International Journal of Drug Policy xxx (xxxx) xxx

Contents lists available at ScienceDirect

International Journal of Drug Policy

journal homepage: www.elsevier.com/locate/drugpo

Research Paper

Trends and psychosocial correlates of same day polysubstance use among people who inject drugs in Australia, 2012-2022

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ARTICLE INFO

Keywords:
Polysubstance use
Injecting drug use
Psychosocial risk factors
Stimulants
Opioids

ABSTRACT

Background: Polysubstance use is associated with negative health and social outcomes among people who inject drugs. We aimed to describe trends in polysubstance use and identify psychosocial correlates and associated drug use risk behaviours. We defined polysubstance use as intentional same day use of more than one of three drug classes: opioids, other non-opioid depressants (hereafter 'depressants'), and stimulants.
Methods: We used 10 years (2012-2022, excluding 2020) of data from annual surveys in Australian capital cities with people who inject drugs (N=5657) to construct five mutually exclusive polysubstance use profiles: opioid-depressant, opioid-stimulant, stimulant-depressant, opioid-stimulant-depressant, and single drug class use. We examined time trends using the Mann Kendall test and identified correlates using multinomial logistic regression.
Results: Same day polysubstance use was relatively common among this sample (43.6%). Opioid-depressant use was the most frequent polysubstance use profile, but this decreased over the study period (32.6% to 13.3%, $p<0.001$). This aligned with observed decreases in use of pharmaceutical opioids ($p<0.001$), opioid agonist treatment ($p=0.007$), and benzodiazepines ($p=0.001$). There was no evidence for any trend in the other polysubstance use profiles, although single drug class use increased (51.9% to 64.7%, $p=0.031$). The different polysubstance use profiles were variously associated with psychosocial factors, including unstable housing and very high psychological distress, and other drug use risk behaviours, including non-fatal overdose, receptive and/or distributive needle sharing, and reusing one's own needles.
Conclusion: Same day polysubstance use has remained relatively common among this sample over time, although the typology has changed. Collectively, our findings point to diverse drug use patterns among people who inject drugs and reiterate the need for a range of harm reduction, treatment, and support options.

Introduction

Polysubstance use is a broad term used to describe the consumption of more than one substance within a defined timeframe, either concurrently (i.e., separately) or simultaneously (Earleywine & Newcomb, 1997). Beyond this, there is little consensus on its definition with respect to timeframe, substances, and intent (Karamouzian et al., 2022). Despite this ambiguity, polysubstance use appears to be a common behaviour among people who inject drugs (Cicero et al., 2020). In this study, we investigate intentional same day (concurrent and/or simultaneous) polysubstance use among people who inject drugs. We define polysubstance use as use of more than one of three drug classes of interest: opioids, other non-opioid depressants (hereafter 'depressants'), and stimulants. This definition does not consider use of multiple drugs within the same class, nor does it consider inadvertent consumption of an adulterated substance.

Motivations for intentional polysubstance use are many but include the desire for an additive (i.e., use of drugs with a common mechanism of action that add together for an enhanced effect) or synergistic effect (i.e., use of drugs with differing mechanisms of action with the resulting

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https://doi.org/10.1016/j.drugpo.2023.104150

effect greater than the sum of individual effects), or to counterbalance the effects of another drug (Compton et al., 2021; Palmer et al., 2020; Valente et al., 2020). Polysubstance use may also be a function of illicit drug markets, in which the availability and purity of drugs fluctuate, and people substitute other substances (Boileau-Falardeau et al., 2022). Therefore, it is possible that profiles and prevalence of polysubstance use change over time.

There is considerable heterogeneity in timeframes used in studies of polysubstance use, ranging from simultaneous to lifetime (Karamouzian et al., 2022). We chose to focus on same day use as this behaviour is associated with both acute and longer-term outcomes, including overdose (Compton et al., 2021), greater challenges in delivering appropriate treatment (Connor et al., 2014; Ford et al., 2021; Li et al., 2021), poorer treatment outcomes (Wang et al., 2017), and greater unmet physical and mental health care needs (Crummy et al., 2020).

Another key methodological challenge in monitoring polysubstance use is the impossibly large number of drug combinations that could theoretically be examined. One pragmatic approach is prioritising analysis of particular combinations that have negative effects or population impacts (Compton et al., 2021). In this study we focus on the intersections between three drug classes: opioids, depressants, and stimulants. Opioids and stimulants are consistently the two most commonly injected drug classes among people in Australia who inject drugs (Heard et al., 2022; Sutherland et al., 2022), while use of depressants is less common but still relatively frequent (Sutherland et al., 2022).

Combined use of opioids and stimulants is of concern due to the pressure it exerts on both the cardiovascular and respiratory systems (Farrell et al., 2019) and its association with both non-fatal (Al-Tayyib et al., 2017; Lukac et al., 2022) and fatal overdose (Barocas et al., 2019). The prevalence of this behaviour has increased in North America over the last decade (Al-Tayyib et al., 2017; Ellis et al., 2018; Glick et al., 2021; Lukac et al., 2022; Sarker et al., 2022) and emerging evidence suggests it is associated with psychosocial factors, including unstable housing (Barocas et al., 2019; Chawarski et al., 2020; Daniulaityte et al., 2020; Glick et al., 2021), unemployment (Chawarski et al., 2020), and comorbid mental illness (Barocas et al., 2019; Hassan & Le Foll, 2019). Combined use of stimulants with alcohol (a depressant) is also common and may increase the risk of cardiotoxicity (Pennings et al., 2002). Another combination of concern is opioids and other central nervous system depressants, which results in a defined increase in adverse events, including overdose and death (Gudin et al., 2013). Previous literature also suggests that people who engage in polysubstance use are more likely to engage in other high-risk drug behaviours, including needle sharing (Darke & Hall, 1995; Glick et al., 2021) and injecting drugs at a higher frequency (Glick et al., 2021; Lukac et al., 2022), which exacerbate the risks associated with polysubstance use. Understanding whether these associated outcomes and behaviours differ by drug combination may improve our ability to deliver appropriate services to people who engage in polysubstance use.

In Australia, different combinations of opioids, stimulants and depressants are among the most commonly implicated drug combinations in unintentional drug poisoning deaths (Chrzanowska et al., 2021). Further, crystal methamphetamine availability, use, and harms have all increased over the past decade (Man et al., 2022), yet it remains unknown whether this has been accompanied by an increase in concurrent use with opioids and/or depressants, and the health and social disadvantage issues that co-occur with this behaviour. In this study, we analyse ten years of annual cross-sectional survey data collected during interviews with a non-representative sample of people in Australia who regularly inject drugs. We aimed to 1) describe trends in same day polysubstance use over time, and 2) identify psychosocial factors and drug use behaviours associated with polysubstance use, as compared to use of a single drug class.

Methods

Study design and participants

We used data from the Australian Illicit Drug Reporting System (IDRS), which includes annual cross-sectional interviews with people who inject drugs. To be eligible for participation, people had to be at least 17 years of age in 2012-2019 surveys or 18 years in 2021-2022 surveys (modified due to ethical constraints), inject drugs at least monthly in the past six months, and reside in an Australian capital city area for at least 10 of the past 12 months (Sydney, Melbourne, Brisbane/Gold Coast, Perth, Adelaide, Hobart, Canberra, or Darwin). Incarceration is not considered to contribute to time of residence in a city, as the goal is to capture data reflecting drug use and markets in the community. Thus, participants incarcerated for more than two months during the past year do not meet the inclusion criteria. Participants were recruited from community-based low-threshold services, including needle-syringe programs, and via word-of-mouth. Accordingly, the IDRS sample is not considered representative of the broader population of people in Australia who inject drugs. The target sample size each year was 900 (n=150 in Sydney and Melbourne, n=100 in the remaining cities). Surveys were interviewer-administered and mostly conducted in-person, with some interviews undertaken via telephone/videoconference in 2021 and 2022 due to COVID-19 restrictions (22% and 18%, respectively). Participants were reimbursed $40 on completion of the interview. Detailed methodology is available elsewhere (Sutherland et al., 2022).

We included all participants who completed a survey between 2012-2022, excluding 2020. In the 2020 survey, some items (including the polysubstance question) were removed to facilitate the addition of COVID-19 items. We excluded participants who did not report use of at least one opioid, stimulant, or depressant the day preceding interview. As we pooled data across years, we excluded people who reported participation in a previous year within the study period (i.e., prior participation in any year 2012-2021, but not 2020) to reduce bias potentially introduced by non-independence of observations.

Outcome measure

Participants were asked to report all drugs (including legal and prescription drugs) they had used the day prior to interview. When considering self-report drug use data, recent use measures (e.g., prior day use) have been shown to minimise recall bias, be sufficiently reliable and valid compared to urinalysis, and be the best indication of an individual's 'typical' drug use (Darke et al., 1991).

To describe patterns of polysubstance use, we considered intersections between use of three drug classes (opioids, depressants, and stimulants) to construct an outcome variable with five mutually exclusive profiles: opioid-depressant, opioid-stimulant, stimulant-depressant, opioid-stimulant-depressant, and single drug class use. Opioids included heroin, opioid agonist treatment (OAT) and other pharmaceutical opioids. Stimulants included methamphetamine and cocaine. Depressants included benzodiazepines and alcohol.

Risk factor variables

We considered the following psychosocial factors: age (continuous), gender (binary: male/female, people who identified as non-binary or gender fluid were excluded due to small numbers that resulted in zero cells for some combinations of risk factor and outcome variable levels [n=39] (Greenland et al., 2016)), highest level of education (four-level variable: did not complete high school, completed high school, completed a trade/technical tertiary course, completed a university/college tertiary course), current accommodation (binary: stable [own/rented/family home, boarding house/hostel, drug treatment residence, public housing] or unstable [shelter/refuge, no fixed address,

rough sleeping or squatting, couch surfing]; (Chamberlain & Mackenzie, 1992)), current employment (binary: no/yes), psychological distress as indicated by the Kessler-10 scale (K10; binary: <30 or ≥30 [indicative of very high distress]), and lifetime incarceration (binary: no/yes).

To investigate the co-occurrence of other drug use behaviours with polysubstance use, we considered the following past-month drug use behaviours: drug injection frequency (binary: less than daily/at least once daily), reuse of own needles (binary: no/yes), and receptive or distributive needle sharing (binary: no/yes). We also considered behaviours relating to the participant's last injection: site of injection (binary: arm/location other than arm) and location (binary: private [private home, medically supervised injecting centre]/public [street/park, car, public toilet, shooting room, prison, stairwell]). Additionally, we assessed association with past year non-fatal overdose (any drug; binary: no/yes), current opioid agonist treatment (binary: no/yes), and potential opioid/methamphetamine dependence (binary: no/yes), indicated by a score of at least 5 for illicit or non-prescribed opioids and/or 4 for methamphetamine on the Severity of Dependence Scale (SDS) (Gossop et al., 1995; Topp & Mattick, 1997). While we considered duration of injecting career as a possible factor, it was highly correlated with age (Pearson's correlation=0.75), so we did not include it for analysis.

Analysis

Analyses were undertaken in R version 4.0.2.

We used the Mann Kendall test to identify the existence and direction of trends in polysubstance use profiles over time as it is non-parametric and allows a small number of time points. To understand which substances were driving changes in polysubstance use profiles, we performed the same test on use of the underlying drugs (i.e., heroin, OAT, pharmaceutical opioids, alcohol, benzodiazepines, methamphetamine, and cocaine). We considered a *p*-value of less than 0.05 statistically significant. We utilised the UpSet plot, which allows visualisation of data with more than three sets (i.e., >3 drugs), to describe patterns of polysubstance (Lex et al., 2014).

To assess psychosocial factors and drug use behaviours associated with polysubstance use profiles, we used multinomial logistic regression and considered single drug class use the referent group. We estimated the association of all factors as independent effects, with year and jurisdiction of interview also included in the model. Given evidence that the association between polysubstance use and non-fatal overdose may be modified by receipt of OAT (Betts et al., 2016), we included an interaction term between those two variables. However, investigation using an ANOVA test suggested the interaction effect was not significant (p=0.556), so we excluded it to ease interpretation of the main effects. We considered a 95% confidence interval that did not include the null value statistically significant.

Missing data

Of the initial sample, 18.8% of cases had missing data for at least one variable of interest and Little's test indicated that data were not missing completely at random (p<0.001; (Little, 1988)). Therefore, we used multiple imputation with chained equations to estimate the multinomial logistic regression model under the missing at random assumption (using the *mice* package, (van Buuren & Groothuis-Oudshoorn, 2011)). We performed 20 imputations with 10 iterations.

Sensitivity analysis

In a sensitivity analysis, we used a complete case approach to re-estimate the multinomial logistic regression model.

Post-hoc analysis

In a post-hoc analysis, we stratified the multinomial logistic regression model by current receipt of OAT.

Ethics

Ethics approval for the IDRS was obtained from the South Eastern Sydney Local Health District Human Research Ethics Community (HREC) and jurisdictional HRECs where appropriate.

Results

Sample characteristics

In total, 5657 participants were retained for the main analysis. Among them, the mean age was 41.8 years (SD: 9.6, range: 17-72) and the majority were male (67.3%, n=3809), unemployed (88.0%, n=4978), and resided in stable accommodation (85.0%, n=4808). Over half reported lifetime incarceration (58.7%, n=3321). Most had an SDS score that indicated possible opioid and/or methamphetamine dependence (75.3%, n=4262), while 29.3% (n=1658) had a K10 score that indicated very high psychological distress. At time of interview, 39.4% (n=2231) were currently engaged in OAT.

Opioid, stimulant and depressant use on the day preceding interview

Opioids were the most common drug class used (reported by 71.1% of participants overall), but this decreased from 83.2% in 2012 to 57.0% in 2022 (tau=-0.899, p<0.001; Fig. 1). Use of OAT (tau=-0.705, p=0.007) and other pharmaceutical opioids (tau=-0.871, p<0.001) decreased, although there was no evidence for any monotonic trend in heroin use (tau=0.256, p=0.362). Among those who used opioids on the day preceding interview, 18.7% reported use of more than one opioid (13.3% of the entire sample). Stimulant use on the day preceding interview increased over time from 21.3% to 48.0% (tau=0.911, p<0.001), the majority of which was methamphetamine use (Fig. 1). Few reported use of more than one stimulant on the same day (3.4% of those who used stimulants; 1.1% of the entire sample). Overall, depressant use decreased from 48.0% to 34.9% (tau=-0.644, p=0.015). Benzodiazepine use (tau=-0.871, p=0.001) decreased but there was no evidence for any monotonic trend in use of alcohol (tau=-0.210, p=0.466).

Same day polysubstance use profiles

Overall, approximately half the sample (56.4%) reported using only one drug class (of opioids, stimulants or depressants) on the day preceding interview. This behaviour increased over the study period (51.9% in 2012 to 64.7% in 2022, p=0.031; Fig. 2). The most common polysubstance profile was opioid-depressant, but this decreased from 32.6% in 2012 to 13.3% in 2022 (tau=-0.956, p<0.001). There was no evidence for any monotonic trend for the other polysubstance use profiles and they were generally reported infrequently. Opioid-stimulant use ranged 4.4-12.2%, stimulant-depressant use ranged 3.6-10.4%, and opioid-stimulant-depressant use ranged 3.1-7.8%.

The typology of same day polysubstance use among all participants is shown in Fig. 3, truncated to the 30 most common combinations. OAT and benzodiazepines was the most commonly reported opioid-depressant combination (5.1% of the whole sample), while the most common stimulant-depressant combination was methamphetamine and alcohol (5.0%). The most common opioid-stimulant combinations were heroin and methamphetamine (3.4%) and OAT and methamphetamine (2.7%). The most common opioid-depressant-stimulant combination was reported by fewer than 1% of the sample.

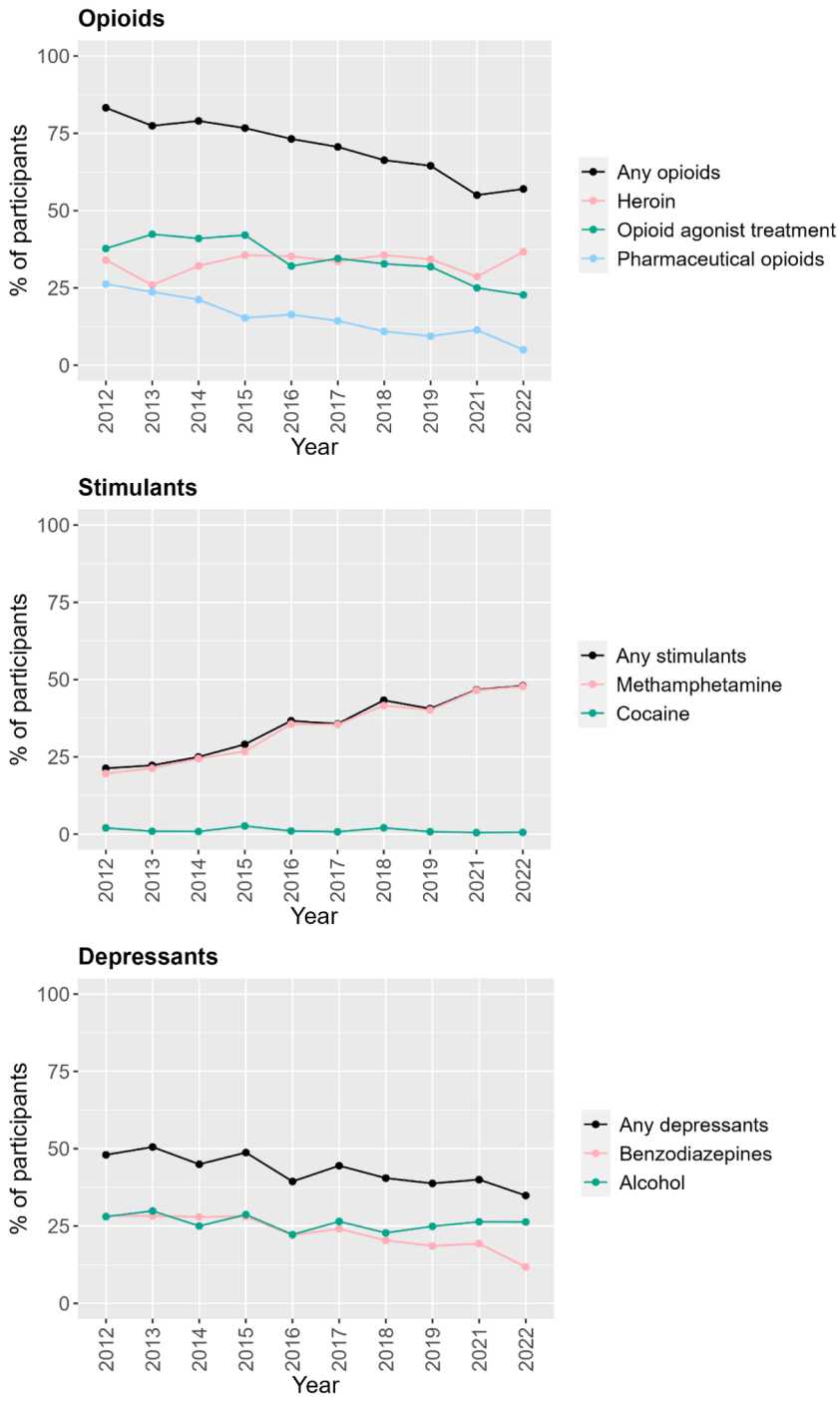

Fig. 1. Use of opioids, stimulants, and depressants, the day preceding interview, among IDRS 2012-2022 samples.

Psychosocial factors and drug use behaviours associated with polysubstance use profiles

The results of the multinomial logistic regression analysis are presented in Fig. 4 (with exact results provided in Appendix A); all psychosocial factors and drug use behaviours that were independently associated with the various polysubstance use profiles are described below, relative to single drug class use.

Participants who reported same day use of opioids and depressants had higher odds of a K10 score indicative of very high psychological distress (aRRR: 1.33, 95% CI: 1.14-1.54), current OAT (aRRR: 2.50, 95% CI: 2.16-2.89), an SDS score indicative of possible opioid and/or stimulant dependence (aRRR: 1.26, 95% CI: 1.06-1.49), injecting into a site other than the arm (aRRR: 1.39, 95% CI: 1.19-1.62), injecting in a public location (aRRR: 1.19, 95% CI: 1.00-1.40), and past year non-fatal overdose (aRRR: 1.68, 95% CI: 1.41-2.01).

Participants who reported same day use of opioids and stimulants had higher odds of currently residing in unstable accommodation (aRRR: 1.61, 95% CI: 1.24-2.10), lifetime incarceration (aRRR: 1.45, 95% CI: 1.15-1.82), current OAT (aRRR: 2.14, 95% CI: 1.72-2.66), an SDS score indicative of possible opioid and/or stimulant dependence (aRRR:1.28, 95% CI: 1.07-1.68), daily or more frequent drug injection (aRRR: 2.34, 95% CI: 1.87-2.92), injecting into a site other than the arm (aRRR: 1.32, 95% CI: 1.05-1.66), and past year non-fatal overdose (aRRR: 1.32, 95% CI: 1.02-1.70).

Participants who reported same day use of stimulants and

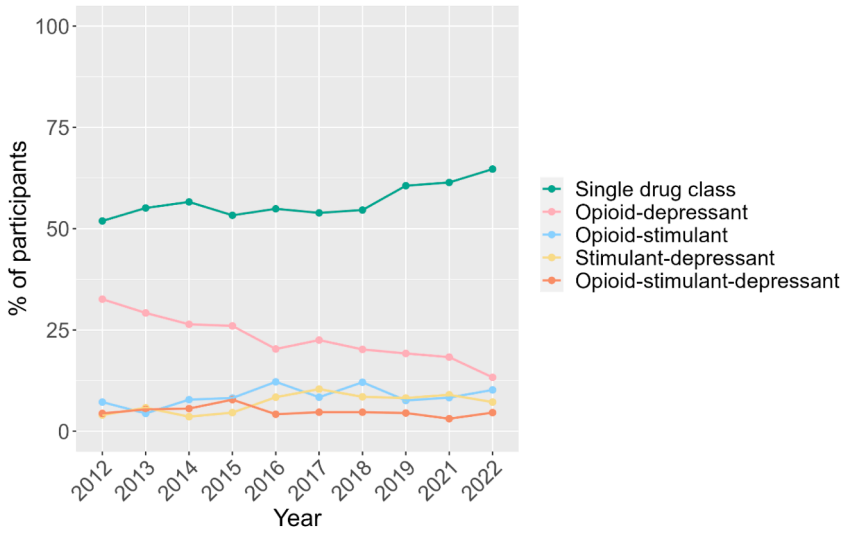

Fig. 2. Same day polysubstance use among the 2012-2022 IDRS samples.

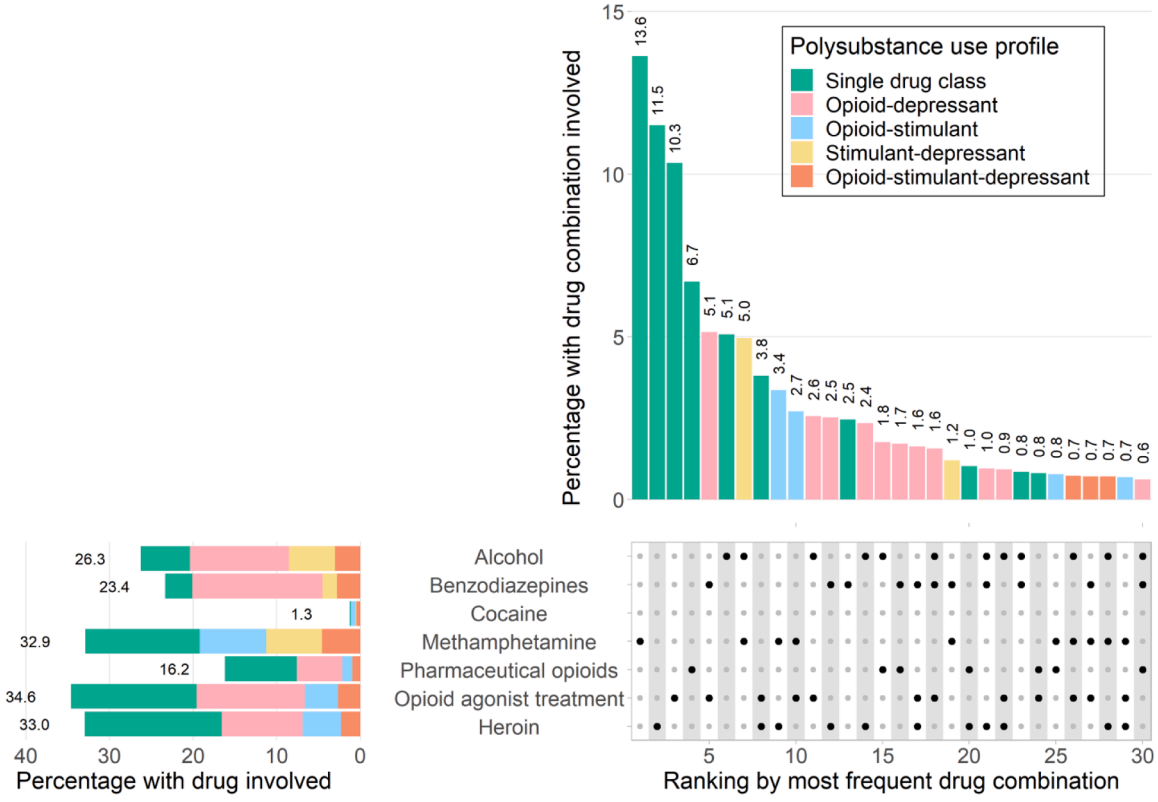

Fig. 3. Patterns of same day polysubstance use among the 2012-2022 IDRS samples.
Notes. Percentages are computed out of total sample (N=5657). The horizontal bars represent the percentage of participants who reported use of each drug type on the day preceding interview; the vertical columns represent the percentage of participants who used the combination of drug class, represented by the black circles. The figure is truncated to the 30 most common drug combinations.

depressants had higher odds of currently residing in unstable housing (aRRR: 1.50, 95% CI: 1.12-2.02), a K10 score indicative of very high psychological distress (aRRR: 1.32, 95% CI: 1.03-1.70), reuse of needles (aRRR: 1.29, 95% CI: 1.02-1.64), and receptive and/or distributive needle sharing (aRRR: 1.62, 95% CI: 1.21-2.17). They had lower odds of current OAT (aRRR: 0.26, 95% CI: 0.18-0.36), an SDS score indicative of possible opioid and/or stimulant dependence (aRRR: 0.77, 95% CI: 0.60), and daily or more frequent drug injection (aRRR: 0.67, 95% CI: 0.53-0.84).

Participants who reported same day use of opioids, stimulants and depressants had higher odds of current OAT (aRRR: 2.95, 95% CI: 2.24-3.88), daily or more frequent drug injection (aRRR: 2.25, 95% CI: 1.70-2.97), past month receptive and/or distributive needle/sharing (aRRR: 1.84, 95% CI: 1.32-2.50), injecting into a site other than the arm (aRRR: 1.81, 95% CI: 1.37-2.38), and past year non-fatal overdose (aRRR: 1.77, 95% CI: 1.31-2.39).

Fig. 4. Psychosocial factors and drug use behaviours associated with same day polysubstance use profiles, as compared to single drug class use, among the 2012-2022 IDRS samples.
Notes. aRRR=adjusted relative risk ratio, CI=confidence interval, K10=Kessler Psychological Distress Scale, SDS=Severity of Dependence Scale. The regression model was also adjusted for year of interview and state/territory of residence. Missing data were imputed using multiple imputation chained equations (with 10 iterations of 20 imputations). Exact adjusted relative risk ratios and associated 95% confidence intervals are provided in Appendix A.

Sensitivity analysis

All but one result were replicated when a complete case approach was utilised to estimate the multinomial logistic regression model (Appendix B). The exception was the association between public injection location and opioid-depressant use, which was no longer significant, although the point estimate was similar.

Post-hoc analysis

Following our finding that current OAT was associated with three of the four polysubstance use profiles, we stratified the regression model by receipt of OAT (Appendix C). Noting the lower statistical power, there was little evidence for differences in the psychosocial risk factors and drug use behaviours associated with the polysubstance profiles by OAT status. The exception was injecting frequency: those in the opioid-depressant group currently prescribed OAT had lower odds of reporting injecting drugs daily or more frequently (aRRR: 0.73, 95% CI: 0.59-0.90), while those not prescribed OAT had higher odds (aRRR: 1.56, 95% CI: 1.27-1.91).

Discussion

Using 10 years of cross-sectional survey data, we showed that same day use of a combination of opioids, stimulants, and depressants is a common behaviour among people who inject drugs. Despite increasing methamphetamine use among the sample over the last decade, there was no evidence for an increase in same day use of stimulants with opioids and/or depressants. Meanwhile, same day opioid-depressant use decreased, and use of only one of opioids, stimulants or depressants increased. After controlling for year and jurisdiction of interview, each polysubstance use profile was variably associated with different psychosocial risk factors (e.g., high psychological distress, unstable housing) and drug use risk behaviours (e.g., non-fatal overdose, receptive and/or distributive needle sharing). There were no clear patterns by polysubstance profile in these associations. Current OAT was associated with same day opioid-stimulant, opioid-depressant, and opioid-stimulant-depressant use.

The finding that concurrent opioid-stimulant use remained stable and infrequent over the past decade is counter to recent observations in North America (Ciccarone, 2021). An overall decrease in opioid use among our sample accompanied the increase in methamphetamine use, potentially indicating that substance substitution rather than addition has occurred. This may partially be a result of decreased availability of

diverted pharmaceutical opioids, with reduced dispensing of morphine and the introduction of tamper-resistant oxycodone in Australia during the last decade (Larance et al., 2018; Peacock et al., 2020). In contrast, a marked increase in opioid use and harms has been observed in North America, characterised by an increased presence of illicit fentanyl and fentanyl analogues (Fischer et al., 2019; Wilson et al., 2020). This so-called 'opioid epidemic' and the more recent increase in stimulant-related harms have been described as 'entwined epidemics' and differentiated from previous stimulant epidemics which have alternated with those of other drugs (Ciccarone, 2021). In Australia, both intentional and unintentional fentanyl use remain infrequent (Geddes et al., 2018; Lam et al., 2022), as do non-pharmaceutical fentanyl-associated drug poisoning deaths (Roxburgh & Nielsen, 2022). Together, our observations suggest Australia is experiencing alternating (rather than co-occurring) trends in use of opioids and stimulants. However, given co-use of methamphetamine and opioids is sometimes merely a reflection of what was available in the local drug market (Palmer et al., 2020), monitoring polysubstance use remains pertinent.

It is promising that same day opioid-depressant use decreased over the last decade and appears to be linked to overall decreases in opioid and benzodiazepine use. In addition to the changes in opioid availability outlined above, prescribing of benzodiazepines in general practice has decreased in Australia since 2011 (Woods et al., 2022). In the context of polysubstance use, benzodiazepines are sometimes used to alleviate withdrawal symptoms of other drugs, including opioids (Vogel et al., 2013). Therefore, it will be important to monitor potential substitute substances, including pregabalin, which can increase risk of overdose when used in conjunction with opioids (Cairns et al., 2019). While we could not examine pregabalin use in this study, recent data suggests use among the IDRS sample has increased and is linked to both opioid and benzodiazepine use (Sutherland et al., 2020), which aligns with observations in Australian general practice prescribing data (Cairns et al., 2019; Schaffer et al., 2021). The emergence of novel benzodiazepines in Australia also warrants monitoring in this context (Bade et al., 2020). While currently used less widely than pharmaceutical benzodiazepines among people who inject drugs in Australia (Sutherland et al., 2022), this is a growing area of concern.

We found that current engagement in OAT was associated with same day opioid-depressant, opioid-stimulant, and opioid-stimulant-depressant use, indicating that use of prescribed OAT with stimulants and/or depressants was a key contributor to polysubstance use among our sample. Increased alcohol and amphetamine use after initiation of OAT has previously been reported, as people may seek alternate pathways to intoxication or self-medication (Dong et al., 2020; Nolan et al., 2016). Our observation that OAT is associated with combined opioid and stimulant use in particular is important in the context of recent findings that care-engaged individuals who engage in polysubstance use are well-treated for opioid use disorder, but remain under-treated for methamphetamine use disorder (Li et al., 2021). Further, while current prescription of OAT reversed the association between higher injecting frequency and opioid-depressant use, the association with opioid-stimulant and opioid-stimulant-depressant use remained, reiterating the complexity of treating concurrent use of opioids and stimulants. Collectively our findings suggest that education campaigns, which target both clinicians who prescribe OAT and people who are prescribed OAT, to reiterate the potential risks in concomitant use of other potentially interactive drugs are warranted. Moreover, treatment providers should ensure availability of support for use of other substances, including methamphetamine and alcohol, for those prescribed OAT. As the number of OAT clients in Australia has increased by 20% over the past decade (Australian Institute of Health and Welfare, 2023), concurrent use of other substances with prescribed OAT will continue to be important to monitor.

The different polysubstance use profiles were variably associated with different drug risk behaviours, namely reuse of one's own needles, receptive and/or distributive needle sharing, injecting at a higher frequency, and injecting into a site other than the arm. These are reasonably logical observations given same day polysubstance use typically requires multiple injections per day and in turn, injecting more often is associated with use of an increased number of injection sites (Darke et al., 2001). Importantly, these drug use risk behaviours are associated with other harms including fatal and non-fatal overdose (Colledge et al., 2019), skin and soft tissue infection (Colledge et al., 2020), and bloodborne virus acquisition (Ciccarone, 2021), highlighting that the elevated risks associated with polysubstance use may be exacerbated by co-occurring risk behaviours.

In alignment with previous findings that polysubstance use is associated with multiple disadvantage (Connor et al., 2014), we observed associations with high psychological distress, lifetime incarceration, and unstable accommodation. Disadvantage may cause drug use to be constrained by market availability rather than preference, which may render intervention at point of use less effective than systemic interventions to reduce disadvantage. The association with unstable housing points to a particularly important avenue for intervention, with previous research indicating unstable housing is an independent risk factor for polysubstance use deaths (Barocas et al., 2019). Further, the association with high psychological distress also aligns with others' findings (Burdzovic Andreas et al., 2015; Salom et al., 2016) and adds further complexity to treatment of dual diagnosis of substance use disorder and mental illness (Drake & Mueser, 2000). Overall, further research on the intersection between psychosocial correlates of polysubstance use is warranted.

Limitations

We used a very specific definition of polysubstance use (i.e., use of more than one of three drug classes), which may limit the comparability of our study. We were also unable to distinguish between concurrent and simultaneous polysubstance use and these behaviours have differential risk profiles. The method we used to construct the polysubstance outcome measure disregarded use of multiple drugs within the same drug class, which may also carry risk. While beyond the scope of this study, further investigation of use of multiple opioids on the same day in particular is warranted. Although use of data on drugs used the day preceding interview minimised recall bias, we may not have captured all same day polysubstance use among the sample. However, prior research shows that behaviour yesterday is a reliable indicator of typical behaviour (Darke et al., 1991). We presented trends in polysubstance use profiles at a national level, but jurisdiction-level differences in drug markets and availability of services for people who use drugs may mean these trends differ sub-nationally. Nevertheless, the key drug market changes that have occurred over the last decade relevant to this study (i.e., increased methamphetamine availability, decreased pharmaceutical opioid and benzodiazepine availability) are applicable nationally. Finally, participants were recruited through harm reduction and treatment agencies in Australian capital cities, meaning health outcomes among our sample may be favourable compared to those who are less service-engaged and/or reside in rural or remote areas. As such, these results should not be generalised to the broader population of people in Australia who inject drugs.

Conclusion

We found same day use of opioids, stimulants and/or depressants to be a relatively common behaviour among our sample of people who inject drugs. Opioid-depressant use decreased over the past decade, potentially driven by reductions in opioid and benzodiazepine use, while same day use of stimulants in combination with opioids and/or depressants remained stable despite a marked increase in methamphetamine use. We found clear evidence that supports previous findings that polysubstance use is associated with myriad psychosocial risk factors and high-risk drug use behaviours. Overall, our findings reiterate

the diversity of drug use among people who inject drugs and underscore the importance of a range of treatment and harm reduction options for substance use, in addition to support for other factors, including housing. While we found no evidence for an increase in potentially harmful polysubstance use, it remains important to monitor in the context of fluctuating drug markets.

Funding sources

Drug Trends and the National Drug and Alcohol Research Centre are funded by the Australian Government Department of Health and Aged Care under the Drug and Alcohol Program. OP is supported by an Australian National Health and Medical Research Council (NHMRC) postgraduate scholarship and a National Drug and Alcohol Research Centre top-up scholarship. RS and AP have NHMRC Investigator Fellowships (#1197241, #1174630) and PD has an NHMRC Senior Principal Research Fellowship (#1136908).

Ethics

Ethical approval for IDRS was granted by the South Eastern Sydney Local Health District Human Research Ethics Committee (HREC) and jurisdictional HRECs; approval for EDRS was granted by the University of New South Wales HREC and jurisdictional HRECs.

Data availability statement

Data were collected during interviews with consenting participants. The data are not publicly available due to ethical constraints.

CRediT authorship contribution statement

Olivia Price: Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Data curation, Conceptualization. **Rachel Sutherland:** Writing – review & editing, Project administration. **Nicola Man:** Writing – review & editing, Visualization. **Raimondo Bruno:** Writing – review & editing, Project administration, Methodology. **Paul Dietze:** Writing – review & editing, Project administration. **Caroline Salom:** Writing – review & editing, Project administration. **Jane Akhurst:** Writing – review & editing. **Amy Peacock:** Writing – review & editing, Supervision, Project administration, Conceptualization.

Declaration of Competing Interest

AP has received untied educational grant from Seqirus and Mundipharma for study of opioid medications. RB has received untied educational grant from Mundipharma and Indivior for study of opioid medications. All other authors have no conflicts of interest to declare.

Acknowledgements

We thank the Chief Investigators and the broader Drug Trends team, past and present, for their contribution to the Illicit Drug Reporting System. We thank Ms Cate King for her assistance with data cleaning and Professor Shane Darke for his helpful advice during revision of the manuscript. We also thank the thousands of participants who have shared their experiences and expertise with us over the years. Finally, we thank the Australian Injecting and Illicit Drug Users League and the University of New South Wales Sydney Community Reference Panel for their review of questionnaires and input on important items.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.drugpo.2023.104150.

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