HHS Public Access

Author manuscript

Exp Clin Psychopharmacol. Author manuscript; available in PMC 2022 June 01.

Published in final edited form as:

Exp Clin Psychopharmacol. 2021 June ; 29(3): 229–235. doi:10.1037/pha0000452.

Drug Checking at Dance Festivals: A Review With Recommendations to Increase Generalizability of Findings

Joseph J. Palamar[1], **Nicole D. Fitzgerald**[2], **Katherine M. Keyes**[3], **Linda B. Cottler**[2]

[1]Department of Population Health, New York University Grossman School of Medicine

[2]Department of Epidemiology, College of Public Health and Health Professions, College of Medicine, University of Florida

[3]Department of Epidemiology, Mailman School of Public Health, Columbia University

Abstract

Dance festival attendees are at high risk for consuming adulterated drugs. In recent years, drug checking studies have been conducted at various dance festivals to provide valuable harm reduction information to attendees regarding drug content. We conducted a review of the literature to determine the generalizability of findings to the target population of interest—festival attendees at risk for using adulterated drugs. Six published studies involving drug checking at festivals were reviewed. All relied on self-selected samples and male attendees were overrepresented based on previous research. Test methods, drugs tested, definitions of adulteration, and prevalence of adulteration varied across studies. Prevalence of detection of adulterants ranged from 11% to 55%. While the drug checking services described appear to have been beneficial for participants, results have limited generalizability to the target population. We recommend that researchers expand beyond the self-selection model in future studies and utilize recruitment methods that involve random sampling techniques such as systematic random sampling, stratified random sampling, or time-space sampling within festivals. We also recommend that individuals approached are surveyed for demographic characteristics, planned drug use at the festival, and willingness to test their drugs. These methods would help determine how representative the sample is compared to the target population and allow for more generalizable estimates. In conclusion, as these valuable harm reduction services expand, it may be possible to reach a wider portion of the population at risk and to obtain more generalizable estimates of engagement, adulteration, and reactions to learning one possesses adulterated drugs.

Keywords

drug checking; recruitment methods; ecstasy; cocaine

The popularity of dance festivals has increased over the past decade. There are now hundreds of dance festivals held throughout the world—some of which are attended by tens

Correspondence concerning this article should be addressed to Joseph J. Palamar, New York University Grossman School of Medicine, Department of Population Health, 180 Madison Avenue, Room 1752, New York, NY 10016, United States. joseph.palamar@nyulangone.org.

or hundreds of thousands of people (Ridpath et al., 2014). Electronic dance music (EDM) festivals in particular have grown both in size and in number in recent years. In fact, EDM is now a $7.2 billion dollar industry (Watson, 2019). EDM dance festivals are legal and more mainstream versions of underground rave parties, which are now commonly sponsored by major corporations, regulated by local governments, and held on public or government-owned grounds. However, despite dance festivals becoming large mainstream events, synthetic drug use among attendees is highly prevalent (Palamar & Keyes, 2020), and there have been numerous clusters of drug-related poisonings and deaths of young adults at such events in recent years (Armenian et al., 2013; Centers for Disease Control & Prevention, 2010; Chhabra et al., 2018; McAndrew et al., 2019; Ridpath et al., 2014; Ruest et al., 2018). It is therefore important for public health practitioners to aim to reduce potential harm among festival attendees who are at risk for use.

Ecstasy, also known as 3,4-methylenedioxymethamphetamine (MDMA) or Molly, is among the most prevalent synthetic drugs used by festival attendees (Griffin et al., 2020; Hughes et al., 2017; Southey et al., 2020). A national survey of adults in Australia who had attended a dance festival found that of the 78% who reported using an illegal drug at their most recent festival attended, 85% used ecstasy (Hughes et al., 2017). Recent studies of adults in New York City (NYC) who attended EDM events at nightclubs or festivals estimated that over a quarter (26.5%) who attended such events used ecstasy in the past year (Griffin et al., 2020; Palamar, 2020b). In fact, an estimated 17.9% of EDM festival attendees used ecstasy the days they attended festivals (Palamar, Acosta, & Cleland, 2019), and a third (33.4%) of EDM event attendees who used ecstasy were estimated to have initiated use at a festival (Palamar, 2020a). While ecstasy is the most prevalent drug used among festival attendees, past-year use of drugs such as powder cocaine (26.1%), lysergic acid diethylamide (LSD; 15.3%), and ketamine (8.5%) is also prevalent compared to the general population (Palamar, 2020b).

Illegal drugs such as ecstasy and cocaine are well-known to be associated with a wide range of risks for adverse effects (Gable, 2004; Nutt et al., 2007; Palamar, Acosta, & Le, 2019), but another potential risk associated with use of such drugs is that they can be adulterated or contaminated with other synthetic drugs some of which can be even more dangerous than the purported drug. For example, synthetic cathinones, which are commonly referred to as “bath salts” in the United States (U.S.), have been among the most common adulterants detected in ecstasy over the past decade (Brunt et al., 2017). Some synthetic cathinones such as α-pyrrolidinova-lerophenone (alpha-PVP, “Flakka”) and methylenedioxypyrovaler-one (MDPV) are about equipotent to methamphetamine (Watterson & Olive, 2017), and mephedrone and methylone may have higher abuse potential than MDMA (Papaseit et al., 2016; Watterson & Olive, 2014). This suggests these compounds may be relatively more dangerous to use than MDMA—especially when used unknowingly or in combination with MDMA. Many other drugs have been commonly detected in ecstasy, including methamphetamine, cocaine, ketamine, 2,5-dimethoxy-4-bromophenethyla-mine (2-CB), 4-fluoroamphetamine (4-FA), 5/6-(2-aminopropyl) benzofuran (5/6-APB), paramethoxyamphetamine (PMA), and paramethoxymethamphetamine (PMMA) (Brunt et al., 2017; Parrott, 2004; Tanner-Smith, 2006). Adulteration, however, is by no means limited to ecstasy. LSD can contain highly potent psychedelic stimulants such as N-methoxybenzyl

(NBOMe) or DOx series drugs such as [1-(4-bromo-2,5-dimethoxyphenyl)-2-aminopropane (DOB; Mendoza-Valencia et al., 2019). Cocaine is also commonly adulterated with substances such as levamisole (Brunt et al., 2017; Energy Control, 2017). In recent years, drugs such as cocaine have also been found to be adulterated or contaminated with fentanyl or its analogs (Armenian et al., 2019), so increased attention is needed toward what purported drugs actually contain in order to help prevent adverse outcomes related to unintentional exposure to such adulterants.

Drug Checking at Dance Festivals

Drug checking at festivals has emerged as a harm reduction method to help people who use drugs ensure that their drugs indeed contain what they were purported to contain. Drug checking has been conducted since at least the 1970s (Renfroe, 1986), and a variety of methods can be used to test drugs for their contents. Some tests can determine the mere presence of specific compounds, while others can detect the amount of compound present, with such testing ranging from colorimetric reagent testing to more advanced methods such as ultra-high performance liquid chromatography-tandem mass spectrometry (UHPLC-MS/MS) (Barratt et al., 2018; Palamar et al., 2020). An estimated 23.1% of EDM nightclub or festival attendees in NYC have had their ecstasy tested in the past year (Palamar & Barratt, 2019). We believe most of such testing in the U.S. is conducted by the attendees themselves or by their peers using standard reagent tests. Reagent tests, however, have been found to have low sensitivity and specificity when testing for adulterants in drugs such as ecstasy (Murray et al., 2003). Some European countries have services in which drugs can be mailed in or dropped off and more advanced analysis is conducted using expensive machinery (Barratt et al., 2018; Brunt et al., 2017; Palamar et al., 2020). Despite varying ability of drug checking services throughout the world, well-equipped drug checking services at places where people commonly use drugs such as at dance festivals has been lacking.

While drug checking organizations such as DanceSafe have been testing people's drugs at festivals and other parties for some two decades (Henricksen, 2000; Saleemi et al., 2017), drug checking studies conducted at festivals have been lacking. However, in recent years, some studies have been conducted in which researchers have formally documented their drug checking efforts at such events along with test results. Since drug checking studies conducted at festivals are in their infancy, we conducted a systematic review of the study methods, results, and generalizability of results of such studies in order to detect potential limitations that can be addressed during future studies.

Methods

We searched PubMed, PsycInfo, Embase, and Web of Science for studies published in English between 2015 and 2020 focusing on drug checking at dance festivals around the world. We limited the search to these years in order to ensure that all studies were recent. We identified articles through the following keyword search: "drug checking," "pill testing," "drug testing," and "fentanyl testing." We then searched within these articles to determine whether dance festivals were a focus of the studies. We searched for mentions of festivals

within located articles in case names of specific festivals were mentioned without the term "festival." We also screened reference lists of eligible articles to determine whether any met our search criteria. While we did not search the Internet directly for grey literature, we considered university or government reports that covered relevant studies.

To be eligible for inclusion, studies had to be based upon drug checking studies conducted at dance festivals, meaning researchers tested participants' drugs at one or more festival. Studies were deemed eligible if results were reported based on aggregated data from multiple festivals, but we deemed studies ineligible for inclusion if drug checking was conducted at multiple types of venues (e.g., dance festivals and nightclubs) with aggregated data. Studies focused on drug checking that did not involve drugs being tested at festivals were excluded. For example, surveys that only asked festival attendees about drug checking behavior, without offering testing, were excluded. Review articles, letters, and editorials were also excluded. Two reviewers (Nicole Fitzgerald [NF] and Joseph Palamar [JP]) independently searched for articles and screened titles and abstracts to determine studies that met eligibility criteria. Both reviewers read all articles identified to confirm eligibility. There were no discrepancies regarding which articles met inclusion criteria. Of 102 unique articles, 72 were research articles; six met the criteria for inclusion in our review. This study was exempt from review from the New York University Langone Medical Center as it did not involve human subjects.

Results

The six studies that fit the criteria are summarized in Table 1. Two studies were conducted in Portugal, two were conducted in Canada, one was conducted in the United Kingdom, and one was conducted in Australia. In all studies, drug checking was conducted inside tents or "hubs" in designated areas of the festivals. Though four studies did not provide information regarding recruitment methods, two noted having recruited via word of mouth during the festival. Regarding demographic characteristics of participants, two studies did not report these, but of studies that did, participants overwhelmingly identified as male (ranging from 66% to 78%). The mean age of participants ranged from 23 to 28.5 years of age; only one study reported participants' education, and 76% of participants reported a college degree (Valente et al., 2019).

Most studies used a combination of drug checking procedures. Four studies utilized Fourier transform infrared (FTIR) or Raman spectroscopy, which are complementary vibrational spectroscopy techniques. One study used only FTIR; the other studies used FTIR or Raman in combination with fentanyl immunoassay strips, colorimetric reagents, thin layer chromatography (TLC), and/or gas chromatography–mass spectrometry (GC–MS). One also utilized mass loss analysis in addition to measure MDMA content in pills (Measham, 2019). While each study focused on specific purported drugs as well as the specific drugs they might contain, each reported prevalence of adulteration differently with rates of detection of adulterants ranging from 11% to 55%.

Two studies recorded whether drugs were discarded by participants (e.g., in amnesty bins at the tent) and three studies queried intention to not use the drug after receiving a result,

regardless of discovering it was adulterated. In one study, 66.7% of participants who learned their drug contained another substance disposed of it (Measham, 2019). Further, in another study that focused on fentanyl adulteration, 16.1% of participants whose drug tested positive for fentanyl discarded it (Mema et al., 2018). With respect to intention to discard any of their drugs, 29%–94% reported intention to either not use the drug or to discard the drug after learning they possessed an adulterated or impure substance.

Discussion

We reviewed six manuscripts that focused on drug checking studies conducted at dance festivals. Each study yielded important results and helped disseminate important harm reduction information to people who might have been at risk for using adulterated or contaminated drugs. Future studies, if conducted in a similar manner, will also likely yield important findings to people who attend festivals and use drugs.

It is difficult to directly compare studies examined in this review as they used a variety of test methods, tested different combinations of drugs, and reported test results in a non-uniform manner. Limitations of test methods used also made it difficult to compare findings. For example, FTIR and Raman have limited sensitivity and can typically only detect the most abundant molecule. Therefore, when a smaller amount of adulterant is present in drug product, it can easily go undetected. Some studies added colorimetric tests to FTIR or Raman to help balance out the low sensitivity of these techniques, but colorimetric tests can also be somewhat limited as results are not always accurate and can be difficult to interpret (McGowan et al., 2018; Murray et al., 2003). Two studies added fentanyl immunoassay test strips, which have high sensitivity and specificity, to test for fentanyl and some of its analogs (Tupper et al., 2018). Two additional studies also included additional testing using GC–MS which provides quantitative results with low pg to ng-level detection (Palamar et al., 2020). However, this type of testing is often not feasible in festival studies as GC–MS machines can cost tens of thousands of dollars and participants would likely have to wait at least 20 min to obtain results. Given the wide variety of test methods used, it is unknown to what extent specific adulterants were present in specific drugs across studies. For example, fentanyl can be detected through test strips and through GC–MS, but it is unlikely to be detected using colorimetric tests or FTIR. In addition, regardless of the methods used to test drugs, focusing on only one type of drug (e.g., LSD) or only testing for one type of adulterant (e.g., fentanyl) does not provide results for other drugs or adulterants being used by attendees.

Reporting results also varied between studies with some studies clearly presenting percent of specific adulterants detected in specific drugs, and others focusing more on whether drugs were what they were purported to be. At least one study also reported results based on specific test results (when multiple tests were used) rather than reporting on combined results. Further complicating interpretation was that sometimes “unexpected” results were based solely on the presence of adulterant drugs, and other times based on the presence of inert substances. Given varying definitions of adulteration, we were unable to directly compare the prevalence of adulteration, though reported prevalence ranged from 11% to 55%. We believe more uniform reporting in future studies could be beneficial. Researchers should also ensure that reporting of results to participants are presented in a uniform and

complete manner. For example, researchers should be clear regarding which compounds were tested for and which were not. Given the current lack of uniform determination of adulteration and communication of test results across studies, we believe research should be conducted to determine best practices. Development of a standard test result form that can be used to record and communicate results across all types of studies would be most beneficial.

With respect to participant responses to results, only some studies gauged disposal or intention to discard of adulterated drugs. It is unknown to what extent intention translated into action. Further, it is unknown to what extent adulterated drugs were thrown on the ground or sold for someone else to use.

Based on the gaps in the literature, we discuss the importance of survey and sampling methods that may help researchers achieve more representative results in future drug checking studies at festivals.

Representativeness of the Target Population

All studies we reviewed were based on individuals who self-selected into visiting the drug checking tent. Those who approached tents were assumed to have been interested in testing their drugs, likely due to concern about the contents of the drug. Therefore, results of these studies may not be generalizable to all festival attendees at risk for using an adulterated drug. This includes people planning to use a drug such as ecstasy, cocaine, or LSD at the festival—presumably a sizable portion of attendees. Researchers would likely want to estimate the percentage of: (a) those willing to test their drugs, (b) those receiving test results suggesting they possess an adulterated product, and (c) those who still take the drug after learning of adulteration.

An important component that cannot be estimated without more generalizable samples, however, is the prevalence of adulterated drugs among festival attendees. Estimation of prevalence can be an important addition to the next wave of drug checking studies. To our knowledge, the demographic and drug use characteristics of the target populations were not known in the studies conducted. For example, it was likely not known what percentage of people attending these specific festivals were male, young adults, or what drugs they planned on using. Further, among those planning to use a drug, it is unknown how concerned they were about drug purity, and it is unknown how willing they would have been to have their drugs tested. There are two ways to obtain such information. One way is for researchers to estimate characteristics of the target population based on previous research. For example, surveys of EDM event attendees in NYC have consistently estimated that the majority identify as white, heterosexual, and male (Griffin et al., 2020; Palamar, 2020b). Although, estimates would likely be needed for the specific festivals of interest as characteristics likely vary across festivals. Another way is to survey and/or have study staff estimate attendee characteristics as well as characteristics of those who allow researchers to test their drugs.

Representative samples are not necessary to answer all research questions related to harm reduction and drug adulteration among festival attendees. However, results of these studies

are conditional in that they only apply to those assumed to have willingly visited a drug checking tent and were also concerned about their drug's contents. The clear majority (66%–78%) of participants also identified as male. We do not believe this is a function of males being more likely to use drugs because studies typically have not found that males are at significantly higher risk for use of drugs such as ecstasy than females in festival scenes, despite males being slightly more likely to attend (Griffin et al., 2020; Palamar et al., 2017). Female attendees in the drug checking studies we reviewed may be underrepresented, which not only limits generalizability to female attendees, but potentially limits important harm reduction services to this subpopulation. Indeed, the service is useful to concerned individuals who approach the tent, but we believe expanding the scope of such studies would make estimates more reliable, and will also help reach a wider population at risk for using adulterated drugs at festivals.

The Value in Conducting Brief Surveys

Active recruitment throughout festivals can eliminate bias normally associated with passive recruitment involving self-selection when representative samples are warranted. Approaching individuals inside the festival or entering the festival, and asking them to take a rapid survey, can serve as an important addition to drug checking studies. Survey recruitment is an efficient method not only to reach individuals to participate in the drug checking portion of the study, but also to collect important data on the target population. A rapid survey can be as short as a couple of questions; it could be administered electronically via tablet or on a sheet of paper. The most relevant questions would likely be (a) whether the individual plans on using a drug that day (and if so, which drug[s]) and (b) if the individual is willing to test the drug at the tent. Ideally, the survey would also query reasons why one may not be interested in having drugs tested (if they report intention to use a drug). These questions would allow researchers to determine the extent to which the target population (those at risk for using adulterated drugs) is in attendance, whether it was reached in the study, and which of those reached ultimately showed up to test their drug. Further, the information collected could help researchers estimate who their services were not reaching. Given the time and effort utilized to survey participants, researchers would likely also want to ask about other important topics (e.g., regarding drug use, perceptions of related risk). We recommend that surveys administered in festival environments are relatively rapid, and we recommend that participants are compensated (e.g., $2, $5) when a survey is longer than 2 min.

Administering rapid surveys also allows researchers to collect response rates—among those approached and within those approached who agree to test their drugs. This is useful not only to determine the representativeness of the sample but also to inform researchers who is not presenting to test their drugs, and this can inform future recruitment methods.

Benefits of Utilizing Probability Samples

All six studies relied on self-selected samples in which enrollees were those who approached the tent on their own. Introducing a form of probability sampling which includes at least one element of randomness in being selected can make such samples more representative. This would eliminate selection bias and ensure that individuals had a similar chance for inclusion

(Evans, 1991). This, however, requires more intense recruitment efforts in which potential participants are approached inside the festival or as they enter the festival, rather than relying on self-selection. Below, we discuss three options for probability sampling to reduce recruitment bias: (a) systematic random sampling, (b) stratified random sampling, and (c) time-space sampling.

Through *systematic random sampling*, a systematic pattern can be applied in which study staff approach every *i*th passerby at the festival. This method can be complicated by the fast pace of people passing by, by people leaving and arriving to hangout areas, and by people who attend in a group. However, while approaching every *i*th individual is indeed systematic, this does not necessarily meet traditional criteria of true random sampling (Lohr, 2019; Swinscow, 1976). It is possible, for example, that underrepresented groups, such as racial minority individuals (who may be less likely to attend) may be inadvertently skipped depending on where the interval begins.

If the researcher is aware of the demographic breakdown of the target population at the selected festival, *stratified random sampling* may be an option. When this multistage sampling method is used, subpopulations of attendees would be stratified into mutually exclusive groups. Such groups can be stratified by characteristics such as perceived age, sex or gender, perceived race/ethnicity, or by section within the festival. Each stratum is treated as an independent population and recruited separately (Lohr, 2019). Researchers can seek to obtain an equal number of people per stratum or over-sample underrepresented subpopulations (e.g., racial minorities), but typically, proportionate to size. An example of this method would be to stratify by age group with one group of recruiters approaching every fifth person who appears below age 21; others would approach every fifth person who appears older.

Time-space sampling, although a form of venue-based sampling, is a multi-stage sampling design that can also be applied to sampling within a festival. When this type of sampling is utilized, times and spaces are selected before recruitment (MacKellar et al., 2007). As such, festival sections and time slots are randomly selected from a list (e.g., Section 1, Time Slot 1 …Section 20, Time Slot 8). Recruiters target individuals in chosen sections and times. Study staff can either add another level of random selection and approach every *i*th individual *or* every individual can be approached (Parsons et al., 2008). Here, it is not a goal to know the demographic breakdown of the target population, though denominators are needed to calculate response rates. As such, counts of all individuals passing a predetermined line in selected areas and times could also be informative—particularly if the researcher decides to weight the data for analysis (Palamar & Le, 2020).

Both response rates and clicker rates can further be used to create sample weights if the researchers aim to calculate estimates of willingness to test drugs, findings of the drug tests, and responses to the findings. Clicker rates are derived from having a staff member count how many people pass a predetermined line (MacKellar et al., 2007). For example, a recruiter can aim to track each person who walks past an imaginary line (e.g., the entrance, the bathroom section, a water fountain) during selected times using a clicker. Weighted data allows researchers to estimate these numbers to the target population rather than merely

describe percentages of the analytic sample. Weights can be computed to ensure that participant characteristics match the known characteristics of the target population and/or to adjust for non-response.

Conclusion

Drug checking studies at dance festivals are important because they generate data to promote harm reduction related to drug use. The studies we reviewed provided valuable harm reduction information to select persons who attended festivals. We believe our recommendations could close the gaps in the field, provide a safer venue for people who use drugs, and with the data, inform the field about what drugs are being used by festival attendees.

Acknowledgments

The authors declare no conflict of interest. This research is supported by grants through the National Institute on Drug Abuse: R01DA044207 (Palamar), U01DA051126 (Cottler), and T32DA035167 (Cottler). The National Institutes of Health provided financial support for the project and the preparation of the manuscript but did not have a role in the writing of the manuscript, nor the decision to submit the present research.

References

Armenian P, Mamantov TM, Tsutaoka BT, Gerona RR, Silman EF, Wu AH, & Olson KR (2013). Multiple MDMA (Ecstasy) overdoses at a rave event: A case series. Journal of Intensive Care Medicine, 28, 252–258. 10.1177/0885066612445982 [PubMed: 22640978]

Armenian P, Whitman JD, Badea A, Johnson W, Drake C, Dhillon SS, Rivera M, Brandehoff N, & Lynch KL (2019). Notes from the field: Unintentional fentanyl overdoses among persons who thought they were snorting cocaine–Fresno, California, January 7, 2019. MMWR: Morbidity and Mortality Weekly Report, 68, 687–688. 10.15585/mmwr.mm6831a2 [PubMed: 31393864]

Barratt MJ, Kowalski M, Maier LJ, & Ritter A (2018). Global review of drug checking services operating in 2017. National Drug and Alcohol Research Centre, UNSW Sydney.

Brunt TM, Nagy C, Bucheli A, Martins D, Ugarte M, Beduwe C, & Ventura Vilamala M (2017). Drug testing in Europe: Monitoring results of the Trans European Drug Information (TEDI) project. Drug Testing and Analysis, 9, 188–198. 10.1002/dta.1954 [PubMed: 26888408]

Centers for Disease Control and Prevention. (2010). Ecstasy overdoses at a New Year's Eve rave—Los Angeles, California, 2010. MMWR: Morbidity and Mortality Weekly Report, 59, 677–681. [PubMed: 20535091]

Chhabra N, Gimbar RP, Walla LM, & Thompson TM (2018). Emergency department patient burden from an electronic dance music festival. The Journal of Emergency Medicine, 54, 435–439. 10.1016/j.jemermed.2017.10.007 [PubMed: 29108735]

Energy Control. (2017). Report on the analyzed substances in Spain by energy control during 2015. http://energycontrol-international.org/energy-control-national-drug-testing-service-report-2015/

Evans SJ (1991). Good surveys guide. British Medical Journal, 302, 302–303. 10.1136/bmj.302.6772.302 [PubMed: 2001503]

Gable RS (2004). Comparison of acute lethal toxicity of commonly abused psychoactive substances. Addiction, 99, 686–696. 10.1111/j.1360-0443.2004.00744.x [PubMed: 15139867]

Griffin M, Callander D, Duncan DT, & Palamar JJ (2020). Differential risk for drug use by sexual minority status among electronic dance music party attendees in New York City. Substance Use & Misuse, 55(2), 230–240. 10.1080/10826084.2019.1662811 [PubMed: 31530057]

Henricksen K (2000). Harm reduction in the rave community. Focus, 15, 1–4.

Hughes CE, Moxham-Hall V, Ritter A, Weatherburn D, & MacCoun R (2017). The deterrent effects of Australian street-level drug law enforcement on illicit drug offending at outdoor music festivals. International Journal on Drug Policy, 41, 91–100. 10.1016/j.drugpo.2016.12.018

Lohr SL (2019). Sampling: Design and analysis. Routledge. 10.1201/9780429296284

MacKellar DA, Gallagher KM, Finlayson T, Sanchez T, Lansky A, & Sullivan PS (2007). Surveillance of HIV risk and prevention behaviors of men who have sex with men—A national application of venue-based, time-space sampling. Public Health Reports, 122, 39–47. 10.1177/00333549071220S107 [PubMed: 17354526]

Makkai T, Macleod M, Vumbaca G, Hill P, Caldicott D, Noffs M, Tzanetis S, & Hansen F (2018). Report on the ACT GTM Pill Testing Pilot: A harm reduction service prepared by the safety testing advisory service at festivals and events (STA-SAFE) consortium. Retrieved January 18, 2021 from https://www.drugsandalcohol.ie/29513/1/Pill-Testing-Pilot-ACT-June-2018.pdf

Martins D, Barratt MJ, Pires CV, Carvalho H, Vilamala MV, Espinosa IF, & Valente H (2017). The detection and prevention of unintentional consumption of DOx and 25x-NBOMe at Portugal's Boom Festival. Human Psychopharmacology. 32(3), Article e2608. 10.1002/hup.2608

McAndrew SE, Smith TL, Groothuis E, Koressel LR, Unti SM, Powell EC, & Tanz RR (2019). Epidemic adolescent binge drinking at Lollapalooza, a music festival in Chicago. Pediatric Emergency Care, 35(6), 391–396. 10.1097/pec.0000000000001072 [PubMed: 28277410]

McCrae K, Tobias S, Tupper K, Arredondo J, Henry B, Mema S, Wood E, & Ti L (2019). Drug checking services at music festivals and events in a Canadian setting. Drug Alcohol Depend. 205, 107589. 10.1016/j.drugalcdep.2019.107589 [PubMed: 31605958]

McGowan CR, Harris M, Platt L, Hope V, & Rhodes T (2018). Fentanyl self-testing outside supervised injection settings to prevent opioid overdose: Do we know enough to promote it? International Journal on Drug Policy, 58, 31–36. 10.1016/j.drugpo.2018.04.017

Measham FC (2019). Drug safety testing, disposals and dealing in an English field: Exploring the operational and behavioural outcomes of the U.K.'s first onsite "drug checking" service. International Journal on Drug Policy, 67, 102–107. 10.1016/j.drugpo.2018.11.001

Mema SC, Sage C, Xu Y, Tupper KW, Ziemianowicz D, McCrae K, Leigh M, Munn MB, Taylor D, & Corneil T (2018). Drug checking at an electronic dance music festival during the public health overdose emergency in British Columbia. Canadian Journal of Public Health, Revue Canadienne de Santé Publique. 10.17269/s41997-018-0126-6

Mendoza-Valencia CY, Mariño Gaviria DJ, Patiño Reyes N, Lopez-Vallejo F, Sarmiento Gutiérrez ÁE, & Trespalacios Rodríguez D (2019). Mix of new substances psychoactive, NPS, found in blotters sold in two Colombian cities. Forensic Science International, 304, Article 109969. 10.1016/j.forsciint.2019.109969 [PubMed: 31593907]

Murray RA, Doering PL, Boothby LA, Merves ML, McCusker RR, Chronister CW, & Goldberger BA (2003). Putting an Ecstasy test kit to the test: Harm reduction or harm induction? Pharmacotherapy, 23, 1238–1244. 10.1592/phco.23.12.1238.32704 [PubMed: 14594341]

Nutt D, King LA, Saulsbury W, & Blakemore C (2007). Development of a rational scale to assess the harm of drugs of potential misuse. The Lancet, 369, 1047–1053. 10.1016/S0140-6736(07)60464-4

Palamar JJ (2020a). Diffusion of ecstasy in the electronic dance music scene. Substance Use & Misuse, 55, 2243–2250. 10.1080/10826084.2020.1799231 [PubMed: 32729760]

Palamar JJ (2020b). Increasing willingness to use synthetic drugs if offered among electronic dance music party attendees, 2017–2019. Journal of Psychoactive Drugs, 52, 324–333. 10.1080/02791072.2020.1761574 [PubMed: 32429796]

Palamar JJ, Acosta P, & Cleland CM (2019). Planned and unplanned drug use during a night out at an electronic dance music party. Substance Use & Misuse, 54, 885–893. 10.1080/10826084.2018.1529186 [PubMed: 30821597]

Palamar JJ, Acosta P, Le A, Cleland CM, & Nelson LS (2019). Adverse drug-related effects among electronic dance music party attendees. International Journal on Drug Policy, 73, 81–87. 10.1016/j.drugpo.2019.07.005

Palamar JJ, Acosta P, Ompad DC, & Cleland CM (2017). Self-Reported Ecstasy/MDMA/"Molly" use in a sample of nightclub and dance festival attendees in New York City. Substance Use & Misuse, 52, 82–91. 10.1080/10826084.2016.1219373 [PubMed: 27661470]

Palamar JJ, & Barratt MJ (2019). Prevalence of reagent test-kit use and perceptions of purity among ecstasy users in an electronic dance music scene in New York City. Drug and Alcohol Review, 38, 42–49. 10.1111/dar.12882 [PubMed: 30575155]

Palamar JJ, & Keyes KM (2020). Trends in drug use among electronic dance music party attendees in New York City, 2016–2019. Drug and Alcohol Dependence, 209, Article 107889. 10.1016/j.drugalcdep.2020.107889 [PubMed: 32050110]

Palamar JJ, & Le A (2020). Underreporting of drug use on a survey of electronic dance music party attendees. Addiction Research & Theory, 28, 321–327. 10.1080/16066359.2019.1653860 [PubMed: 33162873]

Palamar JJ, Salomone A, & Barratt MJ (2020). Drug checking to detect fentanyl and new psychoactive substances. Current Opinion in Psychiatry, 33, 301–305. 10.1097/YCO.0000000000000607 [PubMed: 32187173]

Papaseit E, Perez-Mana C, Mateus JA, Pujadas M, Fonseca F, Torrens M, Olesti E, de la Torre R, & Farre M (2016). Human pharmacology of mephedrone in comparison with MDMA. Neuropsychopharmacology, 41, 2704–2713. 10.1038/npp.2016.75

Parrott AC (2004). Is Ecstasy MDMA? A review of the proportion of ecstasy tablets containing MDMA, their dosage levels, and the changing perceptions of purity. Psychopharmacology, 173, 234–241. 10.1007/s00213-003-1712-7 [PubMed: 15007594]

Parsons JT, Grov C, & Kelly BC (2008). Comparing the effectiveness of two forms of time-space sampling to identify club drug-using young adults. Journal of Drug Issues, 38, 1061–1081. 10.1177/002204260803800407 [PubMed: 20686625]

Renfroe CL (1986). MDMA on the street: Analysis anonymous. Journal of Psychoactive Drugs, 18, 363–369. 10.1080/02791072.1986.10472371 [PubMed: 2880953]

Ridpath A, Driver CR, Nolan ML, Karpati A, Kass D, Paone D, Jakubowski A, Hoffman RS, Nelson LS, Kunins HV, & Centers for Disease Control and Prevention. (2014). Illnesses and deaths among persons attending an electronic dance-music festival—New York City, 2013. MMWR: Morbidity and Mortality Weekly Report, 63, 1195–1198. [PubMed: 25522087]

Ruest SM, Stephan AM, Masiakos PT, Biddinger PD, Camargo CA, & Kharasch S (2018). Substance use patterns and in-hospital care of adolescents and young adults attending music concerts. Addiction Science & Clinical Practice, 13, Article 1. 10.1186/s13722-017-0105-x [PubMed: 29370875]

Saleemi S, Pennybaker SJ, Wooldridge M, & Johnson MW (2017). Who is 'Molly'? MDMA adulterants by product name and the impact of harm-reduction services at raves. Journal of Psychopharmacology, 31, 1056–1060. 10.1177/0269881117715596 [PubMed: 28693371]

Southey M, Kathirgamalingam A, Crawford B, Kaul R, McNamara J, John-Leader F, Heslop J, & Pit SW (2020). Patterns of ecstasy use amongst live music event attendees and their opinions on pill testing: A cross sectional study. Substance Abuse Treatment, Prevention, and Policy, 15, Article 55. 10.1186/s13011-020-00295-1

Swinscow TD (1976). Statistics at square one. V-Populations and samples. British Medical Journal, 1, 1513–1514. 10.1136/bmj.1.6024.1513 [PubMed: 1276743]

Tanner-Smith EE (2006). Pharmacological content of tablets sold as "ecstasy": Results from an online testing service. Drug and Alcohol Dependence, 83, 247–254. 10.1016/j.drugalcdep.2005.11.016 [PubMed: 16364567]

Tupper W, McCrae K, Garber I, Lysyshyn M, & Wood E (2018). Initial results of a drug checking pilot program to detect fentanyl adulteration in a Canadian setting. Drug and Alcohol Dependence, 190, 242–245. 10.1016/j.drugalcdep.2018.06.020 [PubMed: 30064061]

Valente H, Martins D, Carvalho H, Pires CV, Carvalho MC, Pinto M, & Barratt MJ (2019). Evaluation of a drug checking service at a large scale electronic music festival in Portugal. International Journal on Drug Policy, 73, 88–95. 10.1016/j.drugpo.2019.07.007

Watson K (2019). IMS business report 2019–An Annual study of the electronic music industry. International Music Summit Ibiza, Incubating Inclusivity.

Watterson LR, & Olive MF (2014). Synthetic cathinones and their rewarding and reinforcing effects in rodents. Advances in Neuroscience (Hindawi), Article 209875. 10.1155/2014/209875 [PubMed: 25328910]

Watterson LR, & Olive MF (2017). Reinforcing effects of cathinone NPS in the intravenous drug self-administration paradigm. Current Topics in Behavioral Neurosciences, 32, 133–143. 10.1007/7854_2016_33 [PubMed: 27431398]

Table 1

Summary of Reviewed Drug Checking Festival Studies

Study	Festival	Service location	Recruitment	Analytic methods	Participant demographics	Test results	Participant response to results
Martins et al. (2017)	Boom Festival 2014 in Portugal	Mobile laboratory positioned near dance area	Details not provided	Colorimetric reagents and three different TLC solvent systems; select samples confirmed with GC-MS	Participants (n = 110) 78.2% male; mean age 27.1 years (SD = 5.7; range: 18–40)	245 LSD samples tested: 67.3% contained only LSD, 24.1% no LSD; 11.4% contained DOx, 9.8% NBOMe; 2.9% could not be identified	74.2% intended not to use adulterated LSD
Valente et al. (2019)	Boom Festival 2016 in Portugal	“Harm reduction hub” positioned near dance area	Details not provided	Colorimetric reagents and three different TLC solvent systems	Participants (n = 310) 73.0% male; mean age 28.5 years (SD = 7.3; range: 18–57); 76.0% had university diploma	753 samples tested: 9% of MDMA samples contained synthetic cathinones; 11.7% of LSD samples contained NBOMe or DOx	94% intended not to use adulterated drug
Measham (2019)	Secret Garden Party 2016 in the U.K.	Large tent in festival’s “welfare area”	Spread by word of mouth via festival staff and management	FTIR spectroscopy, colorimetric reagent tests, and/or mass loss analysis	Participants (n = 230) 66.0% male; mean age 27.6 years (SD = 7.5; range: 16–51); 87.0% white	230 samples tested: 19.5% contained an unexpected substance	66.7% disposed of adulterated drug
Mema et al. (2018)	Shambhala 2017 in Canada	“Highly visible central location” on festival grounds	Details not provided	Raman spectroscopy, fentanyl immunoassay test strips, colorimetric reagents, and/or GC-MS	Participant demographics not provided	1,971 samples tested for fentanyl: 1.6% tested positive. 2,387 samples tested via colorimetric reagents: 79.2% contained the expected substance	16.1% discarded drug that tested positive for fentanyl in amnesty bin
Makkai et al. (2018)	Groovin’ the Moo 2018 festival in Australia	“Front-of-house” tent next to health tent	Details not provided	FTIR spectrometry	Participants (n = 83) 67.0% male; mean age 23 years (range: 15–47)	83 samples tested: 45% confirmed MDMA as major component; no compounds detected above threshold for the 55% of remaining samples	23% of those with a low purity product intended to discard it or not use it
McCrae et al. (2019)	Electric Love, Bass Coast, Rifflandia, and Vancouver Pride 2018 in Canada	Designated tent at each event	Word-of-mouth and “service promotion”	FTIR spectrometry and fentanyl immunoassay strips	Participant demographics not provided	336 samples tested: 72.5% of psychedelic samples, 62.1% of stimulant samples, and 80.0% of “depressant” samples contained expected substance; one sample tested positive for fentanyl	Data either not collected or not provided

Note. U.K.: United Kingdom; TLC: thin-layer chromatography; GC–MS: gas chromatography–mass spectrometry; FTIR: Fourier-transform infrared spectroscopy. DOx indicates DOB [1-(4-Bromo-2,5-dimethoxyphenyl)-2-aminopropane], DOC (2,5-dimethoxy-4-chlorophenylethylamine), DOI (2,5-dimethoxy-4-iodophenylethylamine), or DOM (2,5-dimethoxy-4-methylphenylethylamine). NBOMe indicates N-methoxybenzyl such as 25I-NBOMe {2-[4-iodo-2,5-dimethoxyphenyl]-N-[(2-methoxyphenyl)methyl]ethanamine}.