# Correspondence between Oral Fluid Drug Test Results and Self-Reported Illicit Drug Use among Music Festival Attendees

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**Abstract**

*Background:* Use of illicit substances is often under-reported. Testing positive in oral fluid provides an objective confirmation of recent intake.

*Objectives:* To examine the agreement between oral fluid test results and self-reported substance use among music festival attendees, and factors associated with reporting past 48 hours drug use among users identified by drug testing.

*Methods:* 1,309 participants were recruited from six music festivals in Norway (June-August 2016). They completed a questionnaire and provided oral fluid samples analysed for amphetamines, MDMA, tetrahydrocannabinol (cannabis) and cocaine. Additionally, their blood alcohol levels were measured.

*Results:* Overall, 5.5% reported use of amphetamines, cannabis, cocaine and/or MDMA during past 48 hours in the questionnaire, whereas 10.8% tested positive in oral fluid. Only 16.7% of identified cocaine users and 31.1% of identified MDMA users reported past 48 hours cocaine or MDMA use, respectively. Higher proportions of identified cannabis and amphetamine users reported past 48 hours use (53.8% and 55.6%, respectively). Multivariable logistic regression analysis showed that among participants who tested positive, those reporting weekly illicit substance use (Adjusted Odds Ratio (AOR) 30.6; 95% Confidence Interval (CI) 6.3-147.9), and using such substances when younger than 18 years (AOR 5.0; 95% CI 1.9-13.4) were more likely to report past 48 hours use.

*Conclusions/Importance:* Oral fluid testing appears to be an important tool when studying illicit substance use among music festival attendees, as significant under-reporting was observed. Among those testing positive, regular and experienced users were more likely to report recent use, compared to less regular and experienced users.

Keywords: illicit drug use; self-report; oral fluid; drug analysis; music festivals

# Introduction

Estimates of illicit substance use are generally based upon self-reported data and they give an indication of the prevalence of users in a jurisdiction or in specific settings. Approximately 275 million people worldwide had used drugs at least once during 2016 and an estimated 11% of these suffered from drug use disorders (UNODC, 2018). The past year prevalence of drug use among European adults (15–64 years) was 5.20% for cannabis, 0.74% for cocaine, and 0.45% for amphetamine in 2015. In North America the rates were higher; 12.4%, 1.77% and 1.97%, respectively (Peacock et al., 2018).

Illicit substances may or may not be harmful to the user. The risk of adverse consequences depends on a range of factors such as the type of substance, frequency, amount used and route of administration. Particularly, frequent use has been associated with dependence, mental and physical health issues and social problems (Degenhardt & Hall, 2012; Patrick, Schulenberg, & O'Malley, 2016). Furthermore, consumption of opioids, larger amounts and/or combination of substances have been associated with accidental intoxication requiring professional emergency care, overdose and death (Chhabra, Gimbar, Walla, & Thompson, 2017; Degenhardt & Hall, 2012; Erickson et al., 1996; Ruest et al., 2018; Turris, Camporese, Gutman, & Lund, 2016). From a public health perspective, it is therefore important to estimate the prevalence of illicit substance use in a population to apply sufficient and timely preventive measures.

Studies using targeted sampling methods in specific settings have found higher prevalence of illicit substance use compared to general population surveys. Such studies have commonly been conducted in nightlife and music festivals (Fox et al., 2017; Gripenberg-Abdon et al., 2012; Hoegberg et al., 2017; Miller et al., 2015; Nordfjærn, Bretteville-Jensen, Edland-Gryt, & Gripenberg, 2016; Van Havere, Vanderplasschen, Lammertyn, Broekaert, & Bellis, 2011), as well as in electronic dance music (EDM) events (Hesse & Tutenges, 2012; Johnson, Voas, Miller, & Holder, 2009; Lim, Hellard, Hocking, Spelman, & Aitken, 2010; Mohr, Friscia, Yeakel, & Logan, 2017; Palamar, Acosta, Sherman, Ompad, & Cleland, 2016).

Even in studies using targeted sampling methods, questionnaires are the most common study instrument. The questionnaires may be sent by post or email, be completed online, or the respondents may be interviewed, over the phone, in person, in groups or by a combination of such methods. However, studies comparing self-reported data with biological test results have found significant under-reporting and the validity of self-reported data have been questioned (Delaney-Black et al., 2010; Fendrich, Johnson, Sudman, Wislar, & Spiehler, 1999; Fendrich, Johnson, Wislar, Hubbell, & Spiehler, 2004; Harris, Griffin, McCaffrey, & Morral, 2008; Harrison & Hughes, 1997; Johnson, 2014; Miller et al., 2015; Rendon, Livingston, Suzuki, Hill, & Walters, 2017; Rosay, Najaka, & Herz, 2007). Studies conducted in nightlife and EDM settings have also found relatively low agreement between the self-reported data and biological measures (Gripenberg-Abdon et al., 2012; Johnson et al., 2009; Miller et al., 2015). On the other hand, studies conducted among patients with problematic drug use have found higher agreement between the two methods (Cone, 2012; Denis et al., 2012; Yonkers, Howell, Gotman, & Rounsaville, 2011). The extent of under-reporting may thus be related to the study situation and the drug phenomenon being studied, in addition to factors such as age, sex, race as well as the type of drug used (Harris et al., 2008; Johnson, 2014; Rendon et al., 2017; Rosay et al., 2007).

Over-reporting may also occur, particularly if the interviewed individual expects that it will be favorable in the actual study setting, either towards the interviewer, friends, or other bystanders (Johnson & Fendrich, 2005; Johnson, 2012). Furthermore, unintended inaccuracies, such as misidentification of the substances used or recall problems may also reduce the validity of self-reported data on illicit substance use (Harrison & Hughes, 1997; Johnson & Fendrich, 2005).

The questionable validity of self-reported information indicates that results from drug testing of biological samples may be superior to self-reported data when examining recent illicit substance use (Fendrich, Johnson, & Becker, 2017; Gjerde, Øiestad, & Christophersen, 2011; Vearrier, Curtis, & Greenberg, 2010). This may be particularly important in settings where such use may be socially undesirable (Groh, Ferrari, & Jason, 2009; Sloan III, Bodapati, & Tucker, 2004).

Still, results from biological sample testing also carry some limitations. The detection times vary between the types of biological samples analyzed. To examine illicit substance use within the past couple of days, oral fluid and blood analysis appear to be superior to other biological materials (Verstraete, 2004). However, some frequent users may test positive in oral fluid and blood for more than two days after last drug intake (Andås et al., 2016; Andås et al., 2014; Jufer, Walsh, Cone, & Sampson-Cone, 2006). A positive urine test result indicates use within the past days or weeks, whereas a positive hair test result may indicate drug use during the period the hair has grown, i.e. several months (Barbosa et al., 2013; Curtis & Greenberg, 2008; Gjerde et al., 2011; Verstraete, 2004). Consequently, the analysis of any biological material will always carry some degree of uncertainty regarding time of drug intake.

The agreement between biological sample test results and self-reported data has been examined in EDM festivals (Johnson et al., 2009; Palamar, Acosta, Ompad, & Cleland, 2017; Palamar et al., 2016). However, such analyses have not been possible in data collected from general music festivals, as these studies have relied on self-reported data (Fox et al., 2017; Hesse & Tutenges, 2012; Jenkinson, Bowring, Dietze, Hellard, & Lim, 2014; Lim et al., 2010), or wastewater or pooled urine testing (Hoegberg et al., 2017; Lai et al., 2013). Consequently, the extent of under-reporting and the associated demographic characteristics in such settings are not known. To address these issues, this study aimed to examine the agreement between oral fluid test results and self-reported substance use among general music festival attendees, and to examine demographic and self-reported substance drug use factors associated with reporting past 48 hours illicit drug use in the questionnaire among users identified by analysis of oral fluid samples.

## Methods

#### Design

This was a cross-sectional study recruiting participants from six music festivals in Norway, July-August 2016. The festivals were geographically spread, and the total attendance ranged from 8,000 to 17,000 visitors. The music genres included pop, pop/rock, rock, alternative to electronic and combinations of these genres. Our research teams comprised between 11 and 17 researchers and research assistants, and the aim was to recruit approximately 200 participants at each festival. All festivals had large numbers of patrons passing through the selected recruitment area(s), and at some festivals, attendees lined up to have their blood alcohol concentration (BAC) levels measured. It was therefore not possible to invite all patrons or to use a systematic random sampling (e.g. selecting only every third or fifth person). Consequently, this was a convenience sample.

Festival attendees were invited to complete a questionnaire, provide an oral fluid sample and to have their BAC measured using a breathalyzer. They were informed that the study was anonymous and voluntary, and informed consent was obtained. Each questionnaire and oral fluid sample was linked with a barcoded label. Participants received a food or soft drink voucher in lieu of reimbursement. More details on the data collection and study participants have been published elsewhere (Gjersing, Bretteville-Jensen, Furuhaugen, & Gjerde, 2018).

The study was approved by the Regional Committee for Medical and Health Research Ethics (approval no. 2016/337).

#### Questionnaire

The paper-and-pencil questionnaire was an adjusted version of the questionnaire used in a nightlife setting in 2014 (Nordfjærn, Edland-Gryt, Bretteville-Jensen, Buvik, & Gripenberg, 2016). It took approximately five minutes to complete and comprised the following items: age (1 if >25), sex (1 if male), born in Norway (1 if yes), level of education (1 if bachelor’s degree or higher) and current employment status (1 if currently working or studying), age of first alcohol intoxication (1 if drunk before the age of 16) and illicit drug use (1 if use before the age of 18), past 30 days smoking status (1 if smoking daily) and use of alcohol, cannabis, amphetamines, MDMA/ecstasy, cocaine and MOP (a fictitious substance to study the extent of over-reporting) during past 48 hours, 30 days, 12 months, and lifetime.

#### Biological measures

The BAC levels were estimated by using the Lion Alcolmeter™ 500 breathalyzer (Lion Laboratories Limited, Vale of Glamorgan, United Kingdom). Samples of oral fluid were collected by using the Intercept® Oral Fluid Collection Device (OraSure Technologies, Bethlehem, PA, USA). The samples were analyzed for 30 illicit and 22 medicinal drugs or drug metabolites (see Table S1 in the online supplementary material) by ultra-high performance liquid chromatography with tandem mass spectrometry detection (Gjerde et al., 2016). The analytical method was specific for the included substances; so qualitatively, the occurrence of false positives was unlikely. Cut-off concentrations (i.e. concentrations above which a test result is reported as positive) for the four most prevalent substance groups in neat oral fluid were for amphetamine 15 ng/mL, benzoylecgonine (cocaine metabolite) 4.3 ng/mL, cocaine 1.1 ng/mL, MDMA (Ecstasy) 2.3 ng/mL, methamphetamine 8.9 ng/mL and tetrahydrocannabinol 0.37 ng/mL, assuming that 0.4 mL oral fluid was collected and diluted with 0.8 mL preservative buffer present in the collection device.

#### Statistical analysis

Statistical analyses were conducted using SPSS® version 25.0 (IBM Corporation, Armonk, NY, USA). To determine the agreement between oral fluid test results and self-reported drug use in the past 48 hours we calculated Cohen’s kappa (κ) for the substances cannabis, cocaine, MDMA and amphetamines. We defined agreements as follows: no agreement κ≤ 0.20; minimal agreement κ=0.21-0.39; weak agreement κ=0.40-0.59; moderate agreement κ=0.60-0.79; strong agreement κ=0.80-0.90; and almost perfect agreement κ>0.90 in accordance with recommendations by McHugh (2012).

Among those testing positive for illicit substances in the oral fluid samples, we used bivariate and multivariable logistic regression analysis to examine which demographic factors were associated with reporting past 48 hours illicit substance use in the questionnaire. Odds Ratios (OR) and 95% Confidence Intervals (CI) were reported. In the multivariable model, we only included independent variables that were statistically significant in the bivariate analysis.

## Results

#### Description of the study sample

In total, 1,837 music festivals attendees were invited to participate in the study. Of those, 1,336 (71.3%) accepted the invitation. Ten were excluded because they were underage, and 17 attendees did not provide both oral fluid samples and questionnaires; thus, this study included data for 1,309 participants. The majority (84%) of participants were recruited from pop/rock festivals, slightly more than half (54%) were younger than 26 years and held a bachelor’s degree or higher, and slightly less than half (47%) were female. About 90% tested positive for alcohol, and 1/3 had a blood alcohol concentration above 0.1%. For more details on study participants, see Gjersing et al. (2018).

Oral fluid tests and self-reported drug useIn our sample of 1,309 festival attendees, 10.8% tested positive for any illicit substance: cannabis 6.0%, cocaine/benzoylecgonine 3.2%, MDMA 2.4%, and amphetamines 0.7% (see Table S1 in the online supplementary material for more analytical results). In comparison, 5.5% reported use of any illicit substance in the past 48 hours. Cannabis was most commonly reported (4.4%), followed by MDMA/ecstasy (1.1%), cocaine (0.8%) and amphetamines (0.5%).

Using Cohen’s kappa we found low but significant agreement between the oral fluid test results and self-reported use in the past 48 hours (Table 1). About half of those who tested positive for tetrahydrocannabinol (THC) reported cannabis use during the past 48 hours. For cocaine, one out of six who tested positive admitted cocaine use during the past 48 hours. However, among the 35 persons who tested positive for cocaine, but did not report such use, one reported MDMA use but tested negative, whereas two reported amphetamine use and tested positive. Furthermore, one third of those with a positive MDMA test result reported use past 48 hours. One of the 22 persons who tested positive for MDMA and did not report such use during the past 48 hours reported amphetamine and cocaine use and tested positive for both substances. Only nine respondents tested positive for amphetamines, yet slightly more than half of these admitted use in the past 48 hours. When including self-reported drug use during the previous month, the proportions disclosing drug use among those who tested positive were only slightly higher; for cannabis four more persons reported using this drug, for cocaine and MDMA two, and for amphetamines one more person reported drug intake during past 30 days compared to reported intake past 48 hours.

<Insert Table 1 about here>

Despite the overall low agreement between the oral fluid test results and past 48 hours self-reported drug use, the Cohen’s Kappa statistics revealed differences across substances (Table 1). We observed a moderate agreement for cannabis and amphetamines (κ=0.60 and κ=0.62, respectively), weak agreement for MDMA (κ=0.43), and finally, minimal agreement for cocaine (κ=0.25).

Of the 141 respondents with a positive oral fluid test result, 39.7% reported past 48 hours illicit substance use in the questionnaire (Table 2). Males, those who reported drinking alcohol until drunk on a weekly basis, had used illicit substances before they were 18 years, had used illicit substances weekly or smoked tobacco daily in the month prior to the interview were more likely to report illicit substance use. Those being employed or studying were less likely to report such use. When adjusting for covariables, multivariable logistic regression analysis showed that among participants who tested positive, those reporting weekly illicit substance use and those using such substances when younger than 18 years were more likely to report past 48 hours use.

<Insert Table 2 about here>

## Discussion

This study showed that under-reporting of illicit substance use was common among general music festivals attendees. The under-reporting was more significant for identified cocaine and MDMA users, than for identified cannabis and amphetamine users. Among those identified as users by oral fluid drug testing, multivariable logistic regression analysis showed that regular and experienced substance users were more likely to report recent use.

A positive drug test result in oral fluid does in most cases indicate drug intake during the last 48 hours, but not always. Some frequent users may test positive in oral fluid and blood for more than two days after last drug intake (Andås et al., 2016; Andås et al., 2014; Jufer et al., 2006). Possibly, this may contribute somewhat to the low agreement between test results and self-reported drug use in this current study, as a person who tested positive in the oral fluid sample might have used the drug(s) prior to the 48-hour interval, and therefore not reported such use in the questionnaire. However, only a small proportion of those who tested positive, but did not report drug use during the past 48 hours reported such use during the past month (see Table 1). This is therefore not likely to explain the low agreement between test results and self-reported drug use

Furthermore, some festival-goers who tested negative reported drug use within the past 48 hours. Previous studies have shown that those only using smaller amounts of cocaine, MDMA or cannabis may test negative less than 48 hours after last drug intake (Verstraete, 2004). This might have occurred for some participants in this current study. For amphetamines, the probability of testing negative within 48 hours is lower than for cannabis and cocaine, as the detection time in oral fluid is normally longer (Verstraete, 2004). The proportion of positive test results in our study is therefore likely to be a minimum estimate, as it is possible that the test results did not detect use due to the issues previously discussed.

The under-reporting was more significant for identified cocaine and MDMA users, than for identified cannabis and amphetamine users. Possibly, cannabis and amphetamine use are more accepted in this particular setting, which could be the reason for less under-reporting for these substances. Our finding of less under-reporting for cannabis is also in line with a previous study among EDM attendees (Johnson et al. (2009), where under-reporting was more common among identified cocaine users (67%) than for cannabis users (32%). The under-reporting of amphetamine use remains more inconclusive, however, as only nine oral fluids samples tested positive for the substance. This means that the high agreement between test and self-reported result for amphetamine comprises a higher degree of uncertainty compared to the corresponding cannabis results based on a higher number of respondents testing positive.

There may be many reasons for not reporting illicit substances use. Some may under-report because of socially desirable responding. The questionnaire was completed at the research site where other festival-goers and research assistants were present. The respondents also had to submit the questionnaire to a research assistant who made sure that all responses were completed. This could be one of the reasons for the low agreement between the test results and the questionnaire. Thus, those employed or studying and those less experienced users may have been more afraid of being stigmatized if they reported such use in the questionnaire than the more experienced and regular users.

One of those who tested positive for cocaine reported intake of MDMA, which was not confirmed by oral fluid testing. Possibly, this person thought that the substance he/she had taken was MDMA. However, another possibility is that it was more socially acceptable to report MDMA use instead of cocaine in this particular setting.

One may think that those with higher alcohol levels when completing the questionnaire would be less concern with other people’s view on own behavior and thus be more likely to report recent use of illicit substances because alcohol intoxication may reduce subjective anxiety (Bradford, Motschman, Starr, & Curtin, 2017). However, having a BAC of 0.10% or higher was not significantly associated with the likelihood of reporting illicit substance use in the logistic regression analyses.

It is also possible that over-reporting could bias our findings. However, only 0.4% reported the use of the fictitious drug MOP during their lifetime, which is a very small proportion compared to those who reported the use of real substances. It is therefore not likely that over-reporting biased the main findings in this study.

The Cohen’s kappa values estimated between the test- and the self-reported results were minimal to moderate. Other studies have also found weak to moderate agreements between the biological testing results and self-reported drug use. A Swedish study of substance use in club settings found an overall Cohen’s kappa of 0.20 when comparing oral fluid testing with self-reports (Gripenberg-Abdon et al., 2012). Johnson and co-workers found an overall Cohen’s kappa of 0.53 (Johnson et al., 2009). Fendrich et al. (2004) found kappa values of 0.11 for cannabis, 0.75 for heroin, and 0.34 for cocaine, when comparing results of oral fluid testing with self-reported use during the past 30 days in a general population survey; when comparing results from urine testing, the kappa factors were higher for cannabis (0.58) and cocaine (0.41). This means that our findings are in line with other studies examining the agreement between test results and self-reported data in other settings than general music festivals.

#### Limitations

The relatively small sample size, 141 participants tested positive for illicit substances, implies modest statistical power for the regression analysis. A repeated analysis, based on a larger number of participants, may obtain a larger number of statistically significant predictors.

The estimated prevalence of recent illicit drug use may have been somewhat underestimated, as the refusal rate is expected to be higher among those who had used drugs recently than among non-users.

It is possible that a small proportion of the participants may have tested positive more than 48 hours before sample collection and denied drug intake during the past 48 hours. Therefore, the disagreement between test results and self-reported drug use may have been slightly overestimated.

# Conclusion

A fairly large under-reporting was observed, more significant for identified cocaine and MDMA use than for identified cannabis and amphetamine use. Among those testing positive, regular and experienced users were more likely to report recent use, compared to less regular and experienced users. Overall, oral fluid testing appears to be an important tool when studying illicit substance use among music festival attendees. To obtain comprehensive data, however, including information on demographic characteristics, frequency and amount of substances used etc., biological test results should be combined with self-reports.

# Declaration of interests

The authors report no conflicts of interest.

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**Table 1.** Agreement between oral fluid drug test results and self-reported illicit substance use past 48 hours among music festival participants (n=1,309). Self-reported use in the past month is also presented.

|  |  |  |  |
| --- | --- | --- | --- |
| **Oral fluid test results** | **Reported  use past  48 hrsa** % (n) | **Cohen’s kappa** (95% CI) | **Reported  use past  monthb** % (n) |
| **Cannabis** |  |  |  |
| Positivec (n=78) | 53.8 (42) | 0.60 (0.50-0.70)\* | 59.0 (46) |
| Negative (n=1,231) | 1.3 (16) |  | 8.4 (104) |
|  |  |  |  |
| **Cocaine** |  |  |  |
| Positived (n=42) | 16.7 (7) | 0.25 (0.10-0.41)\* | 21.4 (9) |
| Negative (n=1,267) | 0.3 (4) |  | 1.9 (24) |
|  |  |  |  |
| **MDMA (ecstasy)** |  |  |  |
| Positive (n=32) | 31.3 (10) | 0.43 (0.25-0.61)\* | 37.5 (12) |
| Negative (n=1,277) | 0.3 (4) |  | 1.7 (22) |
|  |  |  |  |
| **Amphetamines** |  |  |  |
| Positivee (n=9) | 55.6 (5) | 0.62 (0.34-0.90)\* | 66.7 (6) |
| Negative (n=1,300) | 0.2 (2) |  | 1.0 (13) |

aAmong those who tested positive or negative in oral fluid for each substance. bIncluding self-reported use past 48 hrs. cTetrahydrocannabinol (THC). dCocaine or the metabolite benzoylecgonine. eAmphetamine or methamphetamine.

\*p<0.001

**Table 2.** The demographic and substance use characteristics among those testing positive for illicit substances in the oral fluid (n=141), stratified on those reporting past 48 hours use in the questionnaire (n=56) and those not reporting such use (n=85). The likelihood of reporting such use was estimated using bivariate and multivariable logistic regression analyses (n=141).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Reporting illicit substance use**  (n=56)  % | **Not reporting illicit substance use** (n=85)  % | **OR (95% CI)** | ***p*** | **AOR (95% CI)a** | ***p*** |
| Male | 75.0 | 56.5 | 2.3 (1.1-4.9) | 0.027 | 1.1 (0.4-3.2) | 0.794 |
| Age > 25 years | 26.8 | 35.3 | 0.7 (0.3-1.4) | 0.290 | – | – |
| Bachelor’s degree or higher | 42.9 | 58.8 | 0.5 (0.3-1.0) | 0.065 | – | – |
| Having a job or studying | 82.1 | 94.1 | 0.3 (0.1-0.9) | 0.031 | 0.5 (0.1-2.6) | 0.404 |
| BAC ≥ 0.10% | 50.0 | 35.3 | 1.8 (0.9-3.6) | 0.084 | – | – |
| Drunk before 16y | 62.5 | 47.1 | 1.9 (0.9-3.7) | 0.074 | – | – |
| Being drunk weekly | 64.3 | 32.9 | 3.7 (1.8-7.4) | <0.001 | 2.6 (1.0-7.0) | 0.057 |
| Illicit drugs before 18y | 58.9 | 20.0 | 5.7 (2.7-12.2) | <0.001 | 5.0 (1.9-13.4) | 0.001 |
| Illicit drug use weekly | 57.1 | 2.4 | 55.3 (12.4-247.7) | <0.001 | 30.6 (6.3-147.9) | <0.001 |
| Smoking tobacco daily | 39.3 | 15.3 | 3.6 (1.6-8.0) | 0.002 | 1.6 (0.5-5.1) | 0.399 |

aAdjusted odds ratios (AOR) were calculated by including all variables that were statistically significant in the bivariate analyses.

**Table S1.** Drugs analyzed in oral fluid samples from festival participants (n=1309), cut-off concentrations, and findings.

|  |  |  |  |
| --- | --- | --- | --- |
| **Substance** | **Analytical cutoff in**  **oral fluid-buffer-methanol mixture ng/mL** | **Corresponding cut-off in neat oral fluida**  **ng/mL** | **Prevalence  % (n)** |
| ***Illicit substances*** |  |  |  |
| *Cannabis* |  |  |  |
| Tetrahydrocannabinol | 0.047 | 0.37 | 6.0 (78) |
| *Central stimulants* |  |  |  |
| Amphetamine | 1.8 | 15 | 0.5 (7) |
| Methamphetamine | 1.1 | 8.9 | 0.2 (3) |
| Amphetamine or methamphetamine | – | – | 0.7 (9) |
| Cocaine | 0.14 | 1.1 | 2.8 (36) |
| Benzoylecgonineb | 0.54 | 4.3 | 1.4 (18) |
| Cocaine or benzoylecgonine | – | – | 3.2 (42) |
| MDMA (ecstasy) | 0.29 | 2.3 | 2.4 (32) |
| *Illicit opiate* |  |  |  |
| 6-monoacetylmorfin | 0.59 | 4.7 | 0.1 (1)c |
| *Hallucinogen* |  |  |  |
| LSD | 0.0024 | 0.019 | 0.0 (0) |
| *NPSd* |  |  |  |
| 25C-MBOMe | 0.0060 | 0.048 | 0.0 (0) |
| 25I-NBOMe | 0.0077 | 0.062 | 0.0 (0) |
| 2C-B | 0.029 | 0.23 | 0.0 (0) |
| 2C-I | 0.035 | 0.28 | 0.0 (0) |
| 4-methylamphetamine | 0.067 | 0.54 | 0.0 (0) |
| 5F-APINACA | 0.012 | 0.093 | 0.0 (0) |
| 5F-PB-22 | 0.011 | 0.091 | 0.2 (2) |
| Alpha-PVP | 0.016 | 0.13 | 0.0 (0) |
| AM-2201 | 0.011 | 0.087 | 0.1 (1) |
| Diclazepam | 0.024 | 0.19 | 0.0 (0) |
| Dimethyltryptamine | 0.013 | 0.11 | 0.2 (2) |
| Etizolam | 0.027 | 0.22 | 0.1 (1) |
| Ethylphenidate | 0.019 | 0.15 | 0.1 (1) |
| Flubromazepam | 0.025 | 0.20 | 0.0 (0) |
| Flubromazolam | 0.028 | 0.22 | 0.0 (0) |
| Ketamine | 0.043 | 0.34 | 0.2 (2) |
| Methylenedioxypyrovalerone | 0.062 | 0.50 | 0.0 (0) |
| Mephedrone | 0.013 | 0.11 | 0.0 (0) |
| Methiopropamine | 0.011 | 0.087 | 0.0 (0) |
| Salvinorin A | 0.39 | 3.1 | 0.0 (0) |
| THJ-2201 | 0.011 | 0.087 | 0.0 (0) |
| UR-144 | 0.0094 | 0.075 | 0.0 (0) |

(continues next page)

**Table S1 (continued).**

|  |  |  |  |
| --- | --- | --- | --- |
| **Substance** | **Analytical cutoff in**  **oral fluid-buffer-methanol mixture (ng/mL)** | **Corresponding cut-off in neat oral fluida**  **(ng/mL)** | **Prevalence in oral fluid samples  (%)** |
| ***Licit substances*** |  |  |  |
| *Opioid analgesics* |  |  |  |
| Buprenorfin | 0.88 | 7.1 | 0.1 (1) |
| Codeine | 0.57 | 4.5 | 0.2 (2) |
| Fentanyl | 0.10 | 0.81 | 0.0 (0) |
| Methadone | 0.58 | 4.7 | 0.0 (0) |
| Morphine | 0.54 | 4.3 | 0.0 (0) |
| Oxycodone | 0.57 | 4.5 | 0.0 (0) |
| Tramadol | 4.0 | 32 | 0.0 (0) |
| *Sedatives and hypnotics* |  |  |  |
| 7-aminoflunitrazepamb | 0.011 | 0.088 | 0.0 (0) |
| 7-aminoclonazepamb | 0.054 | 0.43 | 0.2 (2) |
| 7-aminonitrazepamb | 0.047 | 0.38 | 0.0 (0) |
| Alprazolam | 0.035 | 0.28 | 0.5 (6) |
| Clonazepam | 0.036 | 0.29 | 0.4 (5) |
| Diazepam | 0.026 | 0.21 | 0.2 (2) |
| Flunitrazepam | 0.024 | 0.19 | 0.2 (2) |
| N-desmetyldiazepamb | 0.051 | 0.41 | 0.2 (3) |
| Meprobamate | 1.6 | 13 | 0.0 (0) |
| Nitrazepam | 0.032 | 0.26 | 0.2 (2) |
| Oxazepam | 0.37 | 3.0 | 0.1 (1) |
| Phenazepam | 0.026 | 0.21 | 0.2 (2) |
| Phenobarbital | 1.7 | 14 | 0.0 (0) |
| Zolpidem | 0.010 | 0.083 | 0.2 (3) |
| Zopiclone | 0.073 | 0.59 | 0.8 (10) |

aFor a volume of collected oral fluid of 0.4 mL.   
bMetabolites.

cIncluding morphine.  
dSubstances classified as NPS in this study.