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No decline in drug overdose deaths in Norway: An ecological approach to understanding at-risk groups and the impact of interventions

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Abstract

Aim: This Norwegian case study examines groups at risk of drug overdose deaths, evidence-based harm reduction interventions, low-threshold services and treatment implemented, as well as trends in drug overdose deaths between 2010 and 2021. We aimed to explore the

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relevance of interventions for at-risk groups and discuss their potential impact on drug overdose trends. **Method/data:** Using an ecological approach, we analysed the following: (1) groups identified through latent profile analysis (LPA) among a sample of 413 high-risk drug users collected in 2010–2012, supplemented with other relevant studies up to 2021; (2) published information on harm-reduction interventions, low-threshold services and treatment in Norway; and (3) nationwide drug overdose mortality figures supplemented with published articles on the topic. **Results:** High-risk drug users in 2010–2012 commonly engaged in frequent illegal drug use, injecting and poly-drug use (including pharmaceutical opioids), which continued into following decade. The interventions implemented between 2010 and 2021 were relevant for at-risk groups identified in the surveys. However, there was no decrease in the trend of drug overdose deaths up to 2021. While relevant interventions may have mitigated a theoretical increase in mortality, new at-risk groups may have contributed to fatal outcomes associated with pharmaceutical opioids. **Conclusion:** The interventions were relevant to the risk groups identified among high-risk drug users and potentially effective in preventing an increase in drug overdose trends. However, tailored interventions are needed for individuals at risk of death from prescribed opioids. Comprehensive studies encompassing all at-risk populations, including both legal and non-medical users of prescription opioids, are needed.

Keywords
amphetamines, dependence, drug use mortality, harm reduction, heroin, high-risk drug use, overdose, people who inject drugs, pharmaceutical opioids, poly-drug use

Background

Illicit drug use is a significant contributor to the global burden of disease (Degenhardt et al., 2018). The use of psychoactive substances entails substantial risks to both drug users and those in their proximity. The harms associated with illicit drug use are multiple, including overdose and premature death, diseases, crime and family breakdown (Babor et al., 2019).

Risk factors for overdose death

Risk factors for overdose death are multiple and include heroin use, use of pharmaceutical opioids (PO; non-prescribed and prescribed), poly-substance use, duration and frequency of drug use, previous history of non-fatal overdose, route of administration, multiple daily injections, prison release and discharge from drug treatment. In addition, well-established overdose correlates are male sex, age, poverty, homelessness, impaired physical health, depression, stigma, social exclusion, availability of services, social-level harms and unemployment (Arendt et al., 2011; Babor et al., 2010; Bartu et al., 2004; Beijer et al., 2007; Binswanger et al., 2007; Darke et al., 2011; Davoli et al., 2007; Degenhardt et al., 2011; Gossop et al., 2002; Mathers et al., 2013; Morrison, 2009; Nambiar et al., 2015; Ravndal & Amundsen, 2010; Simonsen et al., 2015).

Interventions

There are numerous evidence-based interventions available to mitigate health risks among drug users (Babor et al., 2019). Interventions such as opioid substitution treatment (OST), needle and syringe programmes (NSP), supervised drug consumption (SDC) facilities, and the distribution of naloxone nasal spray to drug users and their next of kin have been implemented in various countries. However, efforts to develop interventions specifically aimed at reducing overdose deaths

have historically progressed at a slower pace compared to responses addressing other health-related issues, such as dependence, crime or HIV/AIDS, despite the demonstrated effectiveness of drug treatment (OST) in reducing such deaths (Hedrich & Hartnoll, 2021).

Trends in drug-induced deaths

Overdose deaths have been increasing and represent a major public health concern in many western countries, such as the United States (Hedegaard et al., 2021), Canada (Fischer, 2023), Australia (Chrzanowska et al., 2021) and Scotland (National Records of Scotland, 2021). This trend is a global concern, implying the importance of understanding how to prevent these deaths. Norway, as European country, experiences a high level of drug overdose mortality, although the mortality rates for such deaths remained stable between 2010 and 2021 (Norwegian Institute of Public Health, 2022).

An ecological approach

Evidence-based interventions are interventions that have demonstrated the ability to produce the desired results through scientific studies. However, evaluating their real-world efficiency in practical settings can be challenging. The implementation of multiple interventions concurrently makes it difficult to identify which specific intervention(s) have directly or indirectly contributed to the desired result in a field study. The ideal scenario for studying interventions that reduce overdose death is rarely feasible, as it requires identifying all populations at risk, longitudinally tracking their exposure to different interventions, registering relevant correlates and documenting the outcome (overdose events). A less ideal but still viable approach is an ecological study, which focuses on subgroups of high-risk drug users, examines the relevance of interventions for these groups and monitors the trend in overdose deaths as an outcome measure. The aim of this Norwegian case study was to describe the groups at risk of drug overdose deaths, evidence-based harm reduction interventions, low-threshold services and treatment implemented, as well as trends in drug overdose deaths between 2010 and 2021. We aimed to explore the relevance of interventions for at-risk groups and discuss their potential impact on drug overdose trends.

Methods and data

Ethical approval and consent to participate

The Norwegian Social Science Data Services ruled that informed consent was not necessary since the dataset was anonymous (2009b). The questionnaire had to include the information that participation was voluntary, that the interviewee could refuse to answer individual questions and that the survey was anonymous. The National Committee for Research Ethics in the Social Sciences and the Humanities (NESH) approved the project (2009a).

Mapping of high-risk drug users

To study drug use patterns and adverse health risks among illicit drug users, a convenience sample of 413 drug users were recruited from low-threshold health and social service facilities, shelters and designated cafes in three Norwegian cities between 2010 and 2012. The findings presented in this study have not been previously published. The general description of the materials and methods was provided in a previous article in 2013 (Amundsen & Reid, 2014) and will not be repeated here. The term "high-risk drug user" is employed to describe the sample based on known risk factors for overdose death outlined in Table 1 (Babor et al., 2010). This term refers to individuals who engage in recurrent patterns of use that result in actual harm, such as dependence, disease and premature death, or pose a substantial risk of experiencing such adverse outcomes (EMCDDA, 2016). No

Table 1. Sample description allowing non-response: substance use, demographic and socioeconomic characteristics.

Health risks	All (non-responders excluded for each variable) ($n = 413$)	All non-responders excluded ($n = 351$)
Substance use characteristics		
Amphetamines use 26 days or more[a] (%)	24.1	24.2
Cocaine use last 30 days (yes/no) (%)	14.0	14.8
Heroin use 26 days or more[a] (%)	31.6	35.0
PO use 26 days[a] (%)	46.6	44.4
PO use not prescribed last 30 days (yes/no) (%)	27.6	29.3
Hashish use 26 days or more[a] (%)	40.0	39.9
Sedatives use 26 days or more[a] (%)	39.3	40.2
Alcohol use 9 days or more[a] (%)	20.8	21.7
Poly-drug use last 30 days (mean number of drugs)	3.5	3.6
Injected drugs in past 30 days (%)	74.6	77.2
Years of drug use (mean)	25.0	24.5
SDS[b] (mean)	7.1	7.2
Demographic and socioeconomic characteristics		
Sex, female (%)	23.7	23.7
Age >40 years (%)	62.2	59.5
Education higher than minimum (%)	17.8	17.8
Currently in education or an occupation (%)	7.5	8.0
Own housing (%)	45.5	44.7

PO = pharmaceutical opioid.
[a]During previous 30 days. [b]Severity of Dependence Scale.

follow-up study has been conducted on this specific sample concerning drug overdose death. However, similar samples have been the subject of such studies, revealing a high risk of overdose death (Gjersing & Bretteville-Jensen, 2018; Lauritzen et al., 2012).

Variables in this study. In assessing patterns of drug use, information was collected regarding the use of amphetamines, cocaine, heroin and PO (whether prescribed or not), recording the number of days these substances were used and whether the drug was injected withing the preceding 30 days. In addition, respondents were asked to report the number of days they had used alcohol, hashish (marihuana), gamma-hydroxybutyrate (GHB) or gamma-butyrolactone (GBL), ecstasy, lysergic acid diethylamide (LSD), inhalants, and illicit or legally obtained sedatives within the past 30 days. The use of non-prescribed PO over the previous 30 days was recorded, but without the frequency of use. The cut-off point for dichotomising substance use was primarily defined as more than 25 days per month (26–30 days), indicating daily or almost daily use. Lower cut-offs had to be employed for certain substances that were infrequently used (see Table 1) to facilitate adjusted analyses (see below).

Poly-drug use was defined as the number of psychoactive substances mentioned above

(excluding alcohol) used for more than 1 day within the previous 30 days. The 1-day threshold was implemented to avoid inclusion of accidental poly-drug use of a single substance.

The variable "years of drug use" was estimated by calculating the difference between the user's age group at the time of the interview (middle of a 5-year group) and the age at which they were first exposed to amphetamines, cocaine, heroin or PO.

The Severity of Dependence Scale (SDS) was utilised (Gossop et al., 1995). Forward and backward translations of the SDS between English and Norwegian were conducted. The SDS consisted of five standardised questions aimed at assessing the individual's overall dependence score, which was represented by a continuous variable in the range of 0–15. This variable served as a proxy measure of a drug user's perceived degree of drug dependence.

Demographic and socioeconomic data for each respondent was recorded, including sex, age group, years of education, employment or educational status, and living arrangements (own housing or other).

The non-response rate was in the range of 2%–3% for each variable, except for the SDS, which had a non-response rate of 9%. No imputation routine for missing values was applied. A latent profile analysis (LPA) was conducted, excluding individuals with any non-response on the variables. Sample values based on responders for each variable are shown in Table 1, including a separate calculation that excludes individuals with any non-response on any variable.

All the variables, including sex, age and socioeconomic status, have been identified as health risks in the literature (Babor et al., 2019; Degenhardt & Hall, 2012). In the definitions provided above, female sex, current education or occupation engagement, and own housing are considered protective factors, while the other variables are regarded as risk factors.

Data analyses. A LPA was applied to investigate patterns of psychoactive substance use and drug-related behaviours (Oberski, 2016). This technique aims to identify hidden groups from observed data and is used to reduce a sample with many variables into few subgroups with similar variable values. Due to the large number of variables included, single-parameter distributions were used to derive solutions. Binomial distributions were applied for dichotomous variables, while Poisson distributions were applied for variables such as the number of substances in poly-drug use, SDS score and years of drug use. Demographic and socioeconomic characteristics were estimated separately for each of the five subgroups obtained by LPA.

The final solution for the number of subgroups was primarily based on the Akaike Information Criterion (AIC) and the Bayesian Information Criterion (BIC), with consideration given to avoiding overly small subgroup size. In addition, the interpretability of the subgroups in relation to the study objectives was taken into account. Unadjusted analysis, applying logistic and linear regression, was conducted to assess the significance of differences between the subgroups.

The trend in overdose mortality was estimated using linear regression, with the year (2010–2021) as the independent variable.

Stata version 15 (StataCorp, College Station, TX, USA) was utilised for all analyses. Statistical significance was set at $p < .05$.

Other Norwegian studies with mapping of high-risk drug users. Other published studies of health risks among Norwegian high-risk drug users were included to describe health risks in the period before and during the period 2010–2021 (Burdzovic, 2022; Gjersing, 2017; Gjersing & Sandøy, 2014).

Harm reduction interventions, low-threshold services and treatment

Information on harm reduction interventions, low threshold services and available treatment was sourced from reports, guidelines and scientific literature (EMCDDA, 2019; Ministry of Health and Care Services, 2012; Norwegian

Directorate of Health, 2014, 2019; Skretting & Amundsen, 2018; Waal et al., 2019).

Drug overdose deaths

Data on lethal overdoses from drugs (illicit or licit) were obtained from the Norwegian Cause of Death Registry (NCDR), utilising the definition of overdose ("drug-related or drug-induced deaths") provided by the European Monitoring Centre for Drugs and Drug Addictions (EMCDDA) (Dødsårsaksregisteret {Cause of Death Register}, 2020; EMCDDA, 2007). The EMCDDA has developed a common definition based on the 10th revision of the International Classification of Diseases (ICD-10), in agreement with advice from national experts, focusing on deaths directly related to illicit consumption of psychoactive substances. This includes poisonings by illicit drugs, as intentional poisoning (X61, X64 combined with T43.6 or X62, X64 combined with T40.0–T40.9), non-intentional poisoning/intention not known (X41, X44, Y11 combined with T43.6 or X42, X44, Y12, Y14 combined with T40.0–T40.9), as well as mental and behavioural disorders due to psychoactive substance use (F11–F16, F19).

Poly-drug use has been frequently observed among those who died in the Nordic countries. The median number of detected drugs per death was in the range of 4–6 across the countries, with commonly detected substances including heroin/morphine, methadone, buprenorphine, cocaine, amphetamine, methamphetamine, MDMA, tetrahydrocannabinol and benzodiazepines (Simonsen et al., 2020). Prescribed drugs obtained legally can also serve as underlying cause of such deaths.

Mortality rates (per 100,000 inhabitants aged 15–64 years) were calculated based on population data published by Statistics Norway (Statistics Norway, 2022), covering the period from 1 January 1977 to 1 January 2021).

Other published studies of drug overdose deaths in Norway were included to describe those who died and trends related to drug overdose deaths (Amundsen, 2015, 2017; Burdzovic, 2022; Gjersing, 2017; Gjersing & Sandøy, 2014; Skurtveit et al., 2022).

Results

Mapping of high-risk drug users

Psychoactive substance use and risk aspects of drug use among high-risk drug users 2010–2012. The use of amphetamines in the previous 30 days was reported by 68.7% of the sample, of which 87.1% was injected. The use of heroin was reported by 59.6% (92.6% injected), PO by 66.4% (87.1% injected) and cocaine by 14.0% (32.7% injected). PO use without a prescription in the previous 30 days was reported by 27.8% (55.0% injected). On average, 74.6% of the sample injected drugs. Concomitant use of these drugs was common. Among those who had used amphetamines in the previous 30 days, 66.7% also used heroin and 61.5% used PO. Among those who had used heroin, 76.9% used amphetamines and 71.1% used PO. Among those who had used PO, 63.6% used amphetamines and 63.9% used heroin. Among those who had used PO without a prescription, 82.0% had used amphetamines and 86.5% had used heroin. Poly-drug use was also associated with a high level of injecting. Among those who had used four or more drugs in the last 30 days, 95% injected at least one substance.

A substantial proportion of the sample reported daily or almost daily use of amphetamines, heroin, PO, hashish or sedatives, while the frequency of cocaine use was low (Table 1). The mean number of years since the debut of either amphetamine, cocaine, heroin or PO was 25 years, implying an ageing sample. This was supported by the fact that 62.2% of the sample was aged over 40 years. In the sample, 23.7% were women. Other frequencies and means for aspects of substance use are reported in Table 1.

Reports of GHB/GBL use in the previous 30 days was 15.7%, mainly used for 1–3 days (11.9%), while the use of ecstasy and LSD was reported by 4.6% of the sample, and of

Table 2. AIC and BIC for latent profile models ($n = 351$).

	Log likelihood	Df	AIC	BIC
Two groups	−4874.4	25	9798.9	9895.4
Three groups	−4770.7	38	9617.4	9764.2
Four groups	−4716.7	51	9535.5	9732.4
Five groups	−4668.1	64	9464.2	9711.3

AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion.

inhalants was reported by 1.7%. These figures were so low that psychoactive substances were excluded from the LPA, except when included in the poly-drug use variable.

Latent profile analysis of high-risk drug users. Both AIC and BIC were smaller for five subgroups than four or fewer subgroups (Table 2). The number of respondents in some subgroups was rather small with five subgroups (Table 3).

Consequently, we did not perform the analysis with six subgroups.

Demographic and socioeconomic characteristics within the five subgroups achieved by LPA are shown in Table 4.

The following subgroups emerged (Tables 3 and 4):

1. *Subgroup 1: older opioid users, low level of risk factors, comprising 15.6% of the sample:* long duration of drug use, low dependence, no heroin use, high opioid use, low non-prescribed opioid use, low poly-drug use, 50% inject, 93% aged over 40 years and low proportion of women.
2. *Subgroup 2: injecting opioid users, medium level of risk factors, comprising 23.7% of the sample:* medium duration of drug use, medium dependence, little heroin use, high opioid use, some non-prescribed opioid use, low poly-drug use, 70% inject, medium age and medium proportion of women.
3. *Subgroup 3: older heroin/opioid injectors, high level of risk factors, comprising 29.7% of the sample:* long duration of drug use, high dependence, medium heroin use, high opioid use, high non-prescribed opioid use, high sedative use, medium poly-drug use, 83% inject, 99% aged over 40 years, low proportion of women.
4. *Subgroup 4: heroin/opioid/stimulant injectors, high level of risk factors, comprising 19.1% of the sample:* medium duration of drug use, high dependence, high heroin use, low opioid use, high non-prescribed opioid use, high stimulant use, high poly-drug use, 97% inject, medium age, medium proportion of women.
5. *Subgroup 5: young injectors, high level of risk factors, comprising 12.0% of the sample:* short duration of drug use, high dependence, medium heroin use, low opioid use, high non-prescribed opioid use, high sedative use, low use of amphetamines, medium/high poly-drug use, 80% inject, 52% aged 18–24 years, 74% aged 18–29 years, 48% women.

A higher than minimum level of education was the only sociodemographic factor that did not vary between subgroup 3 (reference category) and at least one of the other subgroups (Table 4). The other sociodemographic factors considered were sex, age, current education or occupation status, and own housing.

Other Norwegian studies mapping adverse health risks. The high prevalence of substance use and injecting has also been reported in later studies of high-risk drug use populations in seven cities in Norway in 2013 and 2017 (Gjersing, 2017; Gjersing & Sandøy, 2014). This indicates that the high-risk drug-using population found in our study was not different from high-risk drug users in the following decade. In the 2017 study, 72% of participants reported injecting practices in the 4 weeks before the interview, which maintained the risk of overdose deaths at

Table 3. Substance use risk profiles within five subgroups achieved by latent profile analysis (latent profile marginal means; $n = 351$).

Health risks: substance use characteristics	Subgroup 1 ($n = 56$, 15.6%)	Subgroup 2 ($n = 84$, 23.7%)	Subgroup 3 ($n = 100$, 29.7%)	Subgroup 4 ($n = 69$, 19.1%)	Subgroup 5 ($n = 42$, 12.0%)
Amphetamines use 26 days or more[a] (%)	22.8 (11.9–39.3)	16.8 (9.0–29.2)	23.3 (14.6–35.2)	46.9 (33.7–6.6)*	6.8 (1.6–24.9) *
Cocaine use last 30 days (%)	1.4 (0.0–21.3)	14.5 (8.0–25.0)*	7.6 (2.7–19.4)	38.4 (26.2–52.3)*	13.1 (5.2–29.0)
Heroin use 26 days or more[a] (%)	0.0 (0.0–1.0)[b]	7.2 (2.3–20.4)*	39.0 (27.0–52.5)	89.2 (67.7–97.0)*	39.4 (24.1–57.1)
PO use 26 days or more[a] (%)	57.6 (41.4–72.3)	49.8 (37.7–61.9)	58.5 (46.6–69.6)	18.2 (9.2–32.9)*	23.7 (12.2–41.0)*
PO use not prescribed[a] (%)	6.7 (1.8–21.7)*	19.9 (11.5–32.2)	28.6 (18.8–40.9)	47.3 (34.2–60.8)*	50.7 (34.0–67.3)*
Hashish use 26 days or more[a] (%)	42.5 (28.5–57.7)	37.9 (26.8–50.4)*	54.9 (44.0–65.3)	22.3 (11.1–39.7)*	31.4 (8.2–48.4)*
Sedatives use 26 days or more[a] (%)	21.5 (11.0–37.9)*	23.7 (14.8–35.6)*	61.7 (50.2–72.1)	34.4 (22.1–49.1)*	52.9 (35.3–69.7)
Alcohol use 9 days or more[a] (% of days)	15.7 (7.0–31.7)*	30.0 (20.2–42.1)	31.5 (22.4–42.4)	22.3 (11.1–39.7)*	15.7 (6.9–31.7)*
Poly-drug use last 30 days (mean number of drugs)	2.5 (2.0–2.9)*	3.2 (2.8–3.7)*	3.7 (3.3–4.2)	4.3 (3.8–4.8)*	4.0 (3.3–4.6)
Injected drugs in past 30 days (%)	50.7 (34.5–64.9)*	70.2 (57.9–80.1)*	83.3 (70.2–91.3)	97.3 (85.9–99.5)*	79.9 (63.6–90.0)
Years of drug use (mean)	32.3 (29.9–34.7)*	16.8 (15.4–18.2)*	34.3 (32.8–35.9)	22.0 (19.9–24.1)*	9.1 (7.9–10.3)*
SDS[c] (mean)	2.9 (1.8–4.0)*	5.5 (4.7–6.3)*	8.3 (7.6–9.0)	9.3 (8.4–10.1)*	9.9 (8.8–11.0)*

[a]During previous 30 days. [b]No confidence interval or significance can be calculated when no variation is present. [c]Severity of Dependence Scale.
*Significance, unadjusted result from regression analysis with subgroup 3 as reference group.

Table 4. Demographic and socioeconomic characteristics within the five subgroups achieved by latent profile analysis (%).

Health risks: demographic and socioeconomic characteristics	Subgroup 1 ($n = 56$, 15.6%)	Subgroup 2 ($n = 84$, 23.7%)	Subgroup 3 ($n = 100$, 29.7%)	Subgroup 4 ($n = 69$, 19.1%)	Subgroup 5 ($n = 42$, 12.0%)
Sex, female	14.3	23.8	15.0	29.0*	47.6*
Age above 40 years	92.9	25.0*	99.0	49.3*	7.1[a]*
Education higher than minimum	19.6	16.7	16.7	17.4	16.7
Currently in education or an occupation	14.3*	8.3	3.0	7.3	11.9
Own housing	57.1	56.0	51.0	17.4*	35.7

[a]52% were aged 18–24 years and 74% were aged 18–29 years.
*Significantly different from subgroup 3, using multinomial logistic regression method.

a high level. More than half of the sample injected amphetamines, 32% injected heroin and 69% reported injecting PO (Gjersing, 2017).

The population of people who inject drugs (PWID), which constitutes the dominating group of high-risk drug users, is likely to have remained stable (Burdzovic, 2022). However, the method of estimation may not be fully trustworthy.

Interventions

The first NSP was initiated in the capital city of Oslo in 1988 to address local needs during the HIV epidemic. The use of specialised drug treatment for drug dependence increased in the early 1990s, and OST was established in 1998. A medically supervised injection centre has been operational in Oslo since 2005.

After 2010, the harm reduction goals within Norway's alcohol and drug policy were defined in a 2011–2012 white paper that aimed to prevent harms such as overdoses (Ministry of Health and Care Services, 2012). A national strategy to address drug overdose death was established in 2014 by the Norwegian Directorate of Health, in collaboration with the 14 municipalities most affected by overdose deaths (Norwegian Directorate of Health, 2014). The strategy encompassed various interventions, including:

1. The distribution of naloxone nasal spray to drug users and their next of kin in 10% of the municipalities, with recent expansions to prisons, police cars and to security guards.
2. A patient safety campaign to prevent overdose after discharge from drug treatment and release from prison.
3. The promotion of a network for street-level preventative measures
4. The "Switch" campaign to encourage a shift from injection to less risky practices such as smoking heroin.
5. The continued expansion of OST.
6. Safer prescribing practices for addictive drugs
7. General advice provided to users and others to reduce risky behaviour

A new national strategy was launched in 2019, introducing several additions: (1) an increased focus on physical health and nutritional status; (2) the provision of new and up-to-date knowledge regarding overdose risk to ensure targeted measures; (3) streamlined follow-up by health services after non-fatal overdose incidents; and (4) the implementation of a warning system for particularly strong or dangerous drugs (Norwegian Directorate of Health, 2019).

Drug treatment in Norway encompasses a range of services including assessment, detoxification, stabilisation, short- and long-term

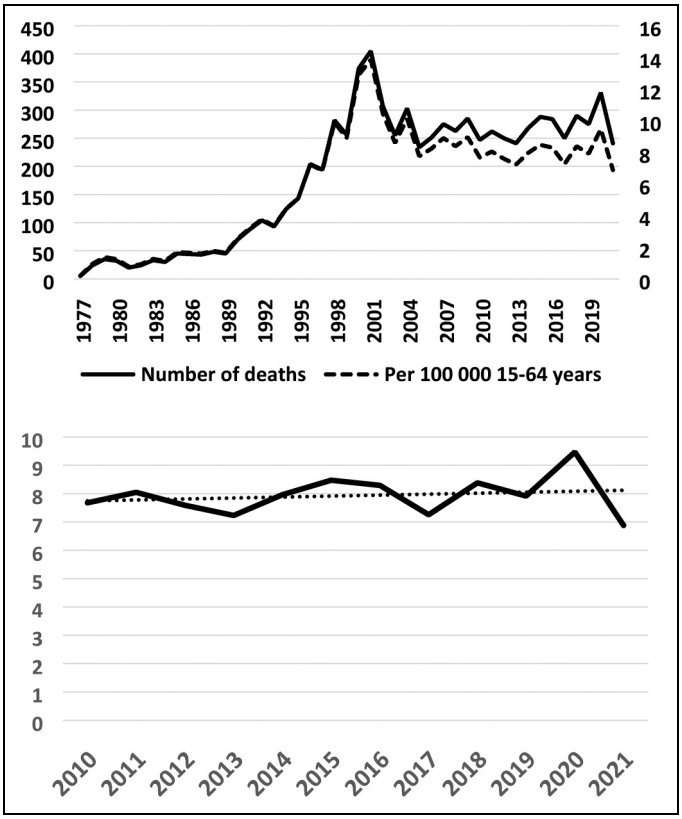

Figure 1. Drug overdose deaths and mortality 1977–2021. Trend 2010–2021. Norway.

residential treatments and medication-assisted treatment, such as OST (EMCDDA, 2019). The number of patients receiving OST has steadily increased since 1998, while new entries to OST have declined since 2010 (Lobmaier et al., 2021).

Many municipalities and non-governmental organisations have established low-threshold health services for drug users as well as social arenas, such as designated cafes. In 2017, 22% of municipalities had a needle and syringe exchange facility (EMCDDA, 2019).

Trends in drug overdose death

Statistics on drug overdose death. Overdoses (drug-induced deaths) and mortality (the number of such deaths per 100,000 inhabitants aged 15–64 years) in Norway increased from 1977 to 2001, followed by a considerable decrease until 2005, and a more stable level thereafter until 2021 (Norwegian Institute of Public Health, 2022). In 2021, the lowest level of drug overdoses since 2013 was recorded. However, mortality due to drug overdose has been stable from 2010 to 2021 (test for trend, $p = 0.58$, 2010–2021) (Figure 1).

Opioids have been the dominating underlying (main) cause of death in the period between 2010 and 2021 (Table 5). The proportion of deaths due to heroin was higher than those attributed to PO until 2016 (Gjersing & Amundsen, 2022).

Other studies of drug overdose deaths. Two studies conducted before 2010 also identified heterogeneity in the sociodemographic situation before drug overdose deaths. A study examining

Table 5. Underlying cause of death 2010–2021 (%).

	2010 *n* = 248	2011 *n* = 262	2012 *n* = 250	2013 *n* = 241	2014 *n* = 268	2015 *n* = 288	2016 *n* = 284	2017 *n* = 250	2018 *n* = 290	2019 *n* = 275	2020 *n* = 331	2021 *n* = 241
Heroin (T40.1)	38	28	25	28	34	35	27	20	23	20	23	23
Other opioids (T40.2)	16	24	21	22	25	24	35	24	28	31	30	26
Other synthetic opioids (T40.4)	6	7	7	8	12	12	11	18	17	18	15	17
Methadone (T40.3)	15	18	24	20	16	10	13	22	13	14	14	17
Psychostimulants (T40.5, T43.6)	11	8	6	7	6	6	5	7	8	8	10	9
Mental and behavioural disorders due to psychoactive substance use (F10–F16, F19)	9	11	13	10	6	11	7	7	9	7	8	7
Other and unspecified (T40.6–T40.9)	5	4	4	4	2	2	1	3	2	2	2	2
Total	100	100	100	100	100	100	100	100	100	100	100	100

all lethal drug overdoses during 2003–2009, using the EMCDDA definition, identified three equally sized clusters: individuals with very low socioeconomic status; disability pensioners; and individuals on the edge of the workforce (Amundsen, 2015). Another study during 2007–2009 matched and compared registry information from the police and the NCDR using the EMCDDA definition on drug overdose death. In principle, the two sources should include the same individuals since the police must always be notified by health services in the event of a suspicious death, including lethal overdoses. However, only 50% were included in both registries, and their characteristics differed. Those not listed in the police registry were older, suicide was more frequently the cause of death, heroin was less frequently listed as the type of drug causing death, and women's cause of death was more often attributed to pharmaceuticals with morphine or codeine compared to those included in both registries. The significant discrepancies in size, overlap and characteristics of the deceased individuals included in two sources of drug death indicate that prevention measures based on these two sources will differ (Amundsen, 2017). In a study examining all non-intentional drug overdose deaths between 2010 and 2018 (approximately 80% of all deaths by EMCDDA definition), those who died from heroin differed from those who died from POs. Women, individuals aged 50 years or older, disability pension recipients and individuals with the highest net wealth had a greater risk of a PO overdose death compared to a heroin overdose death. The same was true for individuals with back problems, accidents and injury diagnoses at primary healthcare encounters. Those who died in public spaces, lived in urban areas, had recent specialised drug treatment encounters, criminal charges and/or a substance use disorder had a higher risk of a heroin overdose death compared to PO overdose death (Gjersing & Amundsen, 2022). Another study found that individuals who died of PO overdose in 2010–2019 were more frequently older women with chronic pain who were using high doses of PO compared to other

overdose deaths (Skurtveit et al., 2022). These four studies suggest that the surveys conducted in 2010–2012, 2013 and 2017 may not fully capture all groups at risk of drug overdose death in the best way.

A study examining the trends in drug overdose in Norway and OST found that instead of a hypothetically expected increase from 2002–2003 to 2016 without OST, the estimates were stable up to 2016, indicating a possible effect of OST (Rogeberg et al., 2021).

Discussion

Summary of main findings

A high prevalence of substance use and injecting has been observed in studies of high-risk drug use populations. In our study of 2010–2012, we identified five subgroups characterised by varying durations of substance use, levels of dependence, heroin use, opioid use, prescribed opioid use, poly-drug use, injection practices, age and proportion of women. Before 2010, NSP, specialised drug treatment for drug dependence, OST and a medically supervised injection centre were established. Following 2010, harm reduction goals within Norway's alcohol and drug policy were defined in a 2011–2012 white paper, followed by the implementation of national strategies that introduced new measures to prevent drug overdose death. Mortality by drug overdose has remained stable between 2010 and 2021. Studies examining drug overdose deaths indicate an increasing number of deaths related to opioids other than heroin (PO), which exhibit distinct characteristics from those dying of heroin. These findings suggest the need for tailored prevention measures.

Did harm reduction interventions meet the needs of high-risk drug users during the last decade?

First, since harm reduction interventions, low-threshold services and treatment began earlier than 2010, we briefly explore whether the health risk situation in 2010–2012 among high-risk drug users may have been influenced by these interventions. Then, we explore whether these interventions adequately met the needs of the groups identified in the LPA analysis in 2010–2012.

The period before 2010–2012. Subgroup 1 of the LPA results, comprising "older opioid users with a low level of risk factors" (16% of the sample), likely benefitted from interventions implemented before 2010–2012. The subgroup consisted of individuals who were receiving OST (scoring high on opioid use (methadone and buprenorphine), low on non-prescribed opioid use). In Norway, methadone and buprenorphine for drug treatment can only be prescribed within the frame of OST. In addition, subgroup 1 exhibited a low level of self-reported health risks and a low level of dependence. Subgroup 3, "older heroin/opioid injectors, high level of risk factors" (30% of the sample) included individuals who were heroin/opioid injectors with a high or medium level of risk factors, as well as a high level of own housing. Both subgroups primarily included individuals aged over 40 years, with many years having passed since their drug use debut. These findings suggest that OST and community housing programmes implemented before 2010–2012 likely had some impact on improving the living situation of the street population. However, injecting practices remained high, which has been associated with a heightened risk of drug overdose death.

The period between 2010 and 2021. At the beginning of the decade, the LPA revealed significant heterogeneity in the health risks of high-risk drug users within our sample. The high level of injecting drug use was alarming across the entire sample. Subgroup 1 (older opioid users, low level of risk factors) exhibited the lowest level of health risk behaviour, while subgroup 2 (injecting opioid users, medium level of risk factors) demonstrated a medium to high level of risk. Three subgroups of all ages (subgroup 3: older heroin/opioid injectors; subgroup 4: heroin/opioid/stimulant

injectors; and subgroup 5: young injectors), accounted for 60% of the sample, and exhibited a high level of risky drug use and dependence. Interventions such as NSP, take-home naloxone spray and the "Switch" campaign have been designed to promote safe injection practices, prevent fatal overdose and reduce injection rates within these high-risk groups, aiming to meet the needs of high-risk drug users in our sample. However, the "Switch" campaign, which seeks to facilitate a transition from injection to smoking or snorting of heroin in supervised consumption services, has only achieved partial success (Dunleavy et al., 2021; Gehring et al., 2022), as acknowledged in Norway until 2021 (personal communication, Arild Knutsen, an activist promoting the "Switch campaign" and chairman of the Association for Humane Drug policies (https://www.fhn.no/). On the other hand, OST has been successful in reducing "at risk of death" among groups with heroin/opioid dependence and should meet the needs of high-risk drug users in our sample.

Risky behaviours in our study included the consumption of non-prescribed PO and medium to high levels of poly-drug use. This aligns with PO and poly-drug use being well-known findings in deaths due to drug overdose (Simonsen et al., 2020). The first Norwegian national strategy aimed to promote safer prescribing of addictive drugs, and this focus continued in the next strategy. It is not known whether this intervention has been successful.

It is worth noting that drug treatment helps to reduce overall drug use (Lauritzen et al., 2012).

Subgroup 5 (young injectors) comprised younger drug users with an average of 10 years since their drug use debut (12% of the sample). This group exhibited a high level of health risks. Notably, we observed a high prevalence of frequent heroin use, non-prescribed PO, sedatives and poly-drug use among younger high-risk drug users, suggesting a potentially long trajectory of drug use ahead of them. Women accounted for nearly half of this subgroup, whereas they constituted less than 30% in any other subgroup.

In general, the interventions implemented after 2010–2012 were evidence-based and deemed adequate for addressing the health risk situation among the high-risk drug users in our sample (Babor et al., 2019; Global Drug Policy Observatory, 2021; Thornton, 2021). However, information regarding the efficiency of the "Switch" campaign is not convincing, and there is no other specific intervention directly targeted at reducing injection practices. Nevertheless, other interventions may indirectly contribute to reducing injection practices by addressing factors such as drug use in treatment and improving living conditions. Despite this generally positive assessment, including Norway's high ranking in drug policy in alignment with key United Nations recommendations on human rights and health (The Global Drug Policy Observatory, 2021; Thornton, 2021), drug overdose mortality has not declined since 2010, neither nationally (Figure 1) nor in the three municipalities where our study was carried out (Norwegian Institute of Public Health, 2022). However, it is worth noting that mortality has also not increased, in contrast to observed trends in many other countries (Chrzanowska et al., 2021; Fischer, 2023; Hedegaard et al., 2021; National Records of Scotland, 2021).

Why did drug overdose deaths not decrease between 2010 and 2021?

We suggest four mechanisms that may, theoretically, underly the lack of change in drug overdose mortality.

First, the interventions may have prevented a potential increase in overdosing, as observed in several other countries. A study of drug overdoses in Norway's OST supported this notion, indicating it to be an effective strategy to reduce fatal opioid-related overdoses. Instead of a hypothetically expected increase from 2002–2003 to 2016 without OST, the estimates remained stable with the implementation of OST (Rogeberg et al., 2021). Moreover, despite an ageing population of high-risk drug

users between 2010 and 2021, which would typically result in higher mortality, such an increase did not occur (Bech et al., 2022; Norwegian Institute of Public Health, 2022).

Second, an effective and efficient intervention will rarely ensure that all individuals change risky behaviour. To achieve a significant result in a scientific study, it is sufficient for a proportion of the individuals included to change their behaviour during an intervention. The high-risk drug-taking pattern of more than 60% of the sample may indicate that preventing fatal overdosing is not a simple task. Therefore, relevant interventions must continue.

Third, the size of the population at risk of overdose deaths may have influenced the number of overdoses and mortality. With the same risk of death, a larger population of high-risk drug users implies a higher number of deaths compared to a smaller population. In a dynamic situation over time, some individuals leave the population of high-risk drug users due to death or permanent/ temporary cessation of drug use, while others enter. The population will increase when recruits outnumber individuals leaving. Subgroup five (comprising 12% of the sample) consisted of younger individuals with a higher level of risk and more recent entry to high-risk drug use. This indicates recruitment into the at-risk population, while the proportion of individuals leaving is unknown.

Fourth, interventions aimed at preventing deaths from overdose must steadily prepare for newcomers to high-risk drug use. These individuals may have been recruited through similar pathways as other high-risk drug users, or through new pathways, potentially rendering interventions ineffective for a proportion of the at-risk population. One specific group worth considering is those experiencing overdoses involving PO, see Table 1 (Gjersing & Amundsen, 2022; Norwegian Institute of Public Health, 2022). This group can be categorised into the following two subgroups: (1) traditional users who have added PO use to heroin use or transitioned from heroin use to PO (with or without prescription); and (2) newcomers with different backgrounds – potentially individuals who primarily use PO without any prior history of illegal drug use. Some may include older women with chronic pain (Amundsen, 2015, 2017; Gjersing & Amundsen, 2022; Skurtveit et al., 2022). These four studies highlighted significant heterogeneity in the sociodemographic profiles preceding drug overdose deaths, suggesting that not all those at risk share the low socioeconomic situation as those interviewed in our survey of the high-risk street population during 2010–2012, as well as the two additional surveys in 2013 and 2017. Therefore, even though we found that the interventions in Norway to prevent overdose deaths were suitable for addressing the needs of the high-risk drug users in these surveys, it is evident that additional interventions are needed to prevent PO-related deaths among individuals with no history of illicit drug use and those with a more favourable socioeconomic situation.

Comparisons to other studies

Other studies have utilised LPA to investigate the relationships between risk factors and outcomes, such as mortality and morbidity, among high-risk drug users (Gjersing & Bretteville-Jensen, 2018; Hautala et al., 2017; Roth et al., 2015; Schneider et al., 2019). These studies have employed different study populations and variables, implying that the established subgroups and their risk patterns varied across studies. As a result, it was challenging to making direct comparisons between our study and these previous findings. However, a consistent finding was the necessity for more tailored preventative interventions and treatment to mitigate morbidity and mortality.

We have found no similar case studies conducted in other countries.

Limitations of the study

The ecological study design employed in this study was suboptimal for drawing conclusions regarding the effectiveness of harm reduction

and treatment interventions in the Norwegian setting between 2010 and 2021, see the subsection "Ecological study of risk groups for overdose death, interventions to prevent such deaths and trends in drug overdose death". Conducting better studies requires substantial resources over a long period, which were not available. Therefore, we do not assert any definitive evidence of the interventions' efficiency in this case study.

The self-reported data in studies involving high-risk drug users are only as accurate as the drug users' recollections, presentations and perceptions of their own situations. Therefore, these data may be biased by factors such as time and implicit goals. However, the information provided by the respondents represents the core of what occupied them daily. It has been observed that drug use may be underreported due to fear of social stigma, or conversely, exaggerated to seek sympathy or treatment (Macleod et al., 2005; Napper et al., 2010). Nevertheless, there is no apparent reason why this potential bias would selectively impact specific subgroups in this study. Hence, the comparisons between subgroups are likely to be valid. The respondents had nothing to gain by exaggerating or altering facts in this study. The reliability and validity of self-reported drug use have previously been established (Darke, 1998; Napper et al., 2010). The study conducted during 2010–2012 did not encompass all the known health risks mentioned in the introduction due to time constraints, as the interview was designed to last 15–20 min to enhance respondents' participation. We believe that the list comprised many important health risks. Although the high-risk sample was not selected by randomised methods, the individuals were recruited from sites representing a diverse range of the local services available to high-risk drug users in Norway. Both public and non-governmental services were included. However, all findings must be interpreted within the context of a convenience sample, which is a characteristic of most studies of high-risk drug users. Caution should be exercised when generalising the findings to the general high-risk population or to other countries. The fourth paragraph of the subsection "Why did drug overdose deaths not decrease from 2010 to 2021?" suggests that our survey was not representative of all high-risk drug users in Norway.

The sub-sample in which all non-responders were excluded ($n = 351$) may have exhibited slightly elevated risks in comparison to the total sample ($n = 413$). Heroin use, use of non-prescribed PO and drug injection demonstrated higher estimates in the sub-sample, although the difference was not significant (Table 1, column 2).

It remains unclear whether the national strategy launched in 2019 to address drug overdose death may have influenced the risk factors associated with drug overdose death between 2019 and 2021. This uncertainty is compounded by the possible impact of the COVID-19 pandemic, particularly after March 2020.

Further use of existing interventions and future research needs

The three subgroups in our sample that exhibited the highest level of health risks during the period 2010–2012, accounting for approximately 60% of the sample, reported varying average duration since drug use debut, suggesting potentially different levels of experience with harm reduction interventions and treatment. The heavy health risk practices call for prevision of comprehensive support encompassing various types of interventions. A primary concern should be reduction of injecting practices, as the efficiency of the "Switch" campaign has been limited so far (Dunleavy et al., 2021; Gehring et al., 2022). Recently, in 2020, it became possible also to smoke heroin in two injection rooms. Furthermore, Babor et al. (2019) mention heroin substitution, planned to commence in Norway in 2022, as an effective measure for reducing health risks. In addition, psychosocial treatment, contingency management and therapeutic communities are identified as effective approached, all of which are available in Norway.

The lack of success in reducing drug overdose deaths infers a need for more tailored harm reduction interventions and treatment. This applies not only for the street-based population of high-risk drug users but also to other individuals at risk, such as those using PO without a history of illicit drug use and high-risk drug users with higher socioeconomic status who are not reached by current interventions targeted at the street population. A recent overview of interventions that contribute to reducing drug-related harms emphasises that individual interventions are far more effective when implemented as a part of a broader package (Hedrich & Hartnoll, 2021). The health authorities should persist in their efforts in this domain.

Conducting an updated survey is crucial to examine the risk factors among individuals at risk of overdose deaths, and to explore potential new correlates. However, obtaining a more comprehensive representation of those at risk poses a challenge. In addition to addressing the well-known issues related to street-based high-risk drug users, it is recommended to include individuals who are prescribed PO due to physical conditions. Moreover, individuals diagnosed with narcotic/illegal drug dependence and sedative/hypnotics dependence, who are in contact with primary health services, should be considered a risk group for drug overdose death. To better understand why prevention interventions have limited effectiveness and how harm reduction measures and treatment can be tailored to meet the specific needs of young high-risk drug users, conducting a qualitative study is suggested. Furthermore, new studies should be undertaken to identify additional groups at risk for overdose deaths and those whose needs are not addressed by existing prevention and harm reduction interventions.

Conclusions

The interventions aimed at preventing drug overdose deaths were found to be relevant to the targeted risk groups in surveys conducted among the street population of high-risk drug users and potentially effective in preventing an increase in drug overdose trends. However, it is crucial to recognise the specific needs of individuals at risk of mortality associated with PO and ensure the development of tailored interventions to address their specific circumstances. Further studies are warranted to encompass all at-risk populations, including both legal and non-medical users of PO. By expanding the scope of research to include a broader range of individuals affected by opioid-related risks, we can gain a more comprehensive understanding of the challenges at hand and develop targeted interventions that effectively mitigate the associated harms.

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Supplemental material

Supplemental material for this article is available online.

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