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Global, regional, and national burden of mental disorders among women of reproductive age, 1990–2021: a systematic analysis of the global burden of disease study 2021

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Abstract

Background Women of reproductive age (WRA), a key reproductive group, face mental health issues that impact both their own well-being and that of the next generation. However, research on the burden and trends of mental disorders among WRA remains limited. This study aimed to assess these on a global scale.

Methods The data from the Global Burden of Disease Study 2021 were utilized to analyze the age-standardized prevalence, age-standardized disability-adjusted life years (DALYs), and annual average percentage change (AAPC) of mental disorders among WRA from 1990 to 2021, examining variations by region, country, Socio-Demographic Index (SDI), and age group, along with DALYs attributable to risk factors.

Results In 2021, there were 343.22 million cases of mental disorders among WRA, with the highest DALYs among all diseases. From 1990 to 2021, the global burden increased, particularly for anxiety and major depressive disorders during the COVID-19 pandemic. Significant variations were observed across regions and countries. The different age groups showed different distributions of subtypes. High SDI regions showed the highest burdens, and the AAPC and SDI exhibit different correlation patterns before and during the pandemic. The burden of bullying victimization rose both before and during the pandemic, while intimate partner violence significantly increased during the pandemic.

Conclusions The burden of mental disorders among WRA remained high from 1990 to 2021, exacerbated by the COVID-19 pandemic. Variations exist across regions, countries, age groups, and SDI, indicating a need for the development and adjustment of targeted interventions for WRA.

Keywords Mental disorders, Global burden, Women of reproductive age, Trend analysis, Spatial disparities

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Mental disorders are serious conditions that affect thinking, emotional regulation, or behavior, often associated with distress or impairment in personal, familial, social, educational, occupational, or other important functional areas [1]. Women tend to bear a heavier burden of mental disorders due to various adverse factors, including social determinants (such as economic pressure, limited access to resources, intimate partner violence, discrimination, and stigma) [2–4], and other factors (such as changes in estrogen levels) [5]. As a key population in reproductive health, monitoring the mental disorders burden of women of reproductive age (WRA, defined as women aged 15–49) is crucial for maternal health, offspring development, and social sustainability. Studies have shown that mental disorders in WRA are associated with multiple adverse pregnancy outcomes and can harm the child's future growth, as well as pose risks to the child's mental health later on [6, 7]. In addition, a potential link has recently been found between mental disorders and infertility [8, 9].

The COVID-19 pandemic has created several short- and long-term stressors, presenting unprecedented challenges to global mental health, and WRA are not exempt [1]. However, previous studies have primarily focused on children and adolescents, and there is a gap in high-quality analyses of the burden and trends of mental disorders among WRA. Therefore, this study aims to conduct a systematic analysis of the burden and trends of mental disorders among WRA over the past 32 years, utilizing the Global Burden of Disease Study 2021 (GBD 2021) data, which will provide a solid basis for formulating targeted prevention, screening, and treatment policies.

Methods

Data source and disease definition

The disease burden data of mental disorders analyzed in this study were sourced from the GBD 2021, which provided the latest estimates of epidemiological data regarding the burden of 371 diseases and injuries across 21 GBD regions and 204 countries and territories from 1990 to 2021. All data are readily accessible through the GBD result tool (https://vizhub.healthdata.org/gbd-results/), with comprehensive details on the data input, methodologies, and statistical modelling available in previous reports [10]. In brief, GBD extracts epidemiological information from academic databases, grey literature, expert consultations, and other health-related databases, such as vital registration systems and hospital records (https://ghdx.healthdata.org/gbd-2021/sources). After bias adjustments, this information is transformed into comparable prevalence estimates across locations, ages, genders, years, and causes using DisMod-MR 2.1 and spatiotemporal Gaussian process regression (ST-GPR). The disability weights were multiplied by estimated counts of non-fatal disease outcomes to calculate the number of years lived with disability (YLDs). Years of life lost (YLLs) were calculated by multiplying the number of deaths by the expected remaining years of life at death. Disability-Adjusted Life Years (DALYs) were calculated by summing the YLDs and YLLs. The final estimates of GBD indicators represent the average of 500 draws, while the 95% UI were represented by the 2.5th and 97.5th percentile values of the draws.

According to the GBD 2021 hierarchy, mental disorders, categorized into 10 major groups, include depressive disorders, anxiety disorders, schizophrenia, bipolar disorder, conduct disorder, autism spectrum disorders, eating disorders, idiopathic developmental intellectual disability, attention-deficit hyperactivity disorder and other mental disorders. Moreover, based on the data provided by the GBD 2021, depressive disorders were further subdivided into dysthymia and major depressive disorder, and eating disorders were subdivided into anorexia nervosa and bulimia nervosa in this study. The international classification of disease codes in GBD 2021 are defined in Table S1. The detailed calculation steps for each subtype can be found in previous literature [10]. In this study, the burdens were estimated among WRA, which were defined as those aged 15 to 49 years by the WHO [11].

Socio-demographic index (SDI)

The Sociodemographic Index (SDI) is a composite measure that reflects a country's overall social and economic development, incorporating per capita income, total fertility rate (for ages < 25), and average educational attainment (for ages ≥ 15). A higher SDI value indicates a higher income level and education level, as well as a lower fertility rate. In the GBD 2021, 204 countries and territories were categorized into five groups based on the quintiles of the SDI [10].

Risk factors

GBD 2021 identified relevant risk factors for specific health outcomes by integrating multiple data sources and calculating relative risk (RR) values. DisMod-MR 2.1 and ST-GPR estimated the exposure levels and distributions of each risk factor. The theoretical minimum risk exposure level (TMREL) was determined based on epidemiological evidence, leading to the estimation of the population-attributable fraction (PAF) for each risk-outcome pair. Ultimately, the estimates of the attributable burden were quantified by the product of the PAF and the DALYs associated with the outcome. The specific calculation processes had been detailed in previous research [12]. This study focused on four key risk factors related to mental disorders identified in GBD 2021, including childhood sexual abuse, intimate partner violence (IPV), bullying victimization, and lead exposure. By analyzing the attributable burden of these risk factors on the disease,

this research not only revealed the impact of modifiable risk factors on mental disorders but also provided deeper insights into the disease and explored potential avenues for intervention.

Statistical analysis

The age-standardized rates (ASRs) for WRA estimates were calculated using the direct method of standardization and were weighted using the GBD 2021 world standard population. The 95% confidence interval (CI) was determined by package "epitools" within R software [13]. For specific age groups (e.g., 15–19 years, 20–24 years, up to 45–49 years), we used crude rates as the GBD 2021 provides only these for such groups.

Given the significant impact of the COVID-19 pandemic on global mental health, trends in ASRs for the period before the pandemic (1990–2019) and during the pandemic (2019–2021) were provided. The Joinpoint regression software (version 5.2.0, https://surveillance.cancer.gov/joinpoint/), developed by the National Cancer Institute Division of Cancer Control & Population Sciences, was used to perform Joinpoint regression analysis, which calculated the mean annual percent change (AAPC) to depict the trend over the specified time frame. The Empirical Quantile Method was implemented to construct the 95% CI. Trends were divided into three categories: upward (AAPC > 0), downward (AAPC < 0), and stable (95% CI encompassing 0). Similarly, for the analysis of specific age groups, we used percentage change to show rate variations due to the unavailability of ASR.

The Local Weighted Regression (LOESS) and Pearson correlation coefficient were used to examine the correlation between the ASRs, AAPC, and SDI across 204 countries and territories. We considered $p < 0.05$ as statistically significant. All statistical analysis and graphical representations were conducted using R software (version 4.2.3).

Results

Burden of mental disorders among women of reproductive age in 2021

In 2021, mental disorders contributed to 17.7% of total prevalence cases and 12.9% of total DALYs among WRA, ranking the 10th and 1st among all Level 2 diseases, respectively (Table S2). Among the subtypes of mental disorders, anxiety disorders (7,092.27 per 100,000 people), major depressive disorder (4,373.94 per 100,000 people), and dysthymia (1,883.78 per 100,000 people) had the highest age-standardized prevalence rate (ASPR) (Table 1; Fig. 1A, C and E). The top three components of mental disorder DALYs were major depressive disorder (33.1%), anxiety disorders (31.2%), and schizophrenia (9.2%) (Table 1; Fig. 1B, D and F).

At both regional and national levels, the highest ASPR for mental disorders was found in Tropical Latin America and Greenland, while the highest age-standardized DALYs rate (ASDR) was found in Australasia, and Greenland (Tables S3-S4, Figure S1, Fig. 2A and B). Among the subtypes of mental disorders, anxiety disorders and major depressive disorders are the two predominant components of the ASPR and ASDR in most countries or territories, with the exception of East Asia and Myanmar, where the ASPR of dysthymia exceeds that of major depressive disorder (Figures S2-S3). For anxiety disorders, the highest ASPR and the highest ASDR were recorded in Tropical Latin America, and Brazil (Tables S5-S6, Figures S4-S5). For major depressive disorder, the highest ASPR and the highest ASDR were exhibited in high-income North America, and Greenland (Tables S7-S8, Figures S6-S7).

The trends in mental disorder burden among women of reproductive age

Before the COVID-19 pandemic (1990–2019), although the ASPR and ASDR of mental disorders among WRA remained relatively stable over time globally, there were notable differences at the regional and national levels (Table 1, Tables S3-S4). In detail, an increasing trend in ASPR was observed in five regions and 26.0% of countries or territories, while twelve regions and 30.0% of countries or territories reported a decreasing trend. At the same time, seven regions and 37.7% of countries or territories showed an increasing trend in ASDR, while eight regions and 29.4% of countries or territories experienced decline (Figure S1, Fig. 2C and D). From 2019 to 2021, both the ASPR and ASDR experienced significant global increase (Table 1, Tables S3-S4), with an upward trend observed across all regions and countries. Among these, Southern Latin America and Belarus exhibited the most rapid increases in ASPR for mental disorders, whereas the highest rises in ASDR for mental disorders were recorded in Central Europe and Belarus (Figure S1, Fig. 2E and F).

Anxiety disorders and major depressive disorder are the main components of the burden of mental disorders and are also the two subtypes that exhibited the most significant changes during the pandemic (Fig. 1, Figures S1-S3). Before the pandemic, no significant changes in the global ASPR and ASDR for anxiety disorders, while both the ASPR and ASDR for major depressive disorder showed a slight decline (Table 1). However, at the regional and national levels, regarding anxiety disorders, 13 regions and 50% of countries or areas showed an upward trend in ASPR, with only 3 regions and 4.4% of countries or areas showing a decline in ASPR. Similarly, 16 regions and 58.8% of countries or areas reported an increasing trend in ASDR, while only 3 regions and 4.9% of countries or areas showed a decrease in ASDR

Table 1 Cases and age-standardized rates of prevalence and dalys in 1990, 2019, and 2021, along with their average annual percentage changes for mental disorders in women of reproductive age globally

	Number of cases, in millions (95% UI)			Age-standardized rate per 100,000 people (95% CI)			AAPC (95% CI)	
	1990	2019	2021	1990	2019	2021	1990–2019	2019–2021
Prevalence								
Mental disorders	213.09 (192.35-235.41)	301.86 (272.9-332.76)	343.22 (310.2-379.22)	16,055.43 (16,053.25-16,057.61)	15,637.22 (15,635.46-15,638.99)	17,573.57 (175,71.71-17,575.43)	0.03 (-0.12 to 0.14)	4.45 (3.13 to 7.17)
Anxiety disorders	78.1 (64.39–97.27)	111.48 (91.8-137.97)	138.31 (112.66-170.65)	5,858.75 (5,857.44-5,860.06)	5,780.88 (5,779.81-5,781.96)	7,092.27 (7,091.09-7,093.45)	0.01 (-0.08 to 0.19)	11.84 (7.89 to 13.88)
Dysthymia	23.63 (18.87–29.78)	36.09 (28.46–45.9)	37.26 (29.56–47.18)	1,845.05 (1,844.3-1,845.8)	1,848.73 (1,848.13-1,849.33)	1,883.78 (1,883.18-1,884.39)	0 (-0.01 to 0.03)	0.77 (0.24 to 0.98)
Major depressive disorder	49.64 (41.56–60.18)	68.11 (56.47–83.56)	85.64 (70.31-103.77)	3,773.27 (3,772.21-3,774.33)	3,516.04 (3,515.2-3,516.87)	4,373.94 (4,373.01-4,374.87)	-0.24 (-0.34 to -0.01)	12.72 (8.22 to 16.29)
Bipolar disorder	8.75 (6.98–10.91)	12.86 (10.24–16.02)	13.05 (10.39–16.25)	660.09 (659.65-660.53)	665.67 (665.31-666.04)	667.9 (667.53-668.26)	0.03 (0.03 to 0.03)	0.16 (0.14 to 0.2)
Bulimia nervosa	4.43 (2.87–6.32)	7.18 (4.74–10.18)	7.25 (4.79–10.16)	320.03 (319.73-320.33)	375.87 (375.59-376.14)	376.21 (375.94-376.48)	0.55 (0.54 to 0.56)	0.04 (-0.11 to 0.23)
Anorexia nervosa	1.76 (1.19–2.5)	2.42 (1.67–3.37)	2.42 (1.67–3.35)	122.78 (122.6-122.96)	128.46 (128.3-128.62)	127.47 (127.31-127.63)	0.16 (0.14 to 0.17)	-0.48 (-0.68 to -0.2)
Schizophrenia	4.84 (3.87–5.91)	7.44 (5.91–9.07)	7.54 (6.01–9.19)	380.1 (379.76-380.44)	379.06 (378.79-379.34)	379.43 (379.16–379.7)	-0.01 (-0.01 to -0.01)	0.01 (-0.01 to 0.02)
Attention-deficit/hyperactivity disorder	11.49 (8.15–15.71)	13.57 (9.73–18.35)	13.62 (9.71–18.45)	814.85 (814.38-815.33)	717.56 (717.18-717.94)	712.08 (711.7-712.46)	-0.44 (-0.45 to -0.43)	-0.4 (-0.59 to -0.27)
Idiopathic developmental intellectual disability	18.66 (10.44–26.55)	23.68 (13.49–33.5)	24.2 (13.87–34.33)	1,365.8 (1,365.18-1,366.43)	1,241.93 (1,241.43-1,242.43)	1,254.77 (1,254.27-1,255.27)	-0.33 (-0.34 to -0.32)	0.52 (0.38 to 0.62)
Autism spectrum disorders	6.81 (5.68–8.1)	9.95 (8.32–11.85)	10.12 (8.45–12.03)	508.72 (508.33–509.1)	517.53 (517.21-517.85)	520.05 (519.73-520.37)	0.06 (0.06 to 0.06)	0.22 (0.22 to 0.23)
Conduct disorder	3.14 (2.1–4.69)	3.87 (2.57–5.82)	3.94 (2.62–5.94)	205.7 (205.48-205.93)	217.21 (216.99-217.43)	217.26 (217.04-217.47)	0.19 (0.18 to 0.19)	0.08 (0.06 to 0.1)
Other mental disorders	17.28 (13.23–22.03)	26.92 (20.59–34.13)	27.3 (20.88–34.61)	1,373.75 (1,373.1-1,374.41)	1,370.11 (1,369.59-1,370.63)	1,370.53 (1,370.01-1,371.04)	-0.01 (-0.01 to -0.01)	0.02 (0.02 to 0.02)
DALYs								

Table 1 (continued)

	Number of cases, in millions (95% UI)			Age-standardized rate per 100,000 people (95% CI)			AAPC (95% CI)	
	1990	2019	2021	1990	2019	2021	1990–2019	2019–2021
Mental disorders	31.89 (23.89–41.62)	45.79 (34.18–60.12)	52.73 (39.46–69.16)	2,411.6 (2,410.75-2,412.44)	2,368.51 (2,367.83-2,369.2)	2,696.58 (2,695.85-2,697.3)	-0.11 (-0.17 to 0.03)	7.84 (4.89 to 9.49)
Anxiety disorders	9.33 (6.26–13.08)	13.3 (8.91–18.56)	16.45 (11.02–22.81)	698.3 (697.84-698.75)	690.08 (689.71-690.45)	844.05 (843.65-844.46)	0.02 (-0.07 to 0.2)	11.63 (7.74 to 13.63)
Dysthymia	2.29 (1.45–3.32)	3.5 (2.21–5.06)	3.61 (2.27–5.23)	178.69 (178.46-178.93)	179.53 (179.35-179.72)	182.48 (182.29-182.66)	0.01 (0 to 0.04)	0.71 (0.23 to 0.88)
Major depressive disorder	10.15 (6.82–14.18)	13.92 (9.19–19.47)	17.43 (11.57–24.45)	770.16 (769.69-770.64)	718.83 (718.45-719.21)	891.02 (890.6-891.44)	-0.24 (-0.34 to -0.01)	12.51 (8.05 to 16.06)
Bipolar disorder	1.89 (1.24–2.78)	2.78 (1.8–4.08)	2.81 (1.82–4.1)	142.3 (142.1-142.51)	143.9 (143.73-144.07)	143.77 (143.61-143.94)	0.04 (0.04 to 0.04)	-0.04 (-0.07 to -0.02)
Bulimia nervosa	0.93 (0.52–1.54)	1.5 (0.84–2.48)	1.51 (0.86–2.51)	66.92 (66.78–67.06)	78.78 (78.65–78.91)	78.58 (78.45–78.7)	0.57 (0.56 to 0.58)	-0.14 (-0.23 to -0.04)
Anorexia nervosa	0.38 (0.23–0.61)	0.52 (0.32–0.84)	0.52 (0.32–0.83)	26.53 (26.44–26.61)	27.79 (27.71–27.86)	27.47 (27.4-27.55)	0.16 (0.14 to 0.17)	-0.59 (-0.79 to -0.27)
Schizophrenia	3.11 (2.27–4.11)	4.79 (3.47–6.32)	4.84 (3.51–6.37)	244.12 (243.84-244.39)	244.33 (244.11-244.55)	243.46 (243.25-243.68)	0 (-0.01 to 0)	-0.19 (-0.26 to -0.1)
Attention-deficit/hyperactivity disorder	0.14 (0.07–0.22)	0.16 (0.09–0.26)	0.16 (0.09–0.26)	9.81 (9.76–9.86)	8.64 (8.6–8.68)	8.56 (8.52–8.6)	-0.44 (-0.45 to -0.43)	-0.49 (-0.69 to -0.34)
Idiopathic developmental intellectual disability	0.73 (0.35–1.25)	0.99 (0.48–1.65)	1.02 (0.5–1.69)	53.52 (53.4-53.65)	52.09 (51.99–52.19)	52.78 (52.68–52.89)	-0.09 (-0.1 to -0.09)	0.74 (0.54 to 0.88)
Autism spectrum disorders	1.27 (0.87–1.79)	1.85 (1.27–2.61)	1.87 (1.28–2.64)	94.3 (94.14–94.47)	96.17 (96.03–96.31)	96.38 (96.24–96.51)	0.07 (0.07 to 0.07)	0.1 (0.07 to 0.16)
Conduct disorder	0.38 (0.19–0.62)	0.46 (0.24–0.77)	0.47 (0.24–0.79)	24.6 (24.52–24.68)	26.03 (25.95–26.1)	25.99 (25.92–26.07)	0.2 (0.19 to 0.2)	-0.06 (-0.14 to 0.05)
Other mental disorders	1.29 (0.82–1.93)	2.01 (1.3–3.03)	2.03 (1.31–3.07)	102.35 (102.17-102.53)	102.34 (102.19-102.48)	102.02 (101.88-102.16)	0 (0 to 0)	-0.14 (-0.16 to -0.13)

Notes: 95% UI, 95% uncertainty interval; 95% CI, 95% confidence intervals; AAPC, average annual percentage change; DALYs, disability adjusted life-years

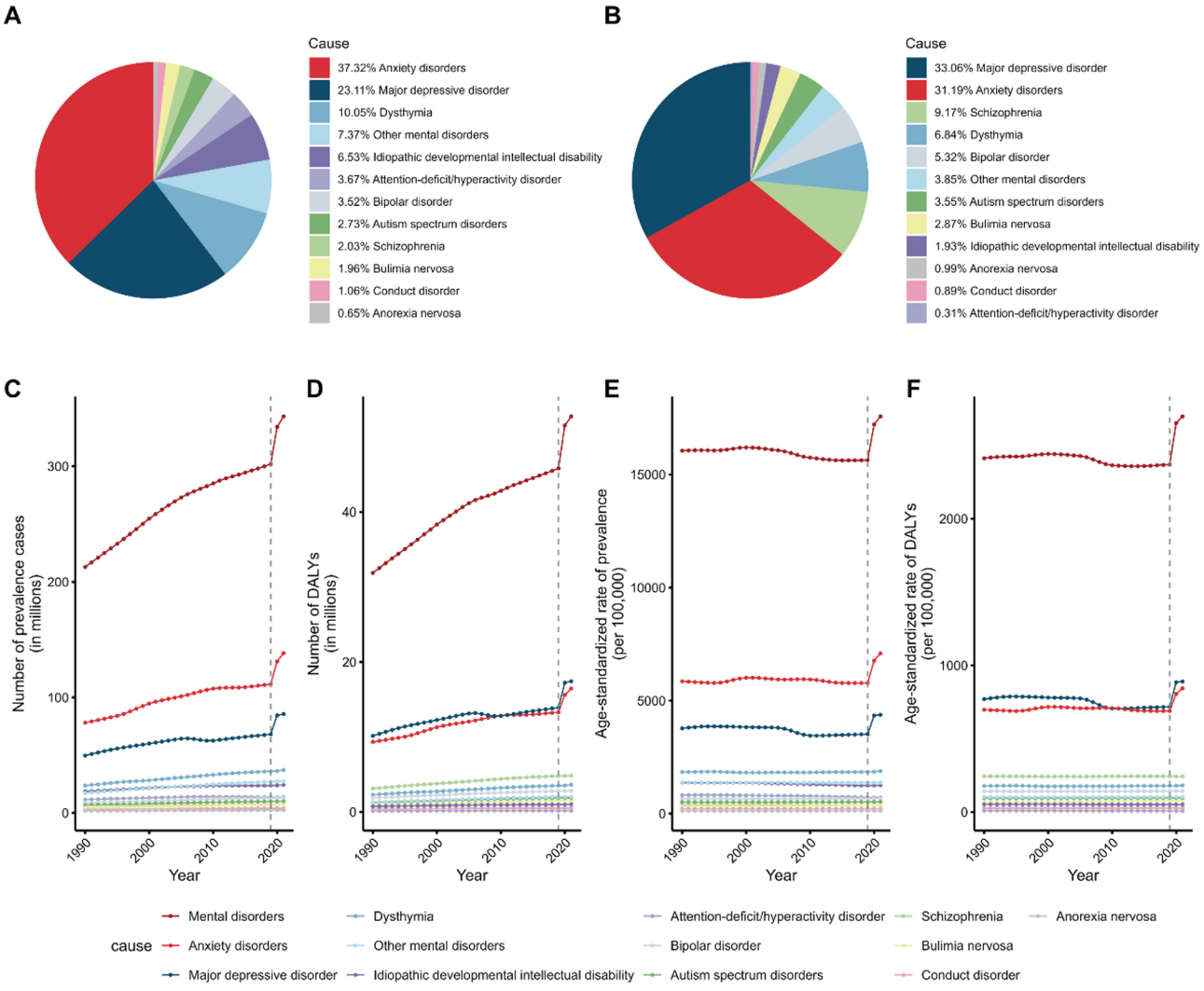

Fig. 1 The cross-sectional and longitudinal trends of prevalence and DALYs of mental disorders among WRA in global. Distribution of prevalence (**A**) and DALYs (**B**) due to the subtypes of mental disorders in 2021. Numbers (**C**, **D**) and age-standardized rates (**E, F**) of prevalence and DALYs due to all mental disorders from 1990 to 2021. The gray dashed line marks 2019. DALYs, disability-adjusted life years

(Tables S5-S6, Figures S4-S5). For major depressive disorder, 5 regions and 23.0% of countries or areas indicated an upward trend in ASPR, while 10 regions and 41.2% of countries or areas showed a decline in ASPR. Additionally, 5 regions and 27.0% of countries or areas exhibited an increasing trend in ASDR, while 10 regions and 40.2% of countries or areas showed a decrease in ASDR (Tables S7-S8, Figures S6-S7). During the pandemic, both the ASPR and ASDR for anxiety disorders and major depressive disorder increased. Notably, Eastern Europe and Belarus experienced the fastest increases in ASPR and ASDR for anxiety disorders, while Central Europe and Bulgaria recorded the fastest increases in ASPR and ASDR for major depressive disorder (Tables S5-S8, Figures S4-S7).

In addition, before 2019, the ASPR for bulimia nervosa, anorexia nervosa, and conduct disorder increased, but this trend slowed or even declined afterward. In contrast, the ASPR for dysthymia, bipolar disorder, idiopathic developmental intellectual disability, and autism spectrum disorders was decreasing or stable before 2019, but rose afterward. Moreover, attention-deficit/hyperactivity disorder showed a steady decline over the two periods. The ASDR exhibited trends similar to the ASPR, except for bipolar disorder, schizophrenia, and other mental disorders, which showed slight declines after 2019, while autism spectrum disorders remained relatively unchanged (Table 1; Fig. 1E and F).

Age-group disparities in mental disorder burden

In WRA, the age distribution of prevalence cases and DALYs for mental disorders is generally consistent. The number of prevalence cases and DALYs for mental disorders peaked in the 30–34 age group, while the rates of

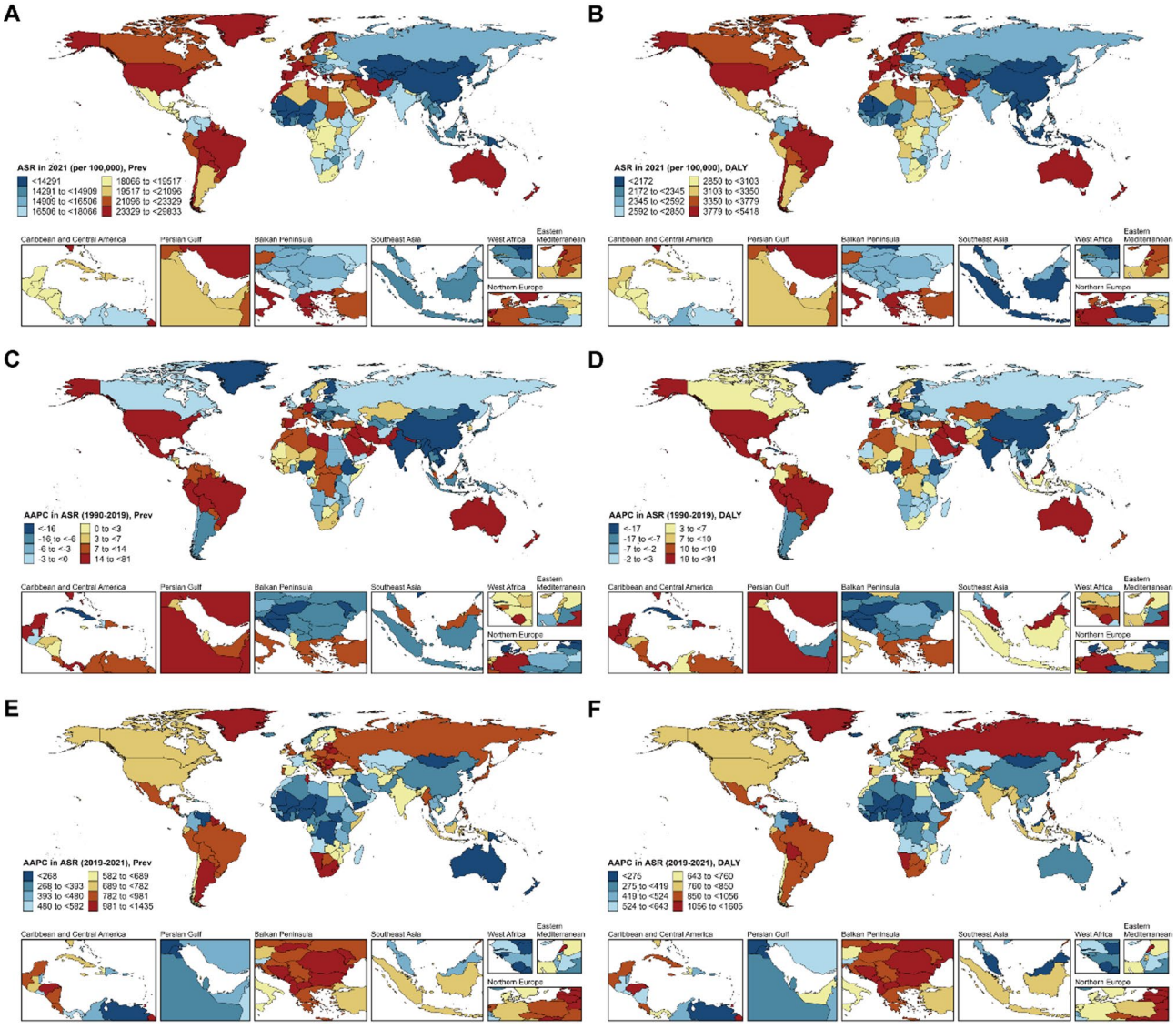

Fig. 2 The cross-sectional and longitudinal trends of prevalence and DALY by 204 countries or territories for mental disorders among WRA. Age-standardised rates of prevalence (**A**) and DALYs (**B**) in 2021, and average annual percent changes of age-standardised rates of prevalence (**C**, **E**) and DALYs (**D**, **F**) during the periods of 1990–2019 and 2019–2021. ASR, Age-standardised rates; DALYs, disability adjusted life-years; AAPC, average annual percent change (%)

prevalence and DALYs peaked in the 40–44 age group. Across all age groups, anxiety disorders and depression presented the highest burdens. For anxiety disorders, the highest number of prevalence cases and DALYs were observed in the 30–34 age group, while the highest prevalence and DALYs rate were found in the 25–29 age group. Additionally, the number of prevalence and DALYs for major depressive disorder peaked in the 35–39 age group, while the rates of prevalence and DALYs peaked in the 40–44 age group (Fig. 3A and B).

From 1990 to 2019, the percentage change trends of different subtypes of mental disorders varied across age groups. Notably, the burden of bulimia nervosa increased significantly in all age groups, with the most substantial change observed in the 20–24 age group. Besides, anxiety disorders rose among individuals aged 35–39, while major depressive disorder showed a slight increase in the 15–19 age group (Fig. 3C and D). During the COVID-19 pandemic, the total burden of mental disorders increased across all age groups. Anxiety disorders and major depressive disorder continue to be the two most significantly changed subtypes of mental disorders across all age groups, reaching their peaks at ages 25–29 and 15–19, respectively, with the rate of increase gradually decreasing with age (Fig. 3E and F).

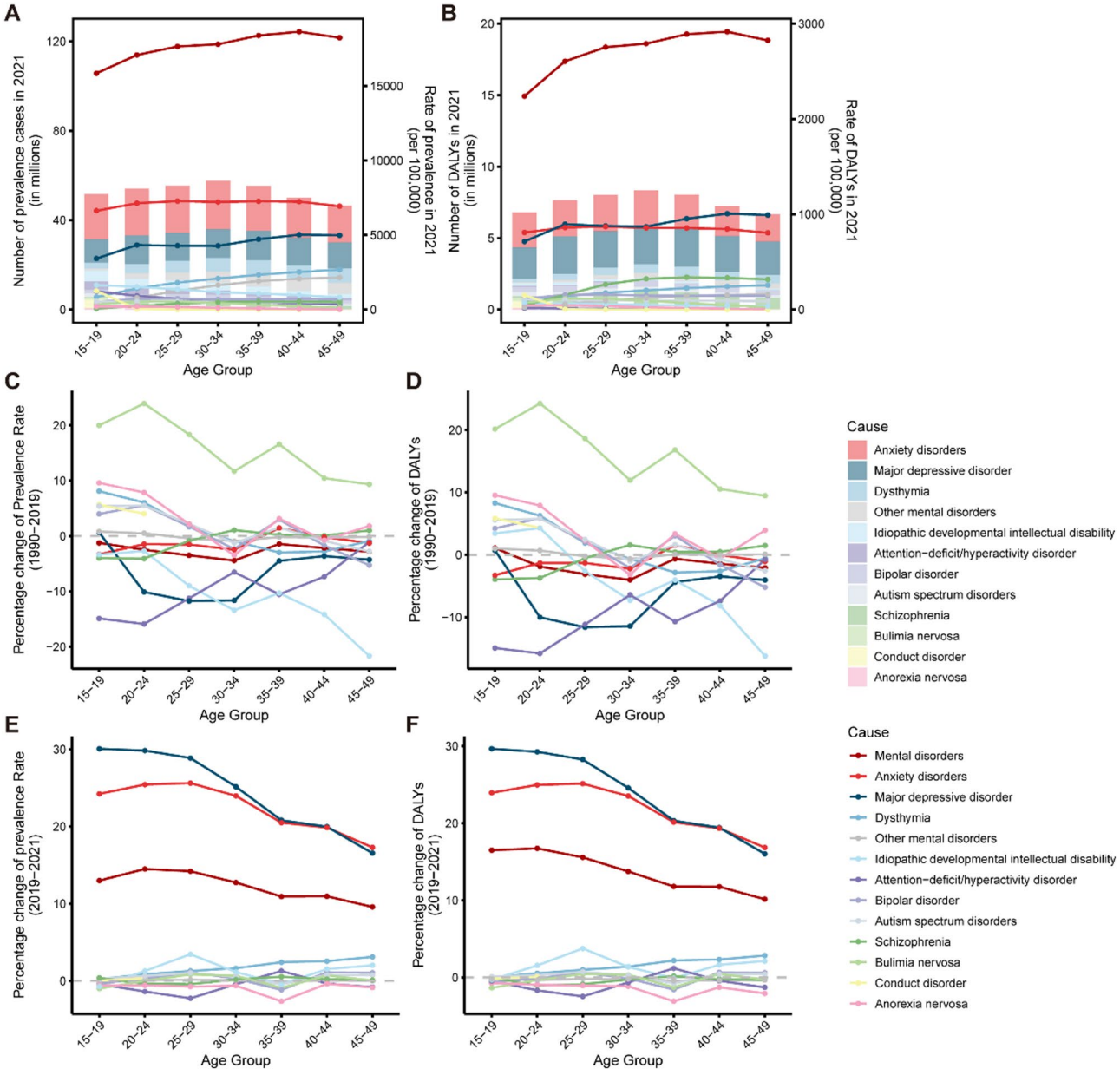

Fig. 3 The cross-sectional and longitudinal trends of prevalence and DALY rates by age for all mental disorders among WRA. Numbers and rates of prevalence (**A**) and DALYs (**B**) of all mental disorders. Percentage changes of prevalence (**C**, **E**) and DALY rates (**D**, **F**) of all mental disorders. DALY, disability-adjusted life-years

Association between ASR, AAPC, and SDI

In 2021, the ASPR and ASDR for mental disorders were highest in high SDI regions and lowest in high-middle SDI and middle SDI regions. Major depressive disorder exhibited a similar distribution (Tables S9-S11, Fig. 4A-D). Correlation analyses indicated a positive relationship between the ASPR and ASDR of mental disorders and anxiety disorders and the SDI (Fig. 4G and J, Figures S8), whereas the correlation for major depressive disorder and SDI was less pronounced (Figures S9).

From 1990 to 2019, only high SDI regions saw an increase in the ASPR and ASDR for mental disorders (Tables S9, Fig. 4E and F). However, the correlation between SDI and AAPC was not significant (Fig. 4H and K, Figures S8-9). During the COVID-19 pandemic from 2019 to 2021, the ASPR and ASDR for mental disorders, anxiety disorders, and major depressive disorder increased most rapidly in medium SDI regions (Tables S9-S11), with the rate of changes positively correlated with SDI. Notably, the rate of increase showed a slight

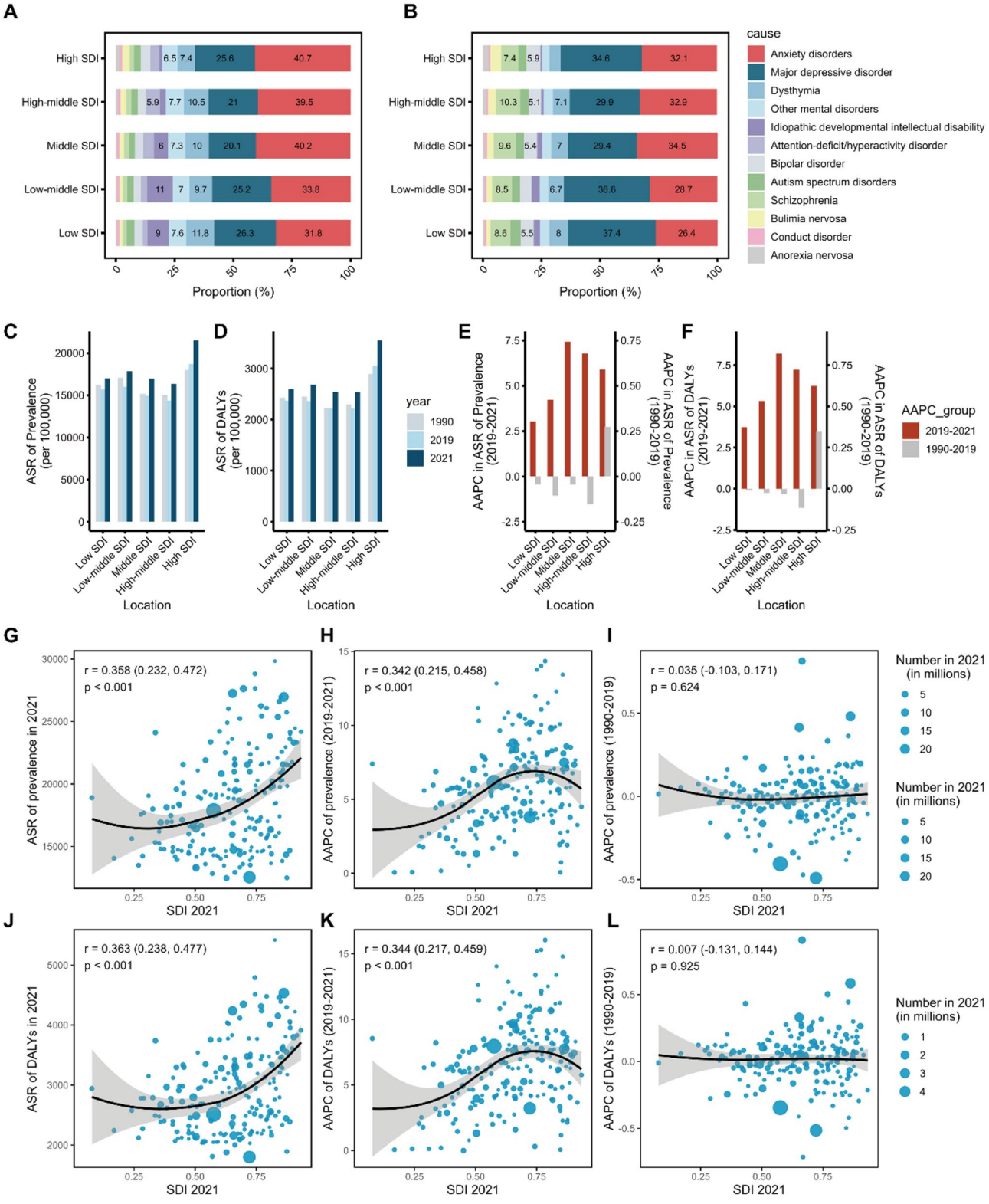

Fig. 4 (See legend on next page.)

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Fig. 4 The cross-sectional and longitudinal trends of prevalence and DALY by SDI for mental disorders among WRA. Distribution of age-standardized prevalence (**A**) and DALYs (**B**) rates due to the subtypes of mental disorders in 2021. The comparison of age-standardized rates (1990, 2019 and 2021) and average annual percent change (1990–2019 and 2019–2021) of prevalence (**C**, **E**) and DALYs (**D**, **F**). Association between age-standardized prevalence (**G**) and DALYs (**J**) in 2021, as well as average annual percent change in age-standardized prevalence (**H**-**I**) and DALYs (**K**-**L**) rates during the periods of 1990–2019 and 2019–2021, with SDI in 2021, for 204 countries and territories. Each blue dot represents a country or territory, and its size increases with the number of prevalence cases or DALYs. Expected values, based on SDI and ASR (or AAPC) in all countries and territories, are shown as a solid line. The shaded area indicates the 95% CI of the expected values. ASR, age-standardized rate; DALYs, disability adjusted life-years; AAPC, average annual percent change; SDI, socio-demographic index

decline as SDI levels rose further (Fig. 4I and L, Figures S8-9).

Disability-adjusted life years from mental disorder burden among women of reproductive age attributable to risk factors

In 2021, the GBD report provided data on four risk factors associated with anxiety disorders, major depressive disorder, and idiopathic developmental intellectual disabilities, accounting for 5.45%, 22.26%, and 65.52% of the total DALYs for these causes, respectively. For major depressive disorder, the highest contributing risk factor was intimate partner violence (98.2 per 100,000 people), followed by bullying victimization (70.23 per 100,000 people) (Table S12).

From 1990 to 2021, the burden of bullying victimization associated with anxiety disorders has been on the rise, and a pattern that was similarly observed for bullying related to major depressive disorder. While intimate partner violence linked to major depressive disorder had been on the decline before the pandemic, it saw a significant increase during this period. Furthermore, there was a slight increase in the burden of childhood sexual abuse associated with major depressive disorder. Additionally, the downward trend in lead exposure associated with idiopathic developmental intellectual disability over the past 30 years experienced a slowdown during the pandemic (Table S12; Fig. 5).

Discussion

Over the past 32 years, the global burden of mental disorders among WRA has remained high, especially after the COVID-19 pandemic, posing a significant public health challenge. Before the pandemic, similar to previous studies on global populations or other demographic groups [14, 15], there were also no significant changes in the ASPR and ASDR of mental disorders among WRA. As highlighted in the WHO Mental Health Report, despite advancements towards global mental health goals since 2001, barriers such as resource scarcity and the unequal distribution of available resources persist, making it common for mental health systems and services to fail to meet people's needs [1]. Nevertheless, from 1990 to 2019, the prevalence and DALYs of mental disorders among global WRA increased by nearly half, highlighting the challenges posed by population growth and demographic changes to healthcare systems. Similar to findings from several COVID-19 pandemic epidemiological studies that concluded the pandemic severely impacted global mental health [10, 14, 16], our research also shows that since the onset of the pandemic, the age-standardized prevalence and DALYs of mental disorders among WRA has surged, particularly in anxiety disorders and major depressive disorders. For this reason, we conducted a detailed analysis specifically on these two subtypes, which is presented in the appendix. And, by 2021, the ASPR of mental disorders among WRA ranked 10th among all level 2 cause classifications in the GBD, while the ASDR ranked 1st, accounting for one-third of the total burden DALYs of mental disorders in the overall population. However, the WHO's 2020 Mental Health Atlas reveals that more than 30% of countries did not compile or report data on mental disorders by age and gender, and there is a specific lack of data for WRA [17]. To achieve Sustainable Development Goals, particularly to reduce global maternal mortality and improve women's mental health by 2030, there is an urgent need to increase attention to the mental health of WRA.

The study shows that significant disparities were evident in the burden and trends of mental disorders among WRA across various regions and countries. In 2021, the regions with the highest burden of mental disorders were Tropical Latin America and Greenland. The accelerating climate crisis [18], structural social inequalities due to urbanization, and inadequate healthcare systems have led to severe mental distress in Tropical Latin America [19, 20]. In Greenland, seasonal variations in light contribute to sleep deprivation, compounded by communication barriers in sparsely populated areas and extreme cold climates, which significantly affect the occurrence of mental disorders [21]. Research shows that mental disorders often coexist with other non-communicable diseases, sharing numerous common risk factors [22]. The unique genetic background of Greenland, along with a shift toward a Western diet, facilitates the rise of chronic diseases, thereby increasing susceptibility to mental disorders [23]. This suggests that incorporating mental health into management guidelines for other chronic diseases may reduce fragmentation and duplication of resources, thereby improving the accessibility of healthcare resources. For example, collaborative care models have been shown to improve mental health outcomes,

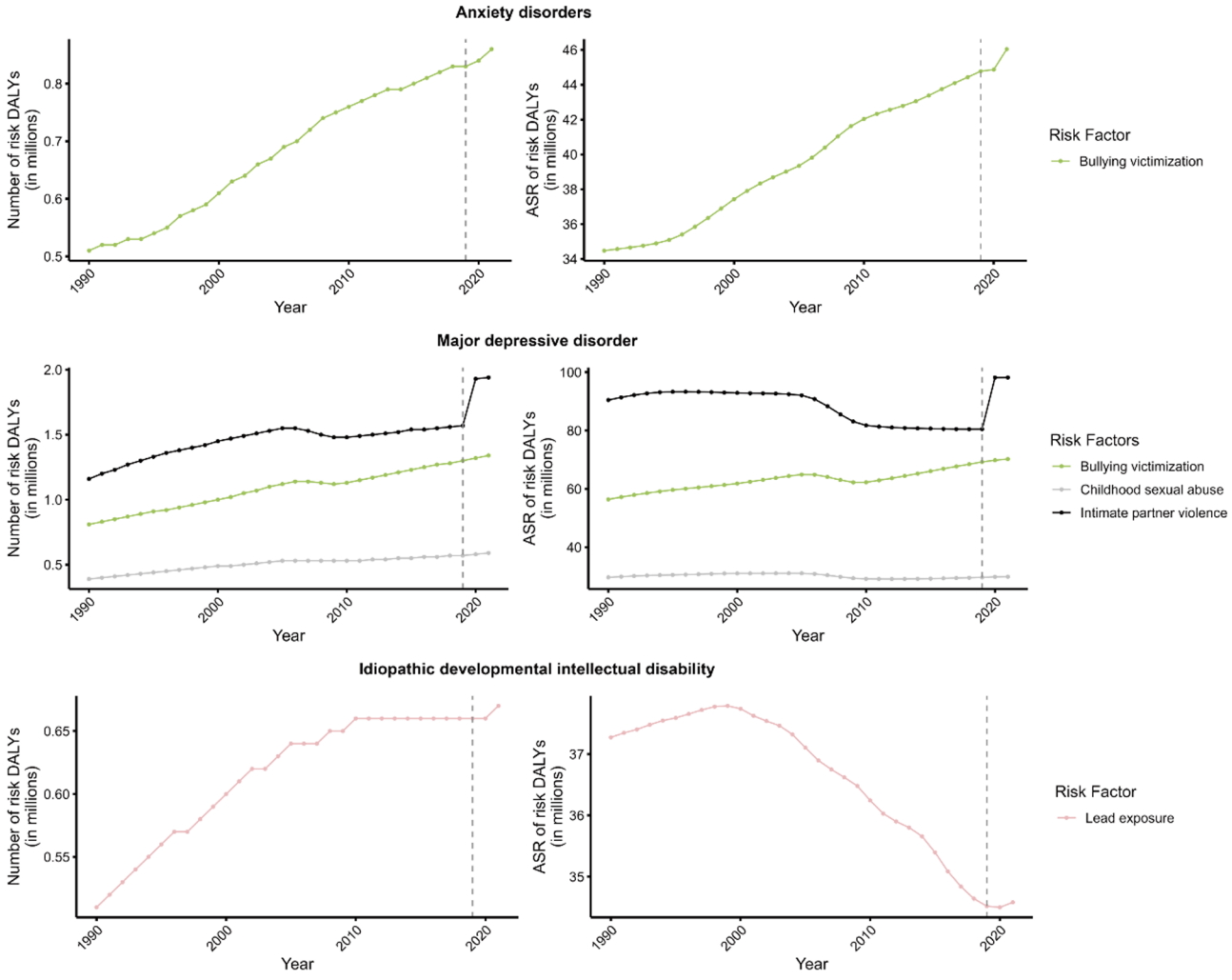

Fig. 5 The longitudinal trends of risk factors to DALYs of mental disorders among WRA. Numbers and age-standardized rates of prevalence and DALYs of risk factors associated with anxiety disorders, major depressive disorder, and idiopathic developmental intellectual disability among women of reproductive age. The gray dashed line marks 2019. ASR, age-standardized rates; DALYs, disability-adjusted life years

including for individuals with comorbid non-communicable diseases [24, 25]. During the pandemic, there was a noticeable increase in the burden of mental disorders in Belarus, which may be related to the economic recession caused by the political turmoil in Belarus during that time [26].

Further analysis based on the SDI reveals potential inequalities in the distribution of mental health burdens associated with socio-economic development. Prior to the pandemic, high-SDI regions experienced an ongoing increase in mental disorder burdens, likely driven by factors such as heightened social pressure, increased work-family conflicts, and growing mental health demands stemming from economic development [27–29]. In contrast, while low-SDI regions face contributing factors like poverty, social instability, and limited public health resources [30], stigma, shame [31], and inadequate diagnostic and reporting systems may lead to underdiagnosis and underreporting, masking the true burden of mental disorders [1, 17]. Meanwhile, middle-SDI regions experienced a significant decline in mental health burdens before the pandemic, demonstrating the positive impact of economic development, continuous improvements in healthcare systems, and rising levels of education on reducing such burdens. However, the higher post-pandemic growth rate of burdens in these regions suggests deficiencies in their mental health systems in responding to major public health emergencies, highlighting the need for further improvement. Therefore, countries and regions should develop prevention and treatment strategies tailored to their specific contexts to address unique needs and enhance their capacity to respond to global public health emergencies. Low-income regions should strengthen screening and work towards improving social culture to create a fairer mental health environment.

Analysis of age groups indicates that different subtypes of mental disorders exhibit varying patterns across age ranges. During the pandemic, the burden on young people grew at the fastest rate, primarily due to the increased prevalence of anxiety and major depressive disorders, contrasting sharply with the situation before the pandemic. Especially, at the 20–34 age group, which experienced the fastest decline in burden before the pandemic, showed a significant contrast during the pandemic. This aligns with the previous research results, which indicated the pandemic has had a greater impact on the mental health of young women [32]. Job insecurity [33] and loneliness [34] were found to be related to anxiety and/or depression among young people during the COVID-19 pandemic. Research has shown that, among the adult population, young adults aged 18–29 reported the largest increase in unmet needs for mental health services [35]. Therefore, policymakers should recognize that young women may face greater mental health challenges during public health emergencies. Policies that improve employment security, foster social support networks, and increase access to mental health services could help address these burdens. Notably, before the pandemic, the burden of bulimia nervosa significantly increased across all age groups, particularly among those aged 20–24, while anorexia nervosa saw the greatest increase in the 15–19 age group. Eating disorders are associated with various factors, including societal standards for thinness, personal obesity, early onset of menstruation, low self-esteem, and other mental illnesses, and they may increase the risk of adverse pregnancy and neonatal outcomes [36, 37]. Research indicates that evidence-based management of these disorders is feasible, but the promotion of effective treatment methods in clinical practice remains insufficient [37]. This suggests that countries or regions should further develop promotion plans, strengthen information sharing, provide training and support, and promote the implementation of effective intervention strategies. In summary, policymakers and practitioners should enhance their capacity to address mental health issues based on the age distribution characteristics of different disease subtypes, in order to improve mental health outcomes and promote overall well-being.

Health issues related to pregnancy and childbirth, along with inequality and injustice in the workplace, have long been important factors contributing to the mental health burden of WRA [38, 39]. During the pandemic, disruption of daily life and routine, Loss of income, perceived risk of COVID-19 infection, and disruptions in prenatal and postpartum care have been contributed to the increased maternal mental health burden [40, 41]. Additionally, women have disproportionately faced unpaid caregiving responsibilities during the pandemic [42]. Therefore, improving the perinatal mental health care system, strengthening legal protections and assistance, ensuring the safeguarding of women's basic rights, and enhancing support for unpaid caregiving responsibilities are crucial policies for reducing the mental health burden on WRA. The Centers for Disease Control and Prevention recommends incorporating screening for mental health issues into preconception care and ensuring that all WRA in the U.S. receive these services [43]. Research indicates that during the pandemic, healthcare providers prioritized the stability and predictability of prenatal care while offering interventions to reduce stressors, which can effectively improve maternal mental health [44]. Most importantly, during the pandemic, it is very common for pregnant women to seek help to manage mental health problems [45], so support services should focus on reducing barriers to accessing formal mental health care. Future research should examine women's workloads, roles, family responsibilities, and their relationship with well-being to find ways to alleviate the effects of overwork and work-family conflict on WRA.

Our research indicated that intimate partner violence (IPV) related to major depressive disorder declined before the COVID-19 pandemic but sharply increased during the pandemic. Since the United Nations introduced the Declaration on the Elimination of Violence against Women in 1993, there has been heightened social awareness [46, 47], and the increased focus on domestic violence and the media influence [48], contributing positively to the reduction of intimate partner violence. However, the pandemic introduced significant stress, with research indicating that lockdown measures and economic pressure are primary factors for the rise in IPV [49]. The increased burden of IPV during the pandemic highlights the need to provide support for WRA who are victims. Policymakers should improve access to counseling and safe reporting mechanisms to offer timely assistance during crises, while also consider providing economic support and job security for vulnerable groups. Moreover, not only during the pandemic but also prior to it, there has been a consistent increase in bullying associated with anxiety disorders and major depressive disorder. In the context of GBD, the definition of bullying victimization is "the bullying victimization of school-aged children and adolescents by their peers." It was found that women might face more severe mental health issues after experiencing bullying compared to men [50]. However, previous prevention efforts have shown inconsistent effectiveness against different types of bullying (including physical, verbal, relational, and cyberbullying). And further research is needed on effective targeted measures, especially given the rising incidence of cyberbullying and the lack of attention to verbal bullying [51, 52]. Furthermore, despite the low prevalence of idiopathic developmental intellectual disability among WRA, the pandemic

has slowed the declining trend of lead exposure, likely due to restrictions on lead screening and treatment [53]. This highlights the necessity of continuing to advocate for and provide lead screening and treatment resources during public health emergencies.

This study has several limitations. First, although GBD employed various methods to eliminate bias, measurement errors in epidemiological estimates were difficult to fully eliminate. Especially in areas with poor conditions and sparse populations, data availability was limited, and estimates often relied on predictive variables and data from neighboring regions, which may have led to incomplete or biased information. Second, estimating mortality attributable to mental health conditions is complex. the estimates of DALYs in this study only include deaths caused by eating disorders, which may obscure the true global burden of mental illnesses. This should be taken into consideration when discussing the results. Third, while the data reflect a sharp increase in the burden of mental disorders, the COVID-19 pandemic has significantly impacted global healthcare systems, and disruptions in diagnosis, treatment, and care during the pandemic may affect actual burden estimates. Furthermore, the long-term effects of the pandemic on mental health remain uncertain, and further assessment and evaluation will be needed in the future.

In conclusion, this study elucidates the distribution and changes in the burden of mental disorders among WRA in the context of the increasing global mental health burden. Findings indicate that the mental health burden among WRA intensified during the COVID-19 pandemic, particularly for anxiety and major depression. Significant disparities in mental health burdens were observed across regions and socioeconomic contexts, with high SDI regions seeing a continuous rise before and after the pandemic, while middle SDI regions experiencing the fastest increase during the pandemic. Young women showed the most significant changes in mental health burden during COVID-19. The rising burden of bullying victimization before and during the pandemic and IPV during the pandemic are concerning. Overall, there is an urgent need to enhance prevention and screening for mental disorders in WRA, develop targeted interventions and rehabilitation support, reduce modifiable risk factors, address health inequities driving the rise in mental health burdens, and improve mental health management strategies for WRA during public health emergencies.

Supplementary Information

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Supplementary Material 1

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Author contributions
Peng Wang and Yifan Cheng conceived the study and designed the protocol. Yifan Cheng, Yutong Zhao, Shuaibing Wang, and Tiandong Li conducted the investigation and data curation. Yifan Cheng, Yutong Zhao, Jicun Zhu, Yuanlin Zou, and Haiyan Liu contributed to the statistical analysis and interpretation of data. Yifan Cheng, Ziqing Xu, and Qian Yang drafted the manuscript, and the other authors critically revised the manuscript. Peng Wang, Hua Ye, and Jianxiang Shi accessed and verified the underlying data. Kaijuan Wang, and Chunhua Song critically revised it for important intellectual content. All authors have read and approved the final version of the manuscript.

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Data availability
Data used for the analyses are publicly available from the website: https://vizhub.healthdata.org/gbd-results/.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
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Competing interests
The authors declare no competing interests.

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