

Disease Burden of Drug Use Disorders in China, 1990-2021, and Trend Projections for 2022-2046: A Postprint

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Abstract

Background Substance use disorders have emerged as a global public health challenge, threatening population health and lives, increasing disease burden, and constraining economic development and social progress. The disease burden varies across different types of substance use, and identifying prevention and control priorities has become a focal point across sectors.

Objective To analyze the temporal trends in the disease burden of substance use disorders in China from 1990 to 2021, including age-standardized incidence rates and disability-adjusted life years (DALY) rates for substance use disorders and five subcategories, and to forecast the trends in incidence and DALY rates from 2022 to 2046, thereby providing scientific evidence for policy development and intervention implementation.

Methods Data were extracted from the Global Burden of Disease 2021 database (GBD 2021) for age-standardized incidence rates and DALY rates of substance use disorders and five subcategories (opioid use disorder, cannabis use disorder, cocaine use disorder, amphetamine use disorder, and other drug use disorders) in China from 1990 to 2021. Joinpoint regression models were employed to analyze annual percent change (APC) and average annual percent change (AAPC) in age-standardized incidence and DALY rates. Bayesian age-period-cohort forecasting models were utilized to project trends in age-standardized incidence and DALY rates from 2022 to 2046.

Results Joinpoint regression analysis revealed that from 1990 to 2021, the overall age-standardized incidence and DALY rates of substance use disorders in China's entire population exhibited declining trends (AAPC: -0.76% and -2.75%, respectively; both $P < 0.05$). Both male and female populations showed decreasing trends in standardized incidence and DALY rates (males: AAPC

-0.69% and -2.50%; females: AAPC -0.85% and -3.09%; all $P < 0.05$). Among the five subcategories, cannabis use disorder was the only one showing upward trends in age-standardized incidence and DALY rates (cannabis: AAPC 0.66% and 0.71%, respectively; both $P < 0.05$), while the remaining four subcategories demonstrated overall declining trends (opioids: AAPC -1.97% and -3.41%; amphetamines: AAPC -1.50% and -1.66%; cocaine: AAPC -0.66% and -2.12%; other drugs: AAPC -0.64% and -3.83%; all $P < 0.05$). Bayesian age-period-cohort forecasting model projections indicated that from 2022 to 2046, age-standardized incidence and DALY rates of substance use disorders in both male and female populations in China would increase, with incidence rate increases of approximately 50.80% for males and 24.27% for females (higher in males), and DALY rate increases of approximately 48.34% for males and 41.46% for females (higher in males).

Conclusion From 1990 to 2021, the disease burden of substance use disorders in China decreased, with males bearing a higher burden than females. Except for cannabis use disorder, the other four subcategories showed overall declining disease burden, with opioid use disorder imposing the most severe burden. However, age-standardized incidence and DALY rates are projected to increase from 2022 to 2046.

Full Text

The Disease Burden of Drug Use Disorders in the Chinese Population from 1990 to 2021 and Trend Predictions from 2022 to 2046

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Abstract

Background: Drug use disorders have emerged as a major global public health challenge, threatening lives, increasing disease burden, and impeding economic development and social progress. The burden varies across different substances, making it critical to identify prevention and control priorities.

Objective: To analyze trends in the disease burden of drug use disorders in China from 1990 to 2021, including age-standardized incidence and disability-

adjusted life year (DALY) rates for overall drug use disorders and five subcategories, and to project trends from 2022 to 2046 to inform policy development and intervention strategies.

Methods: Using data from the Global Burden of Diseases 2021 (GBD 2021) database, we extracted age-standardized incidence and DALY rates for drug use disorders and five subcategories (opioid use disorders, cannabis use disorders, cocaine use disorders, amphetamine use disorders, and other drug use disorders) in China from 1990 to 2021. Joinpoint regression models were employed to analyze annual percent change (APC) and average annual percent change (AAPC). Bayesian age-period-cohort (BAPC) models were used to forecast trends from 2022 to 2046.

Results: Joinpoint regression revealed that age-standardized incidence and DALY rates for drug use disorders in China declined overall from 1990 to 2021 (AAPC = -0.76% and -2.75%, respectively; both $P < 0.05$). Both males and females showed decreasing trends in age-standardized incidence and DALY rates (male AAPC = -0.69% and -2.50%; female AAPC = -0.85% and -3.09%; all $P < 0.05$). Among the five subcategories, cannabis use disorders showed increasing age-standardized incidence and DALY rates (AAPC = 0.66% and 0.71%; both $P < 0.05$), while the remaining four subcategories showed decreasing trends (opioids: AAPC = -1.97%, -3.41%; amphetamines: AAPC = -1.50%, -1.66%; cocaine: AAPC = -0.66%, -2.12%; other drugs: AAPC = -0.64%, -3.83%; all $P < 0.05$). BAPC projections indicated that from 2022 to 2046, age-standardized incidence and DALY rates would increase for both sexes, with incidence rising approximately 50.80% in males and 24.27% in females, and DALY rates increasing approximately 48.34% in males and 41.46% in females.

Conclusion: The disease burden of drug use disorders in China decreased from 1990 to 2021, with males experiencing higher burden than females. Except for cannabis use disorders, the other four subcategories showed declining burden, with opioid use disorders being the most severe. However, projections for 2022–2046 indicate rising age-standardized incidence and DALY rates, warranting urgent attention.

Keywords: Drug use disorders; GBD database; Joinpoint regression; Bayesian age-period-cohort models

Introduction

Drug use disorders impose a substantial global disease burden, with severity varying by region and correlating with sociodemographic index—higher SDI regions experience greater burden. Chronic drug abuse damages the nervous system, impairs cognitive function, causes mood disorders and developmental delays, and increases risks of accidental injury and death. Studies show drug overdose has become a leading cause of injury-related mortality in the United

States, with rising deaths involving synthetic opioids (e.g., fentanyl) and stimulants (e.g., cocaine, methamphetamine) over recent decades. Non-sterile injection practices, such as needle sharing, expose users to infectious diseases including HIV, viral hepatitis, and syphilis. Drug abuse also associates with non-communicable diseases like various cancers (breast, prostate, cervical) and cardiovascular diseases (pulmonary hypertension, arrhythmias, cardiomyopathy). At the individual level, drug abuse severely impacts health; at the societal level, it drives crime including drug-impaired driving, robbery, kidnapping, and violent offenses.

Illegal drugs are substances prohibited for non-medical use by international drug control conventions, typically used recreationally and carrying addiction risk, or medical substances harmful when misused or overdosed. These include but are not limited to opioids (morphine, opium, heroin, synthetic/semi-synthetic opioids), amphetamines, cocaine, and cannabis. This study uses GBD 2021 data to assess disease burden of drug use disorders and five subcategories in China from 1990–2021. We employ Joinpoint regression to analyze APC and AAPC trends across time periods and BAPC models to project trends for 2022–2046, aiming to provide data-driven support for intervention strategies and population health goals.

Methods

Data Sources

Data were extracted from the Global Burden of Diseases 2021 (GBD 2021) database, which provides comprehensive epidemiological estimates from 1990 onward. Detailed source information is available through the Global Health Data Exchange (GHDx).

Data Selection

We selected data for China from 1990–2021, focusing on “Drug use disorders” and five subcategories: “Opioid use disorders,” “Cannabis use disorders,” “Cocaine use disorders,” “Amphetamine use disorders,” and “Other drug use disorders.” Metrics included “Incidence” and “DALYs” for both sexes (“Both,” “Male,” “Female”) across 20 age groups from “0–95 plus,” including “Age-standardized” and “All ages” categories. Age-standardized rates were used for Joinpoint analysis, while BAPC modeling focused on specific age groups (15–19, 20–24, 25–29, 30–34, 35–39, 40–44, 45–49, 50–54, 55–59, 60–64, 65–69 years) to project trends from 2022–2046.

Statistical Analysis

Joinpoint Regression Model Joinpoint regression identifies statistically significant trend segments and inflection points by fitting linear models on a logarithmic scale. The method calculates APC for each segment and AAPC for the

entire study period. We used Joinpoint software (version 5.2.0.0, April 2024) with a log-linear model, employing grid search to identify optimal joinpoints and Monte Carlo permutation tests to determine the number of significant inflection points. The model with the lowest mean squared error was selected to compute APC, AAPC, and 95% confidence intervals (95% CI). $APC > 0$ indicates an increasing trend, while $APC < 0$ indicates a decreasing trend, with $P < 0.05$ considered statistically significant.

Bayesian Age-Period-Cohort Model The BAPC model extends the traditional age-period-cohort framework within a Bayesian context using a random exponential model as the link function. By smoothing age, period, and cohort effects, it provides robust estimates even for sparse or zero-count data. The model uses Integrated Nested Laplace Approximation (INLA) for Bayesian inference, offering a computationally efficient alternative to Markov Chain Monte Carlo methods for estimating marginal likelihoods and posterior distributions. This enables accurate projections of age-standardized or age-specific rates. Our BAPC model focused on the 15-70 age group to forecast age-standardized incidence and DALY rates from 2022-2046.

Results

Joinpoint Regression Trend Analysis

Incidence Trends From 1990-2021, China's age-standardized incidence of drug use disorders showed an overall decline (AAPC = -0.76%, 95% CI: -0.83% to -0.69%). Male incidence declined slightly slower than female incidence (male AAPC = -0.69%; female AAPC = -0.85%). However, both the total population and females experienced modest increases during 2015-2021 (total APC = 0.51%, 95% CI: 0.41%-0.61%; female APC = 0.52%, 95% CI: 0.43%-0.61%), while males saw an increase during 2016-2021 (APC = 0.66%, 95% CI: 0.52%-0.81%) [TABLE:1, FIGURE:1].

Among the five subcategories, cannabis use disorders showed an increasing trend in age-standardized incidence (AAPC = 0.66%, 95% CI: 0.64%-0.68%), while the other four subcategories declined: opioids (AAPC = -1.97%, 95% CI: -2.14% to -1.80%), amphetamines (AAPC = -1.50%, 95% CI: -1.61% to -1.39%), cocaine (AAPC = -0.66%, 95% CI: -0.78% to -0.55%), and other drugs (AAPC = -0.64%, 95% CI: -0.70% to -0.59%). Male AAPC values were slightly higher than female values for all subcategories except other drugs. Recent upward trends were observed for amphetamines (2012-2021, APC = 0.41%), cocaine (2010-2021, APC = 0.27%), opioids (2017-2021, APC = 2.33%), and other drugs (2018-2021, APC = 0.15%). Cannabis incidence remained stable before 2015, increased sharply during 2015-2019 (APC = 5.49%, 95% CI: 5.38%-5.60%), then declined slightly during 2019-2021 (APC = -0.44%, 95% CI: -0.65% to -0.24%) [TABLE:1, FIGURE:2-6].

DALY Rate Trends Age-standardized DALY rates for drug use disorders declined overall from 1990-2021 (total AAPC = -2.75%, 95% CI: -2.97% to -2.53%; male AAPC = -2.50%, 95% CI: -2.73% to -2.27%; female AAPC = -3.09%, 95% CI: -3.31% to -2.87%). However, all groups showed increases during 2016-2021 (total APC = 2.01%, 95% CI: 1.46%-2.57%; male APC = 2.08%, 95% CI: 1.47%-2.70%; female APC = 1.70%, 95% CI: 1.22%-2.19%) [TABLE:1, FIGURE:1].

Cannabis use disorders showed increasing DALY rates (AAPC = 0.71%, 95% CI: 0.69%-0.73%), while the other four subcategories declined: opioids (AAPC = -3.41%, 95% CI: -3.65% to -3.16%), amphetamines (AAPC = -1.66%, 95% CI: -1.81% to -1.50%), cocaine (AAPC = -2.12%, 95% CI: -2.45% to -1.80%), and other drugs (AAPC = -3.83%, 95% CI: -4.31% to -3.36%). Male AAPC values were higher than female values for all subcategories except opioids. Recent increases occurred for amphetamines (2015-2021, APC = 1.53%), cocaine (2012-2021, APC = 1.06%), opioids (2017-2021, APC = 2.68%), and other drugs (2016-2021, APC = 2.90%). Cannabis DALY rates were stable before 2015, rose during 2015-2019 (APC = 5.87%, 95% CI: 5.74%-6.00%), then declined slightly during 2019-2021 (APC = -0.44%, 95% CI: -0.68% to -0.19%) [TABLE:1, FIGURE:2-6].

Prediction Results

Incidence Projections Male age-standardized incidence is projected to increase from 267.74/100,000 (95% CI: 267.25-268.23) in 2021 to 403.76/100,000 (95% CI: 73.05-734.46) in 2046, representing a 50.80% increase. Female incidence is projected to rise from 245.24/100,000 (95% CI: 244.76-245.72) in 2021 to 304.75/100,000 (95% CI: 87.64-521.86) in 2046, a 24.27% increase. Male incidence will remain higher than female incidence throughout 2022-2046, with greater absolute and relative increases [Figure 7: see original paper].

DALY Rate Projections Male age-standardized DALY rates are projected to increase from 207.65/100,000 (95% CI: 207.23-208.08) in 2021 to 308.02/100,000 (95% CI: -477.09 to 1,093.14) in 2046, a 48.34% increase. Female DALY rates are projected to rise from 136.72/100,000 (95% CI: 136.36-137.08) in 2021 to 193.40/100,000 (95% CI: -132.44 to 519.24) in 2046, a 41.46% increase. Male DALY rates will continue exceeding female rates, with larger increases in both absolute and relative terms [Figure 8: see original paper].

Discussion

This study reveals dynamic epidemiological trends in China's drug use disorders. The significant decline in overall incidence and DALY rates from 1990-2021 validates the effectiveness of national drug control policies. Gender analysis shows males carry a higher burden, with AAPC values for age-standardized incidence and DALY rates 0.16% and 0.59% higher than females, consistent with

sociological patterns of greater risk exposure among men. However, Joinpoint analysis reveals concerning gender shifts: female incidence of other drug use disorders has surpassed male rates, and a similar pattern emerged for opioids after 2010. This structural transformation likely reflects three factors: accelerated normalization of substance use among young women, cross-partner influence of drug-using behaviors, and biological specificity in female addiction pathways—international research confirms women progress from initial use to dependence more rapidly. Spanish surveillance data (1995–2009) further demonstrate converging gender gaps in lifetime use rates for alcohol, tobacco, and multiple illicit drugs, suggesting a global epidemiological shift.

By substance category, all except cannabis showed negative growth, notably heroin use declining 26.7% over the past decade, marking success of China’s multi-tiered drug control system. From the historical opium epidemic (1636–1912) to the “drug-free nation” achievement through early legislation and social reform (1949–1978), to the contemporary “compulsory isolation—community rehabilitation—social support” triad addressing new psychoactive substances, China has forged a distinctive governance path.

Nevertheless, both Joinpoint and BAPC models warn of emerging risks. Inflection points appeared in 2015–2016, with projections indicating age-standardized incidence and DALY rates will rebound to 390.92/100,000 and 533.10/100,000 by 2046. This reversal may be driven by: (1) globalization of new psychoactive substances (NPS) growing at 15–20% annually, with poly-drug use exceeding 40%; (2) “elite diffusion” of substance use in high-SDI regions; and (3) pandemic-related increases in home-based drug use and darknet transactions.

Limitations include potential reporting bias from passive surveillance systems, failure to incorporate disruptive variables like AI-enabled drug synthesis, and incomplete analysis of social determinants. Future research should develop socio-ecological models of substance use disorders, create dynamic prediction systems integrating policy parameters, and investigate sex-specific neurobiological mechanisms of addiction.

Conclusion

From 1990–2021, China’s drug use disorder burden declined, demonstrating effective governance, though males experienced higher burden than females. With cannabis use disorders as the exception, four subcategories showed decreasing burden, with opioids being most severe. However, projections for 2022–2046 indicate rising age-standardized incidence and DALY rates, requiring vigilant monitoring and intervention.

Author Contributions

ZHANG Ziyu conceptualized the study, retrieved and analyzed GBD 2021 data, created visualizations, and drafted the manuscript. HAN Shukui revised the

manuscript and figures. MA Xin and SONG Panpan performed secondary data verification. MA Jinxiang and REN Yitao managed quality control and final revisions. CHEN Hongru supervised the entire research process. All authors approved the final manuscript.

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