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Incidence and prevalence of dysthymia among young adults in China, 1990–2021, with forecasts to 2046: an age-period-cohort analysis of the Global Burden of Disease Study 2021

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Abstract

Background Dysthymia, a chronic depressive disorder, poses a significant public health challenge due to its prolonged course and substantial impact on quality of life, particularly among high-risk populations such as young adults. This study aims to investigate trends in dysthymia incidence and prevalence among young adults in China from 1990 to 2021 and to project future patterns through 2026.

Methods Using data from the Global Burden of Disease (GBD) 2021 Study, we conducted an Age-Period-Cohort (APC) analysis to assess the relative risks (RRs) of dysthymia incidence and prevalence among Chinese young adults aged 20–44 years from 1990 to 2021. Bayesian and Nordpred APC models were applied to forecast age-standardized incidence rates (ASIR) and prevalence rates (ASPR) for the next 25 years (2022–2046).

Results Between 1990 and 2019, both ASIR and ASPR of dysthymia exhibited a declining trend. Among females, ASIR decreased from 363.099 (95% uncertainty interval [UI]: 339.146, 387.051) per 100,000 population to 318.100 (95% UI: 296.812, 339.388), while among males, it declined from 232.757 (95% UI: 216.022, 249.492) to 208.467 (95% UI: 193.617, 223.317). Similarly, ASPR decreased from 2,072.562 (95% UI: 1,813.254, 2,331.870) to 1,795.234 (95% UI: 1,582.628, 2,007.841) for females and from 1,278.432 (95% UI: 1,116.869, 1,439.994) to 1,131.620 (95% UI: 994.059, 1,269.180) for males. However, a marked increase was observed from 2020, with 2021 rates approaching 1990 levels for both sexes. APC analysis showed that RRs for dysthymia incidence and prevalence increased with age, particularly beyond 35–39 years. More recent cohorts demonstrated lower RRs compared to earlier cohorts, whereas period effects remained relatively stable. Projections indicate a continuous rise in ASIR and ASPR from 2022 to 2046 for both sexes. Throughout the study period, dysthymia prevalence rates consistently exceeded incidence rates, with females exhibiting higher rates than males.

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Conclusion Enhancing early diagnostic capabilities in primary care, advancing standardized treatment strategies, improving mental health literacy through health education and social media, and implementing targeted interventions for high-risk groups—particularly young women and individuals in early adulthood—are essential for alleviating the burden of dysthymia in China and other countries with similar demographic and epidemiological characteristics.

Keywords Dysthymia, Incidence, Prevalence, Young adults, China, Age-period-cohort analysis

Introduction

Dysthymia is characterized by a chronically depressed mood that typically lasts for two years or longer, often resulting in significant impairments in daily functioning and overall quality of life [1–3]. From 1990 to 2021, the global number of dysthymia patients increased from 0.61 million to 1.08 million, presenting a substantial public health challenge [4]. This challenge is particularly pronounced in developing countries, where limited access to mental health care services exacerbates its long-term consequences [5]. As the world's most populous developing country, China has been facing a substantial burden of dysthymia, reporting the highest number of new cases globally in 2019 [6]. Cultural stigmas surrounding mental illness, combined with insufficient mental health resources, frequently delay the diagnosis and treatment of dysthymia, further intensifying its chronic impact on both affected individuals and the healthcare system [7]. Understanding the temporal patterns and projected trends of dysthymia burden—particularly among high-risk populations—has thus become a critical public health priority.

Among these high-risk groups, young adults are especially vulnerable to dysthymia due to the unique challenges of career development, financial independence, and family responsibilities [8]. Globally, young adults aged 25–44 years account for the largest number of dysthymia cases, highlighting the substantial burden within this demographic [9]. In China, beyond personal stressors, young adults also face broader societal challenges, such as the growing responsibilities of supporting an aging population and adapting to shifting family dynamics, which further compound their mental health vulnerabilities [10]. Despite these risks, dysthymia among young adults often remains clinically unrecognized and inadequately treated, overshadowed by other major mental health disorders [3, 11, 12]. Addressing the mental health needs of this vulnerable group is therefore essential to mitigate the long-term consequences for both individual well-being and societal stability.

While much of the existing research has focused on severe depressive disorders, such as major depressive disorder (MDD) [12–15], dysthymia has received comparatively less attention despite its substantial impact on long-term quality of life and functional outcomes [5, 11]. Additionally, most studies analyzing trends in depressive disorders have predominantly targeted adolescents [16–19], older adults [20], or the general population [21–23], leaving young adults as a relatively underexamined demographic. The age-period-cohort (APC) model has recently emerged as an effective tool to disentangle the effects of age, period, and birth cohort on generational shifts in disease patterns [24, 25]. However, few studies have utilized this model to examine dysthymia in young adults, highlighting a gap in understanding the disorder's long-term trends and its implications for this population.

This study aims to examine the incidence and prevalence trends of dysthymia among young adults in China from 1990 to 2021 and to project these patterns over the next 25 years (2022–2046) using data from the Global Burden of Disease (GBD) 2021 Study. By applying the APC model, this study seeks to reveal the dynamic patterns and future trajectories of dysthymia among young adults by considering the effects of age, period, and cohort. The findings will offer evidence-based guidance for crafting targeted prevention strategies, optimizing mental health resource allocation in China, and informing public health policies in other countries with similar demographic and epidemiological characteristics.

Methods

Data source and definitions

This study used data from the Global Burden of Disease (GBD) 2021 Study, a comprehensive global epidemiological project that assesses the burden of 371 diseases and injuries across 204 countries and regions worldwide from 1990 to 2021 [4]. The GBD study synthesizes data from a wide range of published sources, including peer-reviewed studies and national surveys, ensuring high data quality through rigorous validation processes. The dataset provides detailed information on incidence, prevalence, mortality, years lived with disability, years of life lost, and disability-adjusted life years for various health conditions, including depressive disorders [4].

Dysthymia was defined according to the diagnostic criteria outlined in the Diagnostic and Statistical Manual of Mental Disorders IV Text Revision (DSM-IV-TR: 300.4) [1] and the 10th edition of International Classification of Diseases (ICD-10: F34.1) [2]. It is characterized as a chronic depressive disorder lasting for most of the day, more days than not, and persisting for over two years (or at least one year in children and adolescents) [4].

Detailed methods for calculating incidence and prevalence rates have been previously described in the GBD study 2021 [4]. Data specific to mainland China were extracted from the Global Health Data Exchange, a comprehensive repository of global health and demographic data. The variables analyzed included national incidence and prevalence rates (per 100,000 population) for dysthymia by sex across different age groups from 1990 to 2021. While the age range of "young adults" varies in the literature, partly influenced by increasing longevity, this study defined young adults as individuals aged 20 to 44 years. This classification distinguishes them from middle-aged individuals (aged 45–59) [26, 27] and adolescents (aged 10–19) [18], aligning with the World Health Organization (WHO) definition [28] and the data structure of the GBD 2021 study.

Statistical analysis

This study focused on the incidence and prevalence of dysthymia among young adults aged 20–44 years in mainland China. Incidence refers to the annual rate at which new cases occur in a population, expressed as the number of new cases per person-years, while prevalence represents the proportion of individuals in a population who have dysthymia at a specific point in time or over a defined period [9]. Given the well-documented sex differences in depression burden [5, 11, 15], our analysis was stratified by sex.

To describe the temporal trend in dysthymia incidence and prevalence from 1990 to 2021, age-standardized incidence rate (ASIR) and age-standardized prevalence rate (ASPR) were calculated, adjusting for variations in age distribution across populations to allow for comparisons across different demographic groups. The standardization was based on the global population from 1990 to 2021 as the reference [4], ensuring comparability across different time periods and groups. To examine the dynamic patterns in dysthymia incidence and prevalence rates, we applied the Age-Period-Cohort (APC) model. The APC model helps disentangle the effects of age, period, and birth cohort, which are typically confounded due to linear dependencies among these factors [29]. Age effects refer to changes associated with the biological and social aging, often reflected in varying disease rates across age groups. Period effect captures influences from external factors that affect all age groups simultaneously, such as significant social, cultural, or economic events. Cohort effects are linked to the unique exposures experienced by specific birth cohorts as they age [29, 30]. This study built on previous research [31] and employed the APC model with five-year age intervals and continuous five-year periods (1992–1996 to 2017–2021), along with nine partially overlapping five-year birth cohorts (1950–1954 to 1995–1999). Detailed definitions of interval groups are provided in Table S1 in the Supplementary file. We followed previous studies [29, 32] and employed the Intrinsic Estimator method to independently estimate the effects of age, period, and cohort, effectively addressing the identification problem caused by their linear dependencies. Relative risks (RRs) for incidence and prevalence, derived from natural log-transformed rates, were calculated to represent the effects of age, period, and cohort relative to the overall average across all three factors [29].

For future trend projections, we utilized the Bayesian APC (BAPC) model to forecast sex-specific ASIR and ASPR of dysthymia over the next 25 years (2022–2046). This model extends the traditional generalized linear model (GLM) framework within a Bayesian context, enabling the dynamic incorporation of age, period, and cohort effects [33]. These effects are modeled as evolving continuously over time and are smoothed using a second-order random walk, thus improving the accuracy and reliability of posterior probability predictions. A key advantage of the BAPC model is its reliance on the Integrated Nested Laplace Approximation (INLA) method to approximate the marginal posterior distribution. This approach effectively addresses circumvents challenges such as mixing and convergence issues commonly associated with Markov Chain Monte Carlo techniques, while enhancing computational efficiency [33]. Given its flexibility and robustness in handling time-series data, the BAPC model is particularly well-suited for long-term disease burden forecasting [34]. Due to its capability to capture complex temporal trends and its broad capability, the BAPC model has been extensively validated and widely applied in epidemiological research, especially in studies focusing on age-structured populations and intricate cohort effects [12, 31, 34–36].

In addition, we conducted a sensitivity analysis using the Nordpred age-period-cohort (APC) to assess the stability of our projections. This approach employs the power5 and Poisson-based APC models to generate forecasts [33]. Similar to the BAPC model, Nordpred APC analysis accounts for variations in age, period, and cohort effects and is specifically designed for long-term trend projections in non-communicable diseases based on historical data [30, 35, 37]. Notably, it is particularly effective in moderating exponential growth and constraining linear trend extrapolation, thus aligning more accurately with recent epidemiological patterns [33].

In this study, both projection models were based on observed trends from 1990 to 2021 and incorporated GBD Population Forecasts for 2017–2100 [38] to estimate future dysthymia rates. To evaluate their predictive performance, we applied established methodologies and calculated the absolute percentage deviation (APD) as a measure of model accuracy [35]. The APD quantified

the absolute percentage error between predicted and observed values, with a lower APD values indicating greater validity and precision in predictive performance. To estimate APD, we divided the full dysthymia dataset for young Chinese adults into a training set (1992–2011) and a testing set (2012–2021). The BAPC and Nordpred APC models were trained on historical data to predict trends for the testing period, and the predicted values were compared with actual observations. In our analysis, the mean APD for the BAPC model was estimated at 2.71%, while that for the Nordpred APC model was 3.93% (see Table S2 in the Supplementary file for details), both remaining below the widely accepted 5% threshold for robust predictive performance in epidemiological studies [35, 39]. These results confirmed the accuracy and reliability of both models in forecasting dysthymia trends within our study population.

All analyses were conducted using R software (version 4.3.3), with the packages "BAPC" (version 0.0.36), "INLA" (version 24.06.27), and "Nordpred" (version 1.1).

Results

Descriptive analysis

As shown in Fig. 1, both the age-standardized incidence rate (ASIR) and age-standardized prevalence rate (ASPR) of dysthymia among young adults in China exhibited an overall decline from 1990 to 2019. In 1990, the ASIR was 363.099 (95% uncertainty interval [UI]: 339.146, 387.051) per 100,000 population for females and 232.757 (95% UI: 216.022, 249.492) to 208.467 (95% UI: 193.617, 223.317) for males. The ASPR was 2,072.562 (95% UI: 1,813.254, 2,331.870) per 100,000 population for females and 1,278.432 (95% UI: 1,116.869, 1,439.994) for males. By 2019, the ASIR declined to 318.100 (95% UI: 296.812, 339.388) for females and 208.467 (95% UI: 193.617, 223.317) for males, while the ASPR decreased to 1,795.234 (95% UI: 1,582.628, 2,007.841) for females and 1,131.620 (95% UI: 994.059, 1,269.180) for males. However, both rates increased from 2020 onward for both sexes, with rates in 2021 nearly returning to the levels observed in 1990. Throughout the study period, the ASPR consistently exceeded the ASIR, and both rates remained higher in females than in males. The detailed ASIR and ASPR stratified by sex from 1990 to 2021 are presented in Tables S3 and S4 in the Supplementary file, respectively.

Figure 2 illustrates the age-specific trends in dysthymia incidence and prevalence rates across different periods (see Table S5 in the Supplementary file for details). For both sexes, incidence and prevalence rates increased with age across all time periods. As shown in panel A, dysthymia incidence rates among females increased from 222.261 to 248.122 per 100,000 population at ages 20–24 to 439.476-466.467 at ages 40–44 across the six periods. Among males, the dysthymia incidence rates rose from 146.520 to 154.945 per 100,000 population at ages 20–24 to 290.822-306.773 at ages 40–44. Panel B illustrates the trends in dysthymia prevalence. For females, dysthymia prevalence increased from 969.679-1,047.923 per 100,000 population at ages 20–24 to 2,950.079-3,250.150 at ages

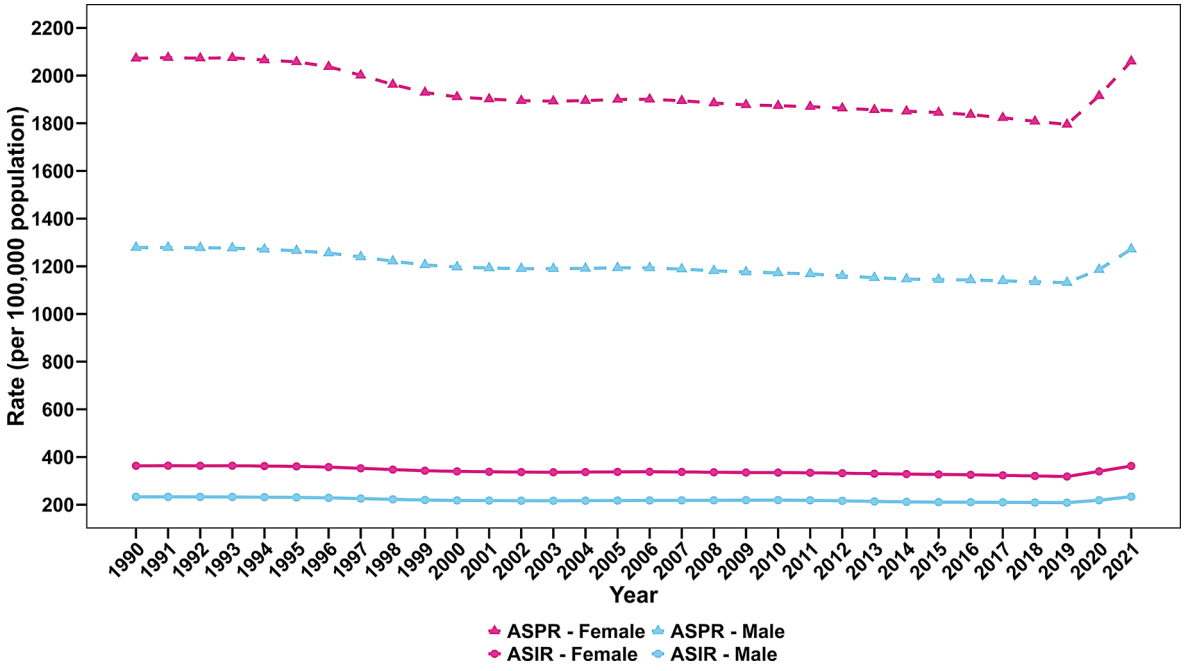

Fig. 1 Age-standardized incidence rate (**A**) and age-standardized incidence prevalence rate (**B**) of dysthymia among young adults aged 20–44 in China, stratified by sex, 1990–2021

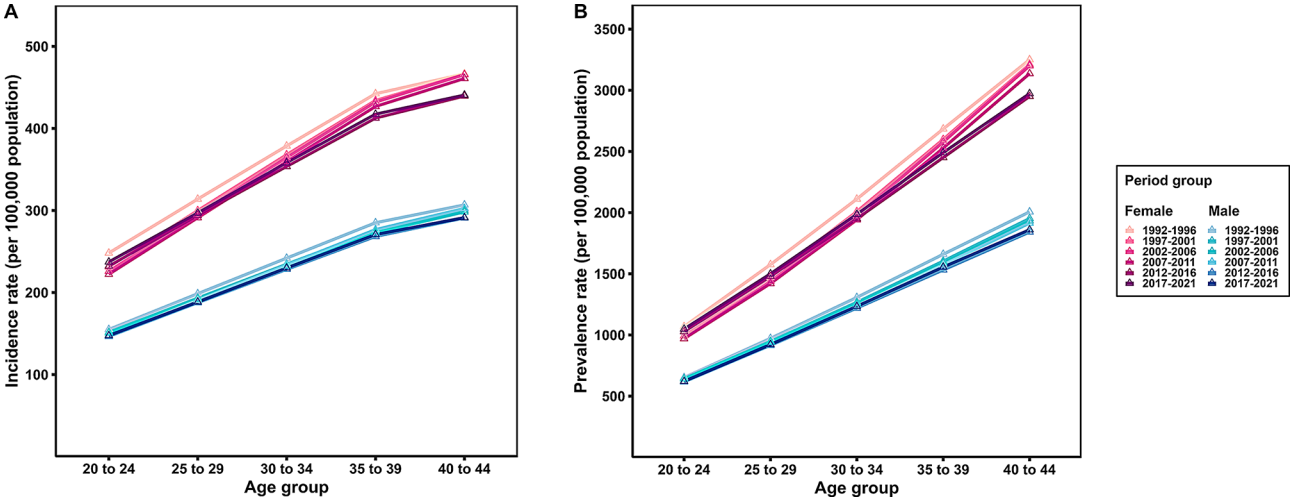

Fig. 2 Age-specific incidence (**A**) and prevalence (**B**) rates of dysthymia by period among young adults aged 20–44 in China, stratified by sex

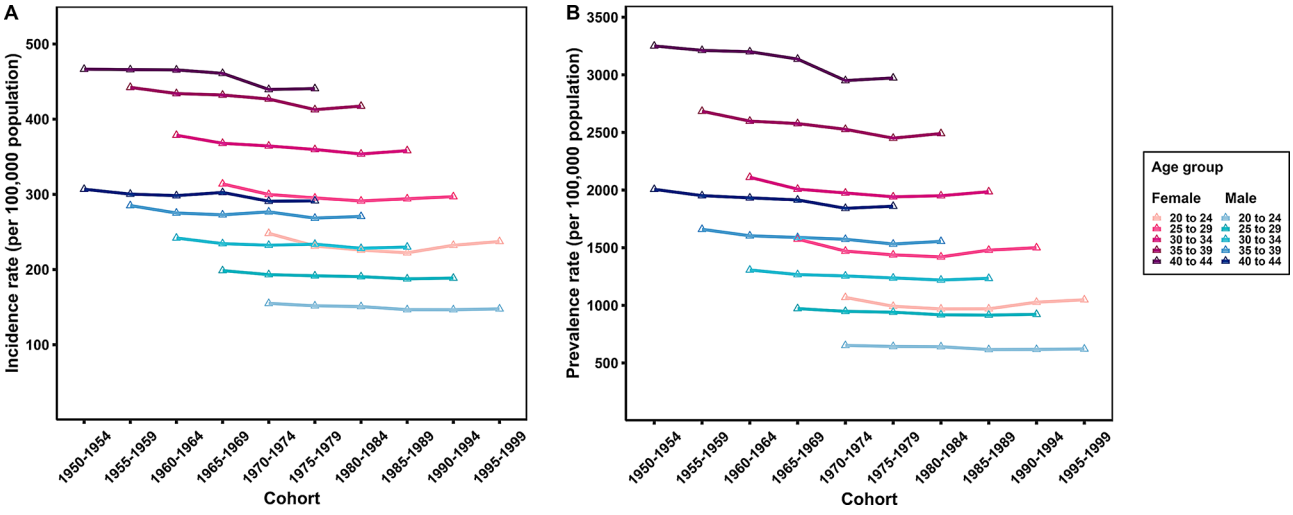

Fig. 3 Cohort-specific incidence (**A**) and prevalence (**B**) rates of dysthymia by age group among young adults aged 20–44 in China, stratified by sex

40–44, whereas for males, the prevalence rose from 616.414 to 651.847 per 100,000 population at ages 20–24 to 1,841.520-2,006.275 at ages 40–44. The magnitude of this increase remained relatively consistent across different periods. Notably, the prevalence rate exhibited a steady, linear increase, while the incidence rate showed a sharper rise between ages 20 and 35, followed by a more gradual increase from ages 35 to 40.

Figure 3 presents the cohort-specific trends in dysthymia incidence (Panel A) and prevalence (Panel B) rates across five age groups from the 1950 to 1999 birth cohorts. Detailed results are provided in Table S6 in the Supplementary file. The results showed a U-shaped pattern in both incidence and prevalence rates across sexes. While the exact shape of the U-curve varied across age groups, the overall trend remained consistent: dysthymia rates initially declined in later cohorts but increased again in more recent birth cohorts. Through all cohorts, females consistently exhibited higher incidence and prevalence rates than males. Within the same birth cohort, both incidence and prevalence rates showed an age-related increased for both sexes, reinforcing the trend observed in age-specific analyses.

Age-period-cohort trend analysis

The relative risks (RRs) of dysthymia incidence and prevalence among young adults in China, as estimated using the APC model, are presented in Fig. 4, with detailed results provided in Table S7 in the Supplementary file. The RRs for age, period, and cohort were estimated independently, controlling for the effects of the other two factors.

For the age effect, both incidence and prevalence RRs increased with age, particularly from the 35–39 age group onwards for both sexes. Specifically, among females, the incidence RR increased from 0.694 (95% confidence

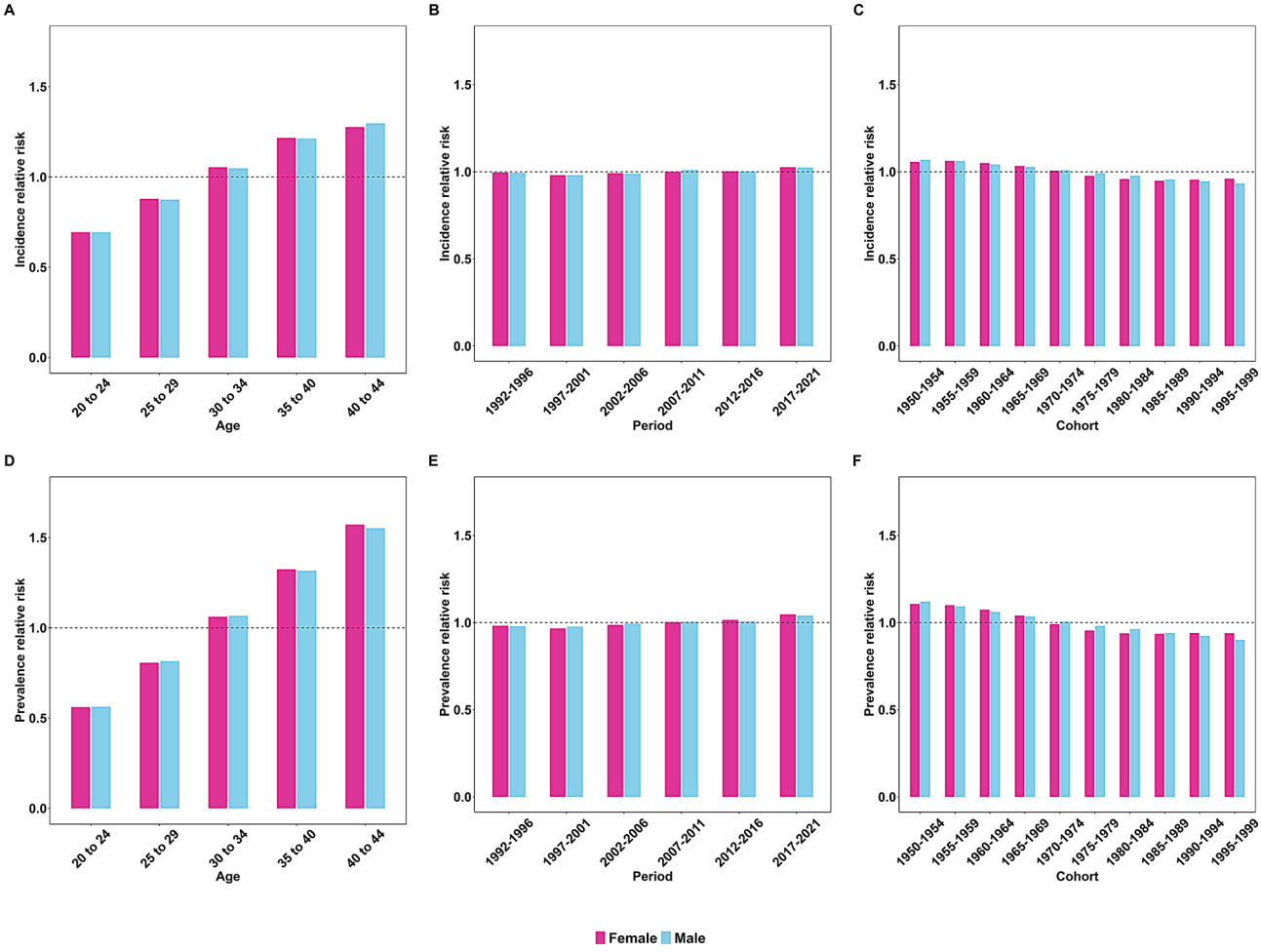

Fig. 4 Relative risks of dysthymia incidence and prevalence among young adults aged 20–44 in China, stratified by sex, due to age (**A**, **D**), period (**B**, **E**), and cohort (**C**, **F**) effects

interval [CI]: 0.693, 0.696) at ages 20–24 to 1.277 (95% CI: 1.275, 1.279) at ages 40–44. For males, the incidence RR increased from 0.694 (95% CI: 0.692, 0.695) at ages 20–24 to 1.297 (95% CI: 1.295, 1.300) at ages 40–44. Similarly, the prevalence RR for females rose from 0.561 (95% CI: 0.560, 0.561) at ages 20–24 to 1.572 (95% CI: 1.571, 1.573) at ages 40–44, while for males, the prevalence RR increased from 0.563 (95% CI: 0.562, 0.564) at ages 20–24 to 1.552 (95% CI: 1.551, 1.553) at ages 40–44. As shown in Panels A and D, starting from the 30–34 age group, the incidence and prevalence RRs surpassed 1, indicating that individuals in these age groups faced a higher risk of developing and living with dysthymia compared to the overall young adult population. The highest RRs were observed in the 40–44 age group, with females consistently exhibiting slightly higher relative risks than males.

Regarding the period effect, as displayed in Panels B and E, the RRs for both incidence and prevalence remained relatively stable across the five period groups before 2017, with most values falling below 1, indicating no significant fluctuations in the incidence or prevalence of dysthymia during this period. However, there was a marked increase during the 2017–2021 period, with both incidence and prevalence RRs rising for both sexes. Specifically, the incidence RR reached 1.027 (95% CI: 1.025, 1.029) for females and 1.024 (95% CI: 1.022, 1.027) for males, while the prevalence RR reached 1.047 (95% CI: 1.046, 1.048) for females and 1.040 (95% CI: 1.039, 1.041) for males, reflecting a possible impact of external factors during this time, such as the COVID-19 pandemic.

For the cohort effect, illustrated in Panels C and F, RRs exhibited a declining trend across more recent birth cohorts. Among females, the incidence RR decreased from 1.057 (95% CI: 1.053, 1.061) for those born in 1950–1954 to 0.960 (95% CI: 0.954, 0.967) for those born in 1995–1999. For males, the corresponding RR decreased from 1.068 (95% CI: 1.064, 1.073) to 0.933 (95% CI: 0.926, 0.940). A similar trend was observed for prevalence RRs. Among females, the RR decreased from 1.107 (95% CI: 1.106, 1.109) in the 1950–1954 cohort to 0.939 (95% CI:

0.936, 0.942) in the 1995–1999 cohort. For males, the prevalence RR dropped from 1.121 (95% CI: 1.119, 1.123) to 0.901 (95% CI: 0.897, 0.904). Overall, individuals born after 1980 exhibited a lower risk for both dysthymia incidence and prevalence compared to those born in earlier cohorts. This trend was consistent for both sexes, though females generally had higher RRs across all cohorts.

Future trend projections

Figure 5 illustrates the projected ASIR and ASPR of dysthymia among young Chinese adults over the next 25 years, based on estimates from the Bayesian APC (BAPC) model. Further details on the projected rates are provided in Tables S8 and S9 in the Supplementary File. The projections suggest a continuous upward trend in the absolute value of both ASIR and ASPR across sexes. These increasing trends aligned with the historical sex-specific patterns observed from 1990 to 2019, with the two rates consistently lower in males than in females throughout the projection period.

To assess the robustness of the predictions, we further conducted a sensitivity analysis using the Nordpred APC model to forecast the ASIR and ASPR of dysthymia among young Chinese adults from 2022 to 2046. As shown in Fig. 6, the results (see Tables S10 and S11 in the Supplementary file for details) exhibited increasing trends consistent with those from the BAPC model. Both models highlight the persistent concern regarding the growing ASIR and ASPR of dysthymia, particularly among young women, over the next 25 years in China.

Discussion

Using data from the Global Burden of Disease (GBD) 2021 Study, this study offers a comprehensive age-period-cohort (APC) analysis of the trends in dysthymia incidence and prevalence among young adults aged 20 to

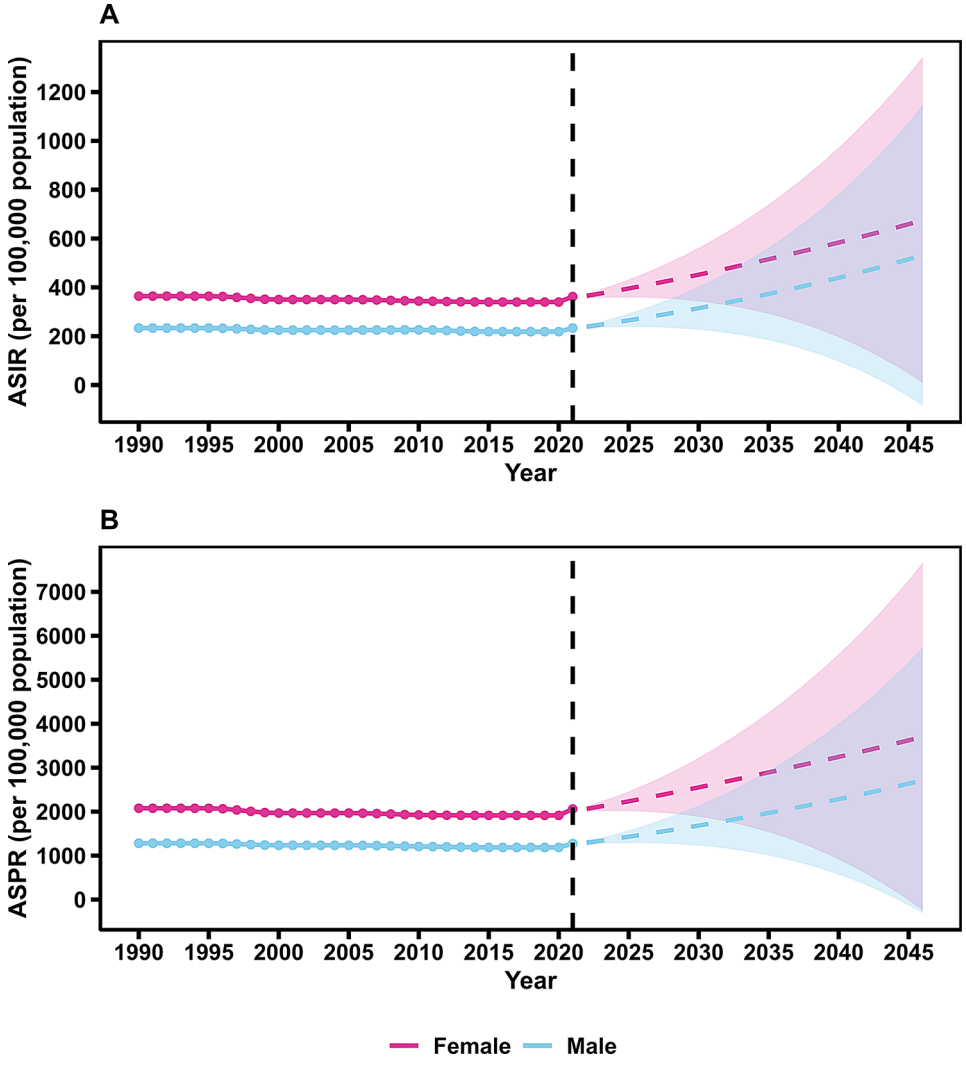

Fig. 5 Projected trends in age-standardized incidence (**A**) and prevalence (**B**) rates of dysthymia among young adults aged 20–44 in China, stratified by sex, 2022–2046, based on BAPC model

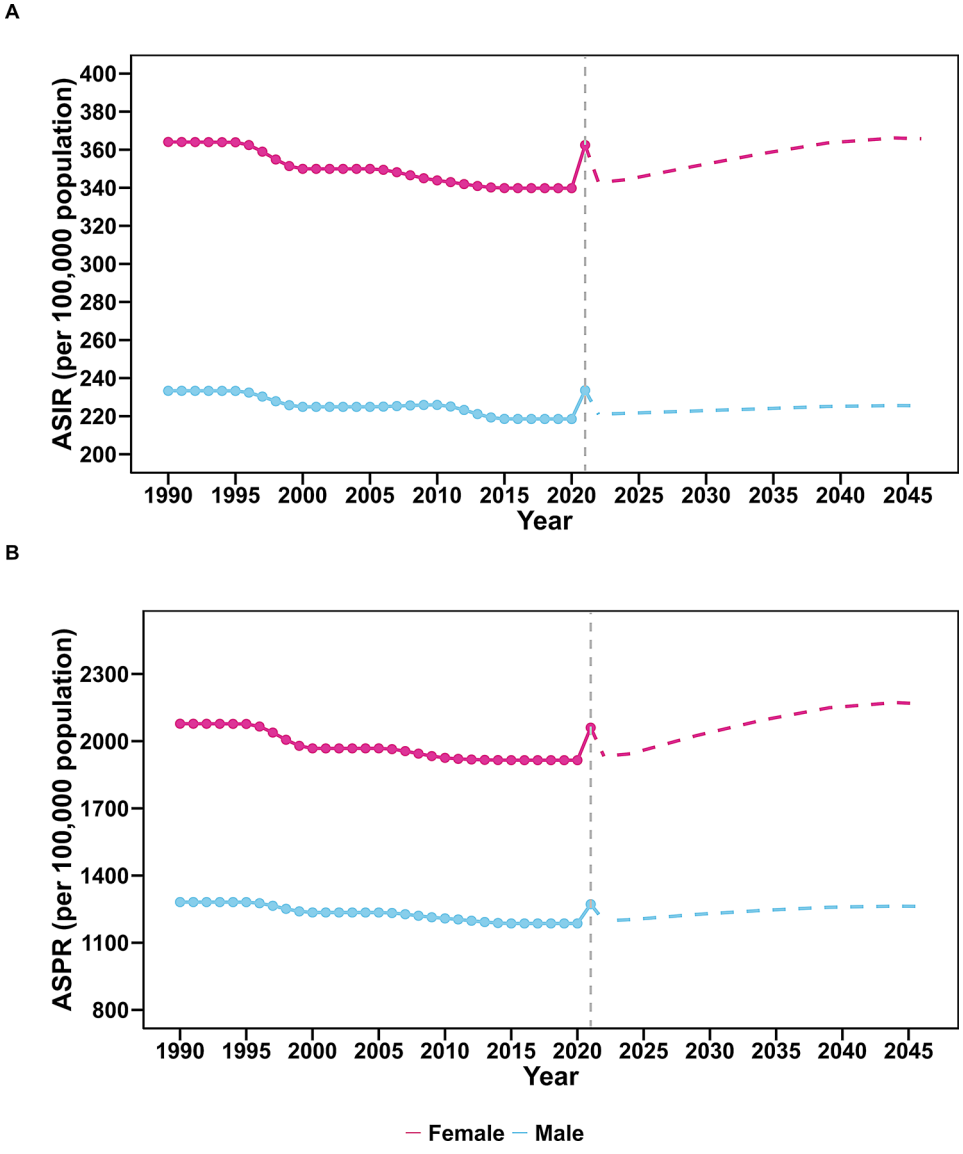

Fig. 6 Projected trends in age-standardized incidence (**A**) and prevalence (**B**) rates of dysthymia among young adults aged 20–44 in China, stratified by sex, 2022–2046, based on Nordpred APC model

44 years in China. The findings indicate a general decline in both age-standardized incidence and prevalence rates from 1990 to 2019, followed by a notable increase starting in 2020. Throughout the study period, the prevalence rates consistently surpassed incidence rates with females exhibiting higher rates than males, a pattern that is consistent with previous research [20–22]. The APC analysis identified significant age and cohort effects, showing that relative risks (RRs) of dysthymia incidence and prevalence increased with age, and that individuals born in more recent cohorts experienced a lower risk compared to those born in earlier cohorts. Projections based on Bayesian and Nordpred APC models suggest a continued rise in both age-standardized incidence rate (ASIR) and age-standardized prevalence rates (ASPR) over the next 25 years, with females remaining at higher rates than males. To the best of our knowledge, this is the first study to apply the APC model to analyze long-term dysthymia trends in this specific population, accompanied by 25-year projections. These findings provide critical insights into the temporal and future burden of dysthymia and highlight the importance of considering both historical trends and future trajectories when formulating public mental health strategies.

During the study period, dysthymia consistently exhibited low ASIR but high ASPR among young adults in China, a pattern similarly observed in other populations within China, such as older adults [11], and consistent with global trends in the general population [9]. This trend reflects the chronic nature of dysthymia,

characterized by persistent symptoms that can endure for years. However, these symptoms are often subtle and may go undetected during early or intermittent stages, posing challenges for clinical diagnosis [3]. Additionally, healthcare providers frequently prioritize more acute depressive disorders like MDD, leading to the under-diagnosis of dysthymia and contributing to its lower reported incidence [12]. Despite growing awareness of mental health issues in China, widespread stigma continues to exacerbate these challenges [40]. On an individual level, self-stigma fosters fear and shame, discouraging individuals from seeking professional mental health services [41]. On a societal level, public prejudice and discrimination inhibit open discussions and the development of supportive environments [42]. In many cases, depression-related conditions are perceived as morally unacceptable or trivial, further complicating accurate and timely detection [6]. Consequently, these dual-level stigmas may contribute to the disparity between dysthymia's low ASIR and its actual ASPR.

Meanwhile, the high ASPR of dysthymia can also be attributed to its chronic and enduring nature. Dysthymia typically follows a long-term course, with patients remaining symptomatic for extended periods [43]. Diagnosed cases tend to accumulate over time, resulting in persistently high prevalence even with a low incidence of new cases. This trend is further exacerbated by social and occupational pressures, particularly among young adults facing intense job competition and societal expectations related to family responsibilities [44]. Furthermore, the under-treatment of dysthymia significantly contributes to its high prevalence [6]. Recent data indicate that only 9.5% of individuals with depression in China received treatment, with even fewer dysthymia patients accessing adequate care [23]. The low rate of spontaneous remission for dysthymia further impedes effective management and recovery [12, 45]. As a result, the chronic nature of the disorder, combined with these societal, cultural, and healthcare barriers, sustains its persistently high prevalence over time.

In line with global trends [3, 46], we observed a significant increase in the age-standardized incidence and prevalence rates of dysthymia among young Chinese adults after 2020. This sharp rise is likely linked to the COVID-19 pandemic, which led to a 25% increase in global depression and anxiety prevalence during its first year [47], a trend also observed in China. As indicated by previous studies, the pandemic may have exacerbated the risk of mental disorders, including dysthymia, not only through its direct physical and psychological effects but also through its long-term economic and social consequences [48, 49]. Psychological stressors, such as isolation, loneliness, relationship breakdowns, and bereavement, were compounded by the pervasive fear of illness, directly contributing to the observed rise in both the incidence and prevalence of dysthymia [50, 51]. Furthermore, economic and social repercussions of the pandemic disproportionately affected young adults, who experienced additional stressors such as job loss, business closures, and financial instability [52]. These challenges have continued to place young adults—particularly those from lower socio-economic backgrounds—at heightened risk for mental health issues, even in the post-pandemic eras [53]. Notably, college students, who constitute a significant proportion of young adults, also experienced elevated levels of mental distress due to school closures, social restrictions, and the challenges of remote learning [54]. These disruptions not only hindered academic progress but also increased social isolation, further escalating the risk of dysthymia within this group. In the post-pandemic context, cultural shifts, including an increased reliance on digital communication and social media, have further influenced mental health [51]. These changes have contributed to a heightened sense of social comparison and exacerbated feelings of isolation, particularly among young adults [53]. Given these multifaceted challenges, it is critical to continue monitoring the mental health of young adults, as the psychological and socio-economic effects of the pandemic are expected to have long-lasting consequences [55].

The APC analysis identified an age effect on dysthymia incidence and prevalence among young adults in China, with RRs for both sexes steadily increasing with advancing age. This finding is consistent with trends observed in both the general Chinese population [11] and among young adults in other developing countries, such as Vietnam [56]. As individuals progress through young adulthood, they often encounter cumulative social and economic pressures that exacerbate pre-existing mild depressive symptoms [57], potentially leading to dysthymia. Life events typical of early to mid-adulthood, such as marriage, parenthood, and increased family responsibilities, contribute to prolonged periods of chronic stress [58]. These multifaceted stressors are likely to underlie the observed rise in dysthymia incidence and prevalence with age. The rapid socioeconomic development in China has also made early adulthood a crucial period for career establishment, during which many young adults face challenges such as job insecurity, promotion pressures, and substantial financial burdens related to home ownership, child-rearing, and caring for aging parents [11, 59]. Economic strain and job instability have been shown to have a strong correlation with the development and persistence of depressive symptoms [41, 45]. Over time, the cumulative effects of these socioeconomic stressors may gradually intensify psychological strain, ultimately increasing the risk of dysthymia onset. This highlights the significance of age-related life evens and stressors

as critical factors in the development and persistence of dysthymia among young adults in China.

Our analysis also identified a notable cohort effect, indicating that young adults born in more recent cohorts, particularly those born after the 1980s, exhibit lower risks of dysthymia incidence and prevalence compared to those born in earlier cohorts. This trend aligns with similar patterns observed in the general population regarding depression in other developing countries such as India [60]. The observed shift can be largely attributed to rapid economic growth, continuous improvements in education and mental health literacy, and sustained government attention and investment, all of which have contributed to an overall higher health-related quality of life for people born in more recent cohorts. China's ongoing social stability and rapid socioeconomic development since the implementation of the Reform and Opening-up Policy in 1978 have played a key role in this positive shift [61]. In contrast to those born in the 1950s and 1960s, who still faced basic subsistence challenges, individuals born in the 1980s and beyond have seen substantial improvements in material living standards [11]. As a result, there has been an increasing focus on mental health issues, and public awareness of mental well-being has grown significantly [61], particularly among young adults [62]. During this period, the widespread implementation of mandatory schooling and the expansion of higher education have especially benefited younger generations. Those born in more recent decades have received more education, which in turn has led to greater mental health awareness and improved mental health literacy compared to earlier cohorts [31, 40]. This shift has likely encouraged young people to take a more proactive approach to monitoring their psychological well-being and seeking professional help when necessary [61]. Additionally, government initiatives, including the *Mental Health Law* and the *Healthy China 2030* blueprint, have prioritized mental health care, improving access to services, and integrating psychological support into primary care [48]. These efforts, coupled with increased investment in community-based mental health services and awareness campaigns, have facilitated earlier interventions and mitigated the risk of depressive disorders, including dysthymia, among more recent birth cohorts [48, 63].

Our projections suggest a continued rise in both the ASIR and ASPR of dysthymia among young adults in China over the next 25 years. Although the available post-pandemic data is limited in terms of time span, we have rigorously accounted for the effects of age, period, and cohort factors in our forecasting model. The results obtained from both the Bayesian and Nordpred APC models are consistent and support the predicted trend. This finding is consistent with prior research forecasting an increase in dysthymia incidence within the general Chinese population [12], a trend we further confirmed among young adults of both sexes. Several factors may contribute to this upward trajectory, including intensifying social pressures, the pervasive influence of social media, and persistent gaps in mental health support. While growing mental health awareness and improved diagnostic practices may lead to earlier identification and intervention, these efforts alone may not fully counterbalance the rising burden of dysthymic, given its chronic and recurrent nature [3]. The projected increase in dysthymia cases among young adults may place significant strain on mental health services in China. To effectively manage this growing burden, it will be crucial to invest in expanding mental health infrastructure, particularly focusing on accessible and affordable mental health care for young people.

One important point to note is that our study also confirms the well-established sex difference in the burden of mental disorder, as highlighted in previous studies [11, 17, 64, 65]. Our findings showed that young females in China consistently exhibit higher incidence and prevalence of dysthymia across both observed and predicted estimates compared to their male counterparts. This disparity is rooted in the significant sex disparities in biological, psychological, and environmental sex differences [65]. As previous studies indicated, biological factors including hormonal fluctuations, genetic predisposition, and variances in females' brain structure and function, as well as key life stages such as menstruation, pregnancy and childbirth [17, 64], increase the risk of dysthymia in women. Psychologically, traits like temperament, personality, and coping mechanisms also play a role. Women, for instance, tend to have higher rumination tendencies, engaging in passive, repetitive analysis of their distress without taking proactive steps to resolve it, which can exacerbate their vulnerability to mental health issues [65] Environmental factors, such as culture-related gender stereotypes, entrenched social norms, structural inequalities, and the dual burden of professional and domestic responsibilities, also pose considerable challenges for young women [11, 65, 66]. Given their increased vulnerability, it is essential that public mental health policies give more focused attention to addressing the unique needs of females, ensuring that interventions are tailored to mitigate these gender-specific risks.

Limitations

Several limitations of this study should be acknowledged. Firstly, although the GBD 2021 utilized a unified data processing and modelling approach, the original data on dysthymia for China were limited [4], particularly due to the scarcity of mental health services in rural and western regions [67], which may lead to underreporting and

bias in the true incidence. Future research could incorporate clinical data to enhance the accuracy of these estimates and provide a more accurate reflection of the burden of dysthymia. Secondly, given the substantial regional and urban-rural disparities in economic development, healthcare access, and cultural factors across China, the generalizability of our findings may be limited. Data from regions with less robust healthcare infrastructure or mental health reporting systems, such as rural or underdeveloped areas, may be underrepresented, potentially influencing the accuracy and applicability of the results across all regions. Future research should focus on incorporating more region-specific data, with collaboration from provincial mental health authorities to conduct detailed analyses, including urban-rural comparisons, which could offer valuable insights into geographic disparities in the prevalence and incidence of dysthymia. Thirdly, while we have tried to provide a comprehensive analysis of the incidence and prevalence trends of dysthymia, both past and future, these trends are constrained by the relatively short observation period following the pandemic in the GBD 2021 data. This brevity may impact the accuracy and reliability of our analysis concerning the pandemic's effects on mental health of young adults and future projections. Future studies may integrate more recent pandemic data and longitudinal follow-ups to better assess the long-term trends in the post-pandemic period, and consider employing advanced modeling approaches that better account for evolving trends and external influences. Finally, while this study focused on dysthymia trends over time, future research should investigate associated risk factors, such as socioeconomic status, lifestyle changes, access to mental health resources and psychological variables. Additionally, qualitative approaches may be used to explore the contributions of public mental health policies and broader cultural influences to stigma and treatment gaps, thus providing a more comprehensive understanding of the dynamics and drivers of dysthymia. Despite these limitations, this study offers important insights and an updated evidence base on the trends and development of dysthymia among young adults in China and other developing countries.

Policy implications

Based on the findings of this study, we offer several implications for policymakers. Firstly, improving the capability for early detection and diagnosis of dysthymia is crucial. The government should implement standardized screening, clear diagnostic criteria, and effective evaluation tools, while enhancing healthcare providers' skills through continuous training. Secondly, improving access to affordable services and advanced technologies for standardized treatment and management of dysthymia is imperative. This involves integrating mental health screenings into primary healthcare, increasing investment in community-based mental health services [67], leveraging digital technology, such as telemedicine and online counseling services, which can enhance the capacity and reach of the limited number of mental health professionals, ensuring broader access to care. Furthermore, devising chronic disease management plans for those individuals with dysthymia is beneficial for addressing the chronicity and its relatively low rates of remission [9]. Thirdly, improving mental health literacy through education and social media is essential to combating the stigma surrounding dysthymia and other mental health disorders. Policymakers should integrate mental health education into school curricula and establish workplace support programs to enhance early recognition and access to care. Public health campaigns leveraging social media can further normalize mental illness and promote greater societal understanding. Finally, in the post-pandemic context, it is crucial to address the escalating social pressures faced by young adults, particularly young women and those transitioning into adulthood. A national mental health program in Australia, "*Beyond Blue*," has proven effective in providing tailored emotional support and interventions focusing on the unique needs from specific age groups and sexes to improve mental health [68]. Policymakers in China should prioritize sex- and age-sensitive healthcare initiatives, informed by the demographic characteristics of the disease burden. These initiatives should include mental health assessments during critical life stages for young women, such as menstruation, pregnancy, and the postpartum period, to identify individuals at risk and implement timely psychological interventions. Furthermore, policymakers should prioritize the provision of tailored mental health resources and adaptive support systems for young adults in the post-pandemic era. This could involve measures such as flexible work hours and psychological counseling services, which would support a healthy work-life balance. Such initiatives will not only assist young adults in navigating current challenges but will also facilitate a smoother transition into middle and later life, contributing to their long-term mental well-being.

Conclusion

This study conducted a comprehensive age-period-cohort (APC) analysis to assess the trends in dysthymia incidence and prevalence among young adults aged 20 to 44 years in China from 1990 to 2021, with forecasts to 2046. The results indicated a declining trend in age-standardized incidence rate (ASIR) and age-standardized incidence rate (ASPR) from 1990 to 2019, followed by an upward trajectory beginning in 2020. The APC analysis identified age and cohort effects, showing that the relative risks (RRs) for dysthymia incidence and prevalence

increased with age, while individuals born in more recent cohorts exhibited lower risks compared to earlier cohorts. Projections based on Bayesian and Nordpred APC models suggested a continued rise in the ASIR and ASPR of dysthymia among young Chinese adults over the next 25 years. Our findings also confirmed persistent sex differences, with females consistently exhibiting higher rates of dysthymia than males. Throughout the study period, dysthymia maintained higher prevalence rates than incidence rates, reflecting its chronic and enduring nature among young adults in China. These findings highlight the importance of enhancing early diagnostic capabilities in primary care, advancing standardized screening and treatment strategies, and enhancing mental health literacy through health education and social media. However, despite significant government initiatives aimed at addressing mental health issues, these efforts are challenged by structural barriers, including stigma, resource limitations, and regional disparities in healthcare access. Targeted interventions for vulnerable populations, particularly young women and those in early adulthood, remain crucial. Future research could benefit from incorporating clinical data to refine these estimates and explore the risk factors influencing dysthymia's evolving patterns, with a focus on addressing the broader socio-economic and cultural factors that shape mental health outcomes.

Abbreviations

APC	Age–period–cohort
APD	Absolute percentage deviation
ASIR	Age-standardized incidence rate
ASPR	Age-standardized prevalence rate
BAPC	Bayesian age-period-cohort
GBD	Global Burden of Disease
MDD	Major depressive disorder
RRs	Relative risks
UI	Uncertainty intervals
WHO	World Health Organization

Supplementary Information

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Supplementary Material 1

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Author contributions

JW formulated the framework of the study and drafted the manuscript. YD conducted the data analysis and substantially revised the manuscript. KT and ZS contributed to the collection, analysis, and interpretation of the data. All authors have read and approved the final version of the manuscript.

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Data availability

The data source of this study is a publicly available database, the Global Burden of Disease (GBD) 2021 Study, which is available at https://ghdx.healthdata.org/gbd-2021.

Declarations

Ethics approval and consent to participate

This study was based on publicly available data from the Global Burden of Disease (GBD) 2021 Study provided by the Institute for Health Metrics and Evaluation. As the study utilized secondary data without directly involving human participants, no specific institutional ethics approval was required. The raw data can be accessed through the link in the data sources section.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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