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Short Communication

The effect of the Music Day event on community drug use

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ABSTRACT

Illicit drugs consumption can be back-calculated based on the analysis of drug residues in wastewater using the wastewater-based epidemiology method. The Music Day, held on June 21 in France since 1982, has grown to global proportions and is now celebrated as World Music Day. This large outdoor event takes place in many cities with people allowed to play music in the streets. As psychotropic drugs are often associated with music events, the goal of this study is to investigate the use of illicit drugs on this day in Bordeaux, the fifth largest urban area in France.

Daily sampling campaigns of composite wastewater were carried out for seven days in two wastewater treatment plants in Bordeaux in 2017 (Music Day) and 2018.

World Music Day in Bordeaux has no observable effect on illicit drug consumption even if this event has massive public participation: this is the first report of the absence of an illicit drug consumption increase in a festival of such magnitude, corroborating the effect of others' views and opinions, because this event takes place publicly in the street and not among peers. Different hypotheses are put forward to explain this fact: inappropriate type of event for drug consumption, effect of other festivals, and influence of the event's timing on a weekday.

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1. Introduction

The consumption of illicit drugs and the associated contamination of wastewater and the aquatic environment is an emerging concern that is currently being monitored in Europe, North America, and Australia [1–3].

Drugs of abuse are increasingly consumed around the world, leading to public health and social problems: global users of illicit products are estimated to number about 230 million worldwide [4] and 12.8 % of Europeans have consumed illicit drugs at least once during their lifetime [5]. Substance dependence and consumption prevalence in the population are mainly estimated from population surveys, seizure data, and mortality rates related to illicit drug use, but these indirect methods are time-consuming and imprecise, as they are limited by the imperfections of the investigation tools. The results are usually published one year after data

collection. These shortcomings consequently complicate the reactivity of public authorities [6].

To provide short-term data, i.e., obtained concomitantly with drug consumption, Zuccato et al. [7,8] developed an estimation method based on the measurement of drug residues in wastewater with the subsequent back-calculation using metabolism data.

Studies have shown significant differences in the consumption of illicit drugs in terms of festival context, i.e., metal, rock, pop, country and folk, ethnic, multi-genre, dance, electro and techno, reggae, and trance [9,10] as well as non-festive periods. Previous data have shown the large over-consumption during musical events depending to music style [10].

Held in France since 1982, the Music Day, also known as World Music Day, takes place on the night of the summer solstice, with amateur and professional musicians allowed to perform in the street. This outdoor event is for all music tastes, and even if this French initiative has progressively expanded to the international scale, its success is evident in France. Overall, 78 % of the French youth population participates in the event, but other age classes are also concerned, thus creating an original event that is essentially outdoor, gratis, and pluri-style, a true population melting pot [11].

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The present study uses the sewage epidemiology method to determine the consumption of major illicit drugs during World Music Day in Bordeaux, the fifth largest city in France with a population of about 1 million inhabitants. The aim of this study is to determine whether this outdoor musical event is associated with increased drug consumption, as normally observed on weekends. Indeed, unlike concerts performed in front of a rather homogeneous amateur audience, the audience of the Music Festival is often more family-friendly and heterogeneous.

The main concerts organized by the municipality in Bordeaux are attended by around 50,000 individuals, but informal scenes abound throughout the city, and this number should be regarded as a minimum (Moginot and Courtiade, comm. pers.).

Wastewater was sampled daily over seven days in two wastewater treatment plants (WWTPs) covering areas with social and economic differences. Since the laboratory has already carried out wastewater-based epidemiology studies in France [1,3,12,13], the results will be directly comparable with data obtained for other metropolitan areas.

2. Materials and methods

2.1. Investigated sites

The Bordeaux metropolitan area has a population of about one million inhabitants. Sewage from the entire urban area is conveyed to five WWTPs, and the two sampled WWTPs correspond to half of the connected population. The population size was estimated from BOD5 measured in influents [14]. WWTP1 catchment includes a university campus, prison, and the main clubbing district. WWTP2 catchment includes a few clubbing places but no student or festive gathering places.

2.2. Chemicals and materials and analytical methods

Material and methods has already been detail in previous studies [12,15].

Briefly, raw wastewater sampling was carried out at the entry of the two WWTPs every day over nine days, from Thursday June 15, 2017 to Friday June 23, 2017 and from Thursday May 17, 2018 to Tuesday May 22, 2018. Sampling was done using refrigerated autosamplers (Endress & Hauser ASP2000; Boissy-Saint-Léger, France) positioned before the bar screen to obtain 24 h flow-weighted composite influent samples with a sampling frequency at least six times per hour according to the Water Framework WWTP procedures. Each day, at the end of sampling, 600 mL of each sample was collected in a polypropylene bottle. At the end of the sampling campaign, all the frozen samples were thawed in the University Paris-Sud laboratory. Samples were immediately filtered and stored at 4 °C before analysis. In short, samples were kept frozen from the time of collection to analysis, and they remained at 4 °C for less than 24 h, the time necessary to collect them with the refrigerated autosamplers.

Quantitative analyses were carried out in the selected multiple reaction monitoring mode in accordance with the European requirement 2002/657/CE for analytical procedures with two transitions for each compound. Calibration standards dissolved in ultra-pure water were prepared in the range 100–2000 ng/L for all compounds, corresponding to 200–4000 ng/L in the sample before preparation, and then injected using the pre-concentration process as for the samples.

To back-calculate consumption, it is necessary to select the drug target residue (DTR) and define the excretion ratio (U_{ex}) of the DTR for each drug. The parent drug was used for MDMA ($U_{ex} = 0.20 \%$) and AMP; a major metabolite was used for the other compounds:

BZE for COC ($U_{ex} = 29.2\%$), THC–COOH ($U_{ex} = 1.5 \%$) for THC, and EDDP for MTD (Table 3).

The back-calculation was carried out using the equation:

$$Q = Q_{day}/U_{ex} \times M_{ratio} \times 1000/N_{inh} \quad (1)$$

where Q_{day} is the load of the DTR calculated from the flow measurement and the raw wastewater concentrations, U_{ex} the percentage of the DTR urinary excretion, M_{ratio} the parent drug/DTR molar ratio, and N_{inh} the number of inhabitants in the catchment area.

3. Results and discussion

3.1. Illicit drug concentrations in wastewater

COC, BZE, and THC–COOH were detected and quantified in all samples of the two campaigns (Fig. 1A–D). In 2017, mean concentrations were 191 ± 70 ng/L for COC, 647 ± 131 ng/L for BZE, and 319 ± 93 ng/L for THC–COOH in WWTP1, and 160 ± 72 ng/L for COC, 968 ± 537 ng/L for BZE, and 256 ± 59 ng/L for THC–COOH in WWTP2. In 2018, mean concentrations were 233 ± 43 ng/L for COC, 882 ± 169 ng/L for BZE, and 451 ± 48 ng/L for THC–COOH in WWTP1, and 127 ± 106 ng/L for COC, 473 ± 341 ng/L for BZE, and 362 ± 134 ng/L for THC–COOH in WWTP2. Concentrations were slightly higher in 2018 compared to 2017 except for BZE and COC in WWTP2: the BZE/COC ratio appears stable in WWTP1 between 2017 ($R = 3.5 \pm 0.8$) and 2018 ($R = 3.8 \pm 0.6$). However, this ratio was higher in WWTP2 in 2017 ($R = 6.2 \pm 1.8$) than in 2018 ($R = 4.3 \pm 0.9$). The usual value observed in reported wastewater-based epidemiology studies is 2.22 [16] with a very large scale ranging from 1.4 to 10). Cocaethylene (CET) was only quantified in 2018, in each WWTP with equivalent concentration range (until 142 ng/L). The increase in the BZE/COC ratio may suggest a degradation of COC in BZE during sampling, which could lead to an overestimation of cocaine consumption. Higher concentrations are observed for both WWTPs and both sampling campaigns on Saturdays and Sundays. MDMA is mainly quantified on weekends (Figs. 1A–1D). CET, a biomarker of alcohol and cocaine co-consumption, was only analyzed in 2018: this biomarker was mainly quantified on the weekend when COC and BZE concentrations are higher.

3.2. Illicit drug consumption

Illicit drug consumption was estimated for cocaine, cannabis, and MDMA and expressed either as the quantity (mg/d/1000 inhabitants) or number of daily intakes (dt/d/1000 inhabitants) (Tables 1 and 2).

Cocaine, cannabis, and MDMA consumption increased between 2017 (Table 1) and 2018 (Table 2) in WWTP1: cocaine: 552 ± 194 and 933 ± 101 mg/d/1000 inhabitants; cannabis: 4.6 ± 1.3 and 8.2 ± 1.5 g/d/1000 inhabitants; MDMA: 50 ± 76 (detection frequency = 3/9 days) and 199 ± 62 (detected every day) mg/d/1000 inhabitants, respectively. A similar trend is observed for WWTP2 except for cocaine: cocaine: 978 ± 516 and 725 ± 453 mg/d/1000 inhabitants; cannabis: 4.4 ± 1.1 and 10.0 ± 4.4 g/d/1000 inhabitants; MDMA: 51 ± 102 (detection frequency = 2/9 days) and 124 ± 170 mg/d/1000 inhabitants (detection frequency = 4/7 days). Regardless of the WWTP, the consumption data observed in the studied catchment area could be compared to the results of Nefau [15]: cocaine consumption was estimated between 14 mg and more than 10,909 mg/day/1000 inhabitants with median values of 504 and 590 mg/day/1000 inhabitants on weekends and weekdays in 25 towns, respectively [15] and weekdays concentrations in the present study of 517.1 ± 129.8 and 757.1 ± 313.7 mg/

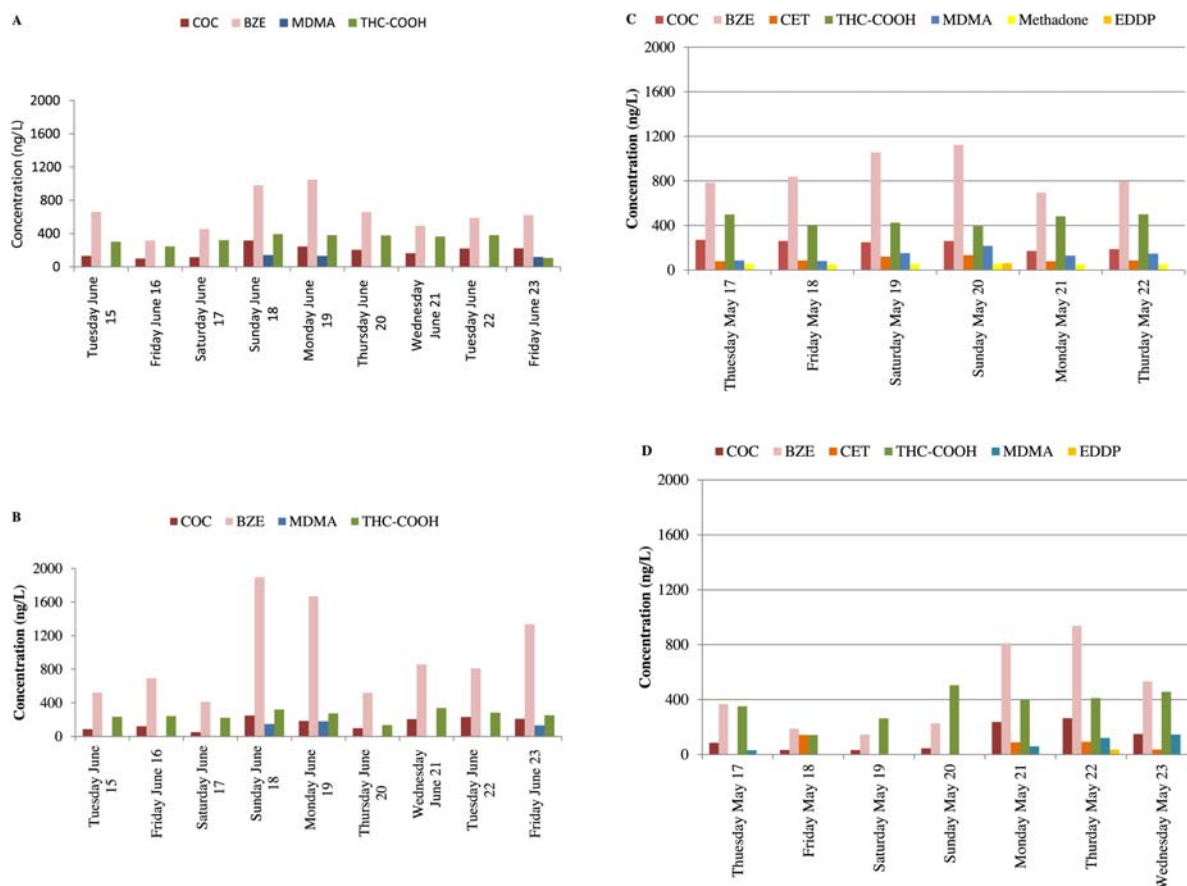


Fig. 1. A. Illicit drug concentration observed in WWTP1 during 2017 sampling. B. Illicit drug concentration observed in WWTP2 during 2017 sampling. C. Illicit drug concentration observed in WWTP1 during 2018 sampling. D. Illicit drug concentration observed in WWTP2 during 2018 sampling.

Table 1

Consumption in mg/d/1000 inhabitants.

	WWTP1 2017			WWTP2 2017		
	Cocaine	Cannabis	MDMA	Cocaine	Cannabis	MDMA
15/06/2017	647	4990	0	552	4190	0
16/06/2017	296	3883	0	671	3951	0
17/06/2017	402	4782	0	374	3413	0
18/06/2017	869	5876	176	1724	4918	188
19/06/2017	979	6005	170	1784	4936	268
20/06/2017	639	6183	0	578	2538	0
21/06/2017	489	6088	0	952	6326	0
22/06/2017	572	6252	0	855	5019	0
23/06/2017	575	1684	152	1318	4203	0
Average	552	4614	50	978	4384	51
S.D.	194	1368	76	516	1081	102

Light gray: samples under weekend effect (Saturday and Sunday). Bold and dark gray: samples under Music Day effect. S.D.: standard deviation.

d/1000 inhabitants to compare to weekends (924 ± 77.8 and 1754 ± 42.4 mg/d/1000 inhabitants). MDMA consumption ranged from 5 to 41 mg/day/1000 inhabitants on weekdays and from 15 to 167 mg/day/1000 inhabitants on weekends. THC rates of consumption range from 3 to 92 g/day/1000 inhabitants on weekdays and from 3 to 100 g/day/1000 inhabitants on weekends. However, the highest value was observed in a city during a specific event, and thus the mean THC consumption is rather between 3 and 20 g/day/1000 inhabitants. Thus, the consumption data observed in Bordeaux are in accordance with data already observed elsewhere in France,

except for MDMA consumption, which has increased as reported in most of European countries since 2013 [5]. These results are in agreement with conventional studies about addictive trends in Bordeaux, including in the survey OPPIDUM [17].

Cocaine consumption increased between 2017 (Table 3) and 2018 (Table 4) in WWTP1 (7.8 ± 2.7 and 12.0 ± 1.3 dt/d/1000 inhabitants) but decreased in WWTP2 (12.5 ± 6.6 and 9.3 ± 5.8 dt/d/1000 inhabitants). Because of the high BZE/COC ratio observed for WWTP2 in 2017, it is clear the cocaine consumption was overestimated for this campaign. MDMA consumption increased between 2017 and 2018 at

Table 2
Consumption mg/d/1000 inhabitants.

	WWTP1 2018			WWTP2 2018		
	Cocaine	Cannabis	MDMA	Cocaine	Cannabis	MDMA
15/05/2018				625	10090	74
16/05/2018				304	3852	0
17/05/2018	895	9605	139	233	7151	0
18/05/2018	866	7083	116	343	12921	0
19/05/2018	1057	7175	212	1121	9254	113
20/05/2018	1065	6302	286	1218	8982	217
21/05/2018	844	9872	219	1231	17784	466
22/05/2018	870	9217	225			
Average	933	8209	50	725	10005	124

Light gray: samples under weekend effect (Saturday and Sunday). S.D.: standard deviation.

Table 3
Consumption dt/d/1000 inhabitants.

	WWTP1 2017			WWTP2 2017		
	Cocaine	Cannabis	MDMA	Cocaine	Cannabis	MDMA
15/06/2017	8.3	146.8	0.0	7.1	123.2	0.0
16/06/2017	3.8	114.2	0.0	8.6	116.2	0.0
17/06/2017	5.2	140.6	0.0	4.8	100.4	0.0
18/06/2017	11.1	172.8	2.7	22.1	144.7	2.9
19/06/2017	12.6	176.6	2.6	22.9	145.2	4.1
20/06/2017	8.2	181.9	0.0	7.4	74.6	0.0
21/06/2017	6.3	179.1	0.0	12.2	186.1	0.0
22/06/2017	7.3	183.9	0.0	11.0	147.6	0.0
23/06/2017	7.4	49.5	2.3	16.9	123.6	0.0
Average	7.8	149.5	0.9	12.5	129.1	0.8
S.D.	2.7	44.3	1.3	6.6	31.8	1.6

Light gray: samples under weekend effect (Saturday and Sunday). Bold and dark gray: samples under World Music Day effect. S.D.: standard deviation.

Table 4
Consumption dt/d/1000 inhabitants.

	WWTP1 2018			WWTP2 2018		
	Cocaine	Cannabis	MDMA	Cocaine	Cannabis	MDMA
15/05/2018	11.5	282.5	2.1	8.0	296.8	1.1
16/05/2018	11.1	208.3	1.8	3.9	113.3	0.0
17/05/2018	13.6	211.0	3.3	3.0	210.3	0.0
18/05/2018	13.7	185.4	4.4	4.4	380.0	0.0
19/05/2018	10.8	290.4	3.4	14.4	272.2	1.7
20/05/2018	11.1	271.1	3.5	15.6	264.2	3.3
21/05/2018	11.5	282.5	2.1	15.8	523.0	7.2
Average	12.0	241	3.1	9.3	294.3	1.9
S.D.	1.3	45	1.0	5.8	129.7	2.6

Light gray: samples under weekend effect (Saturday and Sunday). S.D.: standard deviation.

both WWTP1 (0.9 ± 1.3 and 3.1 ± 1.0 dt/d/1000 inhabitants) and WWTP2 (0.8 ± 1.6 and 1.9 ± 2.86 dt/d/1000 inhabitants). Similarly, cannabis consumption increased between 2017 and 2018 at both WWTP1 (149.5 ± 44.3 and 183.9 ± 49.5 dt/d/1000 inhabitants) and WWTP2 (129.1 ± 31.8 and 294.3 ± 129.7 dt/d/1000 inhabitants). In this context, World Music Day does not appear to be a special day for the consumption of illicit drugs.

This event differs from other monitored festivals [9,10] and special events [18]. Previous studies focus on illicit drug consumption at special events [19–22]. Music Day events are not open-air festivals nor indoor concerts where the public gathers by musical affinity with the consumption being described as homogenous previously studied [9,23–25], i.e., each type of music is associated with the same kind of illicit drug consumption

regardless of where the concert takes place [10]. In addition, the effect of a population's confinement and connivance based on common tastes including illicit drug consumption or tolerance has already been studied [26]. However, the only outdoor event previously reported to induce a modification of illicit drug consumption and taking place in the street, i.e., comparable to World Music Day except in terms of illicit drug consumption, was the Carnival in Brasilia [27]. The Carnival involves traditional letting-go behavior: in this respect, the effect of other people's views and opinions could differ compared to World Music Day, which is a rather recent event compared to the Carnival. While the former focuses only on music, the latter is devoted to entertainment on a broad scale and not only music. The results of the present study suggest that during World Music Day in Bordeaux, illicit drug consumption is moderated by the presence of a conventional and non-peer public.

In 2017, June 21 was a bright sunny day with temperatures ranging from 30 to 35 °C. With such weather, people prefer to be outside than stay in bars. This in turn leads to a lower use of toilets, which can also explain the lack of drugs found in the wastewater at outdoor events. However, compared to outdoor festivals, World Music Day takes place in the streets where conventional behavior is more easily observed.

In the weekend before and after World Day Music, many festivals take place in Bordeaux area, with illicit drug consumption reported by Labadie et al. [28]. It is thus hypothesized that a large number of drug users might prefer these weekend events to World Music Day.

World Music Day is a broad public and non-peer festival. Alcohol is the major psychotropic drug used at this type of event [29], even if some illicit drug use is observed. Two surveys point to the presence of illicit drug users in Bordeaux [30] but neither describe any kind of open drug consumption scene in the city. Drug users seemed opt for alcohol instead of illicit drugs in this context, especially for World Music Day, as observed in the nearby festivals mentioned above.

The choice of substance linked to a special event brings to attention the alternative model of drug consumption [31]. For example, this would mean favoring alcohol over MDMA and cannabis or postponing consumption to the weekend or another music festival. Drug users' preference for money instead of cocaine, what he called: "alternative reinforcers" [32].

4. Conclusion

The city of Bordeaux does not experience an increase in illegal drug use during World Music Day, i.e., the rates of cocaine, benzoylcgonine, MDMA, and cannabis measured in the WWTPs are quite comparable to those observed on other weekdays.

The present article is the first description of a massive festival event without observing an increase in illicit drug consumption. Authors hypothesize that this could be attributed to the effect of others' views and opinions, i.e., the influence of a non-peer audience in a street festival ("*qu'en-dira-t-on*" in French, untranslatable locution). As World Music Day brings together all music styles performed by amateur musicians, this original result could be useful in terms of limiting illicit drug use in festivals by promoting non-affinity publics and styles, even if it will still be necessary to measure the quantity of alcohol consumed along with its consequences and side effects.

Further investigations should be done to corroborate the present result, specially show whether the use of stimulants (e.g., cocaine and MDMA) increases when World Music Day falls on a Friday or Saturday. And herein lies the question of drug choice, which challenges the orthodox conception of addiction.

CRediT authorship contribution statement

Damien A. Devault: Conceptualization, Funding acquisition, Writing - original draft, Writing - review & editing, Formal analysis. **Alexandre Peyré:** Writing - original draft, Writing - review & editing, Formal analysis. **Olivier Jaupitre:** Data curation. **Amélie Daveluy:** Supervision. **Sara Karolak:** Methodology, Validation, Formal analysis, Investigation, Resources, Supervision, Project administration.

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