Iran J Public Health, Vol. 54, No.7, Jul 2025, pp.1493-1503

Original Article

Global and Cross-Country Inequalities in the Fatal and Non-Fatal Burden Attributable to Drug Use Disorders and Subtypes: Findings from the Global Burden of Disease Study 2021

Zhou Lei [1], ***Li Hui*** [2], ****Sun Anxiu*** [3]

1. *Department of Pharmacy, Taixing People's Hospital Affiliated to Yangzhou University, Yangzhou, Jiangsu, China*
2. *Department of Medicine, Taixing People Hospital, Taizhou, Jiangsu, China*
3. *Department of Clinical Pharmacy, Yangzhou University Affiliated Hospital, Yangzhou, Jiangsu, China*

***Corresponding Author:** Email: sunanxiu@aliyun.com

(Received 10 Jan 2025; accepted 24 Mar 2025)

Abstract

Background: Drug use disorders (DUDs) pose a serious public health threat, exacerbating the worldwide disease burden and resulting in a dramatic rise in fatalities. We aimed to explore the global and cross-country disparities in the fatal and non-fatal burden attributable to DUDs and subtypes by sex and age groups from 1990 to 2021.

Methods: The Global Burden of Disease (GBD) 2021 data were analyzed to estimate the fatal [i.e. mortality and years of life lost (YLL)], non-fatal [i.e. disability-adjusted life years (DALYs), years lived with disability (YLD)] burden, trend attributable to DUDs, subtypes by sex and age groups using the joinpoint regression model across India, China, as well as world between 1990 and 2021.

Results: Between 1990 and 2021, the age-standardized fatal and non-fatal rates attributable to DUDs significantly increased in India and the world, whereas substantially declined in China. China experienced a 2-fold higher age-standardized DALYs and YLDs rate in 2021, and India observed the fastest (2-fold) upward trend in the age-standardized mortality and YLLs rate attributable to amphetamine use disorders than the world. The trend in YLD rate attributable to DUDs significantly increased in the young age group <20 years in India. The world experienced a significant increasing trend in the fatal rate attributable to DUDs in the middle age group 20-54 years. Overall, females observed remarkable improvement in the fatal and non-fatal burden attributable to DUDs across India, China and the world.

Conclusion: India and the global population experienced rising age-standardized fatal and non-fatal rates due to DUDs—while China demonstrated progress. The trend varied by DUD subtypes, age group, and gender, with amphetamine use disorders disproportionately affecting India and China and females showing improved outcomes across all regions.

Keywords: Drug use disorders; Mortality; Disability-adjusted life years

Introduction

Over the past decade, Drug use disorders (DUDs) have emerged as a major public health challenge, significantly contributing to the global burden of disease and driving a sharp rise in mor-

DOI: https://doi.org/10.18502/ijph.v54i7.19156

tality. In 2019, DUDs ranked as the 16th leading cause of Disability-adjusted life years (DALYs) worldwide among adults aged 25–49 and the 18th leading cause among adolescents and young adults aged 10–24 (1). According to a 2020 report by the United Nations Office on Drugs and Crime (UNODC), over 250 million people worldwide use drugs, with more than 35 million suffering from DUDs (2). DUDs involve intoxication, dependence, or harmful patterns of psychoactive substance use, often leading to severe social, psychological, physiological, and legal consequences. With far-reaching personal and societal harms, DUDs represent a critical public health crisis that demands urgent attention (3, 4).

The leading two populous countries, India and China, have faced rising morbidity and mortality from DUDs, reflecting broader global trends. In India, opioid dependence (particularly heroin and pharmaceutical opioids) and injecting drug use have driven increased DUD prevalence (5). China, meanwhile, saw a shift from traditional opioids (e.g., opium) to synthetic drugs (e.g., methamphetamine) (6). Strict drug policies initially reduced opioid dependence but correlated with rising stimulant-related harms. Both nations report under diagnosis due to stigma, with mortality often attributed to overdoses (India) or infectious complications (China) (7, 8).

Limited studies investigated the temporal trend of DUD-related mortality and morbidity at the global and national levels (2, 9, 10). However, these studies focused only on DUDs-related mortality (9) and morbidity (2, 10) and failed to estimate non-fatal burden (i.e. DALYs and years lived with disability (YLDs) (9) and fatal burden (i.e. mortality and years of life lost (YLLs) (2, 10) attributable to DUDs and subtypes. In this study, we utilized the most recent GBD 2021 data to conduct a comprehensive analysis of the fatal and non-fatal burden attributable to DUDs and subtypes across India, China, and at the global level based on sex and age groups. These stratified analyses aimed to identify vulnerable populations and inform targeted, evidence-based policy interventions to address the specific needs of different demographic groups affected by DUDs.

Material and Methods

Data source

We obtained data stratified by sex (male, female, and both sexes combined) and age (i.e. <20 years, 20-54 years and ≥55 years) from the publicly available GBD 2021 database (1) (accessed on December 24, 2024) between 1990 and 2021. The GBD 2021 study employed DisMod-MR 2.1, a Bayesian meta-regression modelling tool, to estimate the prevalence and incidence of DUDs. Additionally, mortality estimates related to DUDs were derived using the Cause of Death Ensemble model (CODEm) and spatiotemporal Gaussian process regression (ST-GPR) (1). The GBD study provides comprehensive estimates of various disease and injury indicators**,** including DALYs, YLDs, YLLs, prevalence, incidence, and mortality**,** stratified by age, sex, year, and location**.** These estimates are generated using standardized methodologies**,** with detailed descriptions of the DUD-specific estimation processes available in prior publications (1). The Institute for Health Metrics and Evaluation (IHME) at the University of Washington manages the GBD dataset in collaboration with the WHO, Global Health Observatory, and World Bank Open Data. Given the nature of the data, the University of Washington Institutional Review Board granted a waiver of informed consent for this study (11, 12).

Population and variables understudy

The all-ages number and age-standardized data were extracted for India, China, and the world (including China, India and other 202 countries.). The observed variables were the fatal and non-fatal burden of DUDs, opioid use disorders, cocaine use disorders, and amphetamine use disorders across different sex (males and females) and age groups (i.e. <20 years, 20-54 years and ≥55 years). The fatal burden related to DUDs was mortality and YLLs, whereas the non-fatal burden was DALYs and YLDs. DALYs measure overall disease burden, expressed as the number of years lost due to illness, disability, or prema-

ture death (i.e. DALYs= YLLs+YLDs). YLL is defined as the number of years lost due to premature mortality, calculated by comparing the age at death with a standard life expectancy. YLD is defined as the number of years lived in less-than-ideal health due to disease or injury, weighted by severity (i.e. YLDs= number of cases×duration of disability×disability weight (0-1) (1).

Statistical Analysis

We employed joinpoint regression analysis to analyze temporal trends in the fatal and non-fatal burden of DUDs and their subtypes from 1990 to 2021. This approach calculates the average annual percentage change (AAPC), which reflects the overall trend across the entire study period. The joinpoint model further divides the temporal pattern into multiple statistically significant segments, each characterized by an annual percentage change (APC) that indicates the trend direction within specific time intervals. Trend interpretation was based on the following criteria: a positive trend was identified when either the AAPC or APC with a 95% confidence interval (CI) exceeded zero, while a negative trend was indicated when these values fell below zero. Trends were considered stable when no statistically significant positive or negative changes were observed. We computed AAPCs with corresponding 95% CIs for different sex and age groups, with statistical significance determined by a two-tailed p-value threshold of <0.05. All analyses were conducted using Joinpoint Regression Software (version 4.9.1.0, April 2022), developed by the Surveillance Research Program of the US National Cancer Institute (NCI).

Results

Temporal trend of fatal and non-fatal burden attributable to DUDs

Globally and in India, the absolute number of mortality, DALYs, YLLs, and YLDs attributable to DUDs significantly increased between 1990 and 2021. However, China showed a substantial reduction in the absolute number of mortality, DALYs, YLLs, and YLDs attributable to DUDs during the study period. The age-standardized mortality, DALYs, YLLs, and YLDs rate attributable to DUDs significantly increased both in the world and in India. India experienced the slowest increasing trends in the age-standardized mortality and YLL rates but observed the fastest increasing trends in the age-standardized DALYs and YLDs rate compared to the globe. On the contrary, China had the highest age-standardized DALYs, YLLs, and YLDs rates compared to India in 2021 but observed a remarkable reduction in the age-standardized rates of fatal and non-fatal burden between 1990 and 2021 (Tables 1 and 2, Fig. 1).

Temporal trend of fatal and non-fatal burden attributable to opioid use disorders

The absolute number of mortality, DALYs, YLLs, and YLDs attributable to opioid use disorders significantly rose both in India and the world between 1990 and 2021. China gained a marked improvement in the fatal and non-fatal burden attributable to opioid use disorders. The age-standardized mortality, DALYs, YLLs, and YLDs rate attributable to opioid use disorders significantly increased in the world, whereas India showed a significant upward trend in the DALYs and YLDs rate during the study period. China observed a significant reduction in the age-standardized burden, particularly in the fatal burden attributable to opioid use disorders (Tables 1 and 2).

Temporal trend of fatal and non-fatal burden attributable to cocaine use disorders

The fatal and non-fatal burden attributable to cocaine use disorders significantly increased in the world and India during the study period. The world experienced the fastest increasing trends in the absolute number of mortality and YLLs, and India showed the fastest increasing trends in the absolute number of DALYs and YLDs. However, China showed a significant reduction in the fatal and non-fatal burden attributable to cocaine use disorders. India and the world showed in-

creasing trends in the age-standardized mortality, DALYs and YLLs rate and decreasing trends in the YLDs rate attributable to cocaine use disorders. China experienced a marked decline in the age-standardized mortality, DALYs, YLLs, and YLDs rate attributable to cocaine use disorders (Tables 1 and 2).

Table 1: Temporal tend in the age-standardized mortality, DALYs, YLDs, and YLLs rate due to DUDs in both sexes across India, China and the world from 1990 to 2021

Variable	India		China		World	
DUDs	ASR 2021 (95%UI)	1990-2021 AAPC (95%CI)	ASR 2021 (95%UI)	1990-2021 AAPC (95%CI)	ASR 2021 (95%UI)	1990-2021 AAPC (95%CI)
Mortality	0.6 (0.7, 0.5)	0.3 (0.1, 0.5)	0.6 (0.8, 0.5)	-5.0 (-5.8, -4.2)	1.6 (1.7, 1.5)	0.9 (0.7, 1.2)
DALYs	81 (98, 640)	0.6 (0.3, 0.8)	116 (143, 89)	-2.9 (-3.2, -2.6)	190 (222, 156)	0.5 (0.4, 0.6)
YLDs	56 (73, 39)	0.7 (0.4, 1.1)	83 (110, 57)	-2.0 (-2.2, -1.7)	114 (145, 80)	0.2 (0.1, 0.3)
YLLs	25 (28, 21)	0.3 (0.1, 0.4)	32 (38, 26)	-5.0 (-5.8, -4.1)	76 (81, 72)	0.9 (0.6, 1.2)
Opioid use disorders						
Mortality	0.4 (0.5, 0.4)	0.1 (-0.1, 0.3)	0.3 (0.3, 0.2)	-5.8 (-6.5, -5.1)	1.2 (1.2, 1.1)	1.1 (0.8, 1.4)
DALYs	63 (78, 47)	0.6 (0.4, 0.9)	53 (66, 40)	-3.6 (-3.9, -3.3)	137 (161, 112)	1.0 (0.8, 1.1)
YLDs	45 (59, 30)	0.9 (0.5, 1.3)	39 (51, 26)	-2.6 (-2.9, -2.2)	81 (106, 56)	0.8 (0.7, 0.9)
YLLs	18 (21, 15)	0.1 (-0.1, 0.2)	14 (17, 11)	-5.8 (-6.5, -5.1)	55 (60, 52)	1.1 (0.8, 1.5)
Cocaine use disorders						
Mortality	0.1 (0.1, 0.1)	0.4 (0.1, 0.6)	0.1 (0.1, 0.1)	-3.9 (-4.5, -3.4)	0.2 (0.2, 0.1)	2.5 (2.1, 3.0)
DALYs	3.1 (4.1, 2.1)	0.2 (-0.1, 0.4)	1.5 (2.1, 0.9)	-2.3 (-2.5, -2.0)	13 (17, 11)	0.9 (0.7, 1.1)
YLDs	0.4 (0.7, 0.2)	-0.2 (-0.3, -0.1)	0.8 (1.4, 0.5)	-0.8 (-1.1, -0.6)	6.9 (10.4, 4.2)	-0.3 (-0.4, -0.2)
YLLs	2.5 (3.6, 1.7)	0.2 (-0.1, 0.5)	0.6 (0.8, 0.3)	-3.6 (-4.1, -3.1)	6.9 (7.9, 6.3)	2.5 (2.0, 2.9)
Amphetamine use disorders						
Mortality	0.1 (0.1, 0.1)	1.6 (1.4, 1.8)	0.1 (0.2, 0.1)	-2.8 (-3.7, -1.8)	0.1 (0.1, 0.1)	0.8 (0.4, 1.2)
DALYs	2.5 (3.5, 1.7)	0.6 (0.5, 0.7)	44 (65, 29)	-1.9 (-2.1, -1.6)	20 (29, 14)	-1.2 (-1.3, -1.1)
YLDs	1.6 (2.6, 0.9)	0.2 (0.2, 0.3)	35 (55, 21)	-1.6 (-1.8, -1.5)	15 (23, 9)	-1.7 (-1.8, -1.5)
YLLs	0.8 (1.1, 0.6)	1.6 (1.2, 1.9)	8.6 (10.6, 6.8)	-2.9 (-3.9, -1.9)	5.6 (6.2, 5.1)	0.4 (-0.1, 0.9)

Note: Drug use disorders (DUDs), age-standardized rate (ASR), average annual percentage change (AAPC), disability-adjusted life years (DALYs), years lived with disability (YLDs), years of life lost (YLLs)

Table 2: Temporal tend in the all-ages number of mortality, DALYs, YLDs, and YLLs rate due to DUD in both sexes across India, China and world from 1990 to 2021

Variable	India		China		World	
Drug use disorders	Number, n×1000 2021 (95%UI)	1990-2021 AAPC (95%CI)	Number, n×1000 2021 (95%UI)	1990-2021 AAPC (95%CI)	Number, n×1000 2021 (95%UI)	1990-2021 AAPC (95%CI)
Mortality	8 (9, 7)	2.9 (2.7, 3.1)	11 (13, 9)	-3.8 (-4.6, -3.1)	137 (146, 129)	2.7 (2.4, 3.0)
DALYs	1229 (1506, 963)	2.8 (2.5, 3.1)	1661 (2030, 1278)	-2.6 (-2.9, -2.4)	15562 (18119, 12752)	1.9 (1.7, 2.0)
YLDs	864 (1142, 597)	3.0 (2.6, 3.3)	1158 (1501, 807)	-1.9 (-2.2, -1.6)	9225 (11764, 6536)	1.5 (1.4, 1.6)
YLLs	364 (416, 315)	2.6 (2.4, 2.8)	503 (605, 406)	-4.3 (-5.0, -3.5)	6336 (6724, 5985)	2.4 (2.1, 2.7)
Opioid use disorders						
Mortality	6 (7, 5)	2.7 (2.6, 2.9)	5 (7, 4)	-4.4 (-5.1, -3.7)	99 (108, 92)	2.9 (2.6, 3.2)
DALYs	960 (1188, 713)	2.9 (2.6, 3.2)	849 (1041, 649)	-2.8 (-3.1, -2.6)	11218 (13159, 9188)	2.4 (2.3, 2.6)
YLDs	690 (914, 458)	3.1 (2.7, 3.6)	611 (799, 421)	-1.9 (-2.3, -1.5)	6636 (8617, 4606)	2.2 (2.1, 2.3)
YLLs	270 (320, 218)	2.4 (2.3, 2.6)	237 (291, 188)	-4.9 (-5.6, -4.1)	4582 (4943, 4288)	2.7 (2.3, 3.0)
Cocaine use disorders						
Mortality	0.8 (1.2, 0.6)	2.9 (2.6, 3.1)	0.1 (0.2, 0.1)	-2.8 (-3.3, -2.3)	12 (14, 11)	4.4 (3.9, 4.8)
DALYs	44 (60, 31)	2.4 (2.1, 2.6)	21 (29, 14)	-2.0 (-2.2, -1.7)	1133 (1427, 917)	2.3 (2.1, 2.5)
YLDs	7 (11, 4)	2.0 (1.9, 2.1)	12 (19, 6)	-0.9 (-1.0, -0.7)	556 (834, 343)	1.0 (0.9, 1.0)
YLLs	37 (52, 25)	2.5 (2.2, 2.7)	9 (13, 5)	-3.0 (-3.5, -2.4)	577 (658, 528)	4.1 (3.6, 4.5)
Amphetamine use disorders						
Mortality	0.2 (0.3, 0.2)	4.0 (3.7, 4.3)	2 (3, 2)	-2.0 (-2.9, -1.1)	9 (11, 8)	2.3 (1.8, 2.7)
DALYs	38 (54, 26)	2.7 (2.6, 2.8)	549 (796, 368)	-2.3 (-2.5, -2.1)	1677 (2343, 1171)	-0.1 (-0.3, -0.1)
YLDs	25 (41, 14)	2.3 (2.3, 3.4)	427 (666, 252)	-2.2 (-2.4, -2.0)	1213 (1880, 717))	-0.6 (-0.8, -0.5)
YLLs	12 (17, 9)	3.7 (3.3, 4.0)	121 (149, 96)	-2.6 (-3.5, -1.8)	463 (515, 419)	1.8 (1.3, 2.3)

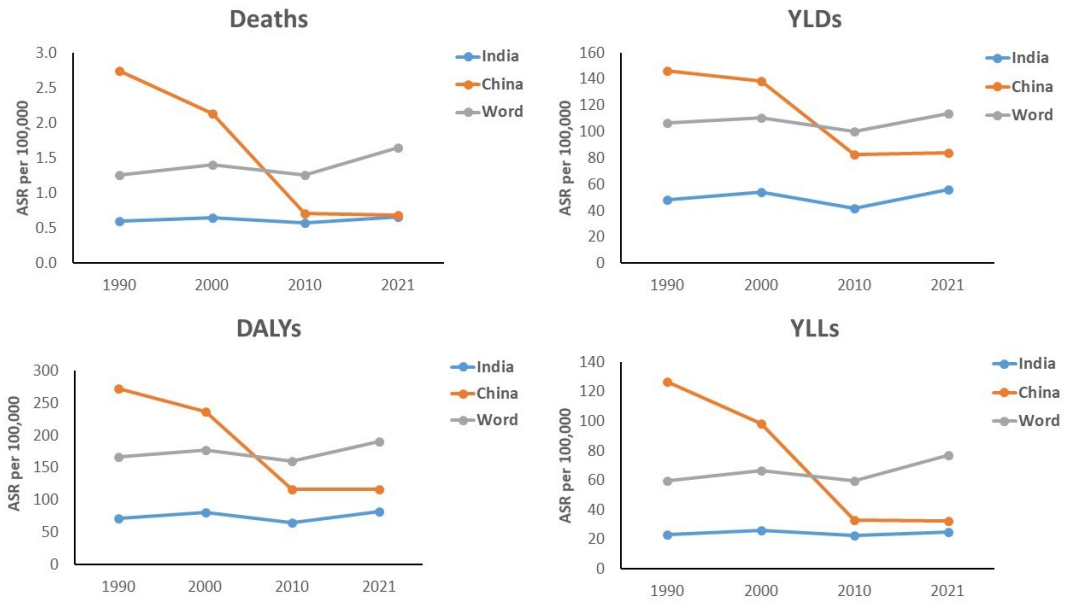

Fig. 1: Temporal trend in the age-standardized rate (ASR) of deaths, DALYs, YLDs, and YLLs across India, China, and the world between 1990 and 2021

Temporal trend of fatal and non-fatal burden attributable to amphetamine use disorders

India observed the fastest increasing trends in the absolute number of mortality, DALYs, YLLs, and YLDs rates attributable to amphetamine use disorders. The fatal burden (i.e. mortality and YLLs) significantly increased, whereas the non-fatal burden (i.e. DALYs and YLDs) significantly declined in the world. China showed significant improvement in both fatal and non-fatal burdens attributable to amphetamine use disorders. The age-standardized fatal and non-fatal burden showed significant upward trends in India. World showed significant upward trends in the fatal burden and downward trends in the non-fatal burden during the study period. However, China showed a significant decline in the age-standardized fatal and non-fatal burden between 1990 and 2021 but experienced 2-fold higher age-standardized DALYs and YLDs rate attributable to amphetamine use disorders compared to the world in 2021 (Tables 1 and 2).

Sex disparities in fatal and non-fatal burden attributable to DUD and subtypes

In India, the age-standardized fatal and non-fatal burden attributable to DUD and subtypes significantly increased in males, and the age-standardized non-fatal burden attributable to DUD and opioid use disorders significantly increased in females. Moreover, the age-standardized fatal and non-fatal burden attributable to cocaine use disorders and amphetamine use disorders significantly declined in females in India. In China, females showed the fastest decline in the age-standardized fatal and non-fatal burden attributable to DUD and subtypes compared to males. At the global level, both males and females experienced significantly increasing trends in the age-standardized fatal and non-fatal burden attributable to DUD. Males showed the fastest increasing trends in the age-standardized fatal burden attributable to cocaine use disorders compared to females. However, females showed the fastest increasing trends in the age-standardized fatal burden attributable to opioid use disorders compared to males (Fig. 2).

Age-specific fatal and non-fatal burden attributable to DUD

In India, the age group <20 years showed a decreasing trend in the mortality and YLLs rate and an increasing trend in the YLDs rate. However, the fatal and non-fatal burdens were stable in age groups 20-54 years and ≥55 years. At the global level, the fatal and non-fatal burden attributable to DUD significantly decreased in the age group <20 years. However, the age group 20-54 years showed an increasing mortality and YLLs rate trend. China experienced a notable reduction in the fatal and non-fatal burden in all age groups. Overall, females observed remarkable improvement in the fatal and non-fatal burden attributable to DUD across all age groups compared to males in India, China and the world (Table 3 & Fig. 3).

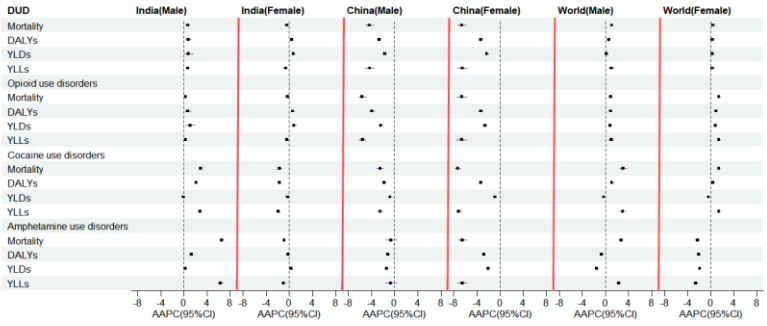

Fig. 2: Average annual percentage change (AAPC) in the age-standardized rate of fatal and non-fatal burden attributable to drug use disorders (DUD) and subtypes in males and females across India, China, and the world between 1990 and 2021

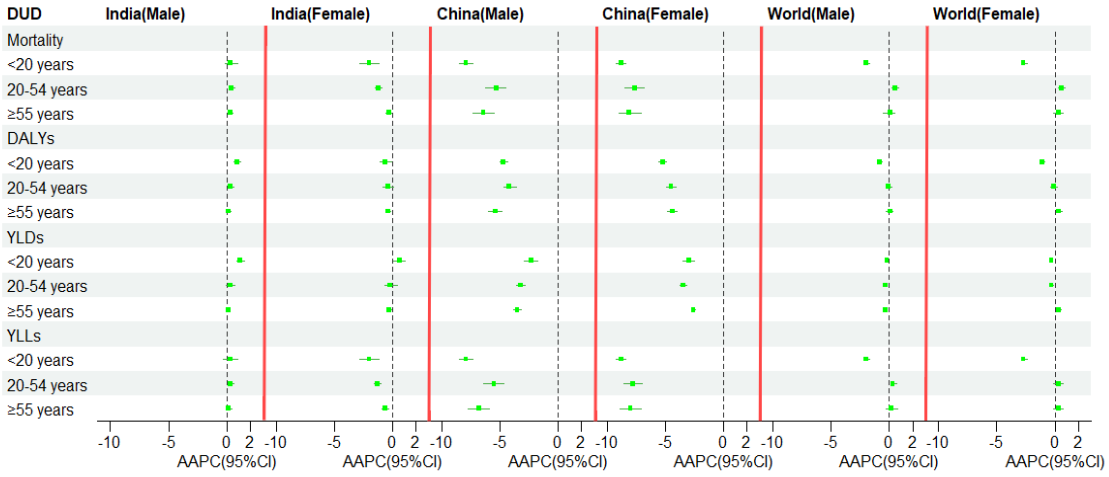

Fig. 3: Average annual percentage change (AAPC) in the age-specific rate of fatal and non-fatal burden attributable to drug use disorders (DUD) in males and females by age groups across India, China, and the world between 1990 and 2021

Table 3: Temporal tend in the age-specific mortality, DALYs, YLDs, and YLLs rate in both sexes across India, China and world from 1990 to 2021

Variable	India		China		World	
DUDs	Age-specific rate 2021 (95%UI)	1990-2021 AAPC (95%CI)	Age-specific rate 2021 (95%UI)	1990-2021 AAPC (95%CI)	Age-specific rate 2021 (95%UI)	1990-2021 AAPC (95%CI)
Mortality						
<20 years	0.1 (0.1, 0.1)	-1.0 (-1.7, -0.3)	0.1 (0.1, 0.1)	-8.2 (-8.7, -7.7)	0.1 (0.1, 0.1)	-2.2 (-2.5, -2.0)
20-54 years	0.6 (0.6, 0.5)	0.1 (-0.2, 0.3)	1.1 (1.3, 0.8)	-6.0 (-6.8, -5.1)	2.6 (2.8, 2.5)	0.5 (0.2, 0.8)
≥55 years	1.8 (2.0, 1.5)	-0.1 (-0.3, 0.2)	0.9 (1.1, 0.7)	-6.9 (-7.8, -6.0)	2.2 (2.4, 2.0)	0.2 (-0.3, 0.6)
DALYs						
<20 years	14 (19, 10)	0.2 (-0.1, 0.6)	19 (25, 13)	-4.9 (-5.2, -4.6)	27 (34, 20)	-0.9 (-1.1, -0.7)
20-54 years	138 (173, 106)	0.1 (-0.2, 0.4)	193 (239, 147)	-4.3 (-4.8, -3.8)	349 (408, 284)	-0.1 (-0.3, 0.1)
≥55 years	84 (99, 70)	-0.1 (-0.3, 0.1)	59 (73, 46)	-4.9 (-5.4, -4.4)	112 (130, 95)	0.2 (-0.1, 0.4)
YLDs						
<20 years	9 (14, 6)	0.9 (0.6, 1.3)	14 (20, 8)	-2.6 (-3.1, -2.1)	20 (27, 13)	-0.3 (-0.4, -0.1)
20-54 years	102 (137, 70)	0.1 (-0.3, 0.5)	135 (178, 94)	-3.3 (-3.7, -3.0)	209 (267, 148)	-0.3 (-0.4, -0.1)
≥55 years	41 (55, 28)	-0.1 (-0.2, 0.1)	38 (51, 26)	-3.0 (-3.2, -2.8)	54 (71, 38)	0.1 (-0.1, 0.1)
YLLs						
<20 years	4 (5, 3)	-1.0 (-1.7, -0.3)	4 (5, 3)	-8.3 (-8.8, -7.8)	7 (8, 6)	-2.2 (-2.5, -2.0)
20-54 years	35 (41, 30)	-0.1 (-0.4, 0.2)	57 (69, 46)	-6.1 (-7.0, -5.3)	140 (148, 132)	0.3 (0.1, 0.6)
≥55 years	43 (49, 37)	-0.2 (-0.5, 0.1)	21 (25, 16)	-7.2 (-8.1, -6.3)	57 (63, 52)	0.3 (-0.2, 0.7)

Note: Drug use disorders (DUDs), average annual percentage change (AAPC), disability-adjusted life years (DALYs), years lived with disability (YLDs), years of life lost (YLLs)

Discussion

This study provides a detailed analysis of fatal and non-fatal burdens attributable to DUDs and subtypes stratified by sex and age across India, China, and the world between 1990 and 2021. The fatal and non-fatal burden of DUDs and subtypes significantly increased at different paces and scales in India and the global level. However, China remarkably improved the fatal and non-fatal attributable to DUDs and subtypes during the study period. The pace of increasing or decreasing temporal trends of fatal and non-fatal burden attributable to DUDs and subtypes varies across sex and age groups in India, China, and the world.

India observed significantly increasing trends in the absolute burden (i.e. all-ages number) and age-standardized rate of fatal (i.e. mortality and YLLs) and non-fatal (i.e. DALYs and YLDs) burden attributable to DUDs. The age-standardized mortality, DALYs, YLLs, and YLDs rate attributable to opioid use disorders and amphetamine use disorders significantly rose between 1990 and 2021. The trend in age-standardized mortality and YLLs rate attributable to amphetamine use disorders was 2-fold faster than the world. Moreover, India showed increasing trends in the age-standardized mortality, DALYs and YLLs rate and decreasing trends in the YLDs rate attributable to cocaine use disorders during the study period. Males observed an increasing trend in the age-standardized fatal and non-fatal burden attributable to DUD and subtypes, whereas females showed an increasing trend in the age-standardized non-fatal burden attributable to DUD and opioid use disorders.

The young population aged <20 years showed an increasing trend in the YLDs rate. The rising trend of DUDs in the young population is alarming. It could be due to several reasons, including peer pressure and social influence, mental health issues, unemployment, and lack of awareness (13, 14). A previous study predicted that substance use disorder would increase by 23% in India between 2013 and 2025 (15). With its large population, India faces significant challenges in providing adequate resources for DUD interventions. A large proportion of affected individuals, including those with severe conditions, never seek treatment. To reduce this public health burden, overcoming treatment barriers at the population level is essential. Public education programs should be developed and tested to increase mental health literacy and fight the stigma associated with DUDs (16).

China has achieved a remarkable gain in the absolute all-ages number and age-standardized fatal and non-fatal burden attributable to DUDs and subtypes during the study period. The mortality and YLL rates substantially declined compared with DALYs and YLDs in China. Females showed the fastest decline in the age-standardized fatal and non-fatal burden attributable to DUD and subtypes compared to males. The fatal and non-fatal burden attributable to DUDs significantly declined across all age groups, particularly in the young age group <20 years. In 2019, substance use disorders accounted for 5.76 million DALYs in China. Between 2000 and 2019, both the numbers and standardized rates of DALYs attributable to substance use disorders decreased by 8.52% and 18.52%, respectively (17).

However, we found that China had the highest age-standardized DALYs, YLLs, and YLDs rates attributable to DUDs compared to India and experienced 2-fold higher age-standardized DALYs and YLDs rate attributable to amphetamine use disorders compared to the world in 2021. It reflects that DUDs, particularly amphetamine use disorders, pose a significant challenge to the healthcare system in China. Due to strict opioid controls, drug users have switched to cheaper and more accessible synthetic stimulants like amphetamines (18). The government of China should find pragmatic solutions (i.e. early identification, targeted prevention, and effective treatment) and take serious action to decrease the associated health burden of DUDs, particularly amphetamine.

Globally, the absolute all-ages number and age-standardized mortality, DALYs, YLLs, and YLDs

rate attributable to DUDs, opioid use disorders, and cocaine use disorders significantly increased between 1990 and 2021. The absolute all-ages number and age-standardized fatal burden significantly increased, whereas the non-fatal burden significantly declined, attributable to amphetamine use disorders. DUDs have been a public health challenge, which potentially affected population health and socio-economic development at the global level (10). Between 1990 and 2019, the absolute number of DALYs due to DUDs increased by 2.6% per year, but there was no significant change in the age-standardized DALYs rate during the study period (10). The age-standardized DALYs rate attributable to opioid use disorders and cocaine use disorders significantly increased, which is in line with our findings (10). We observed the fastest increasing trends in the age-standardized mortality and YLLs rate caused by cocaine use disorders among three types of DUDs over the past 32 years.

From 1990 to 2021, the global mortality rate due to DUDs significantly increased especially in high-income countries (HICs) compared with low to middle-income countries (LMICs). A notable rise in DUD-related deaths was seen in adults aged 25–64, particularly among males (9). We also found that males showed the fastest increasing trends in the age-standardized fatal burden attributable to cocaine use disorders compared to females. Females showed the fastest increasing trends in the age-standardized fatal burden attributable to opioid use disorders compared to males. Moreover, the age group 20-54 years showed an increasing trend in the mortality and YLL rates attributable to DUDs. The mortality rate due to DUDs was predicted to increase significantly until 2040 at the global level (9). These findings underscore the urgent implementation of evidence-based DUD strategies to reduce the mortality burden associated with DUDs, particularly in middle-aged males.

Limitations

We recognized several limitations in our study. First, our analysis relies on GBD 2021 data and consequently inherits all methodological constraints associated with the GBD study framework (19). Second, while we analyzed long-term trends using AAPC (1990-2021), our study did not examine short-term fluctuations through APC metrics. This approach may mask recent variations in DUD patterns and the effectiveness of recent prevention and intervention of DUDs and subtypes.

Conclusion

The absolute number and age-standardized rate of fatal and non-fatal burden attributable to DUDs and subtypes significantly increased in India and at the global level, whereas China showed a substantial reduction during the study period. However, China experienced a 2-fold higher age-standardized DALYs and YLDs rate attributable to amphetamine use disorders compared to the world in 2021. Females showed marked improvement in the age-standardized mortality rate attributable to DUDs and subtypes in the studied population. The young population aged <20 years showed an increasing trend in the YLDs rate in India, and the middle-aged group (20-54 years) observed an increasing trend in the mortality and YLLs rate attributable to DUDs at the global level. These findings suggest urgent and comprehensive strategies to reduce the age-standardized DALYs and YLDs rate attributable to amphetamine use disorders in China and the fatal and non-fatal burden attributable to DUDs and subtypes across India and at the global level.

Journalism Ethics considerations

Ethical issues (Including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors.

Acknowledgements

No funding source was received.

Conflict of interest

The authors have no conflict of interest regarding this review.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material. Further inquiries can be directed to the corresponding authors.

References

1. Vos T, Lim SS, Abbafati C, et al (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet,* 396 (10258):1204-1222.
2. Shao H, Du H, Gan Q, et al (2024). Trends of the Global Burden of Disease Attributable to Cannabis Use Disorder in 204 Countries and Territories, 1990–2019: Results from the Disease Burden Study 2019. *Int J Mental Health Addict,* 10:1-23.
3. Gobbi G, Atkin T, Zytynski T, et al (2019). Association of Cannabis Use in Adolescence and Risk of Depression, Anxiety, and Suicidality in Young Adulthood: A Systematic Review and Meta-analysis. *JAMA Psychiatry,* 76 (4):426-434.
4. Compton WM, Jones CM, Baldwin GT, Harding FM, Blanco C, Wargo EM (2019). Targeting youth to prevent later substance use disorder: an underutilized response to the US opioid crisis. *Am J Public Health,* 109 (S3):S185-S189.
5. Ambekar A, Agrawal A, Rao R, et al (2019). Magnitude of substance use in India. 23.
6. Li J, Ha TH, Zhang C, Liu H (2010). The Chinese government's response to drug use and HIV/AIDS: A review of policies and programs. *Harm Reducti J,* 7:4.
7. Degenhardt L, Charlson F, Ferrari A, et al (2018). The global burden of disease attributable to alcohol and drug use in 195 countries and territories, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet Psychiatry,* 5 (12):987-1012.
8. Citaristi I (2022). United Nations Office on Drugs and Crime—UNODC. In: *The Europa Directory of International Organizations 2022.* Ed(s): Routledge, pp. 248-252.
9. Kim S, Lee H, Woo S, et al (2025). Global, regional, and national trends in drug use disorder mortality rates across 73 countries from 1990 to 2021, with projections up to 2040: a global time-series analysis and modelling study. *eClinicalMedicine,* 79: 102985.
10. Chen A, Zou M, Fan M, et al (2022). Time trends and associated factors of global burden due to drug use disorders in 204 countries and territories, 1990–2019. *Drug Alcohol Depend,* 238:109542.
11. Roth GA, Abate D, Abate KH, et al (2018). Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet,* 392 (10159):1736-1788.
12. Kyu HH, Abate D, Abate KH, et al (2018). Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. *The Lancet,* 392 (10159):1859-1922.
13. Sahu A, Bhati N, Sarkar S (2022). A systematic review and meta-analysis of substance use among medical students in India. *Indian J Psychiatry,* 64 (3):225-239.
14. Mogan K, Venkatesh U, Kapoor R, Kumar M, Health (2022). Determinants of substance use among young people attending an urban primary health center in Delhi. *Int J Adolesc Med Health,* 34 (3).
15. Charlson FJ, Baxter AJ, Cheng HG, Shidhaye R, Whiteford HA (2016). The burden of mental, neurological, and substance use disorders in China and India: a systematic analysis of community representative epidemiological studies. *The Lancet,* 388 (10042):376-389.
16. Armstrong G, Kermode M, Raja S, Suja S, Chandra P, Jorm AF (2011). A mental health training program for community health

workers in India: impact on knowledge and attitudes. *Int J Mental Health Systems,* 5 (1):17.
17. Ma C, Yu S, Huang Y, et al (2020). Burden of Mental and Substance Use Disorders - China, 1990-2019. *China CDC Wkly,* 2 (41):804-809.
18. Su S, Fairley CK, Mao L, et al (2020). Estimation of the impact of changing drug-use trend on HIV, hepatitis C and syphilis epidemics among people who use synthetic drug-only, polydrug and heroin-only during 2005–2035 in China: modelling study. *Sexually Transmitted Infections,* 96 (8):608.
19. Diseases G, Collaborators I (2020). Diseases and Injuries Collaborators. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. *Lancet,* 396 (10258):1204-1222.