI areas exhibited the highest ASPR for BN, recorded at 311.26 cases per 100,000 people (95% UI: 211.22 to 435.75). Conversely, Low SDI areas showed the lowest ASPR for BN, with rate of 96.69 cases per 100,000 people (95% UI: 62.85 to 140.31). Time trends in ASPRs revealed varying patterns in SDI levels, potentially indicating different stages of epidemiological transitions. The BN of Middle SDI regions exhibited the most pronounced increases in ASPRs, with EAPC of 1.42 (95% CI: 1.37 to 1.47) (Additional file 1 and Fig. 2).

Additionally, the ASRs of BN for incidence and DALYs in 2021 further underscored the existing regional disparities. High SDI regions exhibited the highest ASIR and age-standardized DALYs rate, whereas Low SDI regions demonstrated the lowest values for both metrics. The ASIR of BN in High SDI areas was 159.5 per 100,000 people (95% UI: 101.9 to 230.34). In contrast, the ASIR in Low SDI areas was 82.94 per 100,000 people (95% UI: 51.73 to 124.85) for BN. Similarly, the age-standardized DALYs rate in High SDI areas was recorded at 65.38 per

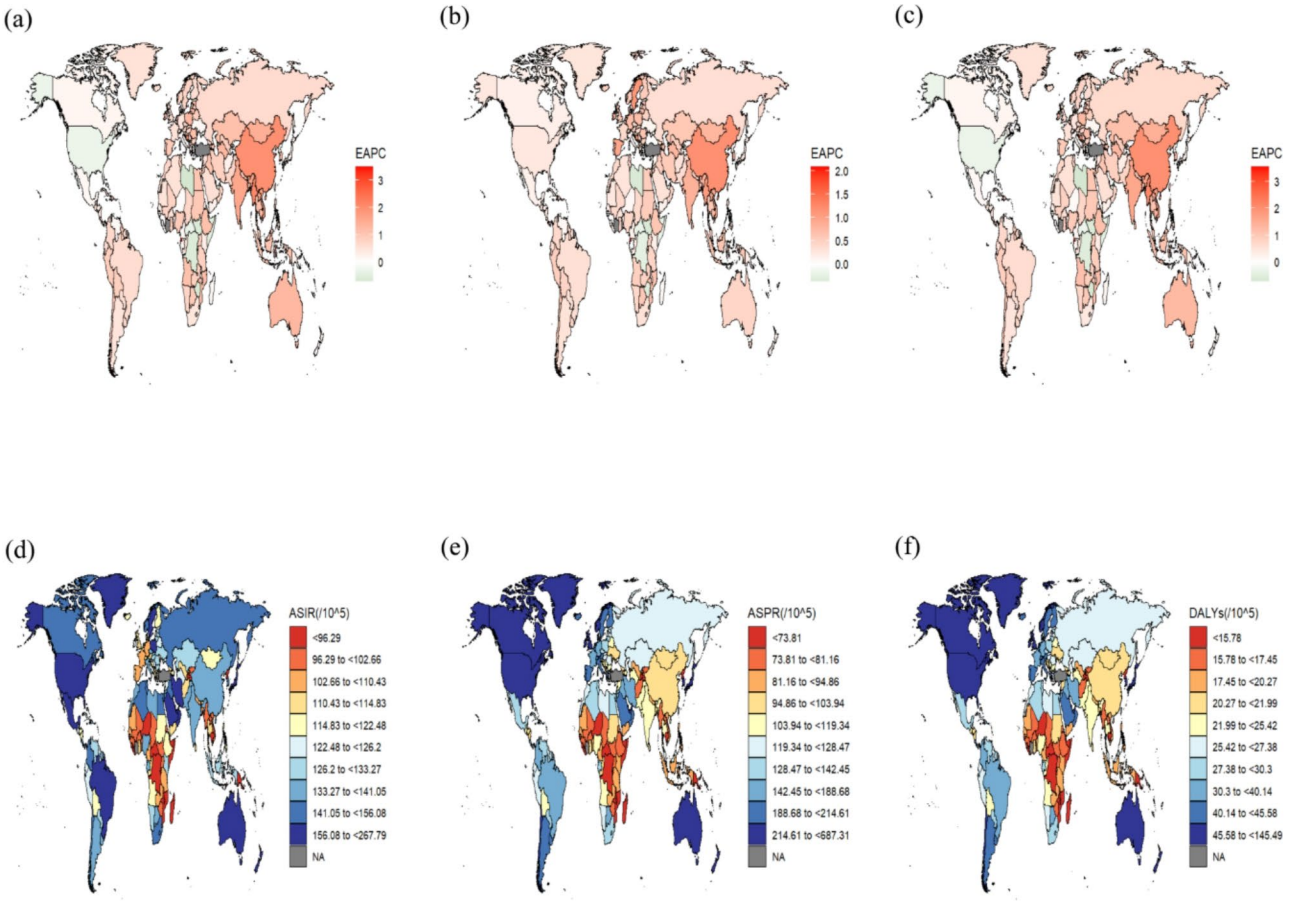

Fig. 1 Global maps of age-standardized rates (ASRs) per 100,000 people by BN in 2021 and estimated annual percentage changes (EAPCs) per 100,000 population by BN from 1990 to 2021. Notes: (**a**-**c**) EAPCs of ASRs for incidence, prevalence and DALYs by BN between 1990 and 2021. (**d**-**f**) ASPR, ASIR, and age-standardized DALYs of BN in 2021

100,000 people (95% UI: 37.29 to 106.61) for BN. In Low SDI areas, the age-standardized DALYs rate was significantly lower, with rate of 20.31 cases per 100,000 people (95% UI: 11.42 to 33.98) for BN (Additional file 1 and Fig. 2). In conclusion, the BN burden in high SDI region is the highest among regions of high SDI, high-middle SDI, middle SDI, low-middle SDI and low SDI.

Burden of BN at the GBD regional level

Our findings indicated that Australasia had the highest global prevalence burden of BN in 2021. Specifically, Australasia exhibited the highest ASPR for BN, at 811.9 per 100,000 people (95% UI: 629.68 to 1041.59). The region with the second highest ASPR for BN was Western Europe, reaching 361.01 per 100,000 people (95% UI: 246.6 to 499.69). Furthermore, High-income Asia Pacific ranked third for ASPR in BN, also at 143.1 per 100,000 people (95% UI: 98.64 to 195.28). Additionally, the time trend from 1990 to 2021 indicated that BN in South Asia showed a notable increase in ASPRs, with an EAPC of 1.44 (95% CI: 1.38 to 1.50). In contrast, BN in High-income North America recorded a substantial decrease in ASPR, with an EAPCs of -0.26 (95% CI: -0.39 to -0.13) (Fig. 1e and Additional file 1).

Our analysis indicated that the incidence of BN in Australasia in 2021 was the highest globally. Specifically, the ASIR for BN in Australasia was 282.01 per 100,000 individuals (95% UI: 187.9 to 399.38). High-income North America and High-income Asia Pacific were regions with the second and third highest ASIR for BN at 178.47 per 100,000 individuals (95% UI: 111.34 to 264.22) and 160.35 per 100,000 individuals (95% UI: 100.96 to 234.27) respectively. In addition, the time trend from 1990 to 2021 indicated that East Asia exhibited the most significant growth in ASIRs for BN, with EAPC of 1.14 (95% CI: 1.07 to 1.21). Notably, ASIRs of BN did not demonstrate a downward trend in any GBD region (Additional file 1 and Fig. 1d).

In 2021, Australasia exhibited the highest age-standardized DALYs for BN. Specifically, the age-standardized DALYs rate for BN in Australasia was 170.34 per 100,000 individuals (95% UI: 106.42 to 262.05). Western Europe and High-income North America were the areas with the second and third highest age-standardized

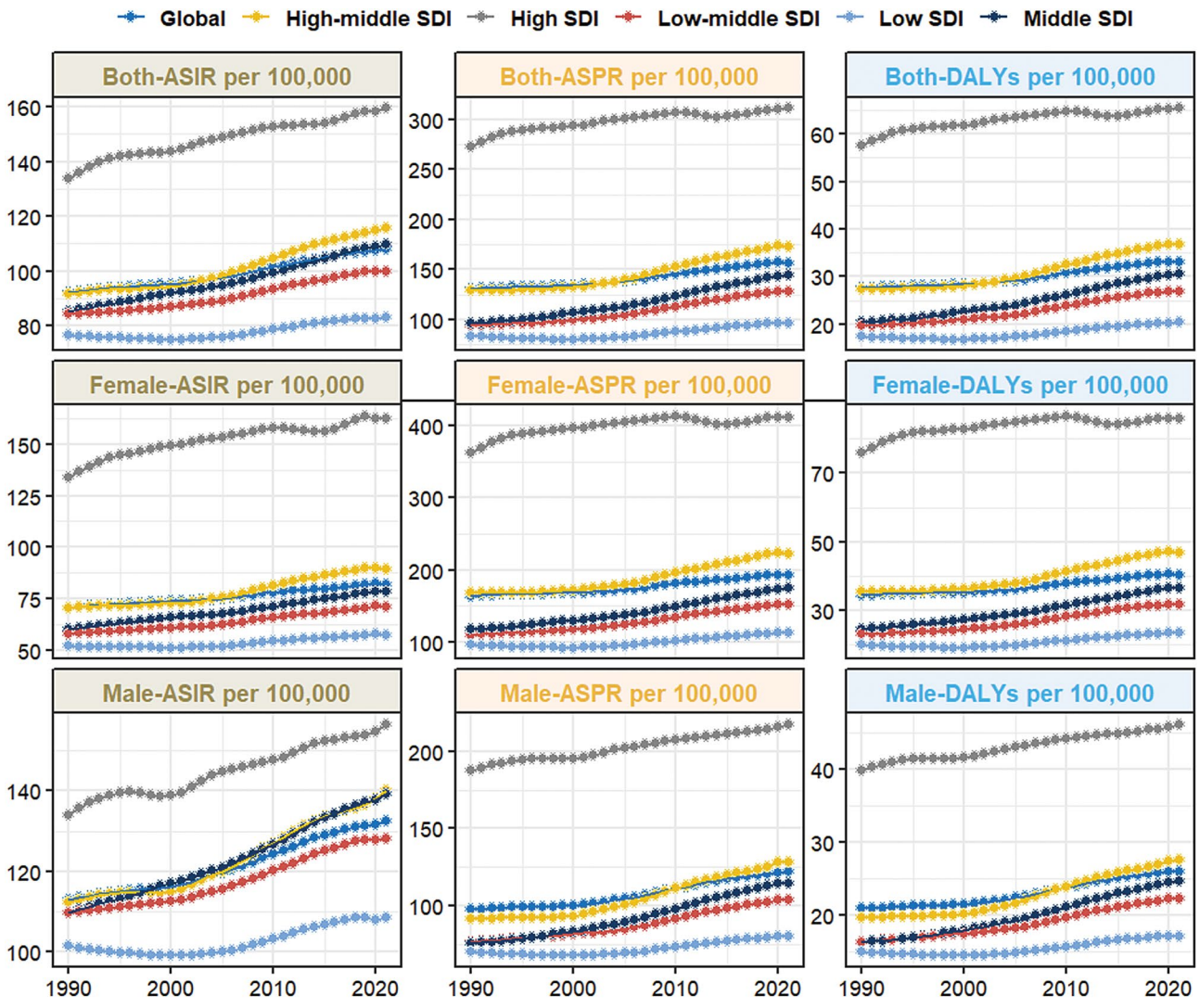

Fig. 2 Time trend graph of ASRs for BN from 1990 to 2021. Notes: ASIR, age-standardized incidence rate; ASPR, age-standardized prevalence rate; DALYs, age-standardized DALY rate; SDI, sociodemographic index

Disability-Adjusted Life Years (DALYs) rates for BN, reporting figures of 75.78 per 100,000 individuals (95% UI: 44.42 to 121.85) and 69.07 per 100,000 individuals (95% UI: 38.67 to 114.63), accordingly. Additionally, the time trend from 1990 to 2021 indicated that East Asia experienced the most significant increase in age-standardized DALYs rate for BN, with EAPC of 1.92 (95% CI: 1.81 to 2.03), accordingly. In contrast, the region that experienced the most considerable decrease in age-standardized DALYs rate for BN was High-Income North America, reporting an EAPC of -0.28 (95% CI: -0.41 to -0.15) (Additional file 1 and Fig. 1f). In addition, we also found that the ASPRs, ASIRs and age-standardized DALYs rates of BN were positively correlated with SDI in GBD regional level (Fig. 3).

Burden of BN at the National level

In 2021, the ASPRs for BN ranged from approximately 881.55 to 43.33 per 100,000 individuals in above mentioned 204 countries. Among all countries, the three countries with the highest ASPRs for BN were Australia (881.55 per 100,000 individuals; 95% UI: 691.92 to 1123.85), Monaco (677.98 per 100,000 individuals; 95% UI: 473.06 to 937.67), and Italy (478.23 per 100,000 individuals; 95% UI: 331.37 to 658.31). It was worth noting that Australia ranked among the top three countries with the highest ASPR for BN, a finding that aligned with the results of our GBD regional-level analysis. This consistency between national and regional data highlighted the significant challenges posed by BN in Australia. In addition, the time trend from 1990 to 2021 indicated that Equatorial Guinea experienced the most significant increase in ASPRs for BN conditions, with EAPC of 3.48

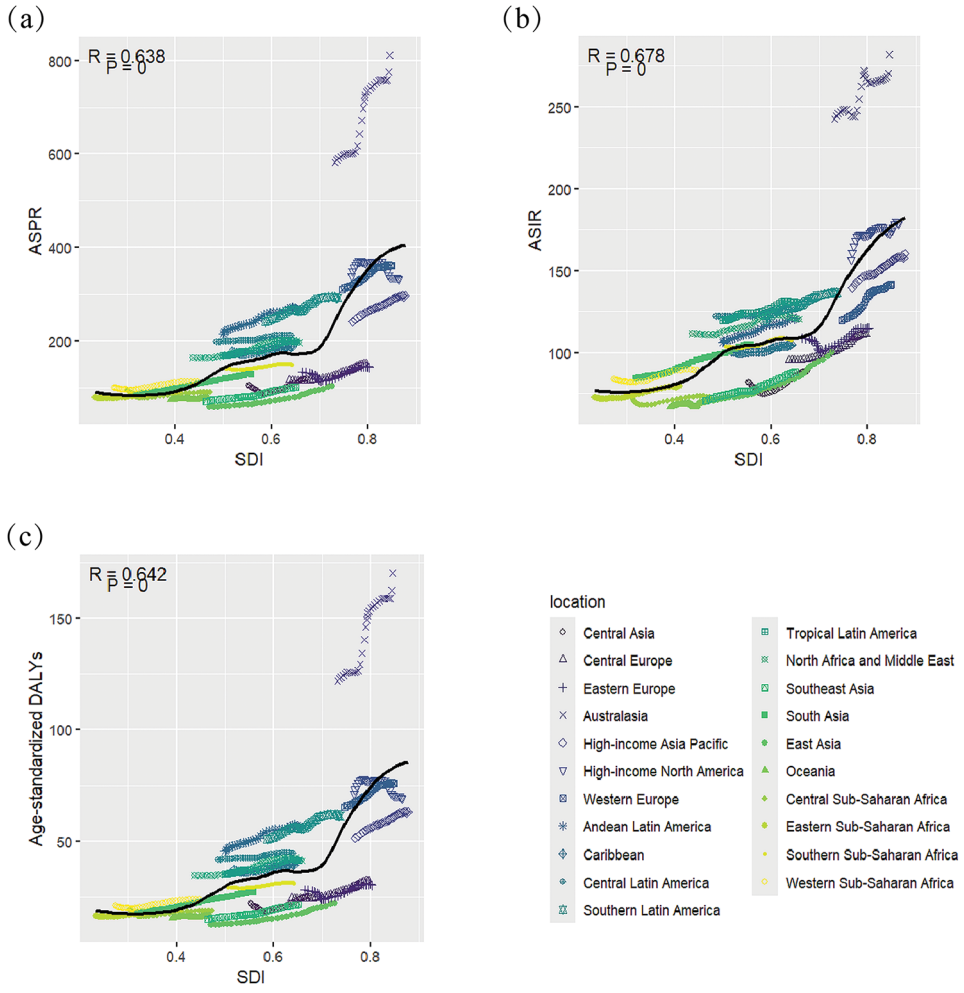

Fig. 3 Regional correlations between sociodemographic index (SDI) and age-standardized rates (ASRs) of bulimia nervosa from 1990 to 2021: (**a**) age-standardized prevalence rate (ASIR); (**b**) age-standardized incidence rate (ASPR); (**c**) age-standardized disability-adjusted life years (DALYs) rate

(95% CI: 2.86 to 4.11). In contrast, Libya experienced the most significant decrease in ASPRs for BN conditions, with EAPC of -0.72 (95% CI: -0.96 to -0.48) (Fig. 1e, Additional file 5 and Additional file 2).

In 2021, the three countries with the highest ASIRs for BN were Sweden (347.13 per 100,000 individuals; 95% UI: 214.25 to 527.83), Australia (289.42 per 100,000 individuals; 95% UI: 193.08 to 407.76), and New Zealand (247.54 per 100,000 individuals; 95% UI: 153.5 to 365.64). Furthermore, the analysis of the time trend spanning from 1990 to 2021 revealed that Equatorial Guinea saw the largest rise in ASIR for BN, demonstrating EAPC of 2.08 (95% CI: 1.79 to 2.38). Conversely, Libya faced the most notable decline in ASPR for BN conditions, reflected in EAPC of -0.37 (95% CI: -0.52 to -0.23) (Additional file 2, Additional file 5 and Fig. 1d).

In 2021, the three countries with the highest age-standardized DALYs rates for BN were Australia (185.04 per 100,000 people; 95% UI: 116.93 to 281.98), Monaco (142.15 per 100,000 people; 95% UI: 82.83 to 230.51), and Italy (100.43 per 100,000 people; 95% UI: 60.3 to 159.7). The three countries with the highest age-standardized DALYs rates for BN were identical to the three countries with the highest ASPRs mentioned previously. In addition, the time trend from 1990 to 2021 indicated that Equatorial Guinea experienced the most significant increase in age-standardized DALYs for BN, with EAPCs of 3.53 (95% CI: 2.9 to 4.17). In contrast, Libya experienced the most significant decrease in age-standardized DALYs rate for BN conditions, with EAPCs of -0.73 (95% CI: -0.97 to -0.48). The time trend results were notably consistent with the previously mentioned findings of ASPRs and ASIRs (Additional file 2, Additional file 5 and Fig. 1d-f). We also found that the ASPRs, ASIRs, and age-standardized DALYs rates of BN exhibited a positive correlation with SDI at the national level, aligning with our analysis results at the GBD regional level (Fig. 4).

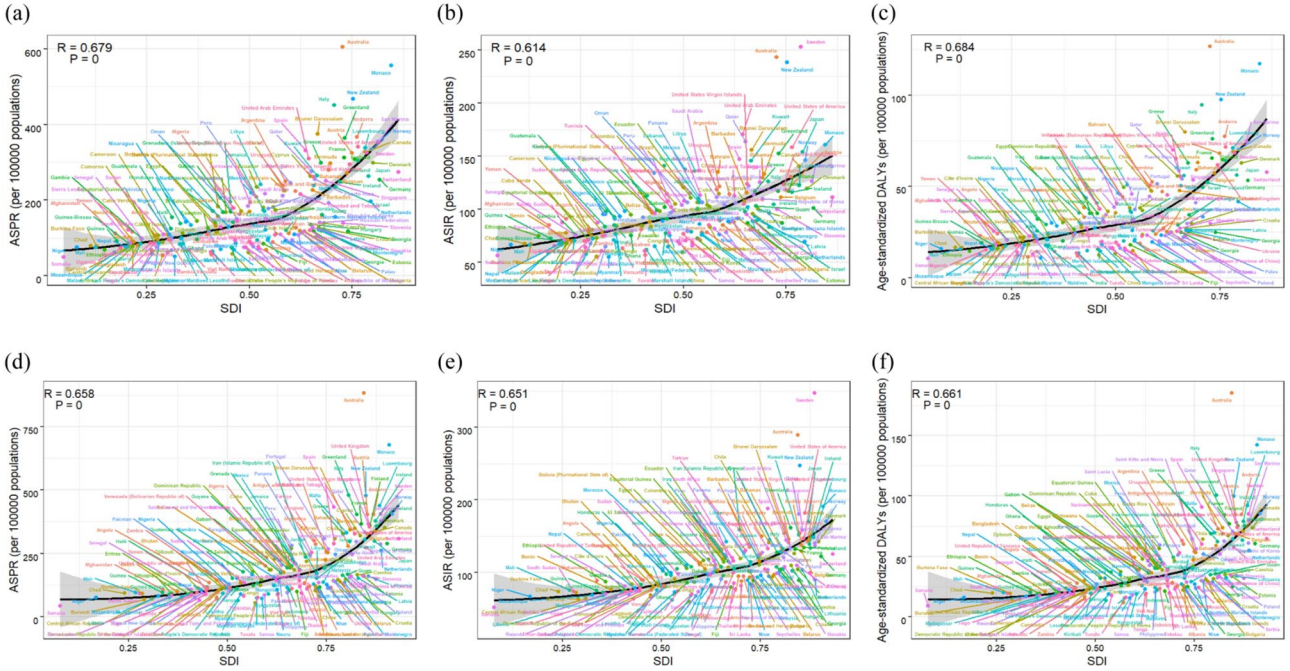

Fig. 4 204 national age-standardized rates (ASRs) and sociodemographic index (SDI) correlation graphs for BN in 1990 and 2021. Notes: (**a**-**c**) the ASIR, ASPR, and age-standardized DALYs rate of BN in 1990. (**d**-**f**) the ASIR, ASPR, and age-standardized DALYs rate of BN in 2021

Age-period-cohort analysis

The findings from the analysis of the APC model demonstrated that the global trends for the prevalence, incidence, and DALYs related to BN were all showing an increase (Fig. 6). The findings of the age effect model demonstrated that the prevalence and DALYs of BN were highest among individuals aged 25 to 29 years (Rate = 398.134/100,000, 95% CI: 396.9591 to 399.3125; Rate = 84.037/100,000, 95% CI: 83.7835 to 84.2913), whereas the incidence rate peaked in those aged 15 to 19 years (Rate = 415.637/100,000, 95% CI: 414.317 to 416.9625). The findings of the period effect model demonstrated that the risks associated with the prevalence, incidence, and DALYs of BN were all experiencing an upward trend, peaking during the period of 2020–2021. Furthermore, the findings from the cohort effect analysis revealed that the occurrence, incidence, and DALYs linked to BN showed an initial rise, then a decline, and finally a resurgence. Notably, the 2015 cohort demonstrated the highest risk for prevalence, incidence, and DALYs, with RR of 1.1791 (95% CI: 1.0503 to 1.3236), 1.1581 (95% CI: 1.1086 to 1.2098), and 1.1822 (95% CI: 1.0537 to 1.3264), respectively (Additional file 3 and Fig. 5). In addition, at the global level, the burden of BN was increasing across all age groups. Notably, the prevalence of BN has risen most rapidly among individuals aged 25–29 years (0.72%, 95% CI: 0.71 to 0.73). Furthermore, the incidence of BN increased most significantly among those aged 20–24 years (0.55%, 95% CI: 0.54 to 0.56). Additionally, the DALYs associated with BN has also risen most rapidly among individuals aged 25–29 (0.72%, 95% CI: 0.71 to 0.73) (Fig. 6 and Additional file 3).

Cross-country inequality analysis

Globally, significant absolute and relative inequalities related to the SDI were observed in the ASPRs, ASIRs, and age-standardized DALYs rates associated with BN. From 1990 to 2021, the SII of BN 's ASPRs increased from – 27.6652 (95% CI: -73.1805 to 17.8501) to -40.5098 (95% CI: -85.1405 to 4.1209). In a similar manner, the RCI for ASPRs related to BN declined from – 0.0171 (95% CI: -0.0868 to 0.0526) to -0.0087 (95% CI: -0.0915 to 0.0742). Conversely, the SII for ASIRs concerning BN rose from 2.0384 (95% CI: -11.6951 to 15.7719) to 13.7049 (95% CI: 2.3937 to 25.0162). And the RCI of ASIRs for BN decreased from – 0.1135 (95% CI: -0.1918 to -0.0352) to -0.0474 (95% CI: -0.1348 to 0.0399). Furthermore, the SII regarding age-standardized DALYs rates for BN shifted from – 3.7947 (95% CI: -11.1687 to 3.5793) to 1.4976 (95% CI: -5.8955 to 8.8908). Conversely, the RCI associated with age-standardized DALYs rates for BN showed a decline from – 0.0165 (95% CI: -0.0863 to 0.0534) to -0.0068 (95% CI: -0.0895 to 0.0759) (Fig. 7 and Table 1).

Projections of future global BN burden

The ASRs of incidence, prevalence, and DALYs associated with BN worldwide are expected to increase gradually. It is estimated that by 2030, the predicted ASR of BN prevalence in women will reach 200.74 per 100,000; the predicted ASR of BN prevalence in men is projected

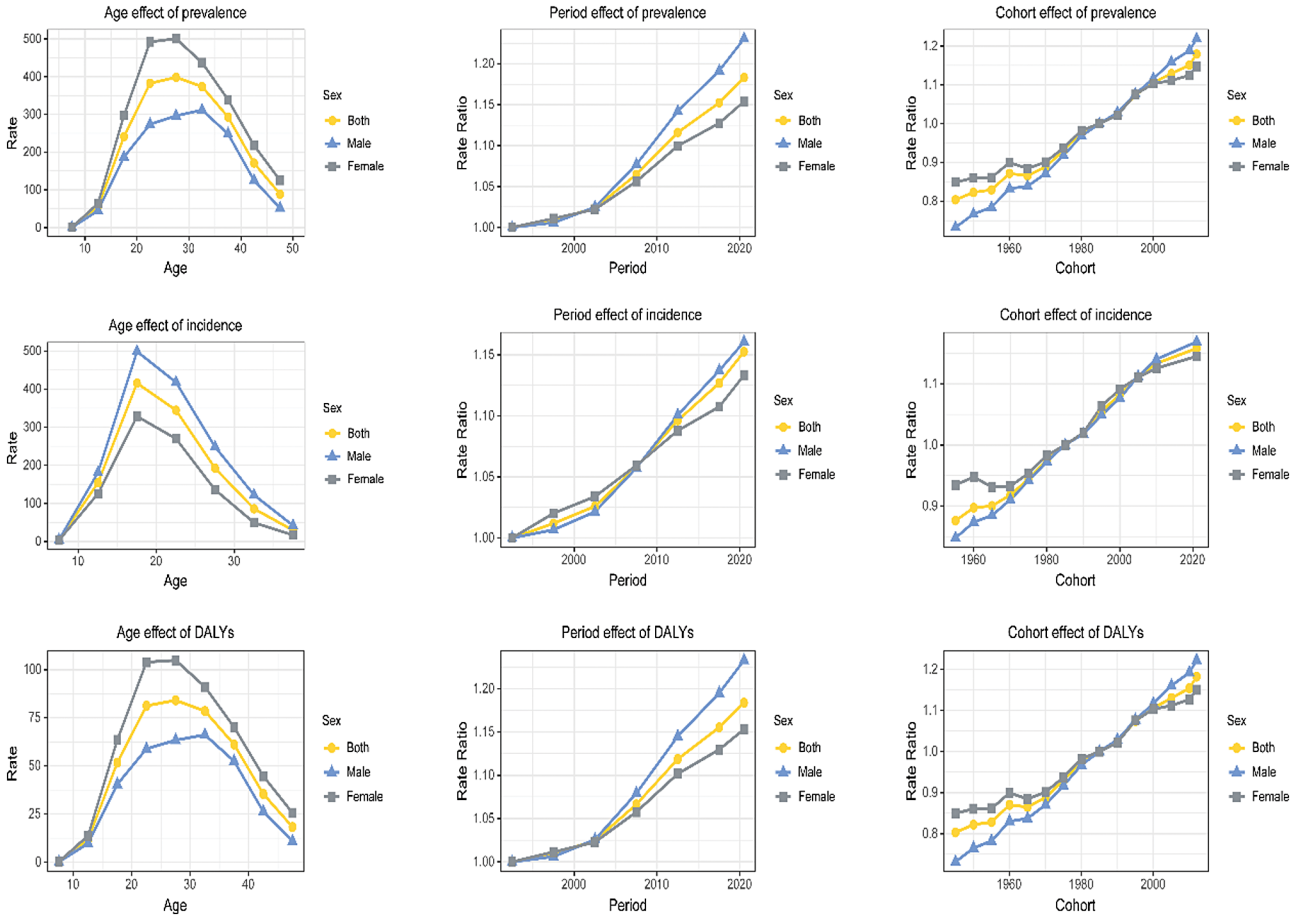

Fig. 5 Map of age, period and cohort effects

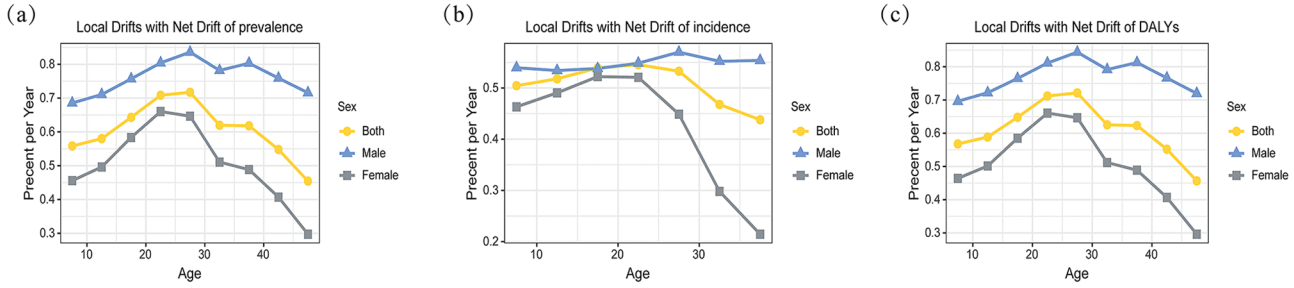

Fig. 6 Map of local drift

to be 128.74 per 100,000, reflecting an increase of 1.13% since 2021. Additionally, compared to 2021, the ASIR of BN was projected to increase slightly by 2030 in both sexes, with a marginally greater increase in males (0.76%) than in females (0.24%). In contrast, the predicted ASR of burden of disease attributable to DALYs of BN for women decreased slightly by 0.31% in 2030, whereas the predicted ASR for men increased slightly by 1.10% (Additional file 4 and Fig. 8).

Discussion

This research is the first to assess the burden estimates of BN on global, regional, and national scales by utilizing data from the GBD 2021. The global burden of BN, assessed through prevalence, incidence, and DALYs, has consistently increased from 1990 to 2021. Notably, the burden of BN escalates with increasing sociodemographic index (SDI) at the regional and national levels. Moreover, the most notable growth was observed in East and South Asia, while the most considerable decreases were noted in high-income North America. In addition,

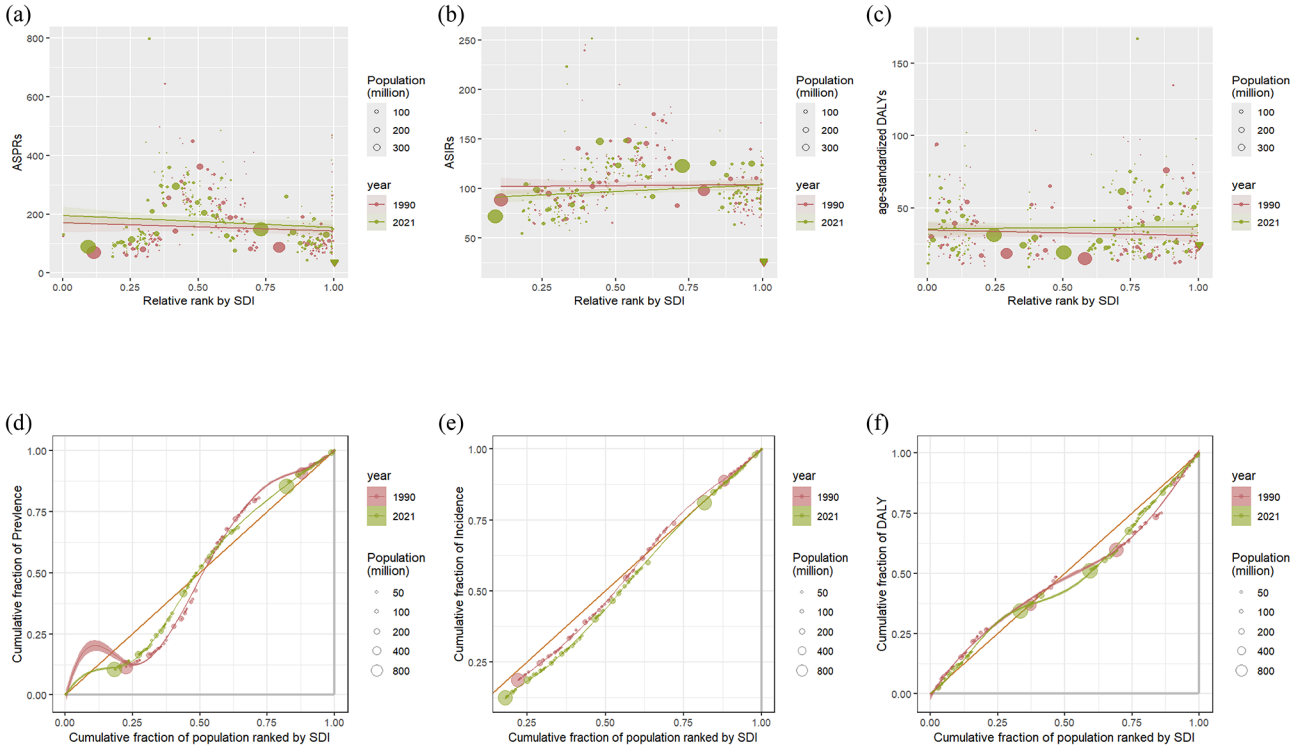

Fig. 7 Cross-country inequality maps for 1990 and 2021. Notes: (**a**-**c**) Health inequality regression curves of Prevalence, Incidence, and DALYs for BN. (**d**-**f**) Concentration curves of Prevalence, Incidence, and DALYs for BN

Table 1 Extent of cross-country inequality for 1990 and 2021

Measure name	Estimate	Lower limit of 95%CI	Upper limit of 95%CI	Estimate	Lower limit of 95%CI	Upper limit of 95%CI
	1990			2021		
Prevalence						
RCI	-0.02	-0.09	0.05	-0.01	-0.09	0.07
SII	-27.67	-73.18	17.85	-40.51	-85.14	4.12
Incidence						
RCI	-0.11	-0.19	-0.04	-0.05	-0.13	0.04
SII	2.04	-11.70	15.77	13.70	2.39	25.02
DALYs						
RCI	0.31	0.27	0.35	-0.01	-0.09	0.08
SII	18.54	1.84	35.24	1.50	-5.90	8.89

Notes: RCI, relative concentration index. SII, Slope Inequality Index

in comparison to 1990, the absolute inequality of BN's global burden has intensified in 2021, whereas the relative inequality has diminished. Finally, our predictions indicate that the global burden of BN will be slightly increasing from 2021 to 2030.

The continued increase in the global burden of BN aligns with a broader trend of rising burdens across all mental disorders [23]. This growing trend may be attributed to heightened awareness of mental health conditions. For instance, the DSM-5 and ICD-11 have modified or expanded the diagnostic criteria for BN, potentially encompassing a wider range of affected individuals while simultaneously reducing the incidence of previously undiagnosed cases [24]. Furthermore, the deterioration of mental health is significantly associated with economic growth [25]. Our research also indicates that the burden of BN exhibits a significant positive correlation with the SDI levels across various regions and countries. This may be attributed to the fact that higher levels of economic development often result in increased social pressure on individuals. In addition, the existing information regarding the epidemiology of eating disorders beyond the Euro-American context remains limited, as many countries do not have a population representation. Despite similar SDI levels, Latin America showed higher BN prevalence than Asia according to GBD 2021 estimates. This disparity may be caused by a greater influence of Western culture on the Latin American

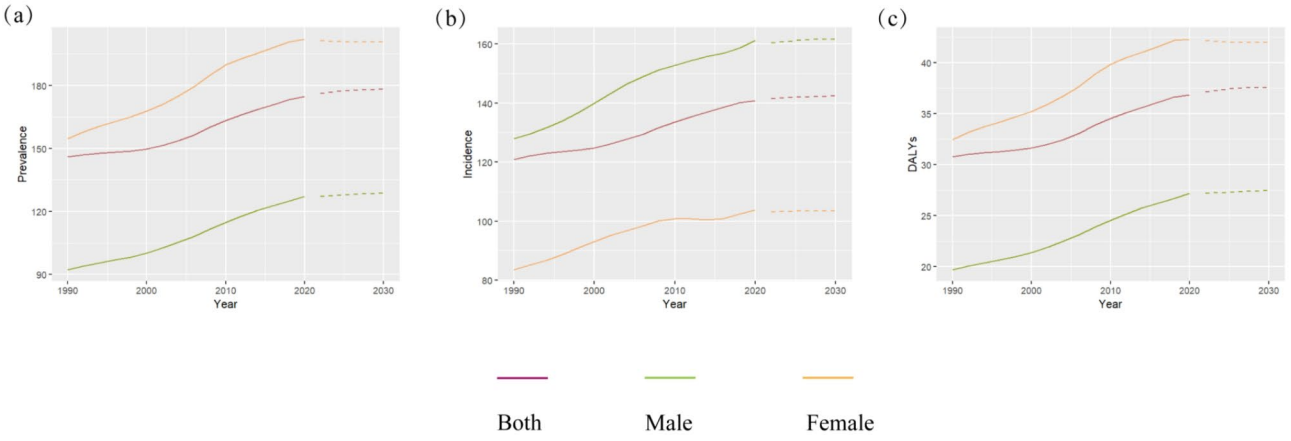

Fig. 8 Forecast graph of prevalence, incidence and DALYs of BN from 1990 to 2030

population compared to their Asian counterparts. Due to the prevalent presence of television, film, and the Internet in Latin American regions, there has been a growing exposure to Western cultures alongside increased attentions to body norms issues, especially among individuals with higher education [26].

Through age-period-cohort analysis, we found that women exhibited a greater burden of BN than men in terms of prevalence and DALYs, which was consistent with previous research [27]. However, it was noteworthy that, in terms of incidence, men endured a greater burden of BN than women. Furthermore, long-term trends indicated that the burden of BN was increasing at a faster rate in men compared to women. Additionally, we observed that the age group with the highest BN burden and the age group with the most rapidly growing BN burden in men were both older than their female counterparts. This disparity might be linked to age-related hormonal changes, medical issues, and variations in life roles that differ by gender [28–30]. For example, testosterone secretion in males declined by 1–2% annually after age 30, with an accelerated decline post-age 40. This age-related hypogonadism exacerbated leptin resistance, further disrupting appetite regulation and potentially contributing to overeating [31, 32].In addition, a distinct delay remained evident in the evaluation, diagnosis, categorization, and treatment for male, which required urgent improvement. All in all, the burden of BN among men is on the rise, which deserves more attention.

In our study, although individuals in high-SDI countries have greater access to superior health and medical services, they have a higher burden of BN than other countries. This phenomenon may be attributed to several factors. First, in high-SDI countries, there is a heightened focus on body shape, resulting in increased social and media pressure regarding the appearance, which may contribute to a higher prevalence of eating disorders such as BN [33]. Second, high-SDI countries tend to attach more importance to mental health than their lower-income counterparts, which leads to a greater demand for medical services aimed at diagnosing and treating mental illnesses, including BN [34]. Third, cross-national differences in mental health stigma may contribute to variations in BN disease burden. Self-stigma regarding mental health may be typically more prevalent in non-Western countries than in Western nations [35]. This higher self-stigma may serve as a significant barrier to treatment-seeking among individuals with mental disorders in non-Western populations. Forth, the ongoing industrialization, modernization, and societal transformations in these populous nations like China and India have been suspected of contributing to the rising prevalence of eating disorders. For example, the swift economic growth that China has undergone since the 1990s has heightened individuals' exposure to multiple risk elements associated with eating disorders, resulting in a greater burden of eating disorders [36]. In addition, our results indicate a downward trend of relative inequalities in the burden of BN disease across countries over time. Here are two possible explanations for the observed decline in cross-national relative health inequality in BN. First, improved diagnostic efficiency in low-income countries may have increased reported prevalence rates of BN, thereby reducing the apparent health disparity relative to high-income countries. Second, effective prevention and treatment strategies in high-income countries may have stabilized BN prevalence rates, contributing to narrowed relative disparities. This trend reflects significant advancements in the prevention and management of BN disease.

Additional, GBD projections suggest a continued increase in the worldwide burden of BN through 2030. This underscores the importance of enhancing our understanding of BN, identifying the risk factors for BN, and exploring effective treatments, but the pathogenesis of BN remains unclear. Therefore, governments in

nations experiencing a high burden of BN should provide assistance for pertinent research and implement measures to effectively alleviate the impact of BN. Furthermore, multiple biological factors contribute to the pathogenesis of BN, including alterations in endogenous hormones, metabolic profiles, and gut microbiota composition [37–40]. Currently, first-line treatments for BN include psychotherapy, antidepressant medication, and nutritional education [41, 42]. However, there is a notable lack of approved pharmacological options specifically for the treatment of BN. Furthermore, studies indicate that approximately 94% of individuals with BN either do not seek treatment or delay in seeking treatment [43]. In summary, it is crucial to expedite the development of effective medications for BN and to enhance the treatment percent among patients suffering from this disorder.

However, there were some limitations in this study. First, the precision of the estimates for BN burden can be influenced by the quality and accessibility of data sources in different countries and regions. In several low- and middle-income nations, the absence of dependable epidemiological data and the underreporting of BN incidences might result in an underrepresentation of the actual burden. Furthermore, the GBD methodology is established on a range of assumptions and modeling strategies, which may bring about some ambiguity in the estimates for BN burden. Although the GBD study utilizes stringent statistical techniques to manage these uncertainties, the findings ought to be regarded as the most reliable estimates given the present evidence.

Conclusion

This research utilized the GBD 2021 database to deliver a detailed overview of the international impact of BN. While the most significant burden of BN is found in affluent Western nations, a rising trend has also been detected on a global scale and across all SDI quintiles, particularly in densely populated regions of Asia. Our findings highlight that BN represents an international health concern and suggest that the differences in burden should be analyzed based on region, nation, gender, and year when setting international health goals. The findings may assist governments internationally in understanding the prevalence of BN within their nations and in developing effective healthcare policies aimed at preventing and intervening early in cases of BN.

Abbreviations

APC	Age-period-cohort
ASRs	Age-standardized rates
ASIR	Age-standardized incidence rates
ASPR	Age-standardized prevalence rates
BN	Bulimia nervosa
CI	Confidence interval
DALYs	Disability-adjusted life years
EAPCs	Estimated annual percentage changes
GBD	Global burden of disease
RCI	Relative concentration index
SDI	Socio-demographic index
SII	Slope inequality index
UI	Uncertainty intervals

Supplementary Information

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Supplementary Material 1

Supplementary Material 2

Supplementary Material 3

Supplementary Material 4

Supplementary Material 5

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Not applicable.

Author contributions

Yihao Ge, Shanshan Zhang, Zhiyong Li and Feng Zhang contributed to acquisition and analysis of data; Zekun Li, Xiaohan Li, Hongmin Guo and Fang Dong contributed to draft the work or substantively revise it. All authors read and approved the final manuscript.

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Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethical approval and consent to participate

This study did not require ethical approval because it used publicly available data and did not involve human participants, animal subjects, or sensitive personal information.

Consent for publication

Not applicable.

Consent to participate

Not applicable.

Patient and public involvement statement

Not applicable.

Competing interests

The authors declare no competing interests.

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