The Association Between Substance Use Prevalence and Youth Mortality: A Comparative Study of Selected EU Countries

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INTRODUCTION: Psychoactive substance use constitutes a significant determinant of morbidity and mortality among adolescent and emerging adult populations across European Union member states. This study aims to examine associations between substance use prevalence and drug-induced mortality rates, with a focus on age- and gender-specific disparities and spatiotemporal patterns across selected EU countries. **METHODS:** The research design employed a quantitative descriptive-comparative analysis of EMCDDA and EUDA datasets spanning the years 2010–2022, complemented by predictive modelling using linear regression (OLS). Mortality rates were standardised per million inhabitants and stratified by gender, age group, and geographic region to identify high-risk cohorts. **RESULTS:** Findings reveal substantial heterogeneity in drug-induced mortality, with the highest rates recorded in Germany, Spain, and Sweden, and a marked predominance among males aged 15–44 years. Forecasting indicates a continuing upward trend in mortality, particularly among young males, underscoring the urgent need for targeted prevention and treatment interventions. **CONCLUSIONS:** Substance use among youth remains a pressing public health concern, characterised by pronounced demographic and regional disparities requiring a multidimensional approach. This study makes a significant contribution to the understanding of drug-related mortality in Europe. It provides an analytical framework to support the development of targeted public health policies and harm reduction strategies.

Keywords | Substance Use Epidemiology, Youth Mortality, Drug-Induced Deaths, European Union Comparative Analysis, Public Health Policy

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1 INTRODUCTION

The use of psychoactive substances among adolescent and emerging adult populations represents a significant public health challenge across the European Union. Empirical research consistently highlights a direct association between the consumption of addictive substances, particularly alcohol, tobacco, and illicit drugs, and increased morbidity and mortality rates within this vulnerable cohort. Despite the implementation of numerous preventive, regulatory, and therapeutic strategies at both national and supranational levels, significant heterogeneity persists across Europe in terms of substance use prevalence and the associated health consequences.

The present study aims to examine the correlation between the prevalence of psychoactive substance use and drug-induced mortality rates among younger age groups in selected EU member states. The chosen comparative methodology facilitates the exploration of spatial and temporal disparities in the incidence of fatal outcomes attributable to acute intoxication or chronic substance abuse. The analysis takes into account gender- and age-specific patterns as well as sociocultural determinants of these phenomena.

By recent epidemiological trends, particular attention is paid to mortality related to opioid use, new psychoactive substances (NPS), and polydrug combinations, which, according to data from the EUDA, are most frequently detected in postmortem toxicological reports. The findings of this study provide a robust empirical basis for the formulation of targeted public health policies and the optimisation of prevention strategies aimed at addressing high-risk behaviour in young populations.

Furthermore, the analysis provides a framework for assessing the effectiveness of current intervention strategies and identifying high-mortality regions requiring urgent action in the areas of harm reduction, accessibility of opioid substitution therapy, and strengthening of youth mental health support systems.

2 LITERATURE REVIEW

Drug-related and overdose mortality constitutes one of the most pressing contemporary public health challenges, significantly affecting both younger and older adult populations across numerous global regions. From a global perspective, a marked increase in mortality associated with substance use disorders has been observed, particularly in high-income countries (Kim et al., 2025). Snowdon (2022) highlights a dramatic rise in deaths linked to fentanyl and stimulants in countries such as the United States and Canada. Nguyen et al. (2024) report a sharp surge in unintentional overdose fatalities involving synthetic opioids, psychostimulants, and cocaine in the U.S., alongside an increase in suicides associated with these substances. In Europe, illegally manufactured fentanyl analogues represent a growing concern (Pichini et al., 2017).

The opioid crisis, especially within the European context, necessitates a multidimensional public health response. Alho et al. (2020) emphasise the critical need to regulate opioid prescribing practices while expanding access to medications for opioid use disorder (MOUD), psychosocial support services, and harm-reduction interventions. Although Europe has not experienced an opioid epidemic comparable to that in the U.S., substantial challenges persist, particularly related to heroin and synthetic opioids (Seyler et al., 2021). Suicidal overdoses represent a distinct and serious threat. Lynn et al. (2022) and Devin et al. (2023) identify strong correlations between poor mental health, chronic pain, and elevated suicide risk. Suicidal behaviour has emerged as a significant predictor of fatal overdose, particularly among individuals with a history of heroin use (Horigian et al., 2022). Mental health disorders such as depression and post-traumatic stress disorder have been shown to exacerbate overdose risk in opioid users (Fendrich et al., 2019).

Regional analyses reveal contextual variability in substance use patterns. Illicit drugs are more commonly implicated in unintentional overdoses, whereas prescription medications predominate in suicidal cases (Shiue et al., 2022; Lundgren et al., 2022). In Spain, overdoses involving commonly prescribed medications among older adults are on the rise (Hernández-Calle et al., 2022). In Taiwan, methamphetamine users are at markedly elevated risk of suicide-related mortality (Lee et al., 2021). Age and gender are critical determinants of overdose risk. Daly et al. (2020) document an increasing incidence of intentional paracetamol overdoses among young women, and Gilley et al. (2019) report a steep rise in hospital admissions for deliberate overdoses among adolescents. Younger individuals are more likely to engage in highly lethal methods such as hanging (Arensman et al., 2016). Kurdil (2022) analysed age trends in acute drug poisonings in Kyiv between 1990 and 2020, identifying young adults aged 20–39 as the most affected group. Risk perception represents another pivotal factor. Many drug users fail to perceive fatal overdose as a credible threat (Hanoa et al., 2023). Recurrent comatose intoxications with gamma-hydroxybutyrate (GHB) are often associated with socioeconomically deprived contexts and risk-permissive lifestyles (Grund et al., 2018). Technological tools hold promise in improving data acquisition in this field. Machine learning has demonstrated potential in identifying concealed suicides within categories of unspecified overdoses, thereby enhancing epidemiological accuracy (Liu et al., 2019).

The role of prescription medications in older populations is also significant. Benzodiazepines and opioid analgesics have been linked to increased suicide risk (Kędziora-Kornatowska et al., 2022). Tralla et al. (2024) identified zopiclone as a common agent in suicide-related intoxications, while Mounteney et al. (2015) documented the emergence of new psychoactive substances that place an added burden on treatment systems. Lastly, serious gaps remain in digital suicide prevention efforts. While search engines display crisis hotline links when users query the word “suicide,” this functionality often fails when drug names are added, thus reducing the effectiveness of digital interventions (Haim et al., 2021).

Comprehensive prevention of drug-related fatalities necessitates integration across mental health services, prescription regulation, social support, and digital outreach. Targeted identification of high-risk populations and granular analysis of local epidemiological trends are essential for reducing both overdose mortality and suicide-related behaviour.

3 METHODS

The study employed a quantitative, descriptive-comparative design to examine trends in drug-induced mortality across European Union member states, Norway, and Türkiye from 2010 to 2022. The analysis was based on data obtained from the European Drug Report (EMCDDA) and the European Union Drug Agency (EUDA), with a specific focus on mortality among young adults aged 15–44 years.

Mortality data were disaggregated by sex and four age groups: 15–24, 25–44, 45–64, and 65–74 years. Comparative analyses were conducted to identify sex-specific and inter-country differences in mortality trends within the EU27+2 region (including Norway and Türkiye). Mortality rates were standardised as deaths per one million population. In cases of missing data, the most recent available years were used.

The methodology also included a predictive component estimating drug-induced mortality rates up to the year 2027. For this purpose, time-series linear regression models were constructed for each sex- and age-specific cohort. The models were estimated using the Ordinary Least Squares (OLS) method, where the calendar year served as the independent variable and the mortality rate as the dependent variable.

Data processing and visualisation were conducted using line and bar charts to illustrate annual trends and regional disparities. Statistical analyses were performed using Microsoft Excel and Python, incorporating NumPy, pandas, matplotlib, and scikit-learn libraries.

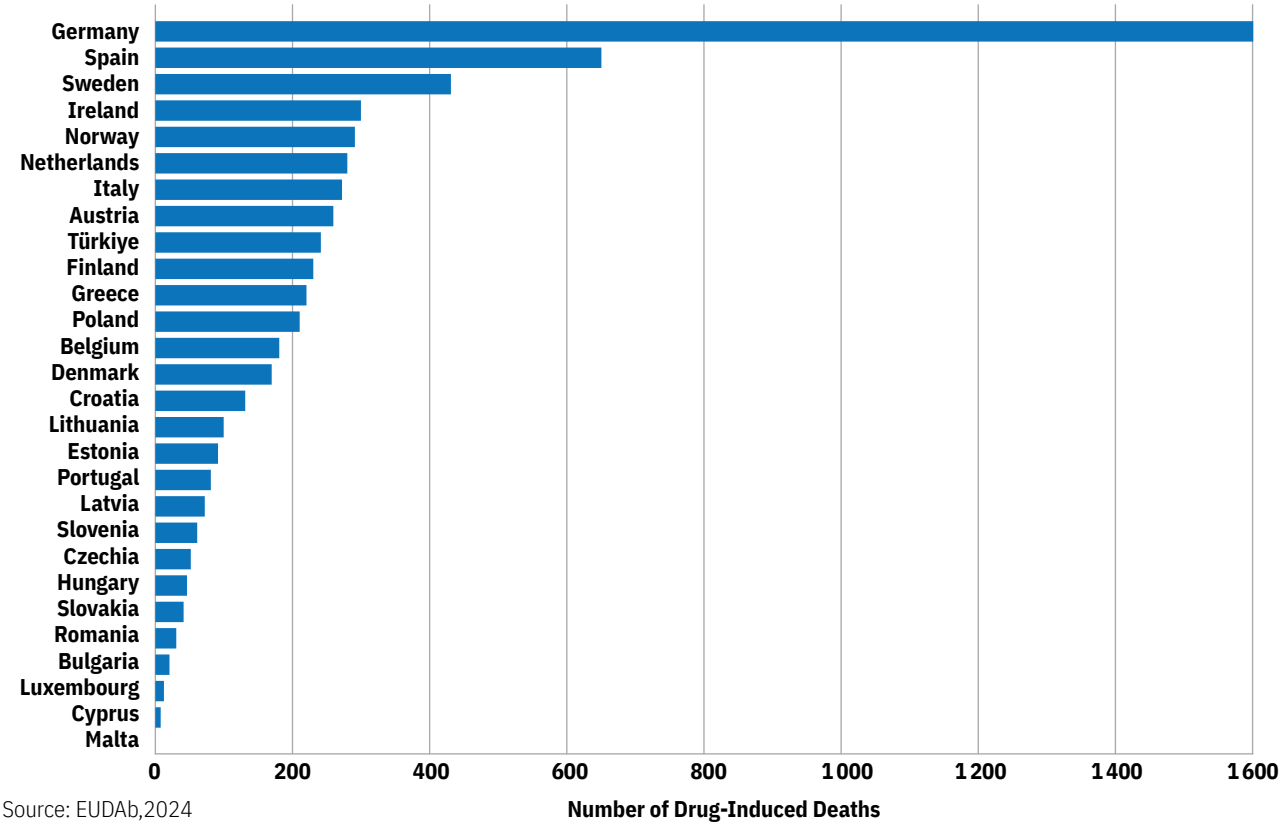
The analysis accounted for differences in the availability of postmortem toxicological data and heterogeneity in national reporting systems. The assessment also included drug-related deaths involving polydrug use, the presence of opioids (including heroin and its metabolites), stimulants (e.g., cocaine, MDMA, amphetamines), and new psychoactive substances (NPS), as well as sex differences in mean age at death.

4 RESULTS

It is estimated that in 2022, there were at least 6,392 drug-induced deaths due to overdose in the European Union (compared to 6,166 in 2021). When including Norway and Türkiye, this number increases to approximately 7,000 deaths. These figures should be interpreted as underestimates, given that drug-related mortality data—especially cumulative totals for Europe—remain limited in coverage and quality. Mortality data for 2022 are not yet available for all countries; in such cases (11 out of the 27 EU member states), the most recently available national statistics are used to estimate the EU total (EUDAa, 2024).

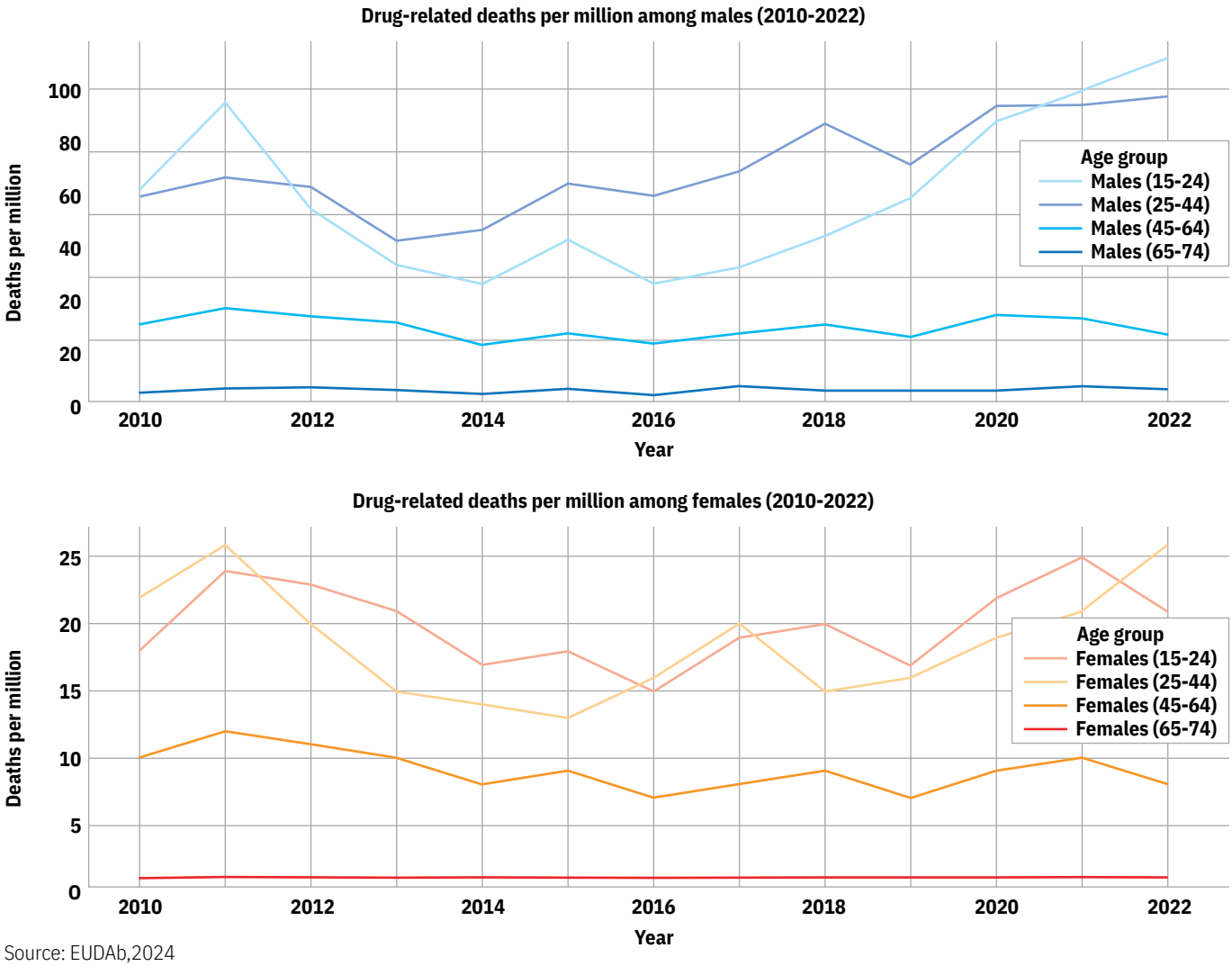
Opioids, including heroin and its metabolites—frequently in combination with other psychoactive substances—were implicated in approximately three-quarters (74%) of all fatal overdoses reported in the European Union in 2022. It is important to note that postmortem toxicological analyses typically detect multiple substances, reflecting a high prevalence of polydrug use. The gender distribution of drug-induced deaths in Europe shows a marked male predominance, with men accounting for 77% of cases and women comprising only 23%. This disparity

Figure 1 | Drug-induced deaths among adults (15-64) in EU, Norway and Turkiye – 2022



Source: EUDAb,2024

Figure 2 | Trends in Drug-Induced Mortality per Million Inhabitants by Age Group and Sex, 2010–2022 (EU, Norway, and Türkiye)



Source: EUDAb,2024

reflects both a higher exposure of men to high-risk substance use behaviours and a greater likelihood of experiencing fatal outcomes. These findings are consistent with long-standing epidemiological patterns in drug-related mortality (EUDAa, 2024).

Marked inter-country variability in the number of drug-induced deaths can be observed across the European Union, Norway, and Türkiye. Germany reported the highest absolute number of cases (approximately 1,600), far exceeding all other countries in the dataset. Spain and Sweden followed, with around 650 and 430 deaths, respectively, together representing a significant proportion of the region's overall drug-related mortality. Intermediate mortality levels (200–300 cases) were observed in Ireland, Norway, the Netherlands, Italy, Austria, and Türkiye. At the lower end of the spectrum were countries such as Cyprus, Luxembourg, and Malta, where the incidence of drug-induced deaths was negligible or zero. These data underscore the considerable heterogeneity in drug mortality rates among countries in the region (see Figure 1).

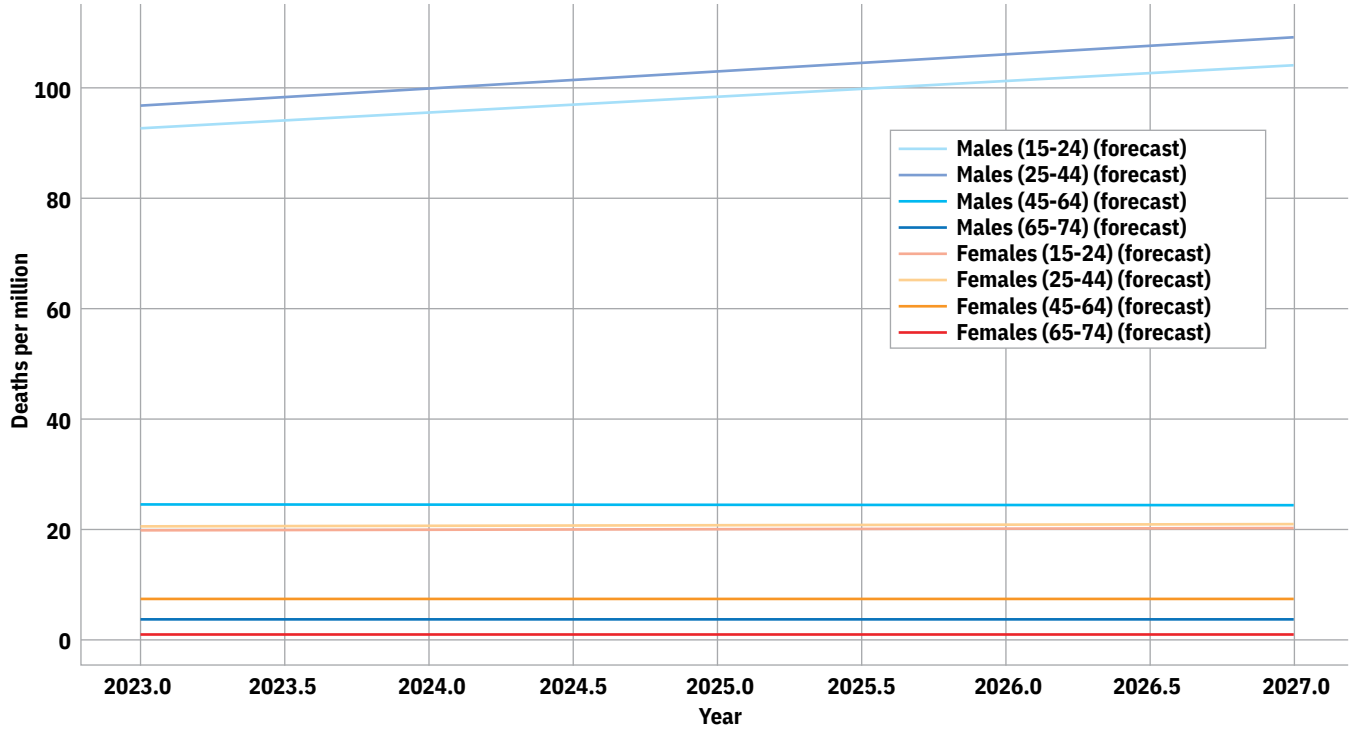
The observed disparities may be attributed to a range of determinants, including inconsistencies in data reporting practices, variations in drug availability and purity, differences in national drug prevention policies, and the quality of toxicological investigations. Cultural and social factors also play a significant role, influencing both the prevalence of psychoactive substance use and associated risk behaviours.

These findings underscore the urgent need to strengthen coordinated public health policies and implement targeted preventive strategies in the most affected countries. Furthermore, they highlight the necessity for harmonised data collection and transparent reporting of drug-related mortality across Europe.

The line graphs presented in **Figure 2** illustrate the temporal evolution of drug-related mortality per one million inhabitants in the European Union, Norway, and Türkiye from 2010 to 2022. The data are disaggregated by sex (male and female) and four principal age cohorts: 15–24, 25–44, 45–64, and 65–74 years.

The data reveal a pronounced predominance of mortality among males across all age categories. The highest mortality rates are observed in young males aged 15–24, reaching over 110 deaths per million inhabitants in 2022. This figure represents the most substantial increase across the entire observed period and reflects an alarming trend of deteriorating conditions within this demographic. A similar, albeit more moderate, increase is also evident among males aged 25–44, whose mortality rate approached 100 deaths per million in 2022.

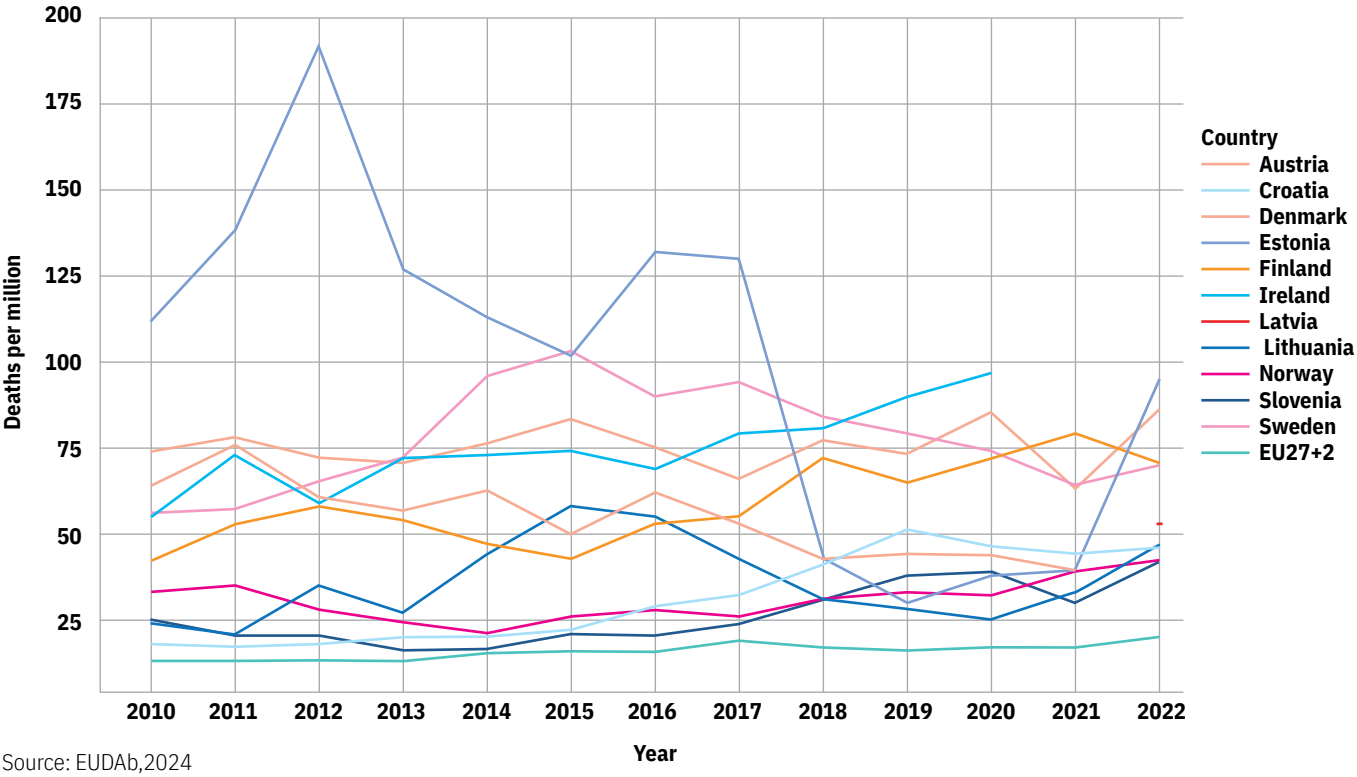
Figure 3 | Forecast of drug-related deaths per million (2023-2027)



In contrast, mortality rates among females remain significantly lower and relatively stable throughout the observed timeframe. The most affected female subgroup comprises women aged 25–44, with mortality rates ranging between 15 and 26 deaths per million. Among the older age groups (45–64 and 65–74 years), mortality remains low and exhibits only minor fluctuations, with no substantial long-term trend changes.

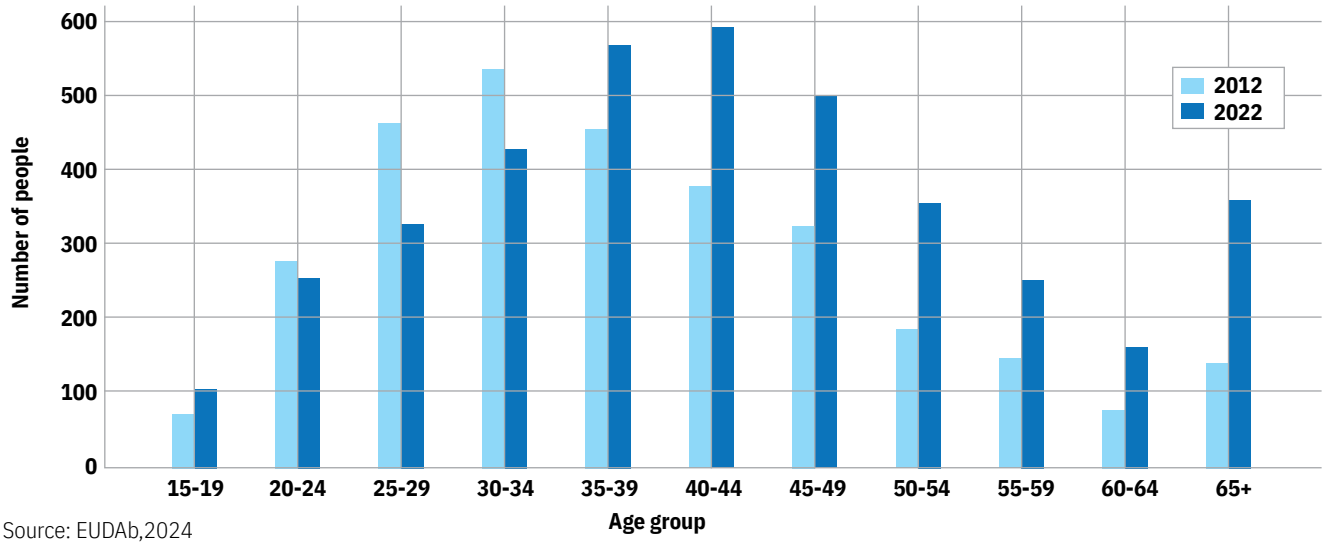
These disparities across sex and age groups highlight the structural unevenness in the population-level impact of drug use. The findings underscore the urgent need for targeted interventions, particularly directed at young males, who exhibit the most pronounced deterioration in drug-related mortality trends. Moreover, the results emphasise the importance of differentiated prevention strategies that take into account age- and gender-specific risk factors.

Figure 4 | Trends in Drug-Related Mortality (per Million Inhabitants) in Selected EU Countries, Norway, and EU27+2 (2010–2022)



Source: EUDAb,2024

Figure 5 | Comparison of age group distribution in 2012 and 2022



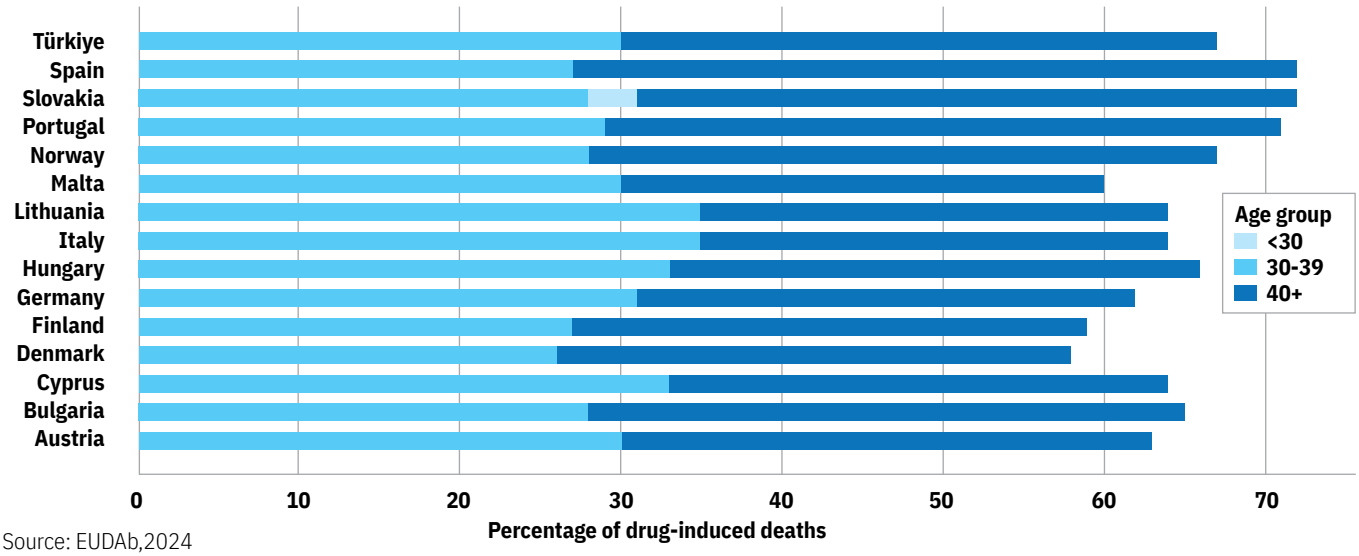
Source: EUDAb,2024

The projection for the years 2023–2027, based on regression analysis, indicates a rising trend in drug-induced mortality among males aged 15–24 and 25–44, where the highest lethality rates are anticipated (Fig. 3). A moderate increase is also expected among females in these age groups. In contrast, mortality among individuals aged 45–74 remains low and largely stable. These findings underscore the necessity for age- and gender-specific prevention and treatment interventions, including expanded access to opioid substitution therapy and harm reduction measures.

Figure 4 illustrates the trend in drug-related mortality per one million inhabitants between 2010 and 2022. The data reveal a marked degree of variability both across countries and over time. Estonia has consistently reported the highest mortality rates, reaching an extreme peak of 192 deaths per million in 2012. Elevated and fluctuating rates are also observed in Ireland, Sweden, and Norway. In contrast, countries such as Slovenia, Croatia, and Lithuania display lower mortality rates, although a slight upward trend has been noted in recent years. The aggregated EU27+2 indicator remains relatively stable, with a modest upward trajectory observed after 2019. These findings highlight the persistent disparities in drug-related mortality across Europe, reflecting differences in drug availability, preventive policy implementation, and the capacity of national healthcare systems.

Figure 5 illustrates the distribution of drug-induced deaths in the European Union by age group in the years 2012 and 2022 (or the most recent year for which data are available). A comparative analysis reveals a shift in peak mortality from younger adults (25–34 years) in 2012 to older age groups (35–44 years) in 2022. This trend indicates an ageing population of drug users and an increasing risk of drug-related fatalities among older adults, underscoring the necessity of extending prevention and treatment efforts to middle-aged and older cohorts.

Figure 6 | Age distribution of drug-induced deaths in 2022 by country



Source: EUDAb,2024

Figure 6 presents the age distribution of deaths caused by the use of psychoactive substances (drug-induced mortality) in 2022, or the most recent year available, across selected European Union countries and Türkiye. The data show that in Western European countries (e.g., Portugal, Spain, Norway), mortality is predominantly concentrated in individuals aged ≥40 years, reflecting the chronicity of opioid dependence and the ageing of the drug-using population. In contrast, Eastern European countries (e.g., Hungary, Lithuania, Bulgaria) exhibit a higher proportion of deaths among younger age groups, which may be associated with acute intoxications and less stabilised patterns of substance use.

The majority of drug-induced deaths in Europe are associated with opioid use, including heroin and its active metabolites, with most cases involving polysubstance intoxications. Postmortem toxicological analyses indicate the presence of opioids in approximately 74% of fatal cases reported across the EU, with substantial geographic variation. Higher prevalence rates have been documented, particularly in Northern and Western European countries (e.g., Denmark, Finland, Norway, Ireland). In contrast, in countries such as Cyprus, Czechia, Hungary, Slovakia, and Türkiye, the involvement of opioids does not exceed 50%.

Incomplete or unspecified toxicological data may result in underestimation of the actual prevalence of opioids in fatal overdoses. Nevertheless, even in the absence of comprehensive toxicological reporting, at least one opioid is frequently detected.

Stimulants—including cocaine, MDMA, amphetamines, and synthetic cathinones—also play a role in drug-related mortality, although their impact varies by country. An increase in MDMA-related fatalities was observed between 2011 and 2017 (Roxburgh et al., 2021). New psychoactive substances (NPS) were identified in approximately 16% of fatal intoxications in 2017, predominantly in the United Kingdom and Türkiye. In these cases, etizolam—a novel benzodiazepine—was most commonly involved, frequently used in combination with opioids and synthetic cannabinoids (López-Pelayo et al., 2021).

5 DISCUSSION

The results of the quantitative analysis reveal substantial variability in drug-induced mortality across European Union member states, Norway, and Türkiye between 2010 and 2022. Germany consistently reported the highest number of fatalities, significantly surpassing those of other countries within the dataset. This may be attributable to a higher prevalence of chronic opioid use, more efficient postmortem toxicological diagnostics, and greater sensitivity of national reporting systems (EUDAa, 2024). However, discrepancies in the classification and coding of causes of death across countries cannot be excluded.

Demographic analysis confirms a longstanding trend of male predominance in overdose fatalities, with men accounting for 77% of all drug-induced deaths. The highest mortality rates were observed in the 25–44-year age group. These findings align with prior studies highlighting higher levels of risk-taking behaviour, increased experimentation with psychoactive substances, and lower treatment-seeking behaviour among men (EUDAa, 2024; Kim et al., 2025).

A particularly concerning trend is the rising mortality among males aged 15–24, indicating a shift in population vulnerability toward adolescents and young adults. This cohort is frequently overlooked in intervention programs that primarily target older users. Therefore, prevention strategies must be tailored to reach youth through schools, universities, and digital platforms—the environments in which they are most active (Hanoa et al., 2023).

Regionally, higher mortality rates are concentrated in Western and Northern Europe, likely reflecting the ageing cohort of chronic opioid users, increased heroin purity and availability, and the growing presence of potent synthetic opioids such as fentanyl and its analogues (Hernández-Calle et al., 2022). Conversely, countries such as Cyprus, Luxembourg, and Malta report low or negligible mortality rates, although these figures may reflect data limitations rather than the actual epidemiological situation.

Polydrug use represents a critical contributing factor in most drug-related deaths. Toxicological findings frequently identify multiple substances, commonly involving opioids in combination with sedatives (e.g., benzodiazepines), alcohol, or stimulants. Such combinations exacerbate the risk of respiratory depression, cardiovascular complications, and acute toxic syndromes (Fendrich et al., 2019). The presence of new psychoactive substances (NPS), such as etizolam and synthetic cannabinoids, is particularly problematic in countries like the United Kingdom and Türkiye, where these substances significantly impact mortality statistics (López-Pelayo et al., 2021).

Based on linear regression analysis, predictive modelling up to 2027 identified high-risk trends, particularly a continued increase in mortality among younger male cohorts. These projections underscore the urgent need to implement innovative public health strategies, including the expansion of harm reduction initiatives, increased availability of opioid substitution therapy (e.g., buprenorphine, methadone), and early intervention through screening programs and outreach efforts.

From a methodological perspective, the study faces several limitations. These include variability in national death reporting systems, incomplete postmortem toxicological data, and a proportion of deaths categorised as “unspecified” in terms of substance involvement. These factors may lead to underestimation of accurate mortality rates and compromise the accuracy of inter-country comparisons (EUDAa, 2024). Despite these constraints, the study offers a robust analytical foundation for the development of targeted drug policy interventions and the identification of high-risk populations.

6 CONCLUSIONS

The comparative analysis of drug-induced mortality across EU member states, Norway, and Türkiye confirms that substance use–related deaths remain a persistent and critical public health challenge, marked by significant regional and demographic

disparities. The findings underscore that the most vulnerable group comprises young males aged 15–44, with a particularly alarming upward trend observed in the 15–24 age cohort. This age group often remains beyond the reach of conventional intervention and treatment strategies, underscoring the need for targeted preventive measures in educational and digital environments.

A key epidemiological insight is the high prevalence of polysubstance use in fatal intoxications, most commonly involving combinations of opioids, benzodiazepines, alcohol, and stimulants—substance patterns associated with heightened risk of respiratory failure and acute toxic syndromes. The presence of novel psychoactive substances (NPS) further complicates clinical management and contributes to increased mortality, particularly in specific geographic regions.

Projections up to 2027 indicate a continued rise in mortality among young men, emphasising the necessity for enhanced public health responses, including expanded access to opioid substitution therapies (e.g., methadone, buprenorphine), harm reduction services, and mobile outreach interventions.

From a methodological standpoint, the study acknowledges several limitations, including incomplete or inconsistent toxicological reporting and disparities in national death surveillance systems, which may result in the underestimation of actual mortality rates. Despite these constraints, the study provides valuable epidemiological insights and serves as a critical foundation for evidence-based drug policy. Ultimately, an effective response requires a multisectoral approach that integrates prevention, treatment, social support, and harmonised data collection.

Authors' contributions: Author IAK designed the study and performed the analysis. Author BI contributed to data collection. Author MF wrote the initial draft, and all authors revised and approved the final manuscript.

Declaration of interest: The authors declare no conflicts of interest.

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