BMC Public Health

RESEARCH

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Global burden and trend of substance use disorders, self-harm, and interpersonal violence from 1990 to 2021, with projection to 2040

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Abstract

Background Alcohol use disorders (AUD), drug use disorders (DUD), interpersonal violence, and self-harm are a major public health concern globally, with high rates of disability, morbidity, and mortality associated with this. This study aims to estimate the disease burden, trends, projections, and disparities of AUD, DUD, interpersonal violence, and self-harm among all ages and sexes from 1990 to 2021.

Methods This study is a secondary analysis utilizing data from the Global Burden of Disease (GBD) 2021 in 204 countries and territories. The incidence, deaths, and disability-adjusted life years (DALYs), projection, and the inequality were estimated for AUD, DUD, interpersonal violence, and self-harm among all age and sex.

Results In 2021, there were 55.78 (46.56–64.31) million new cases of AUD, 13.61 (11.63–15.67) million new cases of DUD, 29.40 (26.17–32.65) million new cases of interpersonal violence, 5.49 (4.6–6.5) million new cases of self-harm globally. By 2040, AUD is forecasted to be 51.98 (29-74.97) million, DUD will be 13.81 (9.23–18.39) million, 36.01 (15.25–56.78) million for interpersonal violence, and 10.55 (3.16–17.94) million for self-harm. In terms of gender and age distribution, males had higher incidence, mortality, and DALYs for AUD, DUD, and interpersonal violence compared to females. Females had higher incidence of self-harm, while males had higher mortality. By age group, individuals aged 15–49 bore the highest burden of DUD, interpersonal violence, and self-harm, while those aged 50–74 had the highest burden of AUD. The burden of these conditions is closely related to the socio-demographic index (SDI). High- and middle-high SDI regions had a heavier burden of AUD, DUD, and self-harm, while low- and middle-low SDI regions had a heavier burden of interpersonal violence. Additionally, from 1990 to 2021, health inequalities for AUD and self-harm decreased, while those for DUD and interpersonal violence increased.

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Conclusions From 1990 to 2021, the disease burden of AUD, DUD, interpersonal violence, and self-harm exhibited specific patterns across different genders, age groups, and regions. Multilevel interventions should be initiated, with a focus on reducing inequalities through resource allocation and policy support.

Keywords Alcohol use disorders, Drug use disorders, Interpersonal violence, Self-harm

Introduction

The harm arising from alcohol use disorders (AUD), drug use disorders (DUD), interpersonal violence, and self-harm are internationally-accepted public health challenge. The high incidence and serious consequences of these behaviors impose an enormous burden on individuals, families and communities. Globally, more than 3 million deaths annually are related to AUD [1], 500,000 deaths are attributed to DUD [2], 470,000 deaths are attributed to interpersonal violence [3], and 700,000 people die by self-harm [4]. AUD, DUD, interpersonal violence, and self-harm are often interconnected and associated with social chaos. The global burden of AUD and DUD is not only attributed to their inherent characteristics as risk factors, but a significant part can be attributed to the health consequences they produce, such as self-harm and interpersonal violence [5–7]. Similarly, the burden caused by interpersonal violence and self-harm can be partly attributed to the influence of AUD and DUD. For example, over 40% of suicide and drug overdose deaths in the United States involved opioids [8]. This complex causal relationship increases the difficulty of burden estimation and the formulation of public health policies. Compared to AUD and DUD, the incidence statistics for interpersonal violence and self-harm may be significantly underestimated, which could be related to various factors, such as personal privacy and social stigma [9]. High-income countries typically have more robust data collection systems, while low- and middle-income countries often lack relevant data. According to the World Health Organization (WHO), data coverage for interpersonal violence and self-harm in sub-Saharan Africa is less than 30% [10], and data collection in conflict-affected regions like Syria and Yemen has nearly stalled [11]. Overall, global statistics remain unclear, making it more challenging to develop and disseminate global public health policies.

Previous studies on these social issues have often focused on specific populations (i.e., adolescents and young adults aged 10–24) and regions [12–14]. For example, research has shown that adolescents have higher rates of opioid and cannabis use, which are closely associated with an increased risk of suicide [15]; suicide is one of the leading causes of death among individuals aged 10–24, particularly in high-income countries [16]. Adolescence is a critical period for psychological and social development, and while this age group is at high risk for these social issues, other age groups such as children, middle-aged adults, and the elderly have received less attention, resulting in an incomplete understanding of the disease burden across all age groups. Furthermore, many studies have primarily concentrated on high-income countries, such as those in North America, Europe, and Australia, while paying little attention to populations in low- and middle-income countries. This limits the overall understanding of the global disease burden.

This study aims to delve into the global burden caused by AUD, DUD, interpersonal violence, and self-harm. Since each iteration of the Global Burden of Disease (GBD) recalculates the prevalence of risk factors and disease burden reports, we have re-estimated the incidence and disease burden of AUD, DUD, interpersonal violence, and self-harm using the GBD 2021 dataset. In addition, by calculating the temporal trends from 1990 to 2021, we can capture the trends of these four risk factors across sex, age, and region. Finally, the burden of disease in 2040 is projected based on a Bayesian age-period-cohort (BAPC) mode. In short, we hope to contribute to public health policy and health promotion initiatives by providing more reliable and detailed data to support global health issues.

Methods

Study design and data sources

The GBD 2021 project estimated the disease burden associated with 371 diseases and injuries for 204 countries and territories from 1990 to 2021 [17]. In this study, we reported the quantitative burden of AUD, DUD, interpersonal violence, and self-harm for the period 1990–2021 by four age groups (0–14 years, 15–49 years, 50–74 years, 75+years), sex, 21 GBD regions and 5 SDI levels.

Case definition of AUD, DUD, interpersonal violence, and self-harm

Substance use disorders were defined based on ICD-10 [18] and the American Psychiatric Association's Diagnostic and Statistical Manual of Mental Disorder, version 4 [19]. Substance use disorders include AUD and DUD [20]. The DUD in the GBD framework include opioid use disorders, cocaine uses disorders, amphetamine use disorders, cannabis use disorders, and other use disorders.

Self-harm is a broad concept, ranging from non-suicidal self-harm to attempted suicide to suicides [21]. The ICD-10 codes for self-harm are X60-X64.9, X66-X84.9, Y87.0. Interpersonal violence includes family and intimate violence and community violence. The ICD-10

codes for interpersonal violence are T74.2-T76.22, X85-Y08.9, Y87.1-Y87.2.

Estimating association between burden and sociodemographic index

Sociodemographic index (SDI) was used in the GBD study as a composite measure of development status, it derived by calculating the geometric mean of per capita income, mean years of schooling among individuals aged 15 years and older, and the total fertility rate (TFR) among females under 25 years of age [22]. SDI scores range from 0 to 1, with 0 representing lowest income, lowest education, and highest TFR, and 1 representing highest income, highest education, and lowest TFR. The SDI score for each GBD location was updated annually.

In this study, we investigate the relationship between SDI and incidence, mortality, and disability-adjusted life years (DALYs) rates attributable to AUD, DUD, interpersonal violence, and self-harm separately.

Decomposition analysis

To qualified the drivers of changes in the counts of individuals with AUD, DUD, interpersonal violence, and self-harm, we estimated the relative contribution of population growth, population aging, and epidemiology changes. We employed the Das Gupta method for decomposition analysis, using algebraic methods to isolate the standardized impact of each factor, and summarizing the influence of various factors on the observed changes.

Inequality analysis

The slope inequality index (SII) and the concentration index are used to measure health inequalities among different regions. The SII is calculated following: first, ranking countries or regions according to their socioeconomic status, calculating the cumulative proportion of health outcomes for each country or region; then, based on the Lorenz curve to illustrate the distribution of health outcomes; the end, the SII value is calculated based on the ratio of the area between the Lorenz curve and the line of perfect equality (the 45-degree line). A positive value of SII indicates that health outcomes are disproportionately concentrated in groups with higher SDI, while a negative value indicates concentration in groups with lower SDI. The concentration index is calculated by numerical integration of the area under the Lorenz curve. The concentration index is derived from the sum of the differences between the health status of each socioeconomic group and its distribution proportion in the total population, sorted by socioeconomic status. The value of the concentration index reflects the concentration of health outcomes among groups with different socioeconomic statuses, with a positive value indicating concentration in higher-status groups and a negative value indicating concentration in lower-status groups, and when there's no inequality, the concentration index is at zero.

In this study, we analyzed the distribution and trends of DALYs caused by AUD, DUD, interpersonal violence, and self-harm among different regions from 1990 to 2021.

Statistical analysis

The actual number was estimated with DisMod-MR 2.1 [23], a Bayesian meta-regression tool that estimates non-fatal health outcomes by location, age, sex, and year. The incidence, prevalence, mortality, years lived with disability (YLDs), years of life lost (YLLs), and DALYs of AUD, DUD, interpersonal violence, and self-harm were original downloaded from the GBD 2021 result tool (http://ghdx.healthdata.org/gbd-results-tool). YLDs are years lived with disability estimated by multiplying estimates of different severity with appropriate disability weights. YLLs are years of life lost due to premature death, calculated from the number of observed deaths and the reference standard life expectancy at age of actual death, which is obtained from the GBD standardized life tables. All accessible data, including those for covariates, were used to develop a set of plausible models and eventually, the best ensemble predictive model to produce estimates of deaths and YLLs by location, age, sex, and year. DALYs are disability-adjusted life years, as the sum of total health loss for each disorder, location, age group, sex, and year. DALYs calculated by the equation of DALYs = YLLs+YLDs. Age-standardized incidence, prevalence, deaths, YLLs, YLDs, and DALYs were estimated using the GBD world population age standard. The temporal trends in incidence, mortality, and DALYs rates from 1990 to 2021 calculated with estimated annual percentage change (EAPC). The EAPC value over 0 indicate an upward trend, and less than 0 signify a downward trend. Annual percentage change (APC) of age and regions trend calculated by Joinpoint regression model. The projection analysis is performed by BAPC to forecast the disease burden until 2040. BAPC employ integrated nested Laplace approximations (INLA) to facilitate comprehensive Bayesian inference, and the Poisson noise will be involved when focus on the predictive distribution. All statistical analysis and visualization of results were performed by using the R software (version 4.3.0) and Joinpoint (version 4.9.0).

Role of the funding source

The funder of the study had no role in the study design, data collection, data analysis, data interpretation, or the writing of the report. All authors had full access to the data in the study and final responsibility for the decision to submit for publication.

Results

Global trend in incidence

Globally in 2021, an estimated 69.39 (95% uncertainty intervals 58.18–79.98) million cases with AUD and DUD, 34.89 (30.77–39.15) million cases have experienced interpersonal violence and self-harm. From 1990 to 2021, there was a declining trend in the annual change of age-standardized incidence rates (ASIRs) worldwide for AUD with an EAPC at -0.79% (-0.83 to -0.75), DUD at -0.36% (-0.39 to -0.32), interpersonal violence at -1.44% (-1.51 to -1.37), and self-harm at -1.42% (-1.51 to -1.32), as shown in Table 1 and Figure S1.

Global trend in mortality

Approximately 0.30 (0.26–0.32) million deaths were associated with AUD and DUD, 1.14 (1.07–1.22) million deaths were associated with interpersonal violence and self-harm in 2021 worldwide. Similarly, from 1990 to 2021, there was a declining trend in the annual change of age-standardized mortality rate (ASMRs) for AUD with an EAPC of -1.75% (-2.16 to -1.35), interpersonal violence at -1.40% (-1.56 to -1.24), and self-harm at -1.97% (-2.11 to -1.83), while DUD showed an upload ASMR with an EAPC of 0.28% (0.01 to 0.56), as shown in Table 1 and Figure S1.

Global trends in dalys

Globally in 2021, an estimated 32.54 (26.28–39.32) million DALYs were associated with AUD and DUD, 60.36 (56.50-64.56) million DALYs were attributable to interpersonal violence and self-harm. From 1990 to 2021, attributable age-standardized DALYs rate (ASDRs) showed a downward trend in AUD, interpersonal violence, and self-harm, with EAPC of -1.3% (-1.49 to -1.11), -1.35% (-1.47 to -1.23), and – 1.96% (-2.1 to -1.82), respectively, while DUD remained relatively stable, with an EAPC of 0.04% (-0.14 to 0.23), as shown in Table 1 and Figure S1.

Global trends by sex

From 1990 to 2021, males experienced higher incidence and death rates for AUD, DUD, and interpersonal violence, and with pronounced fluctuating trends. Conversely, the self-harm incidence was more common in females, and showing an increasing trend for both sexes. The burden of attributable DALYs was higher for males for all four causes. Over the past 31 years, the change in DALYs due to AUD and interpersonal violence have remained stable for females and fluctuated for males. Meanwhile, DALYs due to DUD has increased for all sexes. Despite larger incidence number of self-harm among females, the decline in DALYs is more pronounced for females than males (Fig. 1 and Table S1-3).

Global trends by age group

The trends in ASIRs vary across the four causes, with all ASIRs peaked in the 15–49 age group and show a declining trend from 1990 to 2021 (average annual percent change of ASIR for AUD was – 0.24, DUD was – 0.23, interpersonal violence was – 1.39, and self-harm was – 0.74). Whereas ASDR varies across the four causes, such as for AUD, the peak age group has shifted to 50–74 age group, showed a significant downward trend between 1994 and 1998 with an APC of -4.26 (Fig. 2).

Global projection

Globally in 2040, the projection of incidence and DALYs attributable to AUD will decrease by -2.45% (-45.56 to 40.62) and – 13.52% (-99.07 to 71.88) compared to 2021, and the AUD incidence for males will be 3.83 (3.29–4.09) times higher than females. The incidence, DALYs, and ASDRs of DUD are expected to increase 3.48% (-30.75 to 37.65), 24.60% (-58.47 to 107.50), and 7.18% (-64.27 to 78.54), respectively, while ASIRs will decrease by -11.01% (-40.47 to 18.4), and the burden of DUD still higher for males. The incidence and ASIRs for interpersonal violence are expected to increase by 20.53% (-48.91 to 89.88) and 3.76% (-56.03 to 63.49), while the DALYs and ASDRs will decrease by -22.03% (-95.52 to 51.35) and – 32.87% (-96.15 to 30.33), with the burden of interpersonal violence still being heavier in males. The incidence and ASIRs of self-harm are expected to increase significantly by 96.98% (-40.83 to 234.44) and 69.28% (-49.19 to 187.47), while the DALYs and ASDRs will decrease by -7.52% (-63.95 to 48.84) and – 20.41% (-68.99 to 28.12), respectively. Self-harm remains prevalent among females, with 2.15 (1.08–2.47) times more than male cases, whereas the DALYs is higher among males, with 1.8 (1.78–2.04) times more than females (Fig. 3).

Regional trends

By SDI category, for AUD, DUD, and self-harm, we found the highest ASIR, ASMR, and ASDR in countries with a high and high-middle SDI, and countries with a low SDI had the highest ASMR and ASDR for interpersonal violence. Burden of AUD, DUD, and self-harm were higher in high SDI regions, with an extra 8.74 (7.81–9.59) million incidence cases and 12.42 (11.22–13.5) million DALYs compared to low SDI regions. Conversely, the burden of interpersonal violence was higher in low SDI, with an additional 2.26 (2.12–2.37) million incidence cases and 2.47 (1.99–3.05) million DALYs compared to high SDI (Fig. 4 and Table S4-15).

From 1990 to 2021, among the GBD regions, five Sub-Saharan Africa regions have significantly increased in the incidence of AUD and DUD, and South Asia and East Asia have distinct decreased ASIRs for AUD and DUD. The largest increase of interpersonal violence incidence

Table 1 Global changes in incidence, mortality and dalys of AUD, DUD, interpersonal violence and self-harm from 1990 to 2021

Global	Incidence counts			ASIR, per 100 000			Death counts			ASMR, per 100 000			DALYs counts			ASDR, per 100 000		
	1990	2021	Count change	1990	2021	EAPC	1990	2021	Count change	1990	2021	EAPC	1990	2021	Count change	1990	2021	EAPC
AUD	42320999.31 (34758375.59 to 49270544.35)	55779737.36 (46555775.13 to 64314072.65)	0.32% (0.26 to 0.38)	835.57 (688.06 to 971.83)	673.98 (563.13 to 776.68)	-0.79% (-0.83 to -0.75)	110753.66 (102125.97 to 114921.65)	158468.69 (129565.45 to 173258.87)	0.43% (0.28 to 0.59)	2.47 (2.28 to 2.56)	1.84 (1.5 to 2.01)	-1.75% (-2.16 to -1.35)	12990243.52 (10296142.46 to 16452163.79)	16980984.23 (13531791.33 to 21197117.7)	0.31% (0.24 to 0.38)	266.11 (212.48 to 334.99)	202.39 (161.07 to 253.23)	-1.3% (-1.49 to -1.11)
DUD	10043456.25 (8541086.21 to 11526399.67)	13609362.38 (11625287.78 to 15667184.2)	0.36% (0.31 to 0.4)	184.31 (156.91 to 211.67)	169.39 (145.14 to 195.01)	-0.36% (-0.39 to -0.32)	61774.49 (57328.57 to 66897.82)	137277.92 (129268.62 to 146181.36)	1.22% (1 to 1.49)	1.26 (1.17 to 1.37)	1.65 (1.55 to 1.75)	0.28% (0.01 to 0.56)	8910603.44 (7055603.29 to 10630912.05)	15562161.53 (12752221.99 to 18119263.56)	0.75% (0.65 to 0.85)	166.44 (132.55 to 198.4)	190.97 (156.11 to 222.79)	0.04% (-0.14 to 0.23)
Inter-personal violence	30532907.93 (26665228.45 to 34104552.83)	29398469.66 (26173449.65 to 32645338.17)	-0.04% (-0.06 to -0.01)	555.89 (486.18 to 620.35)	380.86 (339.53 to 420.74)	-1.44% (-1.51 to -1.37)	359571.25 (347873.15 to 371263.47)	397409.97 (376687.98 to 418988.63)	0.11% (0.04 to 0.17)	6.81 (6.59 to 7.02)	4.92 (4.66 to 5.19)	-1.40% (-1.56 to -1.24)	25520310.15 (24340760.12 to 26840838.79)	26829606.6 (25190603.77 to 28718384.56)	0.05% (0 to 0.11)	469.78 (447.23 to 496.02)	336.39 (315.2 to 360.18)	-1.35% (-1.47 to -1.23)
Self-harm	4991727.53 (4220068.18 to 5888530.91)	5487765.49 (4598825.23 to 6504689.68)	0.1% (0.04 to 0.15)	93.16 (79.6 to 109.25)	67.89 (56.6 to 80.76)	-1.42% (-1.51 to -1.32)	709049.24 (610547.72 to 751265.14)	746379.23 (691760.22 to 799846.83)	0.05% (-0.02 to 0.23)	14.86 (12.8 to 15.74)	8.99 (8.34 to 9.64)	-1.97% (-2.11 to -1.83)	34781775.33 (29951610.63 to 36875136.22)	33525091.29 (31307616.58 to 35841263.81)	-0.04% (-0.11 to 0.12)	674.5 (583 to 714.7)	410.19 (383.38 to 438.42)	-1.96% (-2.1 to -1.82)

ASIR, age-standardized incidence rate; ASMR, age-standardized mortality rate; DALYs, disability-adjusted life years; ASDR: age-standardized DALYs rate; EAPC, estimated annual percentage change; AUD, alcohol use disorders; DUD, drug use disorders. Count change calculated based on: (2021 − 1990)/1990*100%; EAPC = 100×(exp(β) − 1), using a linear regression equation where y represents the natural logarithm (ln) of the age-standardized rate for each year, and x represents the year, the EAPC is calculated from the regression equation's slope coefficient β

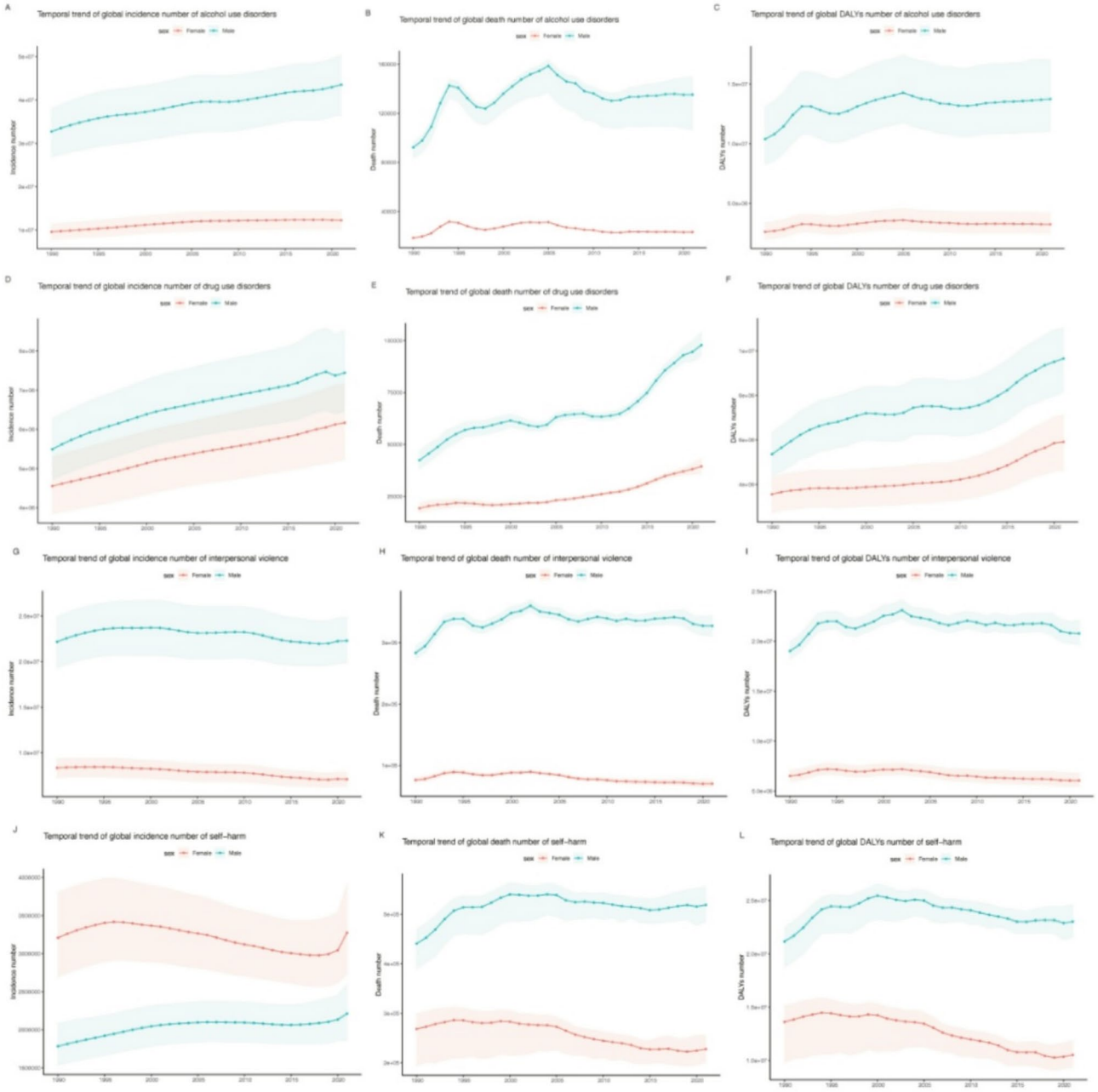

Fig. 1 Epidemiological trends of incidence, death, and DALYs cases for alcohol use disorders (**A, B,C**), drug use disorders (**D, E,F**), interpersonal violence (**G, H,I**), and self harm (**J, K,L**), globally and by sex group from 1990 to 2021. DALYs, disability-adjusted life years

was in Oceania region [2.2% (2.02–2.42)], followed by Western Sub-Saharan Africa [1.15% (1.09–1.22)], where was also increased for self-harm incidence [1.88% (1.73–2.05)]. The downward trend for ASIRs of interpersonal violence has observed in Central Asia [-2.47% (-2.69 to -2.25)], East Asia [-2.55% (-2.72 to -2.39)], and Eastern Europe [-2.29% (-2.69 to -1.9)]. East Asia had the highest downward trend for ASIR in self-harm, with an EAPC of -2.87% (-3.08 to -2.66), as shown in Table S4-15.

In terms of DALYs caused by AUD, the highest burden was in South Asia with 3.23 (2.47–4.27) million and ASDR of 175.81 (133.79-230.88) per 100 000 population in 2021. As for DALYs caused by DUD, the highest burden was in high-income North America with 6.81 (5.76–7.84) million, and the lowest was in Oceania with 9679.65 (6942.86-12722.6). Central Latin America had the highest burden attribute to interpersonal violence with DALYs of 4.56 (4.12–5.03) million and ASDR of 1705.92 (1544-1886.68) per 100 000 population in 2021. South Asia had

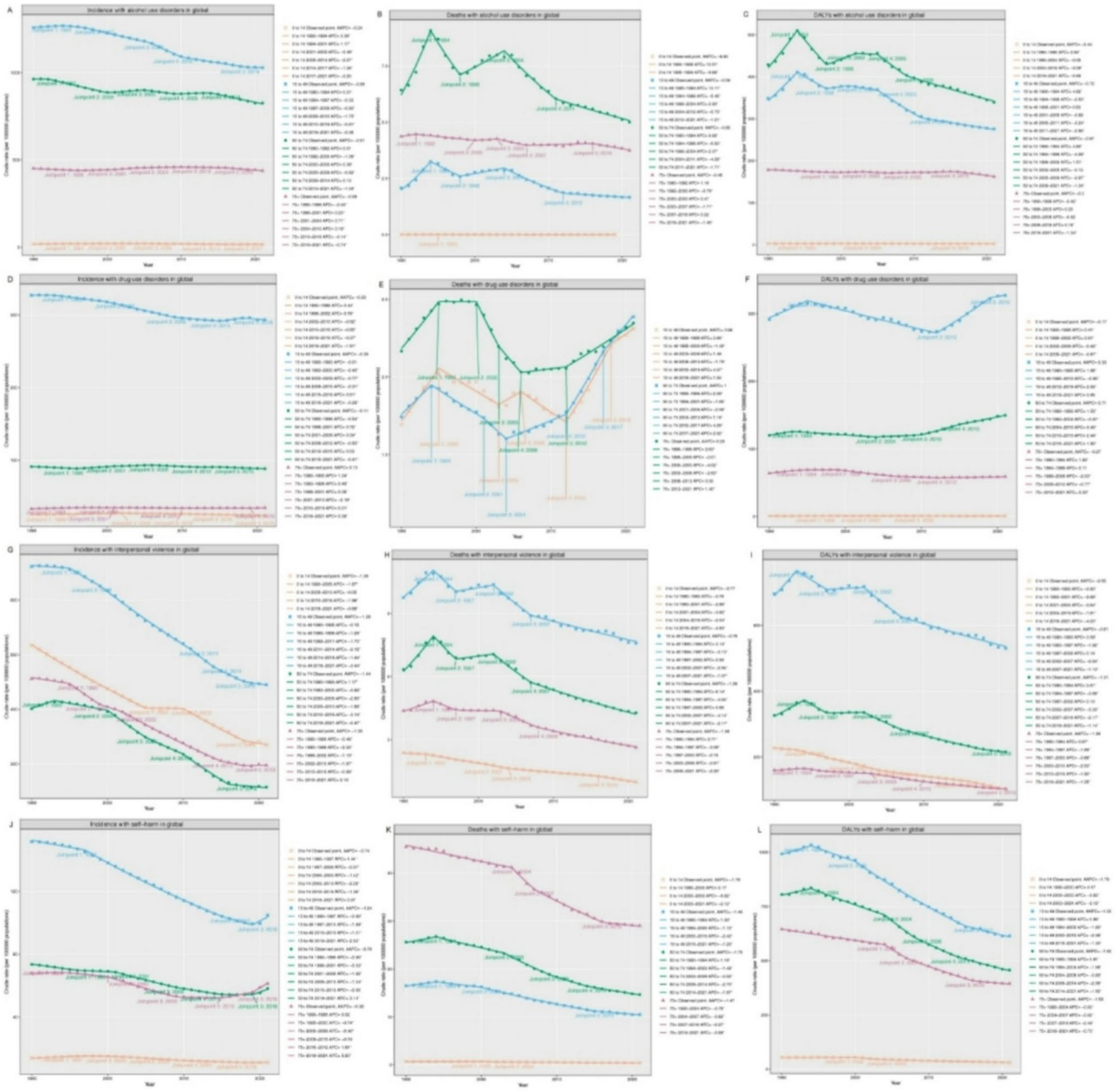

Fig. 2 Annual percentage change for different age groups of incidence, death, and DALYs rates for alcohol use disorders (**A, B,C**), drug use disorders (**D, E,F**), interpersonal violence (**G, H,I**), and self harm (**J, K,L**) across both sex from 1990 to 2021 worldwide. DALYs, disability-adjusted life years

the highest burden attribute to self-harm with DALYs of 11.32 (9.9–12.5) million and ASDR at 576.13 (502.54 to 635.6) per 100 000 population in 2021, and with an EAPC of -1.63% (-1.82 to -1.45) from 1990 to 2021 (Table S4-15).

Trends in ASIR, ASMR, and ASDR by SDI

Figure 5 shown the observed regional and ASIR, ASMR, and ASDR in relation to SDI, and the expected level for each location on the basis of SDI. From 1990 to 2021, we observed the Caribbean, South Sub-Saharan Africa, and Central Sub-Saharan Africa closely followed expected trends in ASDRs from 1990 to 2021. North Africa and Middle East, High-income Asia Pacific, East Asia staying well below expected levels throughout the study period with little change in ASDRs. Eastern Europe well above expected levels with fluctuating ASDRs. For DUD, most regions were closely followed expected trends, expected for Eastern Europe and High-income North America with a higher trend than expected. Conversely, in interpersonal violence, most regions were far from the expected trend, and Southern Sub-Saharan Africa,

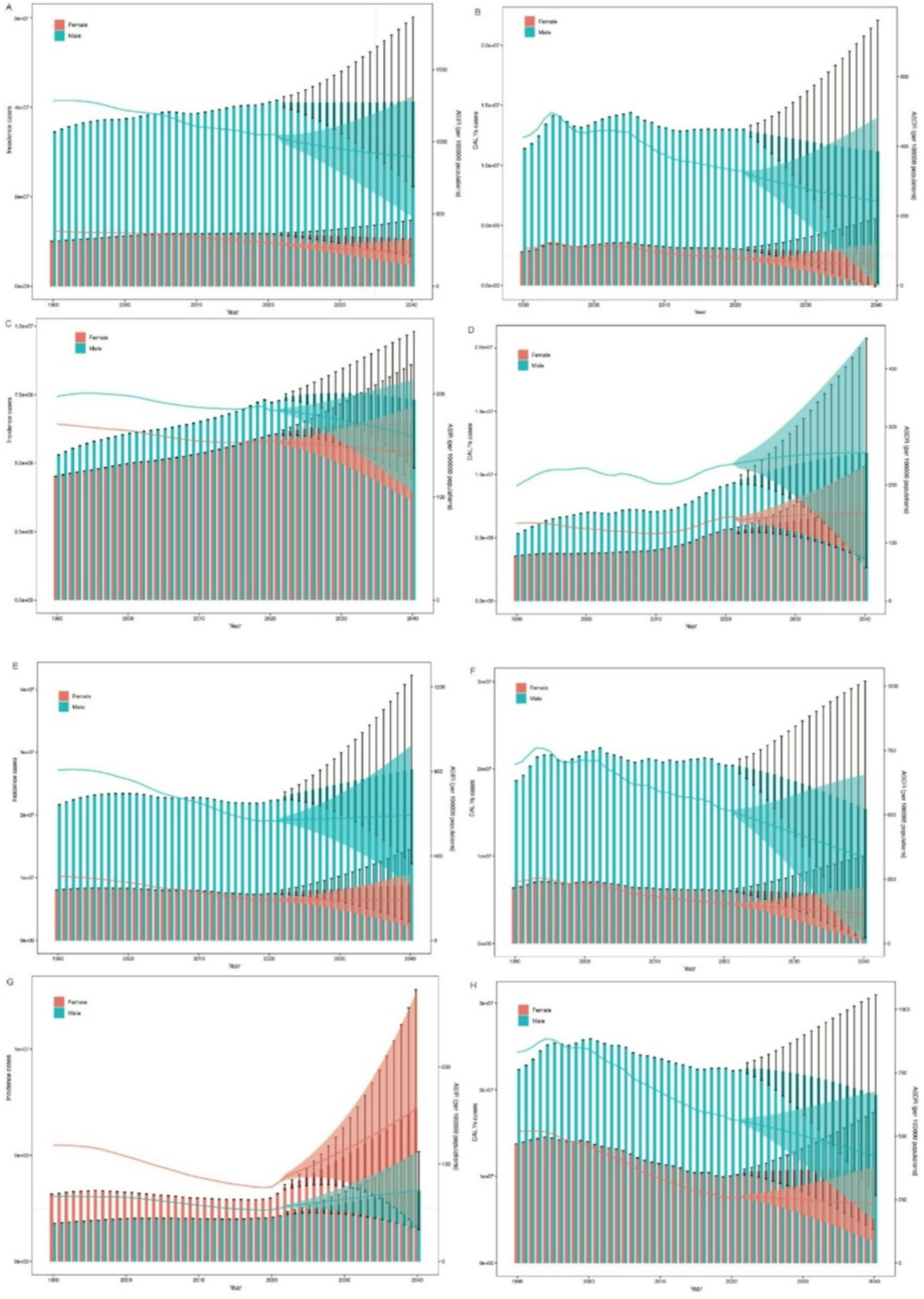

Fig. 3 Projection burden of incidence case, ASIR, DALYs and ASDR for alcohol use disorders (**A, B**), drug use disorders (**C, D**), interpersonal violence (**E, F**), and self harm (**G, H**), globally by sex group from 2022 to 2040. These projections were calculated using the Bayesian Age-Period-Cohort model, under the assumption that current trends will continue without major interventions. ASIR, age-standardized incidence rate; DALYs, disability-adjusted life years; ASDR, age-standardized DALYs rate

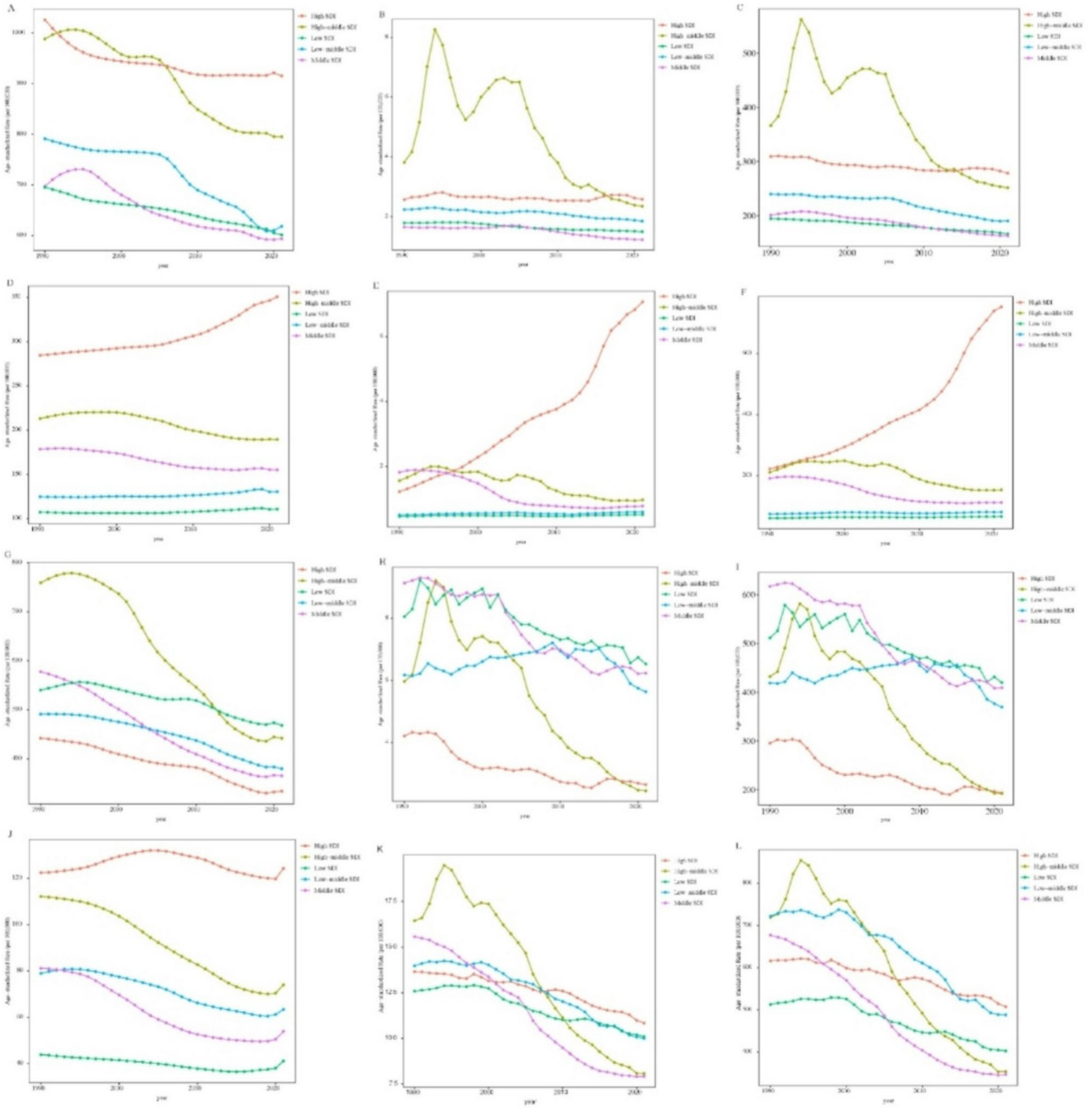

Fig. 4 Temporal trend of age standardized incidence rate, age standardized mortality rate, and age standardized disability adjusted life years (DALYs) rate for the burden of alcohol use disorders (**A, B,C**), drug use disorders (**D, E,F**), interpersonal violence (**G, H,I**), self harm (**J, K,L**), globally and by sociodemographic index (five categories, countries with a high, high-middle, middle, low-middle, or low sociodemographic index) from 1990 to 2021

Central Asia, Central Latin America, and Eastern Europe significantly higher than expected trend over the study trend. Similar to interpersonal violence, ASDRs attributable to self-harm showed an unpredictable trend with a fluctuating line in most regions, and Eastern Europe distinctly higher than expected trend.

Cross-nation health inequality

In 2021, the SII for ASDRs of AUD, DUD and self-harm were 207.32, 121.13, and 134.11, respectively, whereas SII for ASDR of interpersonal violence was − 314.38. A positive concentration index indicates higher burden in high-SDI countries, while a negative index suggests higher burden in low-SDI regions. From 1990 to 2021, the relative gradient inequality, as measured by the relative concentration index, was − 0.15 and − 0.11 for AUD,

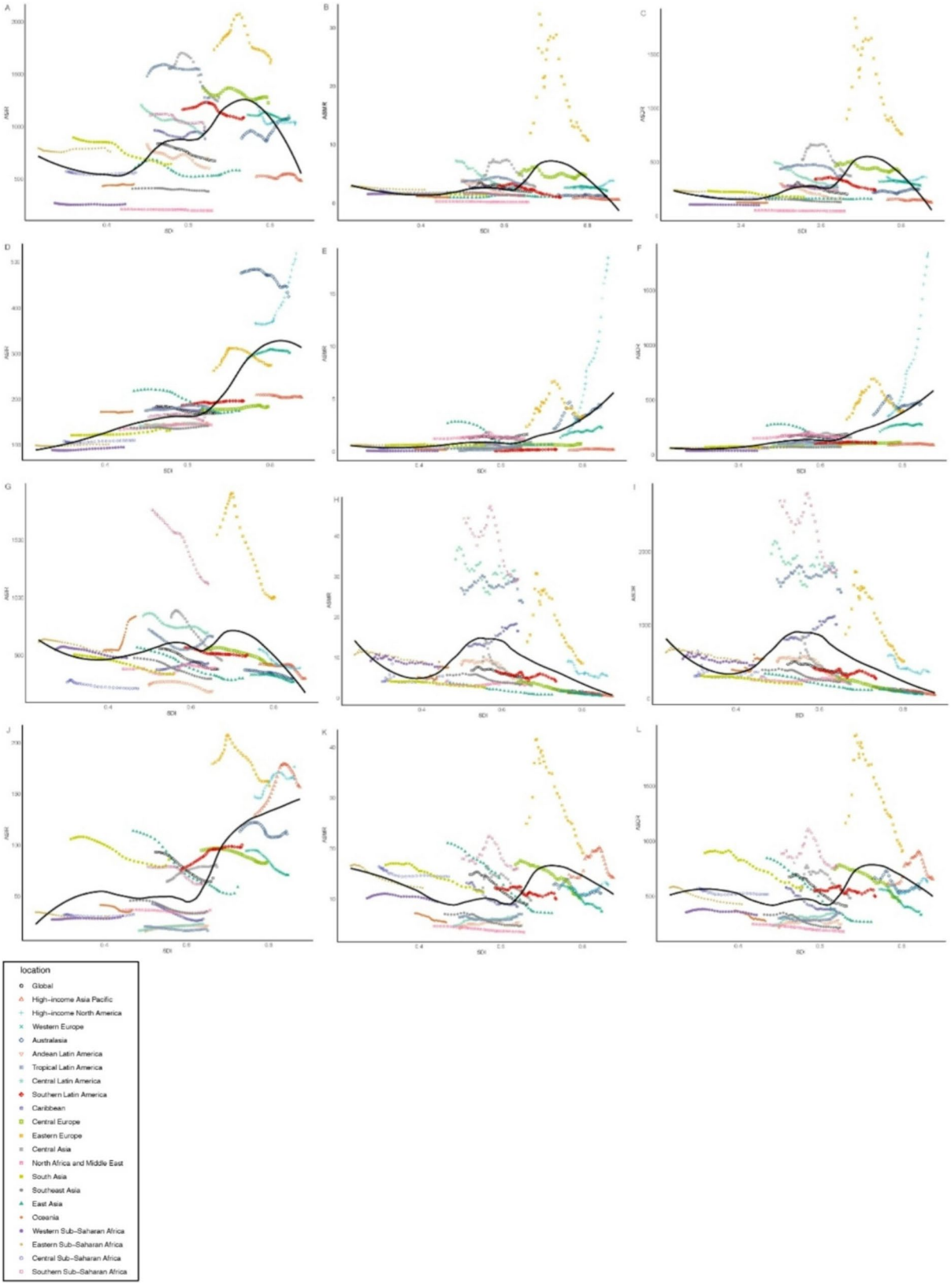

Fig. 5 ASIR, ASMR, ASDR for alcohol use disorders (**A, B,C**), drug use disorders (**D, E,F**), interpersonal violence (**G, H,I**), and self harm (**G, K,L**) from 1990 to 2021. ASIR, age-standardized incidence rates; ASMR, age-standardized mortality rate; ASDR, age standardized disability adjusted life years (DALYs) rate

-0.11 and – 0.42 for DUD, 0.06 and 0.16 for interpersonal violence, and 0.04 and 0.01 for self-harm, which suggests that relative inequality in the burden of AUD and self-harm have decreased, while DUD and interpersonal violence have increased regionally between the poor and the rich populations. From 1990 to 2021, both the SII and relative concentration index decreased for AUD and interpersonal violence, increased for DUD and self-harm (Fig. 6).

Decomposition analysis of the changed dalys

Decomposition analysis revealed that epidemiological alteration demonstrated a considerable positive contribution of 105.62%, 677.97%, 1395.58% to the decreased DALYs burden of AUD, interpersonal violence, and self-harm from 1990 to 2021, respectively. Conversely, epidemiological alteration shown a negative contribution of -23.87% to the decreased DALYs burden of DUD. Population growth and aging negatively impact on reducing burden of DALYs for AUD, DUD, and self-harm, while

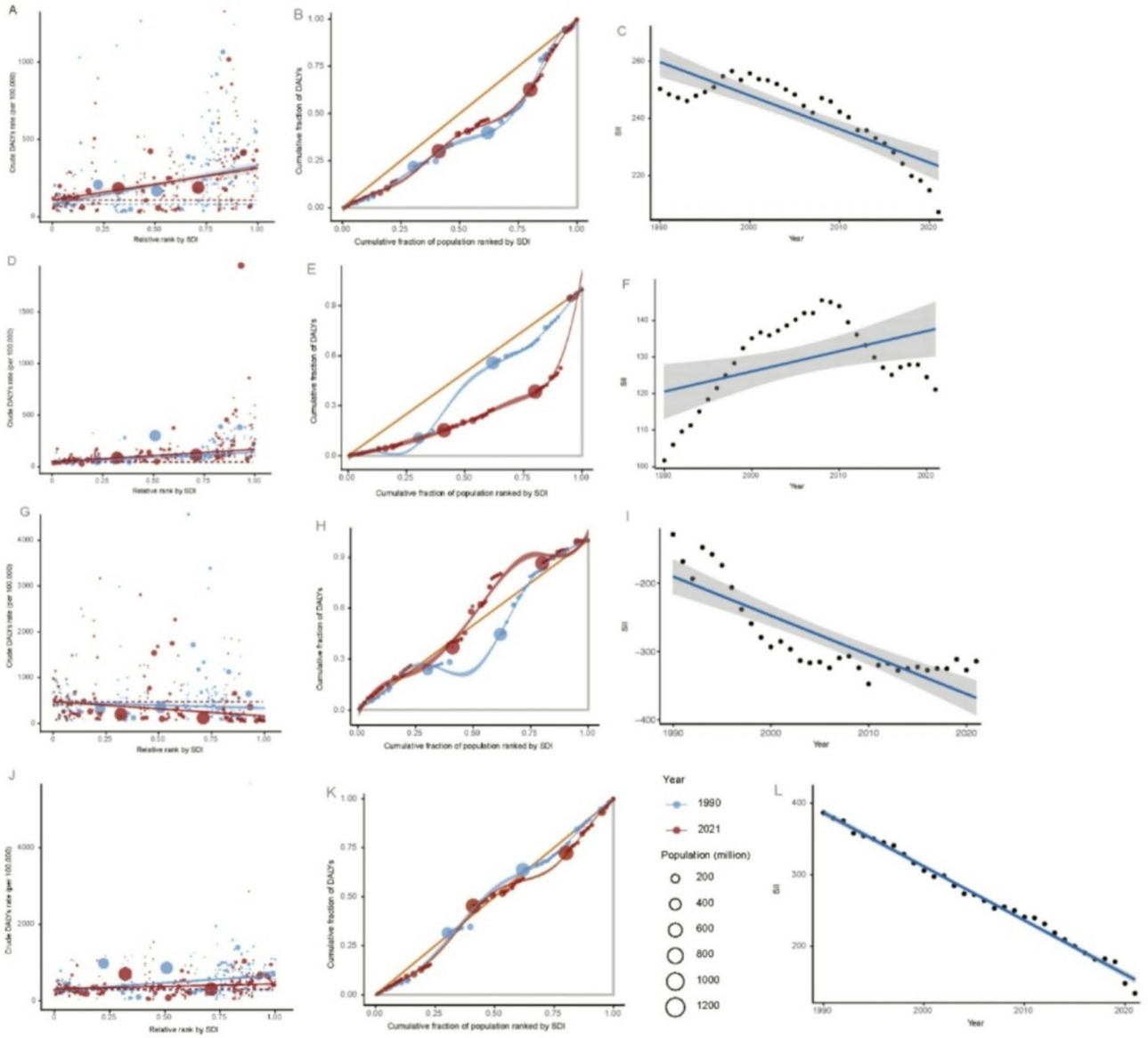

Fig. 6 Health inequality regression curves and concentration curve for alcohol use disorders (**A, B,C**), drug use disorders (**D, E,F**), interpersonal violence (**G, H,I**), and self harm (**J, K,L**) of DALYs. The concentration curve shows the cumulative distribution of DALYs for several conditions across income groups. A positive concentration index indicates higher burden in high socio-demographic index (SDI) regions, while a negative index suggests higher burden in low-SDI regions. The slope index of inequality (SII) curve is a key tool for quantifying absolute disparities between SDI and health outcomes. SII > 0 indicates that DALYs increase with higher SDI, SII < 0 suggests health burdens are concentrated in low-income groups (pro-poor inequality). A larger absolute SII value reflects more severe health inequality. DALYs, disability adjusted life years

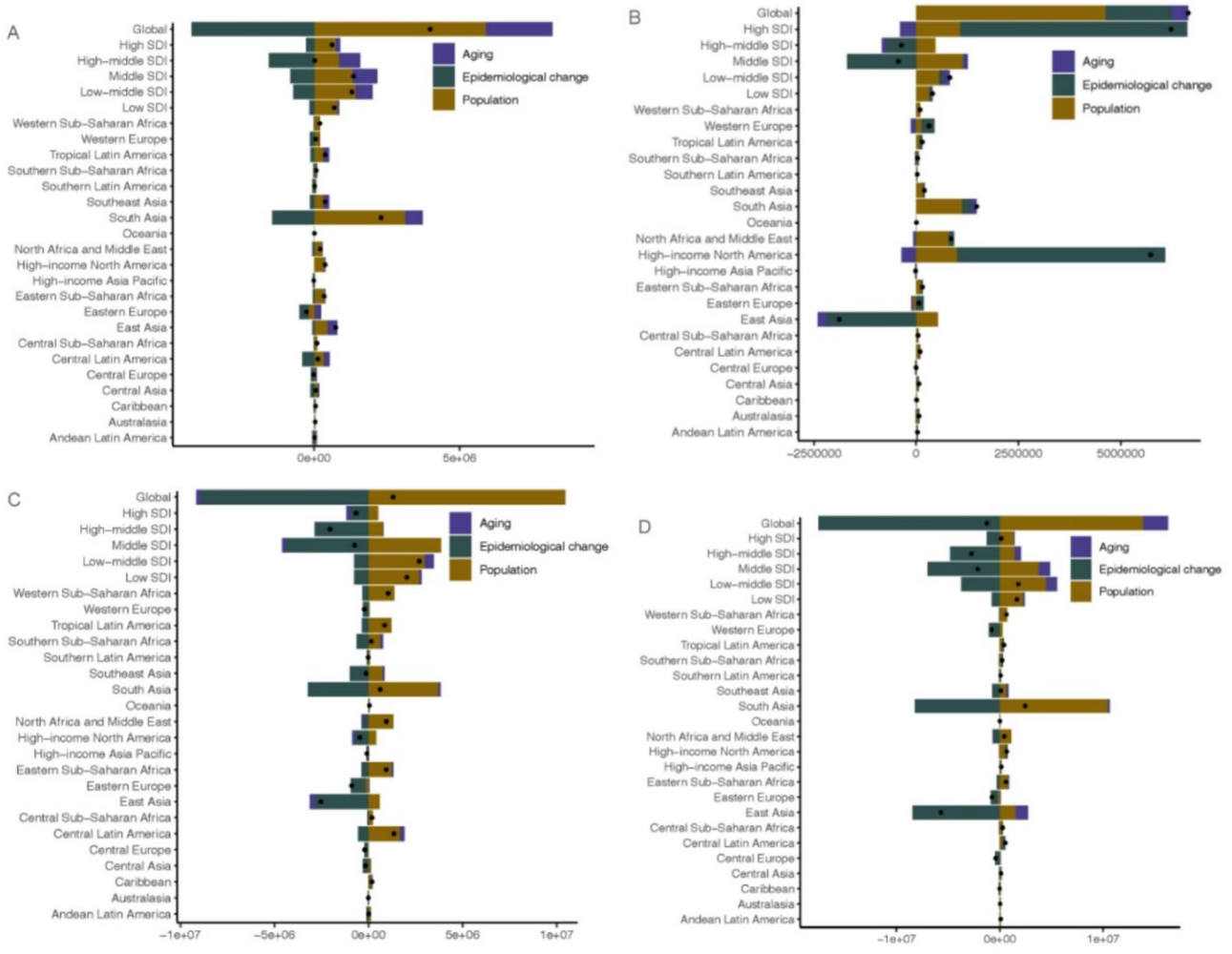

Fig. 7 Decomposition analysis of change in disability adjusted life years for alcohol use disorders (**A**), drug use disorders (**B**), interpersonal violence (**C**), and self harm (**D**)

the increased burden of interpersonal violence has been attributed to population growth (Fig. 7).

In terms of the SDI regions, high SDI had a negative DALYs decreasing effect for AUD, DUD, and self-harm, especially in high-income North American region, which had the most significant increase in the burden of DUD, and mainly attributable to epidemiological alteration with 88.68%. The burden of DALYs associated with all four events increased in low- and low-middle SDI regions, largely attributable to population growth, especially in South Asia, where the burden of the four events was most pronounced (Fig. 7).

Discussion

Main findings

This study estimated the incidence, mortality, and DALYs attributed to AUD, DUD, interpersonal violence, and self-harm worldwide from 1990 to 2021. Globally in 2021, AUD carried the heaviest disease burden among these four behaviors, with an estimated 55.78 million new cases, followed by interpersonal violence with 29.40 million new cases, 13.61 million new DUD cases, and 5.49 million new self-harm cases. Among the new cases of AUD, DUD, and interpersonal violence, and self-harm, the proportions of males were 78%, 54.67%, 75.82%, 40.33%, respectively. In terms of DALYs, the proportion of males were 80.91%, 62.05%, 77.48%, 68.65%, respectively, while for deaths, the proportion of males were 85.32%, 71.26%, 82.31%, 69.54%, respectively. We found that the incidence of self-harm was higher among females, while the disability and mortality rates were lower compared to males, indicating that self-harm is more severe among males, consistent with previous findings [24]. Across age groups, the burden of DUD, interpersonal violence, and self-harm was highest among the 15–49 age group and tend to decreased with increasing age. The burden of AUD was highest among the 50–74 age group, followed by the 15–49 age group, and the

APC trends in DALYs rates these two age groups from 1990 to 2021 were similar. These findings provide key insights for the formulation of public health policies and interventions, emphasizing the importance of prevention and early intervention due to high incidence and mortality rates. Targeted interventions for specific genders and age groups are crucial. The higher incidence and lower DALYs of self-harm among females suggest that they are more likely to seek help and treatment when experiencing mental health problems [25–27], highlighting the need for a more comprehensive mental health counseling and support system. For the 15–49 age group, particularly adolescents and young adults, implementing early identification systems, such as educational programs on drug abuse, violence prevention, and mental health, may improve the current situation of this demographic. For the 50–74 age group, provide specific interventions for AUD, such as screening and brief intervention programs, may facilitate access to treatment and rehabilitation services. Additionally, policies aimed at reducing occupational stress and promoting healthy lifestyles for middle-aged adults may benefit them more. Based on this data, it is possible to guides policy-making, monitors trends in health issues, and ensures the practicality and effectiveness of resource allocation.

AUD

In 2021, the disease burden caused by alcohol has shifted from sub-Saharan Africa to South Asia compared to the 2016 GBD study, and it is still mainly concentrated in low and lower-middle SDI regions, that may be related to stricter alcohol control and public health measures in high income countries. Compared to wealthier drinkers, poorer populations are more likely to engage in heavy episodic drinking, which can significantly increase the risk of death, that may be the primary reason for the life expectancy gap between Eastern and Western Europe [28]. From 1990 to 2021, the global DALYs burden caused by AUD increased by 3.99 million. Except for declines in Central Europe, Eastern Europe, and the high-income Asia Pacific region, all other regions saw an increase, indicating the necessity for global health organizations to establish a framework convention on alcohol control.

The burden of AUD exhibits significant differences by age and gender. From 1990 to 2021, the incidence rate among males has consistently been much higher than that among females. Globally in 2021, the incidence rate among males was approximately 3.53 times that of females. In terms of mortality, although mortality rates declined for both sexes over the 31-year period, the gender disparity increased, from 5.07 times higher in males in 1990 to 6.03 times higher in 2021. The drivers of gender differences in AUD are multifaceted, involving biological [29], sociocultural [30], behavioral [31], and mental health factors [32]. Additionally, males with AUD have a significantly higher risk of suicide than females [32]. Moreover, males are generally less likely than females to seek medical help when facing health issues, leading to delays in the diagnosis and treatment of AUD [33]. There is also evidence that males have lower treatment adherence for AUD [34], resulting in poorer treatment outcomes and an increased risk of alcohol-related deaths. In terms of age distribution, the 15–49 age group has a much higher incidence of AUD than other age groups, though it is encouraging that the incidence rate has declined year by year. While the 50–79 age group does not have the highest incidence rate, it has the highest ASMR and ASDR. That may be due to the cumulative effects of long-term alcohol use, such as cardiovascular diseases and liver cirrhosis, which often interact with AUD, as well as mental health issues triggered by social role transitions [30]. This phenomenon varies across regions, with older adults in low- and middle-income countries likely facing greater health inequalities, leading to a heavier burden of AUD [31]. Therefore, developing gender- and age-specific interventions is key to reducing AUD related deaths.

Currently, the first-line medications for alcohol intervention are naltrexone and acamprosate, with oral naltrexone being more effective than acamprosate in reducing the relapse rate of heavy drinking [35]. However, treatment adherence among individuals with AUD is relatively low. In Australia, only 0–5% of AUD patients adhere to a three-month course of naltrexone or acamprosate treatment [36]. In the United States, the number of deaths attributable to unhealthy drinking can reach 145,000 annually. A 2020 statistical report indicated that over 29.5 million people in the U.S. meet the diagnostic criteria for AUD, yet only 0.9% are receiving treatment [37]. This suggests that pharmacological treatment alone is insufficient to address AUD. Among all mental health disorders, AUD has the lowest treatment rate, which may be related to factors such as low individual willingness to seek treatment [34], economic burdens [31], and insufficient medical resources [38]. When implementing alcohol control measures for this population, it is essential to focus on education and personalized treatment, increase government subsidies and insurance coverage, and expand AUD treatment resources, which may help improve treatment rates.

DUD

Currently, the burden of DUD remains high in high-SDI regions, particularly in high-income North America, where the incidence rate in 2021 was the highest among all GBD regions, at approximately 520.07 (454.13-592.82) per 100,000 population. This may be related to economic accessibility and the established drug communities in

high-income countries. Opioids are listed by the WHO as essential medicines for acute and cancer pain, palliative care, and opioid dependence treatment [39]. In many high-income countries, particularly the United States, the complex intersection of illicit opioid use and increased prescription rates for medical purposes has raised growing concerns about the non-medical use of opioids and opioid-related harms [40]. Over the past two decades, opioid prescriptions for various chronic non-cancer pain conditions have significantly increased in some countries, especially the United States and Canada [40]. Between 2011 and 2013, the United States consumed 68% of the world's prescription opioid analgesics [41]. In 2020, 59.3 million people aged 12 and older in the U.S. used illicit drugs, with 2.7 million suffering from opioid use disorders [42]. In Canada, between April and June 2021, 1,720 people died from opioid poisoning, a 66% increase compared to the same period in 2019, largely attributed to clandestinely produced synthetic opioids, isolation, and limited access to medical and social services [43]. The use of opioids is lower in Africa, Asia, Central America, the Caribbean, South America, Eastern Europe, and Southeastern Europe [41]. Patterns and harms of non-medical opioid use and dependence continue to vary significantly across countries.

The incidence and mortality rates of DUD are increasing annually across all genders, with males having higher DUD mortality and incidence rates than females, although the gender disparity is less pronounced compared to AUD. The issue of drug use among young people is currently a major social concern, with the highest number of new DUD cases occurring among individuals aged 15–39, far exceeding other age groups. The mortality rate in this age group began to rise sharply after 2004, likely linked to the proliferation of prescription drugs in the early 2000s, particularly in North America [41]. Adolescents are at a critical juncture of cognitive and emotional development, making them highly susceptible to drug dependence following external interventions. Regular health screenings should be conducted for these high-risk groups. Individuals with DUD often experience intersecting structural vulnerabilities, which may include comorbid mental illnesses, personality disorders, or mood disorders [44], as well as inequalities in access to resources such as education and income, leading to social exclusion and relative poverty [44]. Public health policies and social interventions that address the causes and consequences of these vulnerabilities can fundamentally reduce the burden of DUD.

Additionally, individuals with AUD and DUD share intersecting structural vulnerabilities [45] and exhibit clear patterns in terms of gender and age. Therefore, peer support may play a crucial role in alleviating patients' resistance to treatment and the social stigma they face [46]. By designing support programs tailored to the characteristics of different gender and age groups, the effectiveness of interventions can be enhanced. Compared to females, males tend to have lower treatment adherence, so providing male-exclusive peer support groups that focus on high-risk behavior interventions may be beneficial [47]. For female, greater emphasis should be placed on mental health and trauma recovery, and creating a safe environment may help them build trust and support networks [48]. Adolescents and young adults are more susceptible to peer influence, making it essential to implement peer support programs in schools and communities to promote healthy communication and interaction among peers [49]. For middle-aged adults, interventions should focus on occupational and family support, while older adults require attention to their social roles, with efforts to reduce loneliness and strengthen health management [50].

Interpersonal violence and Self-Harm

One of the serious consequences of interpersonal violence and self-harm is mental health issues. Strengthening social support to alleviate the psychological pressure on those who have experienced violence and self-harm is crucial. Fortunately, from 1990 to 2021, the incidence, DALYs, and mortality rates of global interpersonal violence and self-harm have shown a downward trend. This reflects increased global awareness of mental health issues and has also expanded opportunities for this population to access mental health services and social support. Previous GBD studies have found that AUD and DUD, as major risk factors for violence and self-harm, significantly impact the social burden of disease. Intervention policies targeting AUD and DUD may help reduce the occurrence of interpersonal violence and self-harm.

The burden of interpersonal violence and self-harm varies significantly across countries and regions. In 2021, the difference in incidence rates between the countries with the highest and lowest rates of interpersonal violence and self-harm could be as much as several dozen times. For instance, Libya had the highest incidence rate of interpersonal violence at 2,673.66 (2,573.79-2,774.52) per 100 000 population, which may be related to political instability and frequent conflict events [51]. Additionally, countries such as El Salvador and Honduras in Central America, as well as Lesotho and South Africa in Southern Africa, also bear a heavy burden of interpersonal violence. Greenland had the highest incidence rate of self-harm at approximately 456.61 (410.02-500.45) per 100 000 population, which may be linked to its high rates of depression and anxiety [52]. These countries face complex challenges in development and public health.

Notably, females have higher rates of self-harm, which may be linked to the fact that they are nearly twice as

likely as males to suffer from depression [53]. According to psychiatric epidemiological survey reports, females tend to focus more on their emotions than males [54], which may explain the higher risk of depression among females. Additionally, we found that males have higher DALYs and mortality rates due to self-harm than females, indicating that they are more likely to choose fatal methods of self-harm when facing mental health issues. It is estimated that 60% of females experience violence at least once in their lifetime [55], and the interpersonal violence suffered by females is more likely to come from intimate partner violence (IPV) [56]. This may be related to the vulnerable status of female in families and society, as well as the remnants of gender discrimination culture. Therefore, interventions targeting females should address their specific needs and vulnerabilities. Males have a higher incidence of interpersonal violence than females, and without effective interventions, this trend is expected to persist until 2040. This phenomenon may result from a combination of biological, sociocultural, psychological, and economic factors [57]. Implementing anti-violence campaigns, providing emotion regulation training, and expanding mental health services may help reduce the interpersonal violence burden among males, thereby improving their health and social outcomes.

The impact of AUD and DUD on self-harm and interpersonal violence: global burden and policy challenges

Many causes of AUD and DUD related burdens are preventable or treatable. Numerous policies aim to mitigate the health, social, and economic harms caused by alcohol and drugs. However, differences in geography, gender, etiology, age, and other factors result in varying effectiveness and cost-effectiveness of these policies, posing challenges in identifying the most efficient and economical methods for prevention and health improvement. It is important to note that AUD, DUD, interpersonal violence, and self-harm are interconnected, complicating the etiology of these social issues. In this study, we found that AUD, as a risk factor, accounted for 68.45% of deaths and 68.87% of DALYs due to self-harm and interpersonal violence, while DUD accounted for 11.11% and 9.92%, respectively. These findings are consistent with previous research. Hoaken et al. concluded that alcohol has a stronger association with violence than any other psychoactive substance [58]. Cherpitel C.J. and colleagues found an inverted U-shaped relationship between blood alcohol concentration and the risk of violence [59], with 14.9% of violence being alcohol-related [60]. Acute intoxication increases suicidal tendencies, while long-term alcohol use increases suicidal ideation [61]. From 1990 to 2021, the proportion of DALYs due to self-harm and interpersonal violence related to AUD and DUD increased globally from 7.6 to 8.4%. Geographically, the proportion related to drug use in high-income North America increased by 6.5%, while the alcohol-related proportion remained relatively stable. In Andean Latin America, the alcohol-related proportion increased by 5% (Figure S2). Overall, policies aimed at controlling alcohol and drug use are also applicable to violence and suicide. Based on our projections, the burden of AUD, DUD, interpersonal violence, and self-harm will remain high globally by 2040. If left unaddressed, this will impose a heavy burden on global public health and social well-being.

Additionally, the attributable burden across different SDI levels reveals varying degrees of AUD, DUD, interpersonal violence, and self-harm, as well as the relationship between burden and SDI. Our findings indicate that as SDI increases, the health impacts of drug use may become more severe, while lower SDI regions face more complex and significant health challenges. Compared to high-SDI regions, populations in lower-SDI regions are exposed to greater socioeconomic disadvantages, such as poverty, lack of education, and violence, and are more susceptible to mental health issues related to self-harm. However, they also have limited access to prevention and treatment opportunities, creating a vicious cycle. Establishing comprehensive policies targeting social disorder factors is crucial for creating a favorable social environment, particularly for "diagnosed individuals" seeking to restore a healthy lifestyle and social well-being. Nevertheless, the coverage of these interventions remains low, especially in low- and middle-income regions. Promoting collaboration among public health, education, law enforcement, and community organizations to jointly develop and implement effective intervention strategies is essential.

Limitations

This study is based on GBD data, covering the burden of AUD, DUD, self-harm, and interpersonal violence globally from 1990 to 2021. It provides a broad temporal and geographical analysis. Additionally, we not only reviewed disease burden trends over the past 31 years but also projected future trends for 2040 using BAPC models, offering important reference points for policymakers. Importantly, this study not only focuses on incidence, mortality, and DALYs but also analyzes differences by gender, age, region, and SDI, providing a multidimensional analytical perspective. However, this study has limitations. In the GBD study, the exclusion of certain DUDs (e.g., cannabis) may lead to an underestimation of deaths. Furthermore, the data collection systems in healthcare facilities in underdeveloped regions are inadequate, resulting in insufficient statistical support for drug use and violence, potentially underestimating the harmful societal impacts of AUD, DUD, interpersonal

violence, and self-harm. Due to social stigma and underreporting, data on self-harm and interpersonal violence may be underestimated, particularly in low-SDI regions. Additionally, diagnostic criteria for mental health disorders and substance use disorders vary across regions, which may lead to underestimation or overestimation of the related disease burden. To obtain more accurate data, it is essential to fully consider the cultural, economic, and social contexts of different regions when compiling statistics for these conditions. Moreover, given the timeliness of the data, the GBD 2021 data may not fully reflect the most current situation [62]. The projections for disease burden up to 2040 are based on trends and assumptions from GBD 2021, and future economic crises, policy changes, and environmental factors (e.g., climate change) may significantly impact the accuracy of these predictions. Therefore, the projected results should be interpreted with caution and dynamically adjusted in light of future real-world data.

Conclusion

Our findings provide insights into the contemporary and future global burden of AUD, DUD, interpersonal violence, and self-harm. From 1990 to 2021, the disease burden of AUD, DUD, interpersonal violence, and self-harm exhibited specific patterns across different genders, age groups, and regions. Multilevel interventions should be initiated to prevent the disease burden related to DUD, interpersonal violence, and self-harm among individuals aged 15–49, as well as the burden related to AUD among individuals aged 50–75, particularly males. Although health inequalities for AUD and self-harm have decreased over the past few decades, relative inequalities for DUD and interpersonal violence continue to worsen, especially in low- and middle-income regions. Efforts should focus on reducing inequalities through resource allocation and policy support.

Abbreviations

AUD	Alcohol use disorders
DUD	Drug use disorders
GBD	Global Burden of Disease
DALYs	Disability-adjusted life years
SDI	Socio-demographic index
WHO	World Health Organization
BAPC	Bayesian age-period-cohort
TFR	Total fertility rate
SII	Slope inequality index
YLD	Years lived with disability
YLL	Years of life lost
EAPC	Estimated annual percentage change
APC	Annual percentage change
INLA	Integrated nested Laplace approximations
ASIR	Age-standardized incidence rates
ASMR	Age-standardized mortality rate
ASDR	Age-standardized DALYs rate

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-22814-0.

Supplementary Material 1

Acknowledgements

None.

Author contributions

Jia An, Qiang Wang, and Zihao Bai drafted the manuscript; Xueying Du first analysis the data; Di Yu and Xuming Mo revised the manuscript. All authors feedback the data statistical analysis, had full access to all the data in the study, and had final responsibility for the decision to submit for publication.

Funding

This work was supported by the National Natural Science Foundation of China (81970265, 82270310, 82370306), and Science and Technology Development Project of Nanjing (YKK21146).

Data availability

GBD data is publicly available for anyone who registers at http://ghdx.healthdata.org/gbd-results-tool.

Declarations

Ethics approval and consent to participate

The GBD data are de-identified and publicly available. Therefore, the study is exempted from institutional ethical board review.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 30 August 2024 / Accepted: 15 April 2025
Published online: 02 May 2025

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