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Assessing Global, Regional, and National Burden of Depressive Disorder Attributable to Childhood Sexual Abuse and Bullying Victimization From 1990 to 2021: A Study on Individuals Aged 10–24 Years

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Abstract

Aims/Background: This study aims to assess the burden of depressive disorder attributable to childhood sexual abuse (CSA) and bullying victimization (BV) among individuals aged 10–24 years from 1990 to 2021. **Methods:** Using the 2021 Global Burden of Disease (GBD) database, disability-adjusted life years (DALYs) for depressive disorder attributable to CSA or BV among the 10–24-year-old individuals from 1990 to 2021 were extracted. The 2021 global burden and trends in these disorders were assessed using the average annual percentage change (AAPC). Disease burden was further verified using cross-national inequalities and panel data models. **Results:** High socio-demographic index (SDI) regions experienced the most significant burden of depressive disorder attributable to CSA and BV among 10–24-year-old individuals in 2021. Females had a higher CSA-related depressive disorder burden, while males had a greater BV-related depressive disorder burden. From a global perspective, the age-standardized disability-adjusted life years rate (ASDR) for CSA-related depressive disorder remained stable from 1990 to 2021, though high SDI regions are increasing annually. Conversely, BV-associated ASDR increased globally, with high and low-middle SDI regions showing rates above the global average and rapid growth in high-SDI areas. Panel analysis showed inverse correlations between the DALY rate for depressive disorder and compulsory education duration, domestic general government health expenditure, and physician density, but a positive correlation with current health expenditure per capita (purchasing power parity [PPP]). Furthermore, BV-attributable depressive disorder DALYs correlated negatively with current health expenditure (% of gross domestic product [GDP]), while CSA-attributable depressive disorder DALYs correlated positively with hospital beds. **Conclusion:** The global burden of depressive disorder attributable to CSA among 10–24-year-old individuals remained stable, while the burden attributable to BV increased, and both showed significant disparities by gender and region. Globally, the heavier burden of depressive disorder in females was linked to CSA, and in males to BV. Geographically, the burden from both factors increased in high-SDI regions. Given substantial variations by gender, SDI, and geography, interventions should be tailored to national development levels and cultural contexts.

Keywords: depressive disorder; childhood sexual abuse; bullying victimization; Global Burden of Disease

1. Introduction

Depressive disorder is a significant global public health challenge, significantly affecting mental well-being [1]. Evidence indicates that approximately 350 million individuals worldwide live with depression, resulting in substantial impairment in psychological and physical health, thereby compromising quality of life [2]. A growing body of scientific evidence has strongly linked specific life experiences, such as childhood sexual abuse and bullying, with the subsequent development of depressive disorders [3,4,5,6,7].

Childhood sexual abuse (CSA) is defined as involving a child in sexual activities that they do not fully understand, are unable to provide informed consent, are physically and biologically underdeveloped to engage, or that violate social, legal, or cultural taboos and norms [8]. Recent evidence indicates that approximately 12–19% of women and 14.8% of men report having experienced sexual abuse during childhood [9]. Furthermore, individuals with a history of CSA have been found to be at a higher risk of developing depressive disorder [10].

Bullying victimization (BV) refers to intentional, repeated, and negative aggressive behaviors toward children or adolescents [11]. Beyond physical, verbal, and emo-



tional forms, BV also includes cyberbullying through digital platforms [12]. According to reports from the United Nations Educational, Scientific, and Cultural Organization (UNESCO), at least one-third of students experience bullying victimization in educational settings. BV shows strong associations with depressive disorder, with psychological effects that may persist into adulthood [13,14]. A study has revealed that victimized children have approximately a 1.80-fold increased risk of developing depressive disorder compared with non-bullied peers [15].

To minimize these risk factors, early intervention approaches tailored to specific populations should be implemented to foster healthy social and emotional development [16]. The 10–24-year age group encompasses rapid and prominent developmental changes, spanning childhood, adolescence, and then early adulthood. These transitions concur with brain maturation, progression through education, puberty changes, entry to the workforce, and shifts in social determinants of health, all of which increase the vulnerability to depressive disorder [17,18,19]. The emergence of depressive disorder during these formative years is linked to considerable long-term consequences, including diminished academic performance, disrupted social interactions, emotional instability, and a decline in overall quality of life [20,21]. Without timely or effective intervention, these conditions persisted into adulthood, elevating the risk of substance use disorders and contributing to social and economic dysfunction [22]. Therefore, well-being and maintenance of mental health should be prioritized in individuals aged 10–24 years, particularly those with histories of childhood bullying or sexual abuse.

This study uses the 2021 Global Burden of Disease (GBD) database to assess the burden of depressive disorder attributable to CSA and BV among individuals aged 10–24 years, with the aim of providing updated global evidence to alleviate this burden and to guide the development of evidence-based public health policies.

2. Methods

2.1 Data Source

The 2021 Global Burden of Disease (GBD) (<https://www.healthdata.org/research-analysis/gbd>) database is an invaluable resource for up-to-date epidemiological research [16]. It provides detailed approximations that enable comprehensive quantification of disease burden and temporal trends, facilitating assessment of health status and variations over time across regions and countries, thereby informing healthcare practices and health policy formulation [23,24,25,26].

The GBD 2021 quantified the burden of 371 diseases and 88 risk factors in 204 countries and territories, stratified by 5 socio-demographic index (SDI) quintiles, using 100,983 disease-related data sources worldwide [16]. This study extracted global estimates of disability-adjusted life years (DALYs) for depressive disorder attributable to child-

hood sexual abuse (CSA) and bullying victimization (BV) among individuals aged 10–24 years from the GBD 2021 database and subsequently determined the age-standardized disability-adjusted life years rate (ASDR).

This study employs disability-adjusted life years (DALYs) as the primary indicator to assess the burden of depressive disorder attributable to CSA and BV among individuals aged 10–24 years, with higher DALY values indicating a greater disease burden [27]. Age-standardized rates are applied to adjust for variations in population age structures, thereby enhancing the precision and consistency of DALY estimates across populations and over time [28].

2.2 Comparative Risk Assessment Attribution

The exposure data for the two risk factors and the estimation of depressive disorder DALYs attributable to CSA and BV were acquired using the comparative risk assessment framework of the GBD 2021 study [24]. The population attributable fraction (PAF) for each risk factor was calculated from its exposure distribution, relative risks, and the theoretical minimum risk exposure level, thereby estimating the proportion of the disease burden due to that factor. Guided by established risk attribution methodologies, this approach ensured that the estimates were suitable for robust cross-population and temporal comparisons [23,24,26].

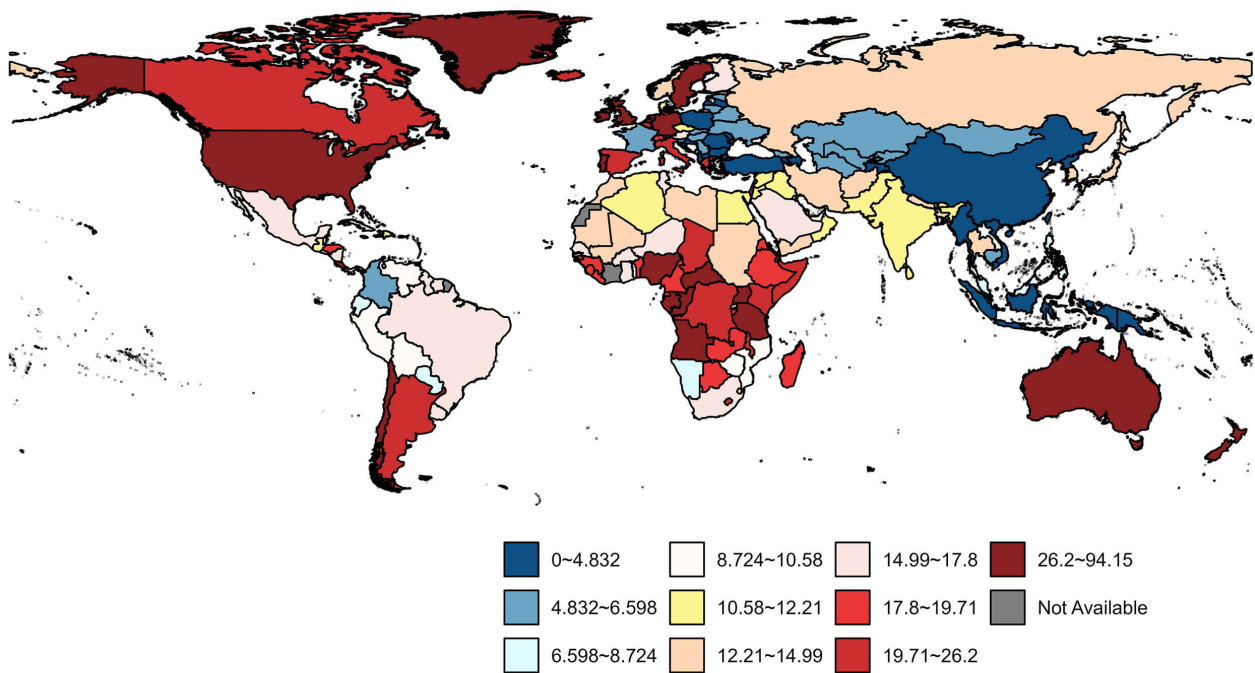
2.3 Trend Analysis

Global disease burden indicators for depressive disorder among individuals aged 10–24 years attributable to CSA and BV in 1990 and 2021 were extracted to assess the worldwide impact of these risk determinants on depressive disorder during 2021. Age- and sex-stratified analyses were conducted to evaluate variations in the disease burden across demographic subgroups. The average annual percent change (AAPC) was calculated using a joinpoint regression model to quantify temporal changes in disease burden for specified health outcomes. R statistical software (version 4.2.2, the R Foundation for Statistical Computing, Vienna, Austria) was used to calculate and visualize the disease burden from 1990 to 2021, and compute AAPC in the age-standardized disability-adjusted life years rate (ASDR) over this 31-year period.

2.4 Inequality Measures

The slope index of inequality (SII) and the concentration index are standard metrics used to quantify absolute and relative gradient, respectively, in the distribution of depressive disorder burden attributable to CSA and BV among those aged 10–24 years across countries [29]. The SII is calculated by regressing national DALY rates on a socio-demographic index (SDI)-based relative rank scale for all age groups, where the relative position of each country corresponds to the midpoint of its cumulative population share in the SDI rankings. Weighted regression models were used to account for heterogeneity of variance. The concentration

A



B

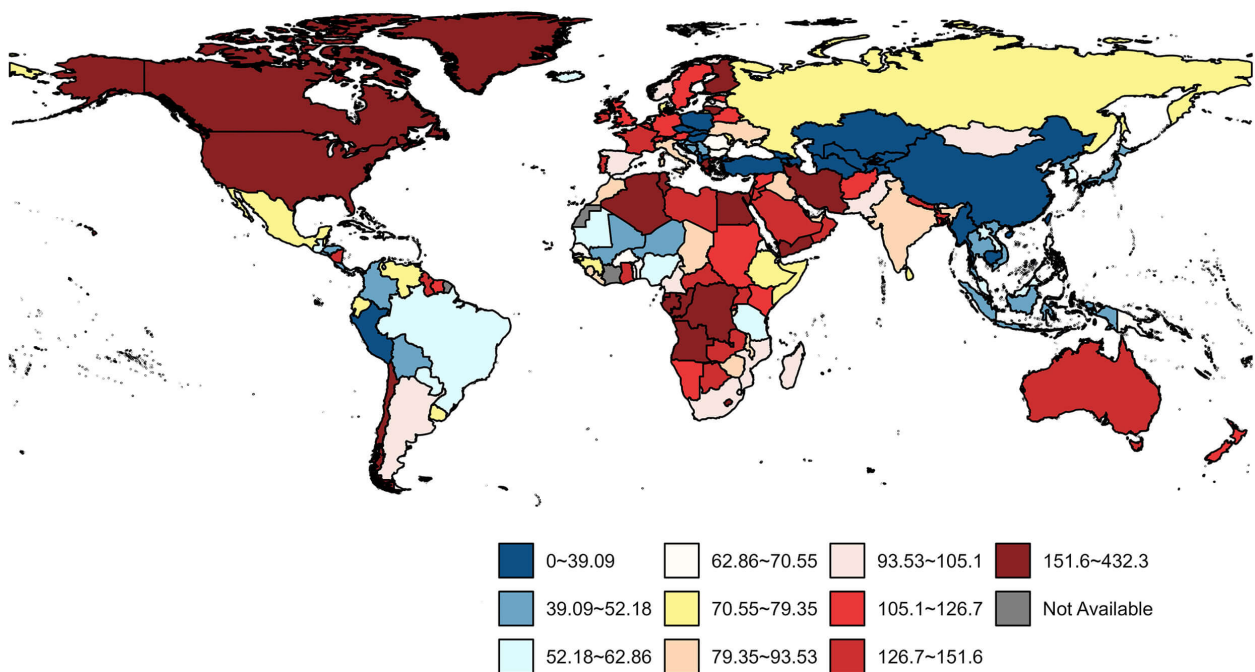


Fig. 1. The age-standardized disability-adjusted life years rate of depressive disorder among individuals aged 10–24 years attributable to childhood sexual abuse and bullying victimization in 204 countries and regions, 2021. (A) Childhood sexual abuse. (B) Bullying victimization.

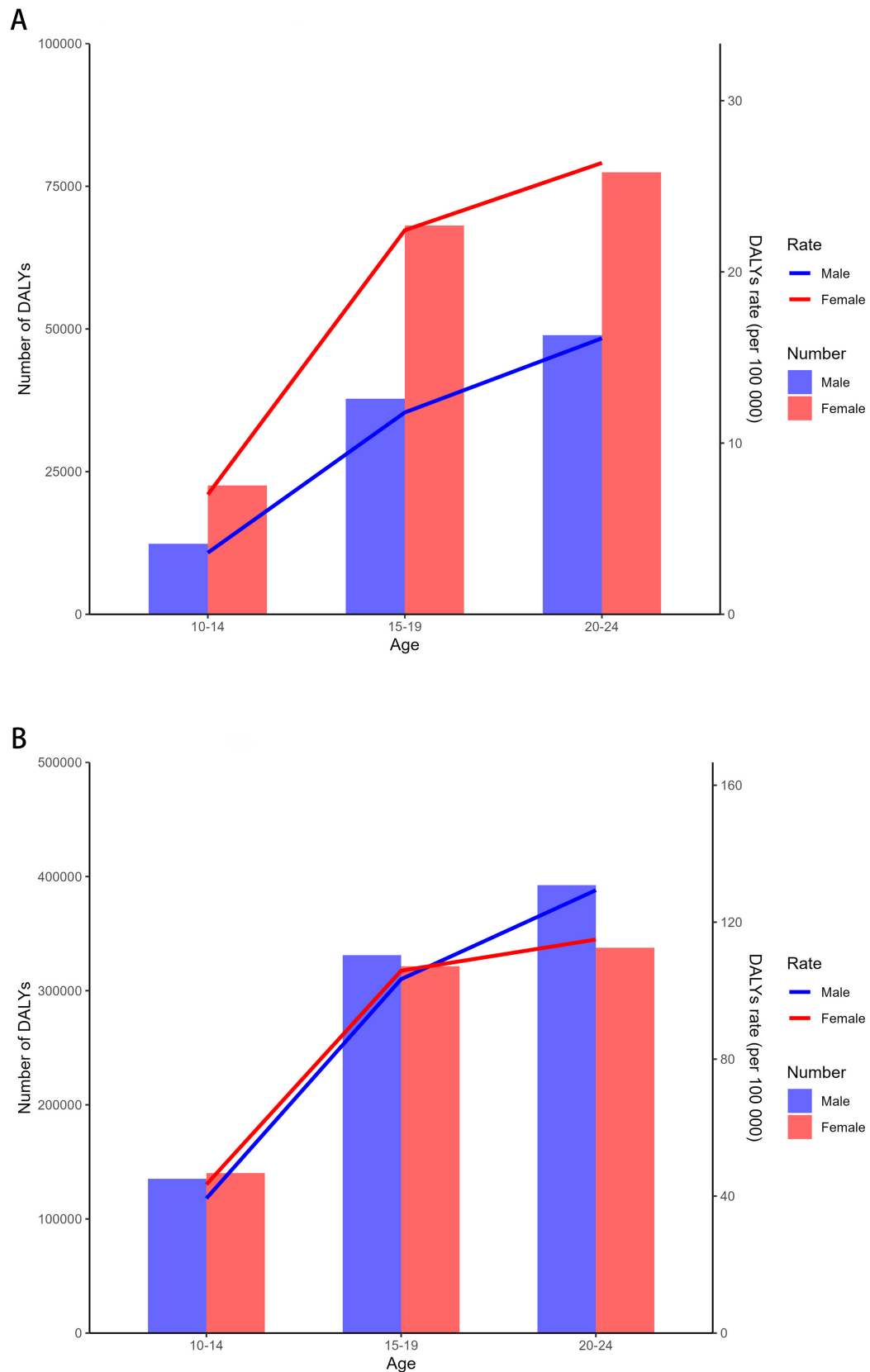


Fig. 2. Age-specific numbers and rates of disability-adjusted life years of depressive disorders attributable to childhood sexual abuse and bullying victimization by sex, 2021. (A) Childhood sexual abuse. (B) Bullying victimization. Abbreviation: DALYs, disability-adjusted life years.

index was computed by numerically integrating the area under the Lorenz concentration curve, using cumulative proportions of DALYs plotted against the cumulative population shares ranked by SDI [30].

2.5 Panel Regression

To investigate the effects of social education level and healthcare expenditure on the burden of depressive disorder attributable to CSA and BV among individuals aged 10–24 years, we compiled national-level indicators of education and healthcare expenditure.

The Hausman test was applied to determine the appropriate data model. The null hypothesis assumed that the individual effects were independent of the explanatory variables, suggesting the use of a random-effect model. The alternative hypothesis indicated that the individual effects were correlated with the explanatory variables, thereby favoring the fixed effects model. If the p -value is less than the significance level, the null hypothesis is rejected. The test results yielded a chi-square statistic of 10.908 with a corresponding p -value of 0.7591, indicating failure to reject the null hypothesis at the 5% significance level. Therefore, a random effects model was adopted for subsequent analysis. For model estimation, robust standard errors clustered at the country level were applied, and year dummy variables were included to adjust for temporal trends. Indicator data were sourced from the World Bank databases (<https://databank.worldbank.org/source/world-development-indicators>).

3. Results

3.1 Global Burden of Depressive Disorder Attributable to CSA and BV Among the 10–24-Year Age Group in 2021

In 2021, the global DALYs from depressive disorder among individuals aged 10–24 years attributable to CSA and BV were 1,877,639.02 (95% uncertainty intervals [UI]: 883,754.83–3,351,020.55). Of the total, 267,201.00 DALYs (95% UI: 118,462.20–485,753.58) were attributable to CSA, while 1,657,938.03 DALYs (95% UI: 748,917.39–3,100,786.53) were attributable to BV.

The regional comparison revealed that Greenland had the highest age-standardized disability-adjusted life years rate (ASDR) of depressive disorder attributable to CSA among this age group, reaching 94.15 (95% UI: 36.83–186.25). New Zealand and the United States ranked second and third, respectively. The Republic of Moldova had the lowest ASDR, at 1.09003942 (95% UI: 0.35–2.58), followed by Taiwan (Province of China) and Viet Nam (Fig. 1A).

Furthermore, Greenland had the highest ASDR for depressive disorder attributable to BV among this age group, at 432.30 (95% UI: 203.91–767.63), followed by the United States and Egypt. The lowest ASDR was recorded in Tajikistan, at 12.91 (95% UI: 4.66–28.17), with Myanmar and Azerbaijan as the next lowest (Fig. 1B).

The high socio-demographic index (SDI) region carried the most significant burden of depressive disorder attributable to CSA among the 10–24 age group in 2021, with a DALYs rate of 30.574 (95% UI: 13.804–52.720) per 100,000 population (Table 1). This was followed by the low SDI region, with 17.541 DALYs per 100,000 (95% UI: 7.582–32.730). For depressive disorder attributable to BV, the high SDI region also showed the highest burden, with a DALY rate of 143.671 (95% UI: 66.589–261.377) per 100,000 (Table 2), followed by the low-middle SDI region at 99.240 (95% UI: 45.631–179.999) per 100,000. The middle SDI region had the lowest burden at 34.106 (95% UI: 14.252–65.184) DALYs per 100,000.

3.2 Age and Sex Patterns of the Global Burden of Depressive Disorder Attributable to CSA and BV Among the 10–24-Year Age Group

Among the 10–24-year age group, females showed significantly higher DALY and DALY rates for depressive disorder attributable to CSA than males in 2021 (Fig. 2A). In both males and females, DALYs and DALY rates increased with advancing age across all three age groups, with more significant increases observed among females aged 15–19 years.

Overall, males demonstrated higher DALYs and DALY rates for depressive disorder attributable to BV than females (Fig. 2B). Males had slightly lower DALYs and DALY rates than females in the 10–14-year age group; however, they surpassed female levels by ages 15–19, with a substantial increase in DALY rate among males in the 20–24-year age group.

3.3 Global Temporal Trends in the Burden of Depressive Disorder Attributable to CSA and BV Among the 10–24-Year Age Group From 1990 to 2021

From 1990 to 2021, the global ASDR of depressive disorder attributable to CSA among the 10–24-year age group remained generally stable. However, both high SDI and low SDI regions exhibited ASDRs above the global average. Notably, the high SDI region demonstrated gradual increases year-by-year, whereas the low SDI region remained relatively stable over time (Fig. 3A). The low-middle SDI region had ASDR levels comparable to the global average, whereas the high-middle and middle SDI regions demonstrated lower ASDRs than the global average, with progressive year-by-year decline. Over the same period, the global ASDR for depressive disorder attributable to BV among individuals aged 10–24 years showed an overall increasing trend. High-SDI and low-middle SDI regions both exhibited higher ASDRs than the global average, with particularly pronounced growth in the high SDI region (Fig. 3B). In the low-SDI region, ASDR increased year-by-year and reached global average levels by 2021.

From 1990 to 2021, most countries experienced increasing trends in the burden of depressive disorder at-

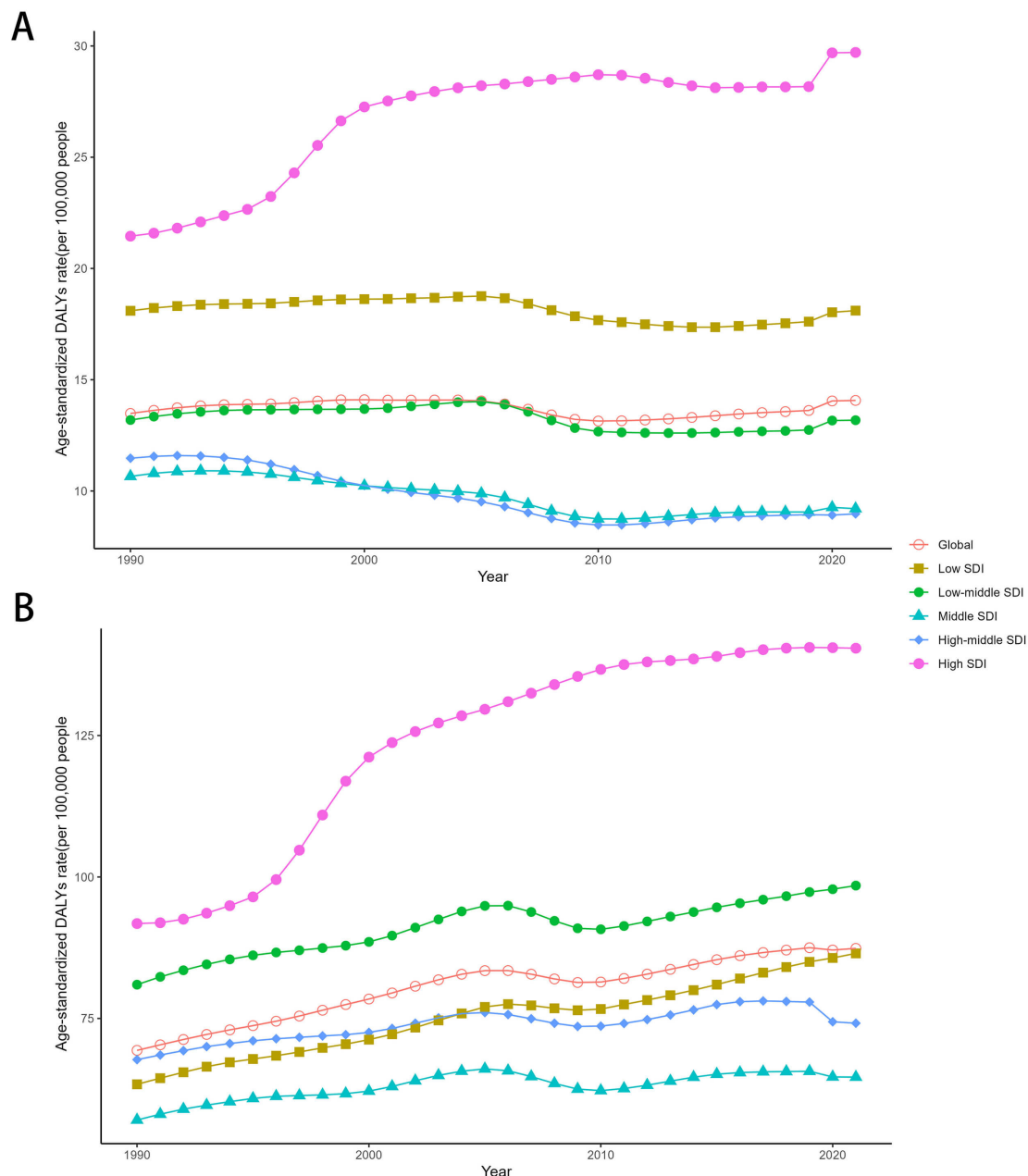


Fig. 3. Age-standardized disability-adjusted life years rate of depressive disorder attributable to childhood sexual abuse and bullying victimization in five socio-demographic index groups for both sexes, 1990–2021. (A) Childhood sexual abuse. (B) Bullying victimization. Abbreviations: DALYs, disability-adjusted life years; SDI, socio-demographic index.

tributable to CSA among individuals aged 10–24 years. The highest average annual percent change (AAPC) in CSA-attributable depressive disorder was observed in the United States, Mexico, Canada, Norway, and Sweden (Fig. 4A). Conversely, the lowest AAPC was observed in China, Cuba, Bosnia and Herzegovina, Sri Lanka, and Singapore.

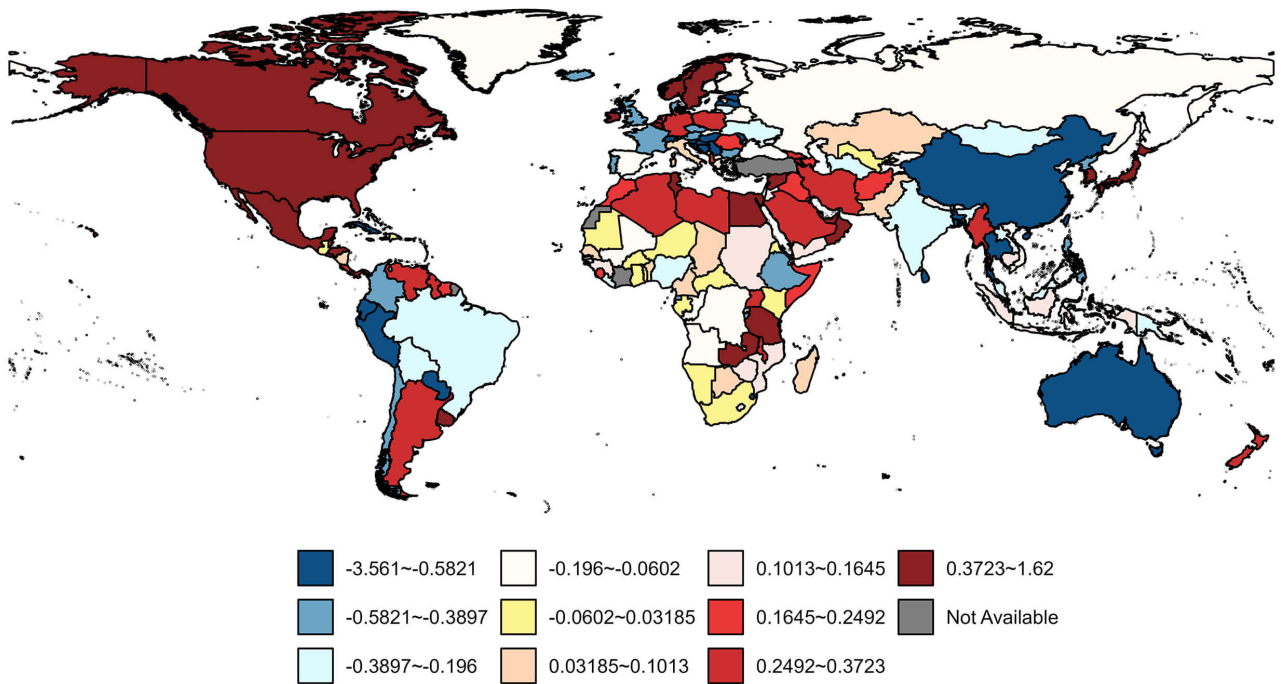
Over the same period from 1990 to 2021, the burden of depressive disorder attributable to BV among individuals aged 10–24 years also increased globally. The highest AAPC for BV-attributable depressive disorder were recorded in Niger, Burkina Faso, Guinea, Djibouti, and Somalia (Fig. 4B). The countries with the lowest AAPC com-

prised China, Bosnia and Herzegovina, Cuba, Singapore, and Chile.

3.4 Cross-Country Inequality Analysis

The global burden of depressive disorder attributable to CSA among individuals aged 10–24 years demonstrates both absolute and relative SDI-related inequalities (Fig. 5A,B). As indicated by the slope index of inequality (SII), the difference in DALY rates between high- and low-SDI countries changed from -5.16 in 1990 to -4.17 in 2021, suggesting a greater disease burden in populations with lower socioeconomic status, though with some im-

A



B

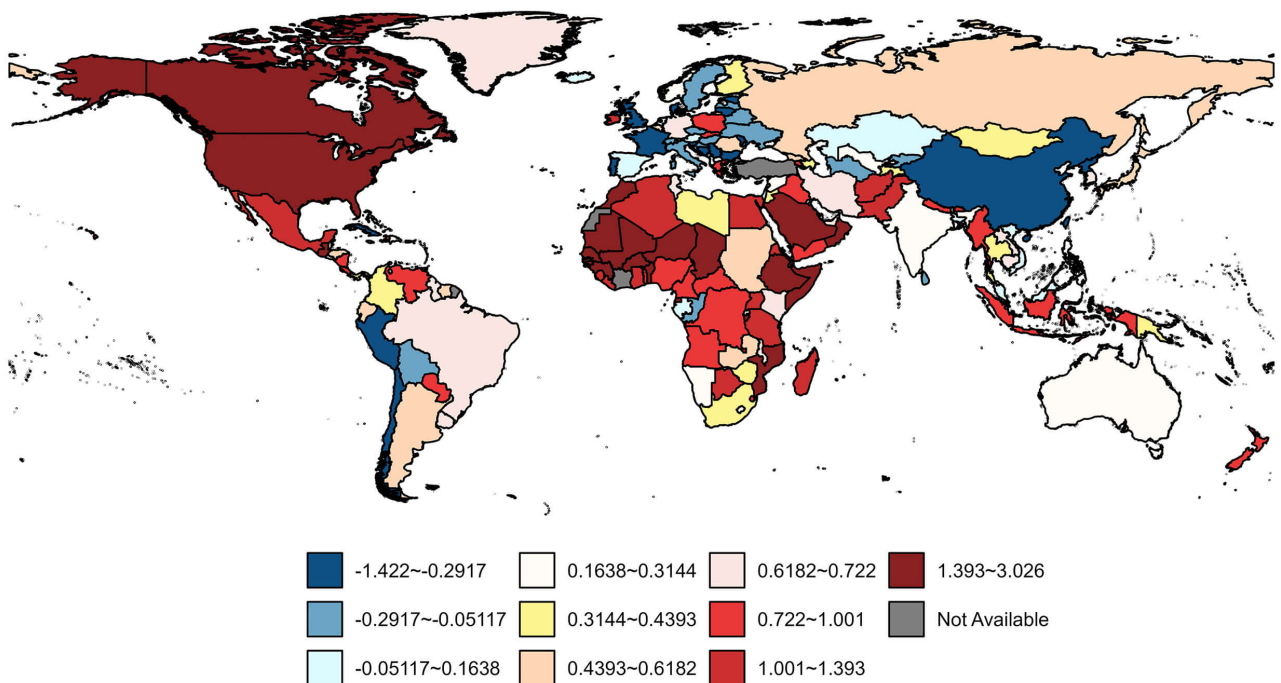


Fig. 4. The AAPC of depressive disorder among individuals aged 10–24 years attributable to childhood sexual abuse and bullying victimization in 204 countries and regions, 1990–2021. (A) Childhood sexual abuse. (B) Bullying victimization. Abbreviation: AAPC, average annual percentage change.

Table 1. In 2021, the disability-adjusted life years of depressive disorder attributable to childhood sexual abuse among individuals aged 10–24 years, stratified by socio-demographic index quintiles, along with changes observed from 1990 to 2021.

Region	DALYs		
	Percentage (%)	Rate per 100,000	Percentage change (%)
High SDI	3.171 (1.742, 4.925)	30.574 (13.804, 52.720)	–13.646 (–24.959, –0.635)
High-middle SDI	1.750 (0.940, 2.697)	9.091 (4.113, 16.018)	–35.559 (–45.838, –22.601)
Middle SDI	1.992 (1.079, 3.130)	9.306 (4.186, 16.727)	–28.497 (–41.158, –13.996)
Low-middle SDI	2.374 (1.251, 3.837)	13.302 (5.763, 25.381)	–15.086 (–33.993, –9.850)
Low SDI	3.081 (1.708, 4.804)	17.541 (7.582, 32.730)	–11.484 (–23.294, –0.257)

Abbreviations: DALYs, disability-adjusted life years; SDI, socio-demographic index.

Table 2. In 2021, the disability-adjusted life years of depressive disorder attributable to bullying victimization among individuals aged 10–24 years, stratified by socio-demographic index quintiles, along with changes observed from 1990 to 2021.

Region	DALYs		
	Percentage (%)	Rate per 100,000	Percentage change (%)
High SDI	14.990 (8.259, 24.085)	143.671 (66.589, 261.377)	–3.517 (–10.038, 6.947)
High-middle SDI	14.428 (8.240, 23.440)	74.952 (34.423, 141.276)	–7.783 (–0.173, 8.684)
Middle SDI	13.947 (7.478, 23.015)	34.106 (14.252, 65.184)	–5.628 (–10.086, 1.500)
Low-middle SDI	17.723 (10.397, 27.441)	99.240 (45.631, 179.999)	2.234 (–5.744, 14.911)
Low SDI	14.813 (7.862, 24.571)	65.229 (28.173, 125.413)	19.866 (12.570, 29.557)

provement over time. Furthermore, the 2021 concentration curve lies predominantly above the line of equality compared with 1990, with concentration indices of 0.07 (95% confidence interval [CI]: 0.02–0.12) in 1990 and 0.03 (95% CI: –0.03–0.1) in 2021, indicating a reduction in cross-country inequality.

Similarly, the global burden of depressive disorder attributable to BV among this age group showed both absolute and relative SDI-related inequalities (Fig. 5C,D). The DALY rate gap between high- and low-SDI countries decreased from 19 in 1990 to 5 in 2021, demonstrating higher DALY rates in higher socioeconomic groups, though with reduced absolute difference. Notably, the concentration index decreased from 0.03 (95% CI: –0.01–0.07) in 1990 to 0 (95% CI: –0.05–0.05) in 2021, reflecting a significant improvement in the equity of health resource distribution or disease burden allocation across countries.

3.5 The Relationship Between Country-Level Socioeconomic and Healthcare Factors and Depressive Disorder Attributable to CSA and BV Among 10–24-Year-Old Individuals

The results of the panel model analysis are summarized in Table 3. We found that countries and regions with higher current health expenditure per capita (purchasing power parity [PPP], current international \$) showed higher DALY rates for depressive disorder among individuals aged 10–24 years attributable to both CSA (0.705, 95% CI: 0.098–1.313, $p = 0.0018$) and BV (5.192, 95% CI: 1.412–8.972, $p = 0.0048$). A greater number of hospital beds (per 1000 people) was associated with elevated DALY rate for CSA-attributable depressive disorder (0.195, 95% CI: 0.037–0.353, $p = 0.0158$). However, inverse association

was observed for compulsory education duration (years) (CSA: –0.201, 95% CI: –0.309– –0.092, $p = 0.0003$; BV: –0.825, 95% CI: –1.496– –0.154, $p = 0.0160$), higher domestic general government health expenditure (% of gross domestic product [GDP]) (CSA: –0.002, 95% CI: –0.003– –0.001, $p = 0.0228$; BV: –0.010, 95% CI: –0.016– –0.004, $p = 0.0071$), greater government health expenditure per capita, PPP (current international \$) (CSA: –0.003, 95% CI: –0.005– –0.001, $p = 0.0003$; BV: –0.016, 95% CI: –0.026– –0.005, $p = 0.0039$), and a higher number of physicians per 1000 people (CSA: –0.474, 95% CI: –0.774– –0.175, $p = 0.0019$; BV: –2.655, 95% CI: –4.510– –0.799, $p = 0.0051$).

Furthermore, higher total government expenditure on education (% of GDP) demonstrated a marginal association with lower CSA-attributable DALY rates (–0.180, 95% CI: –0.362–0.002, $p = 0.0521$), while higher current health expenditure (% of GDP) was significantly associated with reduced BV-attributable DALY rates (–3.084, 95% CI: –5.705– –0.463, $p = 0.0211$).

4. Discussion

This study systematically evaluated the global burden of depressive disorders attributable to childhood sexual abuse (CSA) and bullying victimization (BV) among individuals aged 10–24 years from 1990 to 2021. The results demonstrate that the global age-standardized disability-adjusted life years rate (ASDR) for CSA-attributable depressive disorder remained generally stable during this period, suggesting partial improvements from sexual education and prevention efforts. Conversely, the ASDR for BV-attributable depressive disorder increased, highlighting persistent challenges in protecting children and adoles-

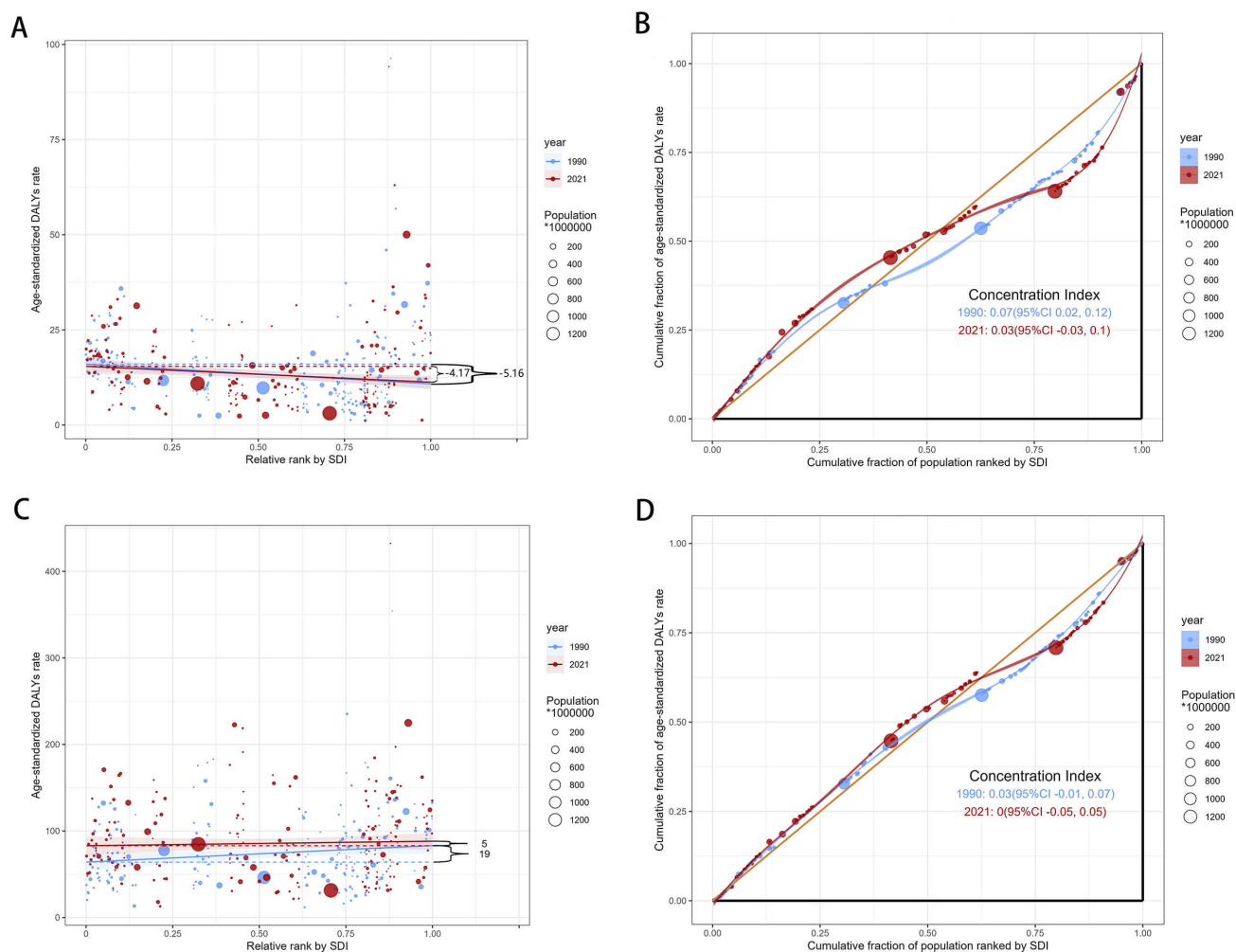


Fig. 5. Health inequality regression and concentration curves for the age-standardized DALY rate of depressive disorders attributable to childhood sexual abuse and bullying victimization. (A,B) Childhood sexual abuse. (C,D) Bullying victimization. Abbreviations: DALYs, disability-adjusted life years; SDI, socio-demographic index. * means per 1,000,000 people.

cents from bullying worldwide. This overall stability in the global ASDR, despite upward trends in most countries, is likely due to offsetting national trends and population-weight effects.

Our findings reveal significant regional differences in the burden of depressive disorder across socio-demographic index (SDI) strata. High SDI countries exhibited a particularly high burden of depressive disorder attributable to both CSA and BV. Despite favorable socioeconomic conditions, these nations face substantial mental health pressure from high social competition, fast-paced lifestyles, and work-family conflicts, which may hinder the effectiveness of CSA prevention efforts [31,32]. Additionally, the large immigrant populations in many high SDI regions are exposed to elevated bullying risk [33,34].

In low and low-middle-SDI countries, economic hardship, social instability, and limited public health resources exacerbate mental health concerns [35,36]. Children living in conflict and post-conflict environments are at particularly high risk of sexual violence and bullying [37], as

exemplified by the widespread sexual assault against child soldiers during civil war in Sierra Leone [38]. However, growing public awareness and improved child protection policies have led to greater focus on youth mental health and public health interventions in many low- and middle-income countries, particularly in sub-Saharan Africa [39].

Given the regional disparities in disease burden, high-SDI countries should enhance school-based education and public awareness campaigns, with greater emphasis on adolescent mental health and psychological support for victims of sexual abuse and bullying. Conversely, low-SDI regions need to prioritize the development of mental health services, strengthen legal frameworks addressing CSA and BV, and improve mechanisms to encourage reporting.

Although the 2021 Global Burden of Disease (GBD) methods and outputs, based on the DisMod-MR 2.1 model, are generally regarded as robust and reliable, country-level estimates should be interpreted with caution. The GBD 2021 study uses several approaches to reduce bias and inaccuracies; however, residual bias cannot be completely ex-

Table 3. Association coefficients between the burden of depressive disorder attributable to childhood sexual abuse and bullying victimization among individuals aged 10–24 years and socioeconomic and healthcare factors estimated by a global panel data model.

Indicators	Age-standardized DALY rate			
	Childhood sexual abuse		Bullying victimization	
	β (95% CI)	<i>p</i> -value	β (95% CI)	<i>p</i> -value
Adolescents out of school (% of lower secondary school age)	0.003 (−0.029, 0.034)	0.8660	−0.078 (−0.272, 0.116)	0.4308
Compulsory education, duration (years)	−0.201 (−0.309, −0.092)	0.0003	−0.825 (−1.496, −0.154)	0.0160
Government expenditure on education (% of GDP)	−0.180 (−0.362, 0.002)	0.0521	−0.158 (−1.292, 0.977)	0.7855
Current health expenditure (% of GDP)	−0.237 (−0.659, 0.184)	0.2691	−3.084 (−5.705, −0.463)	0.0211
Current health expenditure per capita, PPP (current international \$)	0.705 (0.098, 1.313)	0.0018	5.192 (1.412, 8.972)	0.0048
Domestic general government health expenditure (% of GDP)	−0.002 (−0.003, −0.001)	0.0228	−0.010 (−0.016, −0.004)	0.0071
Domestic general government health expenditure per capita, PPP (current international)	−0.003 (−0.005, −0.001)	0.0003	−0.016 (−0.026, −0.005)	0.0039
Hospital beds (per 1000 people)	0.195 (0.037, 0.353)	0.0158	−0.207 (−1.168, 0.754)	0.6731
Physicians (per 1000 people)	−0.474 (−0.774, −0.175)	0.0019	−2.655 (−4.510, −0.799)	0.0051

Abbreviations: DALYs, disability-adjusted life years; CI, confidence interval; GDP, gross domestic product; PPP, purchasing power parity.

cluded, particularly in low-income regions and areas with limited health statistics, which may compromise the accuracy of burden estimates. In contrast, higher diagnostic rates of depressive disorder and greater reporting of CSA and BV in high SDI regions may lead to higher disease burden estimates in these regions.

Furthermore, factors related to regional heterogeneity require careful interpretation. Despite using a standardized global analytical framework, the findings may be influenced by substantial disparities in socioeconomic conditions, cultural norms, and healthcare systems across countries. For instance, cultural norms may systematically suppress reporting CSA or BV, leading to potential underestimation of their actual prevalence, especially where discussion of sexual matters is sensitive or stigmatized. Moreover, Greenland consistently shows the highest ASDR for CSA- and BV-attributable burden; however, the wide UIs (e.g., BV ASDR 203.9–767.6) suggest significant instability due to small sample size. Considering the potential volatility of estimates derived from limited data, such findings should be interpreted with particular caution.

Our study also reveals significant gender disparities in the burden of depressive disorder attributable to CSA and BV among adolescents and young adults. The greater burden of depressive disorder attributable to CSA in females is primarily driven by their substantially higher exposure rates. Due to variation in CSA definitions and data collection methodologies across countries, reported prevalence rates among girls range from about 6% to 62% [40], with most studies estimating at least 6–15% [40], whereas CSA prevalence among males is considerably lower [41]. These findings highlight the need for strengthened sexual

education in schools and families, particularly for adolescent girls, to enhance prevention awareness, and to ensure that those who have experienced sexual abuse are encouraged to seek timely professional help.

Furthermore, females are more likely to develop depressive disorder than males [42]. Fluctuations in ovarian hormones are regarded to modulate stress sensitivity, brain structure and function, and inflammatory responses, thereby increasing depression risk in women [43].

Conversely, males experience a greater burden of depressive disorder from BV, likely reflecting their significantly higher rates of bullying victimization [44]. This gender-specific pattern is evident across most regions of the world and is particularly pronounced during adolescence. Educational institutions should intensify anti-bullying initiatives, and governments should formulate context-specific policies to guarantee adolescents access to free, high-quality psychological support services.

To further investigate how socioeconomic and healthcare factors, including education levels and health expenditures, affect the global burden of depressive disorder attributable to CSA and BV among individuals aged 10–24 years, we analyzed global panel data from multiple countries and regions spanning 32 years. Our analysis revealed negative correlations between DALY rate for depressive disorder in this age group and several indicators: duration of compulsory education, domestic general government health expenditure, and physician density (per 1000 individuals). However, our regression analysis also shows that current health expenditure per capita (PPP, current international \$) was positively associated with higher DALY rates. This likely reflects greater capacity in better-resourced health-

care systems, especially in high SDI regions, to detect, diagnose, and manage these conditions. The positive correlation is therefore interpreted as an outcome of more robust surveillance and diagnostic-therapeutic frameworks linked to higher expenditure levels. These findings highlight the importance of strengthening education systems and optimizing health resource allocation to minimize the global burden of CSA- and BV-associated depressive disorder.

Since 2019, the AAPC for depressive disorder has shown an upward trend [45]. Concerns regarding viral infections, school closures, and social restrictions during the Coronavirus Disease 2019 (COVID-19) pandemic have likely contributed to worsening mental health among adolescents [46,47]. Reduction in in-person schooling and outdoor activities limited access to educational and social support systems, elevated stress levels, and exacerbated existing psychological issues [48]. Furthermore, prolonged exposure to computer screens has been linked to increased fatigue, increased cyberbullying, and a higher prevalence of mental health symptoms [49,50,51].

From 1990 to 2021, the global burden of depressive disorder attributable to CSA and BV among individuals aged 10–24 years continued to increase, with notable disparities across genders and geographic regions. Given these substantial differences across gender, SDI level, and geographic location, prevention and intervention strategies should be designed and implemented according to each country's specific development context and sociocultural characteristics. Furthermore, evidence from our panel analysis supports the implementation of targeted measures, including strengthening legal, policy frameworks and creating safer and more inclusive environments in schools, families, and communities, to help alleviate the burden of depression associated with CSA and BV.

5. Conclusion

The global burden of depressive disorder attributable to childhood sexual abuse remained stable from 1990 to 2021, while the burden from bullying victimization increased significantly. Females bore a greater burden from childhood sexual abuse, whereas males were more affected by bullying victimization, with high SDI regions experiencing the highest rates overall. Longer education duration and higher government health expenditure were associated with lower depression burden. Targeted, gender-sensitive interventions are urgently needed to address these persistent risk factors among young populations.

Key Points

- Global ASDR for CSA-attributable depressive disorder remained stable (1990–2021), while BV-attributable ASDR increased, especially in high SDI regions.
- Females showed higher CSA-related depression burden; males had higher BV-related burden, with disparities widening during adolescence.

- High SDI regions carried the heaviest burden for both risk factors, followed by low and low-middle SDI regions.

- Cross-national inequality in disease burden decreased from 1990 to 2021, but significant disparities persist across countries.

- Longer compulsory education and higher government health expenditure correlated with lower depression burden; higher current health expenditure per capita correlated with higher detected rates.

- Findings support gender-specific, context-tailored prevention strategies and strengthened mental health services globally.

Availability of Data and Materials

The data used in the present study can be obtained from the GBD 2021 (<https://ghdx.healthdata.org/gbd-2021>).

Author Contributions

HZ and XQL conceived and designed the study. YNM, JZJ and QG drafted the manuscript. YNM, QG, JZJ, ZJC, QWJ, GZR and MXS analyzed the data. HZ and XQL were responsible for checking and reviewing the article. YNM, QG, JZJ, HZ and XQL accessed and verified the data. All authors contributed to the important editorial changes in the manuscript. All authors read and approved the final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Not applicable.

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Conflicts of Interest

The authors declare no conflicts of interest.

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