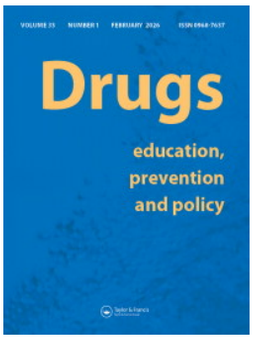

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Evaluating the impact of an on-site drug testing facility providing real-time drug alerts upon first-aid presentations at a Belgian festival

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ABSTRACT

Background: Illicit drug use at festivals can cause an extensive burden on medical emergency services. This study investigated the prevalence of intoxications at a Belgian festival over 6 years and examined the influence of real-time drug alerts, after the detection of high-dose MDMA tablets by an on-site drug laboratory, introduced in 2022, on intoxication prevalence and first aid service use.

Methods: Demographic data and type of drug intoxication were collected retrospectively from festivalgoers who presented at the first aid service of a Belgian festival between 2018–2024. Presentation rate and transport-to-hospital rate were collected.

Results: In 6 years, 291667 attended the festival, 4086 of which attended on-site first aid and 362 of these presented intoxicated. Alcohol (49%, n = 178) and amphetamine (MDMA included) were most prevalent (37%, n = 133). The number of intoxications increased yearly and was highest in 2023 (77). In total, 24 real-time drug alerts were disseminated (2022-2024).

The proportion 'unknown' intoxication decreased after implementation of on-site drug testing 29.7% ($n = 44$) vs. 17.8% ($n = 38$), $p = 0.008$). The number of hospitalizations was similar 2% ($n = 3$) vs. 3.7% ($n = 8$), $p = 0.35$.

Conclusion: It might be that, after broadcasting real-time drug alerts, festival attendees might be more vigilant about drugs, however, the true impact remains unclear and might be influenced by other factors. The lack of power might underestimate the impact on hospitalizations.

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Introduction

The most common drugs used at festivals are 3,4-Methylenedioxy methamphetamine (MDMA), followed by cocaine, Lysergic acid diethylamide (LSD) and cannabis, dependent on the type of music festival (Bijlsma et al., 2020; Brunt et al., 2017; EMCDDA, 2024; Palamar et al., 2021; Van Havere et al., 2012). Multiple life-threatening complications have been described after (MDMA) toxicity (Armenian et al., 2013). The use of these substances can lead to significant physical and psychological harm, such as hypo- or hyperthermia, respiratory failure, multi-organ failure, seizures, etc. (McCrae et al., 2019; Southey et al., 2020). Combining alcohol and psychoactive drugs can work synergistically and prolong or strengthen (un)desired effects (Johnson et al., 2020; Palamar et al., 2021). An unknown drug composition or dosage can cause unexpected effects including toxicity, accidental overdose or even death (Ivers et al., 2022; West et al., 2021).

On-site drug testing facilities can provide rapid qualitative and quantitative identification of illicit drugs, and therefore establish harm reduction at large events by directly informing people who use drugs. On-site drug testing facilities may operate in a nonpublic-facing way, for example, by testing drug samples provided by medics or surrender bins, or as a full drug checking service, offering festivalgoers the opportunity to drop off their drugs and receive personalized results of the drug sample contents (Barratt & Measham, 2022). Furthermore, on-site testing services can provide information on current drug trends and, if the testing facility allows it, they can inform on-site medical services of

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the emergence of new psychoactive substances (Measham, 2019; Palamar et al., 2020; Schneider et al., 2016). In this way, they can enable a swift and tailored health service response (Barratt & Measham, 2022). Moreover, real-time detection of unexpected substances can decrease drug-related harm (Brien et al., 2023), as it has been shown that real-time drug alerts is harm-reducing (Johnson et al., 2020). However, on-site drug testing services remain legally and commercially sensitive (Barratt & Measham, 2022).

According to a survey in Flanders in 2022, about half of the festivalgoers used drugs in the past year (Vlaams Expertisecentrum Alcohol en andere Drugs vzw (VAD), 2022). This can potentially put a heavy load on available medical facilities. Following the death at the festival in 2021, a mobile drug testing laboratory was installed on-site during the 2022 edition. Confiscated drugs were analyzed by the laboratory. If a large dose of drugs was detected by the on-site laboratory, a picture of the specific drug was broadcast on large screens to inform all visitors of the potential dangers (Figure 1).

To date, no data have been reported on the impact of broadcasting real-time drug warnings to festivalgoers. Visitors who presented intoxicated at the first aid of a Belgian electronic dance festival were asked which drug they had taken. Hence, this study retrospectively examined the effect of broadcasting real-time drug alerts, when detected by the on-site drug testing laboratory, on intoxication prevalence and festivalgoer discharge over a five-year period.

Methods

Three researchers (HG, TL, PV) independently extracted data in retrospect by reviewing all files from every festivalgoer who presented at the first aid station at a Belgian techno festival (2018, 2019, 2021, 2022, and 2023). All data were collected manually (written festivalgoer files) and sequentially transcribed into Excel

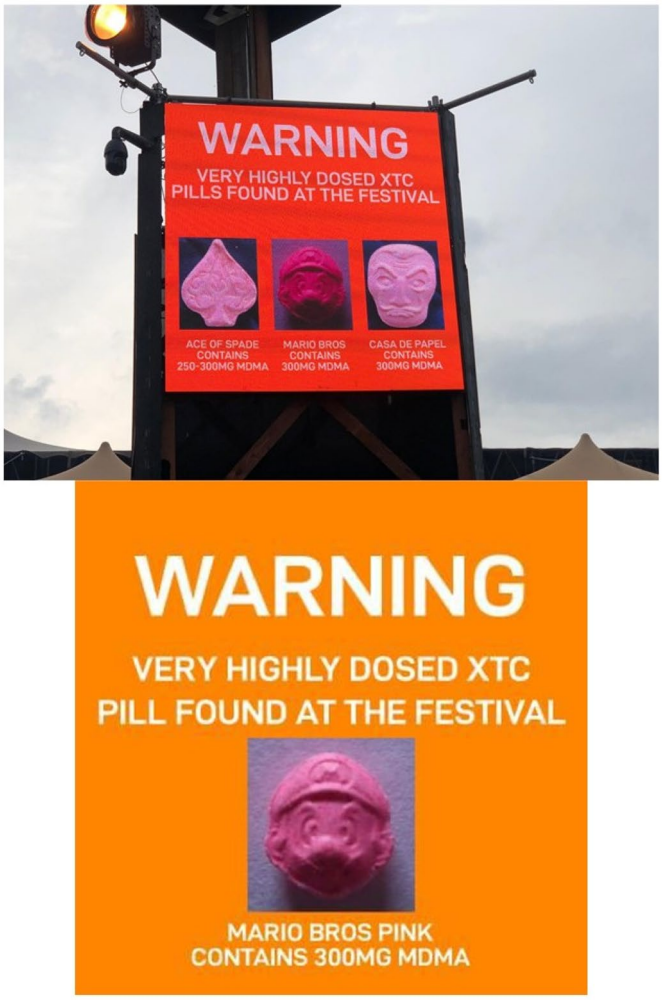

Figure 1. Examples of real-time drug alerts on the festival site.

(Microsoft®, Redmond, WA, USA). In 2020, there was no festival because of the COVID pandemic.

Demographic data were collected (age, sex) from every festivalgoer treated at the first aid services. Every festivalgoer who presented intoxicated at the first aid service was asked, on a case-by-case basis about possible drugs and alcohol use. If the festivalgoer seemed intoxicated, he/she was asked about active drug use. If no symptoms of intoxication were present, no questions about intoxication were asked. Use reported by festivalgoers was categorized in following subgroups: alcohol, amphetamine (including 3,4-Methylenedioxy methamphetamine (MDMA), ketamine, cannabis, cocaine, GHB and others. Festivalgoers who were clinically intoxicated but could not be questioned about type of use (by example because they were unconscious) were classified as unknown.

Furthermore, we stratified festivalgoers based on the site of discharge in following categories: festivalgoers returning back to the festival, home or to the hospital. Festivalgoers who returned to the festival or went home, were treated by emergency physicians present at the first aid station located at the festival site.

Details about the combination of spectroscopic with chemometric analyses of the on-site laboratory have been published elsewhere (Meert et al., 2025). In brief, drugs were registered, measured and homogenized. Powders, crystals, fluids, and tablets were analyzed. Sequentially, the Raman and Fourier transform-infrared (FT-IR) spectrum of the specific drug were evaluated and sequentially interpreted by a trained operator. When MDMA was detected with FT-IR, chemometric quantification occurred (OPUS Quant 2). Polydrug combinations were able to be detected (including unregulated/unexpected substances such as vitamins, caffeine, sildenafil, etc.)

After it was determined which tablet had a high MDMA content (>200mg/tablet), these high-dose concentrated tablets were displayed on large screens on the festival (Figure 1). Alerts were all for high-dose MDMA tablets. Concentrations of MDMA are expressed as hydrochloride salt (Meert et al., 2025). Time between a positive result (high-dosed pills) and real-time alerts took about 30 minutes. The decision to launch a specific alert was always made after consultation and agreement between the police and the public prosecutor.

The purpose of the real-time alerts was to warn the festivalgoers of hazardous substances. For fear of 'habituation or prevention of alert fatigue', the number of alerts was limited. The decision to launch a drug alert on the large screens was a joint decision by the police commander on site, the representative of the prosecutor's office, and the responsible emergency physician.

Ethics approval and consent to participate

For this study, ethics approval was waived by the Ethics Committee for Research of Ziekenhuis Oost-Limburg. Purely retrospective studies do not fall under the scope of the Belgian Experiments Act (article 3, §2). As such, a retrospective study does not qualify as an experiment (and thus also not as "Human subject research") and therefore, based on the Experimental Act, no written informed consent of the participants is required for this study. Use of the dataset was approved by 'Rode Kruis Vlaanderen'.

Our data policy complies with the rules of Regulation 2016/679 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data of 27 April 2016 (General Data Protection Regulation) and to the Belgian legislation relating to data protection.

Statistical analysis

Data are described as median with interquartile range (IQR) (25%–75% QI) by using JMP Pro 17 (JMP®, SAS Institute). Pearson Chi Square and Fisher exact testing were used to compare categoric and ordinal variables, respectively. *P*-values less than 0.05 were considered significant.

Results

In 2022, the main substance detected was MDMA (56%), followed by cocaine (16%) and THC (10%) (Figure 2). Others were ketamine (10%), new psychoactive substances (NPS) (6%) (including 3-MMC, 4-CMC, Alpha-PIHP, 2C-B and 4-FMA), GHB (2%), LSD (2%) or prescribed drugs. Sixteen of these MDMA tablets (11%), contained a high dose of MDMA (>200mg hydrochloride salt).

In 2023, similarly, the main substance detected was MDMA (59%), followed by cocaine (11%) and ketamine (9%). One tablet did not contain any drug.

In 2024, MDMA was most prevalent (57%), followed by cocaine (15%) and ketamine (12%). Others were synthetic cathinones, GHB, and amphetamines. Almost all (93%) of the drug tablets contained MDMA. Of these, 33% contained high concentrations of MDMA (> 200 mg) (Meert et al., 2025).

The number of real-time drug alerts in 2022 was 3. In 2023 and 2024, there were 10 and 11 real-time drug alerts launched on the large screens, respectively.

A total of 1.4% all visitors (4086 of 291667), visited the first aid station at the festival from 2018 until 2024 (Table 1). Of these visitors, 8.8% ($n = 362$) presented

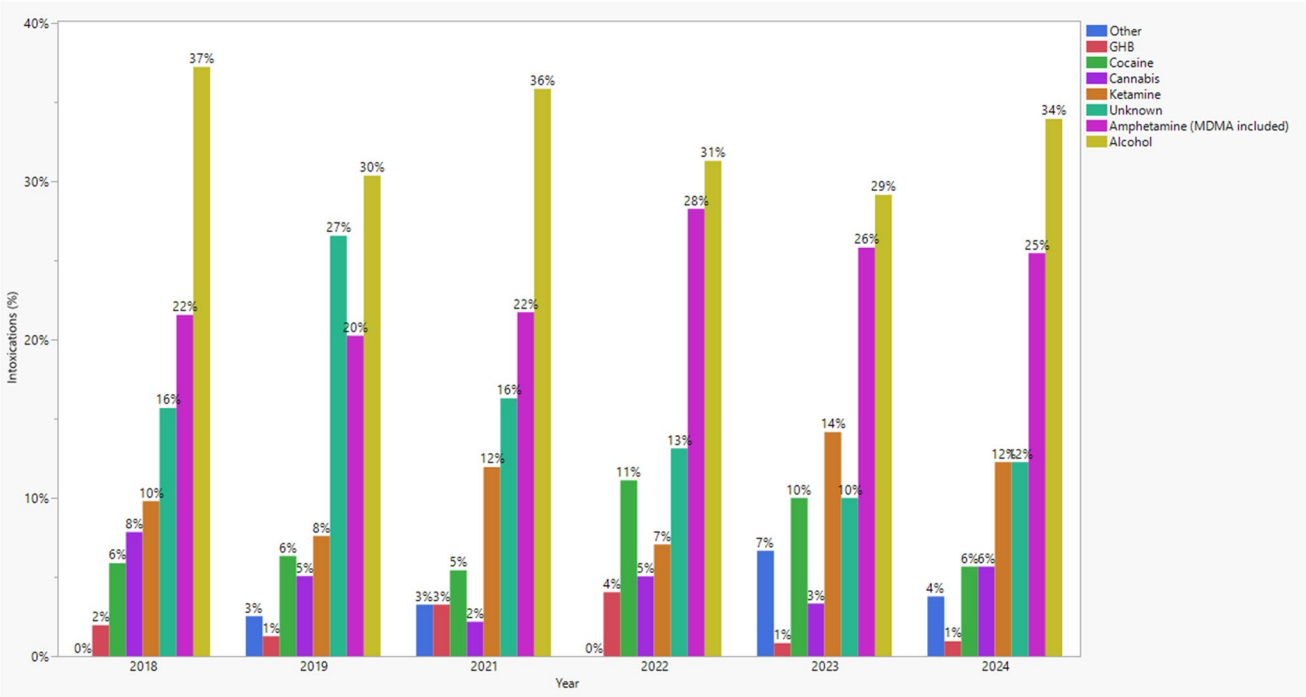

Figure 2. Drug and alcohol prevalence over a five-year period. Number and type of intoxications differed annually ($p = 0.0001$). Of all intoxications during 5 years, most common are alcohol intoxications (49%, $n = 142$), followed by amphetamine (36%, $n = 106$), unknown (24%, $n = 69$), ketamine (16%, $n = 46$), and cocaine (12%, $n = 36$).

Table 1. Total festival visitors, intoxications, festivalgoer presentation ratio (FPR), sex, age, discharge location and transfer to hospital rates (TTHR), deaths and number of real-time drug alerts stratified per year.

Year	Visitors (n)	First aid visitors (n)	Intoxications at first aid, n (%)	FPR	Male (n)	Age (years, median, IQR)	Discharge to festival, n (%)	Discharge to home, n (%)	Transported to hospital (n)	TTHR	Death (n)	Number of real-time drug alerts
2018	46000	826	38 (0.08)	0.83	24	27 (24-29)	35 (92)	3 (8)	0	0	0	/
2019	48515	847	53 (0.11)	1.09	39	27 (24-31)	41 (77)	10 (19)	2	0.04	0	/
2021	45577	483	57 (0.13)	1.25	34	25 (23-29)	44 (77)	12 (21)	1	0.02	1	/
2022	59673	1005	66 (0.11)	1.11	45	28 (24-32)	54 (82)	10 (15)	1	0.02	0	3
2023	43597	1090	77 (0.17)	1.77	54	28 (24-35)	56 (73)	15 (19)	6	0.14	0	10
2024	48305	720	71 (0.15)	1.47	43	29 (25-35)	60 (85)	10 (14)	1	0.02	0	11

intoxicated because of self-reported drugs and/or alcohol intoxication. Median age of intoxicated festivalgoers was 27 years (IQR 24–31, range 18–50**)** Two thirds (67%, $n = 239$) of the intoxicated festivalgoers identified as male, 33% ($n = 119$) identified as female. Of four, sex was unknown.

Alcohol intoxication was the most prevalent intoxication at the first aid station (49%, $n = 178$), followed by amphetamine (MDMA included) (37%, $n = 133$), unknown (23%, $n = 82$), ketamine (16%, $n = 59$), and cocaine (12%, $n = 42$). Number of intoxications increased yearly, with exception of year 2024: 13% ($n = 38$) in 2018, 18% ($n = 53$) in 2019, 20% ($n = 57$) in 2021, 23% ($n = 66$) in 2022, 26% ($n = 77$) in 2023, and 20% ($n = 71$) in 2024, $p < 0.0001$ (Figure 2). Festivalgoer presentation ratio (FPR) increased yearly until 2024 (Table 1).

The majority ($n = 290$) of intoxicated festivalgoers was able to rejoin the festival. In total, 3% ($n = 11$) of all intoxications were transported to the hospital. Transfer to hospital rates were comparable per year, with no hospital transfer in 2018 and highest transfers in 2023 ($n = 6$), $p = 0.12$ (Table 1). There was no difference in the proportion of festivalgoer discharge between different years, $p = 0.18$.

Comparison of intoxications prevalence and festivalgoer discharge between 2018, 2019, and 2021 vs. 2022–2024

The number of intoxicated festivalgoers was lower in 2018–2021 compared to 2022–2024 ($n = 148$ vs. $n = 214$). Moreover, proportion of gender distribution did not differ between both groups (M 67% 2018–2021 vs. M 66% 2022–2024, $p = 0.84$) Proportion of amphetamine intoxicated festivalgoers (MDMA included) was similar after on-site drug testing 32% ($n = 47$) 2018–2021 vs.

40% ($n=86$) 2022–2024, $p=0.10$. Proportion of festivalgoers with GHB overdose did not differ between both groups 3% ($n=5$) 2018–2021 vs. 2.8% ($n=6$) 2022–2024, $p=0.75$. Proportion of ketamine intoxications was comparable between both groups 14.9% ($n=22$) 2018–2021 vs. 17.3% ($n=37$) 2022–2024, $p=0.54$. Proportional cocaine intoxications were similar between both groups 8.8% ($n=13$) 2018–2021 vs. 13.6% ($n=29$) 2022–2024, $p=0.16$. Moreover, cannabis and alcohol intoxications did not differ between both groups 6.8% ($n=10$) vs. 7.0% ($n=15$), $p=0.93$, and 51.4% ($n=76$) 2018–2021 vs. 47.7% ($n=102$) 2022–2024, $p=0.49$, respectively. The proportion 'unknown' intoxication decreased after implementation of on-site drug testing 29.7% ($n=44$) 2018–2021 vs. 17.8% ($n=38$), $p=0.008$).

The number of festivalgoers who needed hospitalization after intoxication was similar between both groups 2% ($n=3$) 2018–2021 vs. 3.7% ($n=8$) 2022–2024, $p=0.35$.

Discussion

This study examined a 6 years of drug use among festivalgoers presenting at the first aid of a Belgian techno festival. The number of intoxications increased yearly with a maximum of 77 (0.17%) in 2023. In 2024, the number of intoxications was 71 (0.15%). Indeed, before the introduction of the on-site drug laboratory (3-year period: 2018–2021), 144 festivalgoers were intoxicated, and thereafter, 214 were (3-year period: 2022–2024). The utilizations rate of the first aid increased. Moreover, no difference in proportion of reported drug type after implementation of the laboratory could be detected, with exception of the 'unknown' drug. It could be that festivalgoers became more aware and vigilant over which drug they used after introduction of the lab (and displayed information thereof) and therefore, the intervention was beneficial. Calle et al. observed similar findings: ethanol/alcohol and MDMA are still the most prevalent party drugs causing health problems and urge intoxicated festivalgoers to seek help (Calle et al., 2019). Canadian drug checking services have observed that psychedelics and stimulants are the most common drugs detected among attendees of electronic dance music festivals (McCrae et al., 2019). Similarly, at a music festival in Australia, self-reported drugs of participants were compared with wastewater (Puljević et al., 2024). High levels of illicit drugs were present in the wastewater and a discrepancy was observed between reported drugs and detected drugs. This study highlights the importance and utility of on-site drug testing facilities (of confiscated drugs), as described in this paper, as well as drug checking services since festivalgoers may be misled and take higher doses or even other substances than intended.

The number of real-time drug alerts was higher in 2023 compared to 2022. Indeed, in 2023 more high-dosed MDMA pills were detected. Despite that 2022 was the first year of the introduction of the on-site laboratory, the proportion of alerts per number of detected high-dose MDMA pills was similar in 2023. This could mean that collaboration was already successful between the local police officer, representative of the prosecutor's office and the representative emergency physician.

Measham (2019) reported a 95% reduction in drug-related transportations to hospital after introduction of an onsite drug checking service, where, unlike in the present study, individuals who submitted drugs could find out their contents and purity alongside a tailored health intervention. This effect may due to early presentations for drug-related problems combined with confidence amongst paramedics in treating intoxications on-site instead of sending the festivalgoers to the hospital (Measham, 2019). Drug checking services have also been implemented as official national (harm-reducing) policy in countries such as the Netherlands, Sweden, Germany, Switzerland, France, Spain, Austria and Canada (Johnson et al., 2020; Measham, 2019; Southey et al., 2020). In these countries, through partnerships with event sponsors and healthcare services, mobile facilities have been installed where festivalgoers can take drug sample for analysis by a drug testing facility. In addition to providing individualized information, drug purity and composition information is also anonymously projected on information screens at the festival site, after approximately 30 minutes (Johnson et al., 2020; Palamar et al., 2020). This approach is believed to influence the behavior at the time of consumption unlike broad anti-drug campaigns, and reduce drug-related harm by educating the public so that they can make informed choices (Johnson et al., 2020). Valente et al. investigated the impact of drug checking services on behavior of festivalgoers (Valente et al., 2019). The group assessed drug samples and festivalgoers were invited to complete a questionnaire. When the drug was tested and the result was unexpected (not the drug the festivalgoer expected): the majority did not want to use the drug. On the other hand, if the drug was the drug the festivalgoer expected, majority would certainly use the drug. This method can also contribute to harm reduction and might be integrated into this Belgian festival in the near future.

After implementation of real-time drug alerts at a Portuguese Festival, the detection and subsequent prevention of consumption of specific substances (Dox, 25x-NBOMe) was achieved (Martins et al., 2017). The real efficacy of onsite drug testing services can be measured in a decrease in hospital admissions or drug-related

deaths. No change in type of festivalgoer discharge after introduction of the mobile laboratory was observed in our study. This could be because of underpowering of the study (only 10 festivalgoers over 5 years had to be hospitalized). It could also be stated that after introduction of the laboratory, there was no increase of hospitalizations and festivalgoers may be more careful in (not) taking an overdose on-site and may be more likely to seek medical care faster at the first aid station.

Albeit some articles suggest that there are adverse effects to sharing information about the contents of drugs, through on-site drug testing or drug checking services, such as false sense of security or a normalization of drug use (Ivers et al., 2022), to date there is no scientific evidence to support this theory. There are no indications that these interventions lead to experimenting with substances among people who are drug-naive, nor that it leads to an increased intake among people already experienced with drug use (Hollett & Gately, 2019; Ivers et al., 2022; Murphy et al., 2021; Ritter, 2020).

Designing proper drug alerts is challenging and complex. It is clear that festivalgoers have different educational backgrounds and knowledge levels, and therefore, these drug alerts cannot be suitable for all. In this study, clear and very short sentences were chosen to include in the drug alerts (Volpe et al., 2023). Other early warning systems that disseminate information about the contents and concentration of drugs, including MDMA, include: The Know (Australia), High Alert (New Zealand), the Trimbos Instituut Drugs Information and Monitoring System (The Netherlands) and the Canadian Community Epidemiology Network on Drug Use (Volpe & Barratt, 2025).

Criticism of drug testing is well described in the narrative review of Scott et al. The authors state that evidence is limited and that the harm-reducing effect of drug testing measures remains debatable (Scott & Scott, 2020). Further research with well-conducted trials is warranted.

There are several limitations to this study. Naturally, the design of this study was a Belgian monocentric retrospective, and noncontrolled, therefore no causal relationships can be drawn at all. However, it has been shown that in this setting, prospective studies are very rare and quite challenging to set up (McQueen & Davies, 2012). In addition, some data were missing. Substances taken by festivalgoers who were too intoxicated to mention which drug they had taken, were classified as 'unknown'. This could have contributed as confounder. Furthermore, festivalgoers self-reported which drugs they had taken, without analytic verification. It would be interesting to investigate the difference in prevalence between self-reported drug use and actually observed drug use of intoxicated festivalgoers.

Conclusion

Large music festivals attract thousands of visitors, among whom illicit drugs are more frequently used than in the general population. Excessive use of these substances leads to significant physical and psychological damage and unknown composition or dosage of these drugs increases the risk of unexpected effects including accidental overdose or even death.

In this retrospective analysis, the number of intoxications increased annually. There was no difference in proportion of intoxications after introduction of an onsite drug testing lab. The proportion of 'unknown' drug however decreased after implementation of the on-site drug testing facility. There was no change in number of hospitalizations despite the increased number of intoxications. This might indicate that the intervention was beneficial.

Further prospective research is needed to investigate if drug control services could lead to a reduction in undesired health effects and need for medical services at this festival.

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