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Use of synthetic stimulants and hallucinogens in a cohort of electronic dance music festival attendees

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ABSTRACT

Novel psychoactive substances (NPS), often characterized as unregulated psychoactive compounds designed to circumvent existing legislation, have become mainstream on the illicit drug market. Because of their physical and mind-altering properties, NPS may be deliberately or inadvertently ingested at electronic dance music (EDM) festivals to enhance the attendees' appreciation of the music and overall experience. Their widespread use at EDM festivals have been well documented and several adverse events and fatalities associated with NPS ingestion have been reported in the United States. The diversity and rapid turnover in the prevalence of any particular NPS at any given point of time has created several challenges for public health officials, law enforcement, and forensic science communities. Epidemiological studies are often published long after drugs have cycled through the peak of their popularity with users and the scope of testing frequently failing to detect, identify or report the most recently available drugs. The aims of the study included discovering emerging NPS, ascertaining their overall prevalence and determining patterns of use and trends within this targeted population.

Over the course of two years, biological samples were collected from 396 (126 blood samples; 227 urine samples; and 384 oral fluid samples) EDM festival attendees. Additionally, survey data regarding prescription and recreational drug use within the last week were collected with follow-up questions related to what substance(s) the person had ingested, amount taken, when the substance was last taken and perceived effects. All biological samples were screened and subsequently confirmed and/or quantified, when appropriate. In response to survey questions, 72% of the participants reported using a recreational drug or medicinal substance within the last week. Users most commonly reported using marijuana and alcohol, followed by "Molly" and cocaine. Of the 396 individuals tested, approximately 75% of the population was positive in at least one biological specimen for drugs and/or alcohol. Of those positive samples, 36% were confirmed to contain one or more NPS and/or 3,4-methylenedioxymethamphetamine (MDMA). High rates of turnover and spikes in popularity related to NPS are supported by samples confirming positive for alpha-PVP in 2014, however, one year later not a single case was positive for alpha-PVP, and instead increasing numbers of subjects were positive for ethylone.

1. Introduction

The appearance of a diverse group of psychoactive chemical substances, which began as a trend in 2008 in the United States with the appearance of the synthetic cannabinoids, has continued through 2016 with the appearance of novel and unapproved benzodiazepines [1,2], and opioids [3]. Between 2008 and 2015, the market was dominated by the appearance of novel phenethylamine-based drugs, many of which had stimulant and hallucinogenic properties. Collectively these drugs are now referred to as novel psychoactive substances (NPS), a term adopted by the Council of the European Union as "... a new narcotic or psychotropic drug, in pure form or in a preparation, that is not scheduled under the Single Convention on Narcotic Drugs of 1961 or the Convention on Psychotropic Substances of 1971, but which may pose a public health threat comparable to that posed by substances listed in those conventions" [4]. However, the European Monitoring Center for Drugs and Drug Addiction (EMCDDA) clarified in the operating guidelines of the European Early Warning

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System that the term 'new' or 'novel' did not refer to newly invented, but rather 'newly misused' substances [5].

Data about the appearance of these substances in the drug supply is significantly lacking for several key reasons. Forensic and clinical laboratories are challenged by the appearance of NPS since they are frequently not included in mass spectral libraries and databases, and consequently go undetected in targeted screening methods used in most laboratories, based on immunoassay, and liquid chromatography with tandem mass spectrometric or time of flight detection. As such, they may not be recognized as being present. When a novel compound is detected, there is significant effort in making an identification. Reference materials for NPS are typically unavailable for many months following their first report, and laboratories typically have few resources to track down the identity of these new compounds. Even after their identification, there are no mechanisms currently for rapid dissemination of this information other than by word of mouth between practitioners. Another source of information about new drugs in the general supply comes from admissions to drug use in the emergency room, however these are very infrequently toxicologically confirmed leading to misinformation about the identity of novel agents.

Rates of appearance of novel substances is still high. The EMCDDA reported 24 new substances in 2009, and 41, 49, 74, 81, 101, and 98 in 2010 through 2015 respectively [6]. In the 2016 European Drug Report, the EMCDDA recognized the use of illicit substances including NPS to be a "global burden of disease" and reported 14 new cathinones and six phenethylamines for the first time [6,7]. In the United States, the National Forensic Laboratory Information System (NFLIS), is used to monitor the appearance of NPS by collecting drug identification results and associated information from drug cases submitted to and analyzed by federal, state and local forensic laboratories. The NFLIS data shows that drug cases reported to contain synthetic cannabinoids and synthetic cathinones dramatically increased between 2013 and 2015 [8]. For synthetic cathinones, the number of reported cases rose from 16,811 in 2013 to 51,824 in 2015 with methylone, alpha-PVP and ethylone accounting for 91% of the reported phenethylamines during this period [8]. According to the Global Drug Survey 2017, 13.3% of respondents (n = 10,100 to the nearest 50) in the United States reported purchasing an NPS in the past 12 months [9]. Although this system works well for seized drugs and ensures that intelligence on drug use patterns in distribution is evidence based, there is no equivalent mechanism for monitoring through toxicologically confirmed analyses, the extent or relative prevalence of NPS drugs in toxicological samples.

In the United States, the rave culture, characterized by all-night dance parties and loud "techno-rock" and electronic dance music (EDM), has become a popular venue for these recreational drugs [10–16]. A 2015 study of young adults entering nightclubs or EDM parties found 42.8% (n = 679) self-reported ecstasy use and 35.1% reported lifetime NPS use with psychedelic phenethylamines and cathinones accounting for 14.7% and 6.9% of those responses, respectively [17,18]. Recent studies, which investigated drug and alcohol use at clubs featuring EDM, found upon exiting, one fourth of the participants tested positive for drugs (THC, cocaine, benzoylecgonine, cocaethylene, norcocaine, amphetamine, methamphetamine, MDMA, MDEA, MDA, morphine, codeine, oxymorphone, 6-MAM, hydrocodone, hydromorphone, oxycodone, methadone, PCP, ketamine) and approximately half were impaired or intoxicated by alcohol [19]. Moreover, the use of NPS at EDM festivals has been documented by surveys with EDM attendees and is reflected in discussion groups online associated with EDM culture [20–23]. Attendees frequently ingest NPS drugs for their mind altering and euphoric effects, which they believe enhance the overall festival experience. In this report, we describe the use of drugs by attendees at an EDM event in Florida as one indicator of trends in NPS use in the United States, providing specific insights into the use of psychostimulants in the cathinone drug class.

2. Methods

2.1. Sample collection

The research protocol was approved by the Committee for the Protection of Research Subjects: Institutional Review Board (IRB) at Arcadia University (Glenside, PA). Samples were collected in March 2014 and March 2015. In total, 396 subjects, 18 years of age and older, attending a large EDM festival (>150,000 participants) in Miami, FL (188 males; 127 females; 81 unidentified) were recruited for this study. Subjects were recruited by peer recruiters (graduate students aged 20–25), who, working in pairs, approached potential subjects as they walked to the event, within a radius of approximately a quarter mile of, and within sight of, the main gate. The project was thoroughly explained to each subject, and they signed a statement of informed consent, according to the approved IRB protocol. Subjects were asked some screening questions to verify their attendance at the event (knowledge of the event, intention to attend, peer confirmation, or production of a ticket), and exclusion criteria included, participants who were deemed unable to donate a required blood, urine or oral fluid specimen, individuals who appeared too visibly intoxicated to give consent, or subjects who were unable to understand the study as described. Subjects who agreed to participate then completed a short paper-based survey, and were asked to provide samples of blood, oral fluid and urine.

Participants were given a unique identification number that linked survey data and samples, but personal identifying information was removed from both. Participants could withdraw at any time and donated to their level of comfort. Participants who donated any sample were given a bottle of water, and subjects who provided all three specimens (blood, urine and oral fluid) were given a $20 gift card.

2.2. Survey data

Subjects were asked a brief series of IRB-approved questions on a paper-based survey that included age, gender and whether or not they had taken any medication or recreational drug within the last week. Participants who answered "yes" to that question were asked a series of follow-up open-ended questions about what substances the participant thought they had ingested, symptoms experienced while taking the substance, method of ingestion, dosage, and how long ago they had taken that substance.

2.3. Biological sample collection

Blood draws were performed in a sterile environment by a licensed phlebotomist, and samples were collected into two grey top tubes containing sodium fluoride and potassium oxalate. Urine samples were self-collected by the subjects into a sterile collection cup in a private lavatory. Oral fluid samples were collected using a Quantisal® oral fluid collection device (Immunalysis, Pomona, CA). According to the manufacturer's instructions, subjects were directed to place the sorbent pad collector under the tongue and close their mouth until the adequacy indicator turned blue, which resulted in approximately one milliliter (mL) of sample being collected. The collector was then transferred into the transport tube, which contained three mL of stabilizing buffer. All samples were initially stored refrigerated (4° C) on site and shipped on dry ice, prior to being frozen (−80° C) until analysis.