Original Paper

The NBOMe hallucinogenic drug series: Patterns of use, characteristics of users and self-reported effects in a large international sample

Journal of Psychopharmacology
2014, Vol. 28(8) 780–788

DOI: 10.1177/0269881114523866
jop.sagepub.com

Will Lawn[1], Monica Barratt[2], Martin Williams[3], Abi Horne[4] and Adam Winstock[5,6,7]

Abstract

The NBOMe compounds are a novel series of hallucinogenic drugs that are potent agonists of the 5-HT_{2A} receptor, have a short history of human consumption and are available to buy online, in most countries. In this study, we sought to investigate the patterns of use, characteristics of users and self-reported effects. A cross-sectional anonymous online survey exploring the patterns of drug use was conducted in 2012 (n = 22,289), including questions about the use of 25B-NBOMe, 25C-NBOMe, and 25I-NBOMe and comparison drugs. We found that 2.6% of respondents (n = 582) reported having ever tried one of the three NBOMe drugs and that at 2.0%, 25I-NBOMe was the most popular (n = 442). Almost all (93.5%) respondents whose last new drug tried was a NBOMe drug, tried it in 2012, and 81.2% of this group administered the drug orally or sublingually/buccally. Subjective effects were similar to comparison serotonergic hallucinogens, though higher 'negative effects while high' and greater 'value for money' were reported. The most common (41.7%) drug source was via a website. The NBOMe drugs have emerged recently, are frequently bought using the internet and have similar effects to other hallucinogenic drugs; however, they may pose larger risks, due to the limited knowledge about them, their relatively low price and availability via the internet.

Keywords

Demographics, hallucinogen, internet drug market, legal drugs, NBOMe, n-bomb, oral drugs, psychedelic, psychoactive drugs, public health, recreational drugs, risk behaviour, survey

Introduction

First synthesized in the early 2000s, the NBOMe drugs ('n-bomb' or 25-I/25-C/25-B) are psychoactive N-methoxybenzyl analogues of the 2C-X (e.g. 2C-B) family (Figure 1) of phenethylamines (Erowid, 2011a; Zuba et al., 2012) belonging to the class of 'classical hallucinogens' (Nichols, 2004). These drugs (Braden et al., 2006; Ettrup et al., 2011) and other classical hallucinogens (Fiorella et al., 1995) act as agonists of the 5-HT_{2A} receptor. It is this activation of the 5-HT_{2A} receptor that is generally accepted as the mediator of the subjective and behavioural effects of hallucinogens (Geyer and Vollenweider, 2008; Marek et al., 1996).

The addition of the N-methoxybenzyl group to the analogous 2C-X compounds, which makes them become 'NBOMe compounds', has been shown to significantly increase the compounds' affinities to the 5-HT_{2A} receptor (Braden et al., 2006). For instance, the 5-HT_{2A} affinity of 25I-NBOMe (K_i = 0.044nM) is over 10 times greater than the 5-HT_{2A} affinity of 2C-I 0.73 (K_i = 0.73nM) (Braden et al., 2006). Due to their relatively high affinity for the 5-HT_{2A} receptor, the NBOMe drugs produce greater behavioural responses in animals (Halberstadt and Geyer, 2014) and require lower doses to produce subjective effects in humans (Erowid, 2011c), compared with their 2C-X counterparts.

Human consumption of the NBOMe drugs appears to have begun in 2010, when they became available online (Zuba et al., 2013). At the current time, NBOMe drugs are mostly uncontrolled around the world, although they are illegal in New Zealand, Poland, Sweden and Israel (Erowid, 2012a; Zuba et al., 2012) and were made temporarily illegal in the UK on 10 June 2013 (Home Office, 2013). The three most available NBOMe drugs online are 25B-NBOMe, 25C-NBOMe and 25I-NBOMe, and it is reported that one dose costs as little as $1.50 AUD ($1.37 USD) (Ralston and Davies, 2013). Although other NBOMe drugs

[1]Clinical, Educational and Health Psychology, University College London, London, UK
[2]National Drug Research Institute, Curtin University, Perth, WA, Australia
[3]Monash Institute of Pharmaceutical Sciences, Monash University, Melbourne, VIC, Australia
[4]School of Psychology, University of Sussex, Brighton, UK
[5]South London and Maudsley NHS Foundation Trust, London, UK
[6]Institute of Psychiatry, King's College London, London, UK
[7]Global Drug Survey, London, UK

Corresponding author:
Will M Lawn; Clinical Psychopharmacology Unit, Clinical, Educational and Health Psychology, University College London, Gower Street, London, WC1E 6BT, UK.
Email: will.lawn.12@ucl.ac.uk

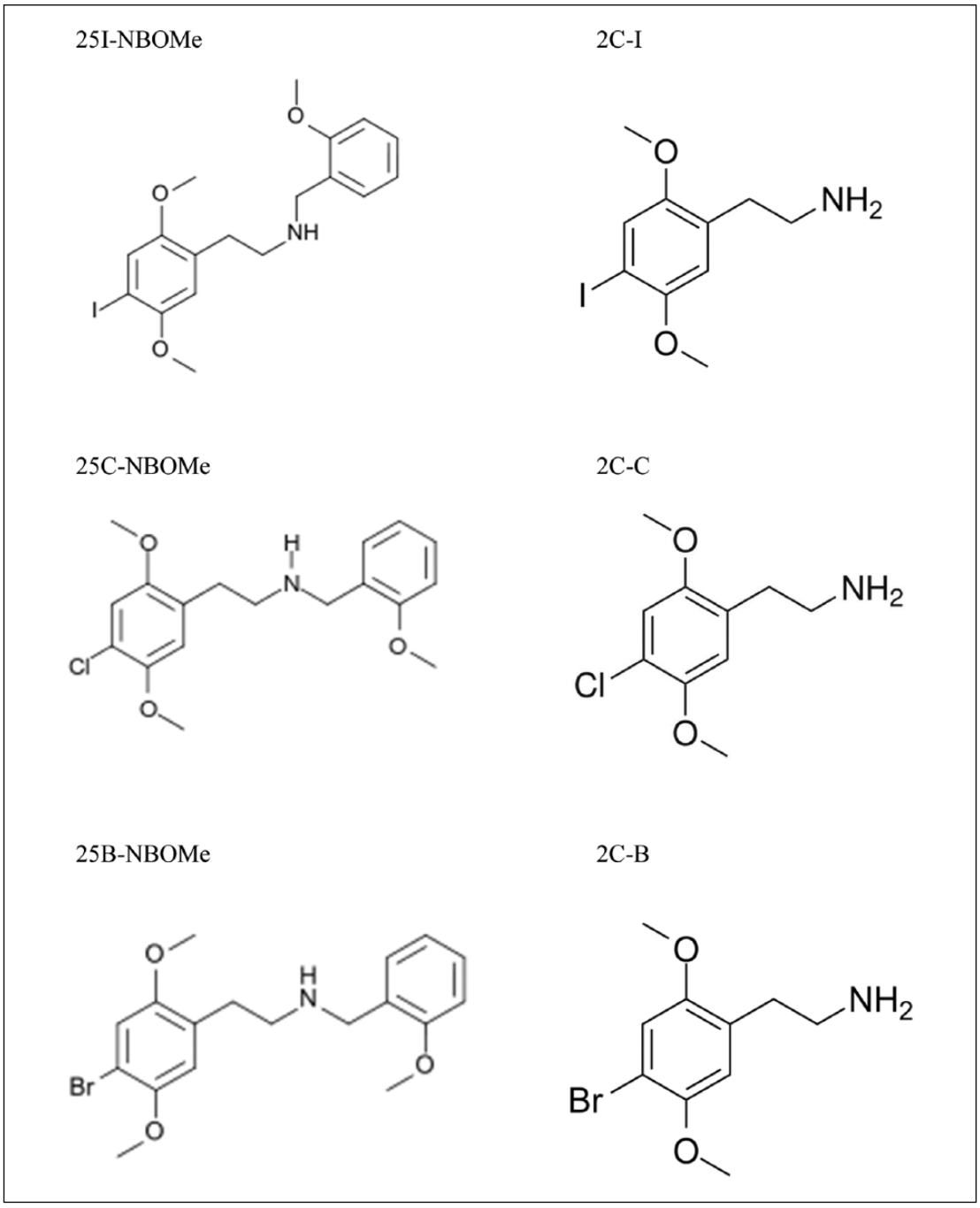

Figure 1. Molecular diagrams of the NBOMe series and 2C-X series.
NBOMe: hallucinogenic N-methoxybenzyl analogues of the 2C-X family of phenethylamines, agonists of the 5-HT_{2A} receptor; 2C-X: the generic name of a family of drugs called 2C, where an alphabetical letter replacing X would specify which one.

exist, for instance mescaline-NBOMe (Erowid, 2011a) and 2CD-NBOMe, this article will focus on only 25B-NBOMe, 25C-NBOMe and 25I-NBOMe.

No human clinical studies with the NBOMe drugs have been reported; however, anecdotal reports suggest that they provoke similar effects to other classical hallucinogens (Erowid, 2011b), which would be expected, given their stimulation of the 5-HT_{2A} receptor. People who have experimented with these drugs report euphoria, visual and auditory hallucinations, and dissociations with reality (Erowid, 2011b).

NBOMe drugs are sold on blotter paper or as powder (Erowid, 2011a), and require very small doses (200 – 1000μg) (Zuba et al., 2013), with nasal insufflation requiring smaller amounts than sublingual administration (Erowid, 2012b). Given the small dose required and the lack of knowledge about these drugs, the risk of overdose is significant. Furthermore, there is growing concern that NBOMe drugs are being sold as lysergic acid diethylamide (LSD) (Caldicott et al., 2013; Ninnemann and Stuart, 2013).

There are at least nine media reports of deaths following the use of a NBOMe drug (Erowid, 2012b) and various academic

reports concerning the hospitalizations of people whom consumed 25I-NBOMe (Hill et al., 2013; Rose et al., 2013; Stellpflug et al., 2013). Furthermore, NBOMe drugs appear to more easily produce sympathomimetic effects (Hill et al., 2013) relative to LSD, which may result in hospitalizations (Ninnemann and Stuart, 2013). While deaths due to the pharmacological effects of NBOMe drugs have been reported, there have been no documented human deaths from an LSD overdose (Passie et al., 2008).

Given that no experimental studies nor quantitative analyses of recreational NBOMe use have taken place, the potential harm and effects of these drugs remain largely unknown. Their recent emergence, apparent legal status, potential to be misrepresented as LSD, and availability on the internet also augment the associated concerns.

Therefore, this study sought to investigate the patterns of use of these novel compounds; the characteristics of the users; the drugs' subjective effects, when compared with other hallucinogenic drugs; and its prevalence of use, albeit in a self-nominating sample. We expected the subjective effects to be similar to classical hallucinogens and the history of use to be mostly within the last year.

Method

The Global Drug Survey conducts annual, anonymous online surveys of drug use, in partnership with global media partners and using onward promotion through social networking sites. The research tool and methods are based on previous work by the group, conducted over the last decade. Accessing a large sentinel drug using population in this way allows for the rapid assessment and identification of novel drugs of abuse. Our team has successfully used this methodology to identify new drug trends before they reach the wider community (McCambridge et al., 2007; Winstock et al., 2011). The methods used, including their utility, validity and limitations, were described previously (Winstock et al., 2001, 2011, 2013).

When compared with traditional epidemiological criteria for public health surveillance, this data-collection method has significant limitations. For instance, it recruits from a self-nominating population and relies upon self-reported data, concerning substances whose true composition is uncertain. Nonetheless, this method is useful for determining new drug trends, and their associated harms and effects, in a timely fashion.

At the time of conception of the 2013 Global Drug Survey, only 25B-NBOMe, 25C-NBOMe, and 25I-NBOMe were known to be in recreational usage; hence, other NBOMe drugs are not included in this study. It must be noted that other NBOMe drugs seem not to have grown much in popularity (Erowid, 2011b).

In this study, basic information was collected to identify the demographic using NBOMe drugs, including: age, gender, currency used and drug use history. We used 'currency used' as a proxy measure of country of residence, because a large amount of 'country of residence' data were missing. The number of respondents reporting other novel psychoactive substance and traditional drug use in the last 12 months was used to illuminate the relative prevalence of NBOMe use. In order to quantify the subjective effects of the NBOMe drugs and compare them against similar hallucinogenic drugs, respondents were asked to name the last new drug that they tried and answer questions about their experience. Specifically, they were asked to rate, from 0 to 10: 'the pleasurable high', 'the strength of the effect', 'the negative effects while high', 'the comedown after use', 'the urge to use more of the drugs when using', 'the value-for-money' and 'the risk of harm following a session of use'. Furthermore, they were asked how the drug was administered, how the drug was sourced, how long the effects lasted, how long it took for 'peak effects' to occur after a single dose, and what the 'predominant effect' of the drug was.

In order to assess NBOMe and other drug use, we collected absolute numbers and percentages of people reporting having 'ever used a drug', used 'in the last 12 months', and used 'in the last month'. To determine the recency of NBOMe use, those whose last new drug was a NBOMe were asked which year they had tried it. We used a chi-square test to determine whether there were differences in the proportions of males and females within the NBOMe user group and a group of comparison hallucinogen users. An independent *t*-test was used to test whether there was a significant difference in age between the NBOMe and the hallucinogen user group. The predominant effect, route of administration, duration of effect, time until peak effect, and subjective effects of the NBOMe drugs were assessed by consideration of absolute numbers and percentages.

We reported valid percentages, rather than absolute percentages, when data were missing.

Results

Whole sample demographics

A total of 22,289 responses were collected in late 2012. One-third (n = 7,360; 33.9%) of respondents were from the UK, 7,784 (35.9%) were from Australia, 3,756 (17.3%) were from the USA, 2,164 (10.0%) were from the Euro-Zone, and 618 (2.9%) were from Canada. Most (68.6%) respondents were male and the mean age was 31.4 years (SD = 12.4; range 16 – 100).

Overall drug use

The sample contained many experienced hallucinogen users: 39.4% of respondents reported having ever used LSD, 43.1% had used magic mushrooms, and 26.0% ketamine (Table 1 has complete prevalence statistics).

Use of any one of the three NBOMe drugs was reported by 582 respondents (2.6% of entire sample). The most popular of the three was 25I-NBOMe (n = 442; 2.0%), followed by 25B-NBOMe (n = 267; 1.2%) and 25C-NBOMe (n = 65; 0.8%). Because the separate drugs are close chemical analogues and their effects were reported to be similar, our analysis was carried out by considering the NBOMe drugs together.

Table 2 presents the numbers and percentages of the entire sample of questionnaire respondents whom had taken certain novel psychoactive substances and traditional drugs over the last 12 months. Many respondents reported taking cannabis (n = 13,965; 62.7%), 3,4-methylenedioxy-N-methylamphetamine (MDMA) (n = 7971; 35.8%) and cocaine (n = 5290; 23.7%) in the last 12 months, and these numbers are much greater than those for an NBOMe drug (n = 526; 2.3%); however, the last 12-month prevalence for a NBOMe drug is similar to other novel psychoactive substances (Table 2).

Recent NBOMe drug use

Use of an NBOMe drug within the last month was reported by 189 (0.8%) respondents. Almost all (93.5%) respondents whose

Table 1. Prevalence (absolute number and %) of hallucinogenic drug use in entire questionnaire sample.

	Ever used		Last 12 months used		Last month used	
	N	%	*N*	%	*N*	%
LSD	8774	39.4	3340	15	1149	5.2
Magic mushrooms	9604	43.1	3586	16.1	1180	5.3
Ketamine	5784	26.0	2505	11.2	1182	5.3
2C-I	1054	4.7	419	1.9	65	0.3
2C-B	1866	8.4	879	3.9	242	1.1
2C-E	777	3.5	338	1.5	58	0.3
2C-C	180	0.8	91	0.4	18	0.1
25B-NBOMe	65	0.3	47	0.2	24	0.1
25C-NBOMe	267	1.2	233	1.0	112	0.5
25I-NBOMe	442	2.0	406	1.8	177	0.8
Any NBOMe drug	582	2.6	526	2.4	189	0.8
Any 2C-X drug	2526	11.3	1263	5.7	348	1.6

LSD: Lysergic acid diethylamide; NBOMe: hallucinogenic N-methoxybenzyl analogues of the 2C-X family of phenethylamines, agonists of the 5-HT_{2A} receptor; 2C-X: the generic name of a family of drugs called 2C, where an alphabetical letter replacing X would specify which one.

Table 2. Last 12-month prevalence (absolute number and %) of selected novel psychoactive substances and traditional drug use in entire sample.

	Last 12-month period of use	
	N	%
Cannabis, any form	13,965	62.7
MDMA, any form	7971	35.8
Cocaine	5290	23.7
Synthetic cannabis, herbal	1021	4.5
Mephedrone	871	3.9
Methoxetamine	545	2.4
Any NBOMe drug	526	2.4
Benzo-Fury (5/6-APB)	316	1.4
Methylone	279	1.2
Synthetic cannabis, powder	175	0.8
MDPV	95	0.4
N-ethyl ketamine	44	0.2
Flephedrone (4-FMC)	20	0.1

MDMA: 3,4-methylenedioxy-N-methylamphetamine; MDPV: methylenedioxypyrovalerone; NBOMe: hallucinogenic N-methoxybenzyl analogues of the 2C-X family of phenethylamines, agonists of the 5-HT_{2A} receptor; 2C-X: the generic name of a family of drugs called 2C, where an alphabetical letter replacing X would specify which one.

last new drug tried was a NBOMe drug, tried it in 2012 (Figure 2), whereas 56.6% of the people whose last new drug tried was a 2C-X drug, tried it in 2012, and these percentages were smaller still for LSD (45.6%), 'magic' mushrooms (42.9%) and ketamine (35.8%). Furthermore, the percentage of lifetime NBOMe users for whom a NBOMe drug was also their last new drug tried was high (40.9%), and this was higher than for LSD (14.3%), magic mushrooms (13.5%), ketamine (18.9%) and the 2C-X drugs (26%). These results strongly suggested that NBOMe drugs have begun to be used very recently.

Demographics of NBOMe users

We defined 'user' as anyone whom had used a drug within the last 12 months (n = 522). The majority (n = 296; 56.7%) of NBOMe users were from the USA, 21.3% (n = 111) were from the UK, 10.2% (n = 53) were from the Euro-Zone, 9.8% (n = 51) were from Australia and 2.1% (n = 11) were from Canada. This distribution was significantly different from that of non-NBOMe-users ($\chi^2(4) = 606.99$; $p < 0.001$); however, due to the self-nominating nature of this sample, this result should be considered with caution (see discussion).

To compare the gender ratio and age of NBOMe users with other drug users, two groups were analysed: people who reported using an NBOMe drug in the last year (NBOMe group) (n = 522) and people who reported using a 2C-X drug, LSD or magic mushrooms, but not an NBOMe drug in the last year (classical hallucinogen group) (n = 4884). Most respondents who reported using an NBOMe drug within the last year had also used one of these classical hallucinogens within the last year (n = 449).

The proportion of males in the NBOMe group (97.7%) was significantly larger than in the classical hallucinogen group (77.5%) ($\chi^2(1) = 57.235$; $p < 0.001$). The average age of the NBOMe user group was 21.5 (SD = 5.3) and the average age of the classical hallucinogen group was 26.2 (SD = 8.7). Without assuming equal variances in the groups, these ages were significantly different ($t(858.074) = 17.702$; $p < 0.001$, $r = 0.272$).

Description by those whom a NBOMe drug was 'the last new drug tried'

The following results are from a subpopulation of the sample whom gave information on their last new drug tried and whom listed it as: a NBOMe drug (n = 233; 1.3%), LSD (n = 1130; 6.5%), magic mushrooms (n = 1157; 6.6%), ketamine (n = 993; 5.7%) or a 2C-X drug (n = 615; 3.5%).

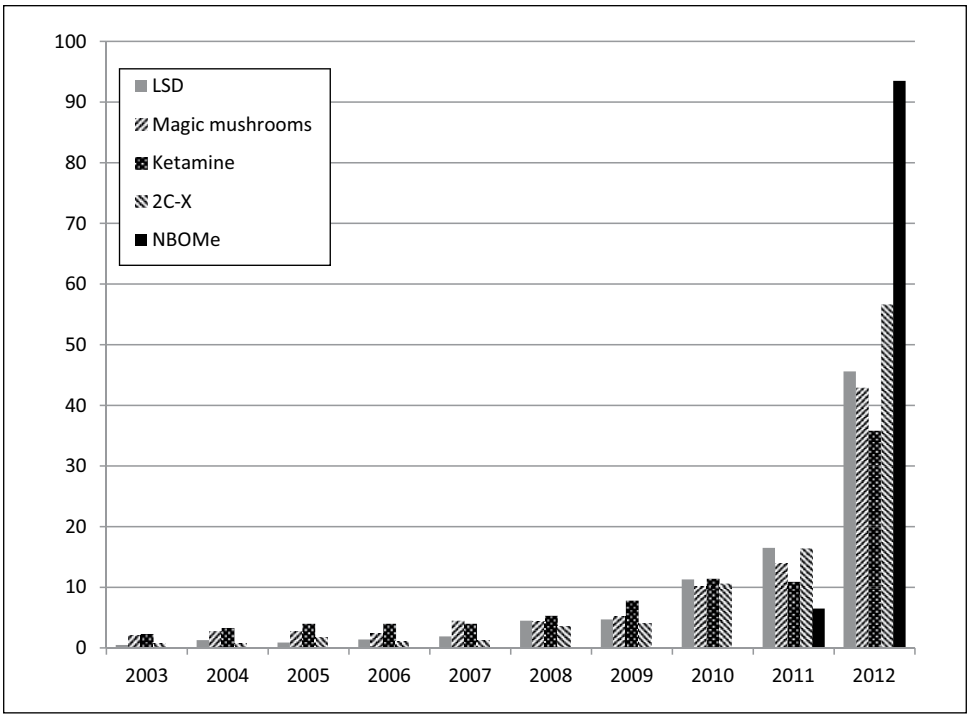

Figure 2. The year in which the last new drug was tried. The majority (93.5%) of people whose last new drug tried was a NBOMe drug, tried it in 2012. 2C-X: the generic name of a family of drugs called 2C, where an alphabetical letter replacing X would specify which one; LSD: lysergic acid diethylamide; NBOMe: hallucinogenic N-methoxybenzyl analogues of the 2C-X family of phenethylamines.

The prevalence of lifetime hallucinogenic drug use within the NBOMe as last new drug tried group was large. Most (72.2%; n = 169) had used LSD, 65.4% (n = 153) used magic mushrooms, 45.2% (n = 108) used any 2C-X drug, and 33.8% (n = 79) used ketamine. In fact, 88.9% (n = 208) of this group had tried at least one of these other hallucinogenic drugs. This experience with hallucinogenic drugs makes their ratings of NBOMe drugs somewhat more valid, as their ratings will be made with experiential knowledge of other hallucinogenic drugs.

Almost all (93.5%) respondents whose last new drug tried was a NBOMe drug stated that its 'predominant effect' was 'psychedelic: LSD or ketamine-like', while 2.2% described it as 'empathogen: MDMA-like', 1.3% 'stimulant: cocaine-like' and 0.4% 'cannabis-like'. A further 2.6% of this group described its predominant effect as 'other'.

The most common source of NBOMe drugs was 'from a website' (n = 99; 41.7%). The second most common source was 'a friend' (n = 92; 39.7%), and the third most common 'from a dealer' (n = 37; 15.9%).

The majority (n = 190; 81.2%) of the group reported 'swallowed' or 'other' as the route of administration. 'Other' responses were 'sublingual', 'buccal' (i.e. between the gum and cheek), 'tab on tongue', or something similar. Thus, the most common route of administration was swallowing or sublingual/buccal administration, although a minority (17.9%) of these people reported nasal insufflation. Given that subjective effects may vary with different routes of administration, the effects of oral/sublingual/buccal versus nasal are reported separately for the NBOMe drugs. The most common route of administration was reported for the comparison of hallucinogens. Oral or sublingual/buccal administration were considered together for NBOMe drugs, because it is not possible to determine if people whom reported oral administration simply swallowed the drug or left it under the tongue or something similar, and then swallowed it.

The variation in time to peak effect was large (Figure 3). The modal time to reach peak effect was 2 hours, for oral/sublingual/buccal (n = 52; 27.8%) and 45 minutes, for nasal administration (n = 9; 20%) of a NBOMe drug. Furthermore, 19.0% (n = 8) of those who administered it nasally reported a peak effect by 20 minutes or less, which was significantly larger than the 2.1% (n = 4) of those who swallowed or took it sublingually ($\chi^2(1) = 19.874$; $p < .001$). In comparison, LSD has a modal onset of 2 hours, the 2C-X drugs 90 minutes, magic mushrooms 60 minutes and ketamine, 5 minutes (Winstock et al., 2013).

There was large variation in the duration of effect from a single dose of an NBOMe drug: 95% of respondents reported a duration of effect between 3 and 13 hours (Figure 4). The modal duration was 6 hours, for both oral/sublingual/buccal (n = 51; 27%) and nasal administration (n = 13; 31%). Of those who administered it nasally, 21.4% (n = 9) reported a duration of effect of less than 6 hours; which was more than the 15.7% (n = 30) of those who swallowed it or took it sublingually, but not significantly so ($\chi^2(1) = 0.809$; $p = 0.368$). Comparatively, the modal duration reported by those whose last new drug was LSD, was 8 hours; for magic mushrooms, 6 hours; for any 2C-X drug, 6 hours; and for ketamine, it was 60 minutes (Winstock et al., 2013).

Nasally and orally/sublingually/buccally-administered NBOMe drugs were rated by those surveyed as giving the third and fourth most pleasurable high, respectively, with 6.6 (SD = 1.9) and 6.4

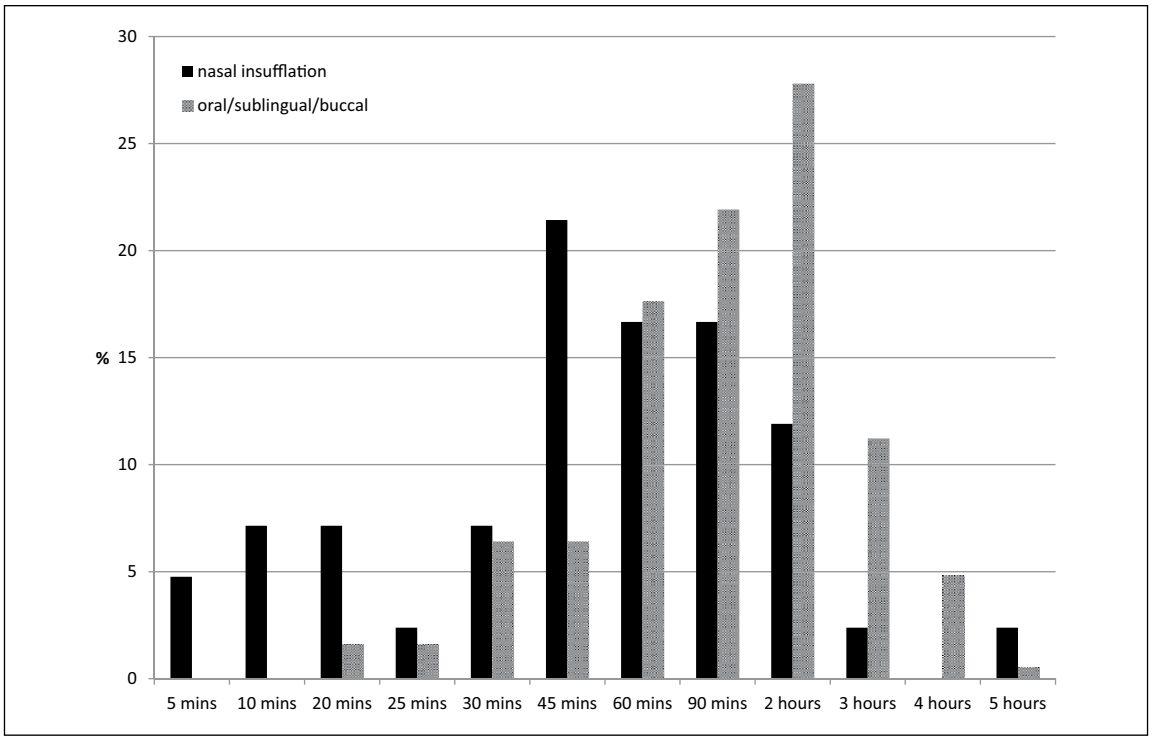

Figure 3. Time to reach peak effect from an NBOMe drug, for nasal and for oral/sublingual/buccal administration.
NBOMe: hallucinogenic N-methoxybenzyl analogues of the 2C-X family of phenethylamines.

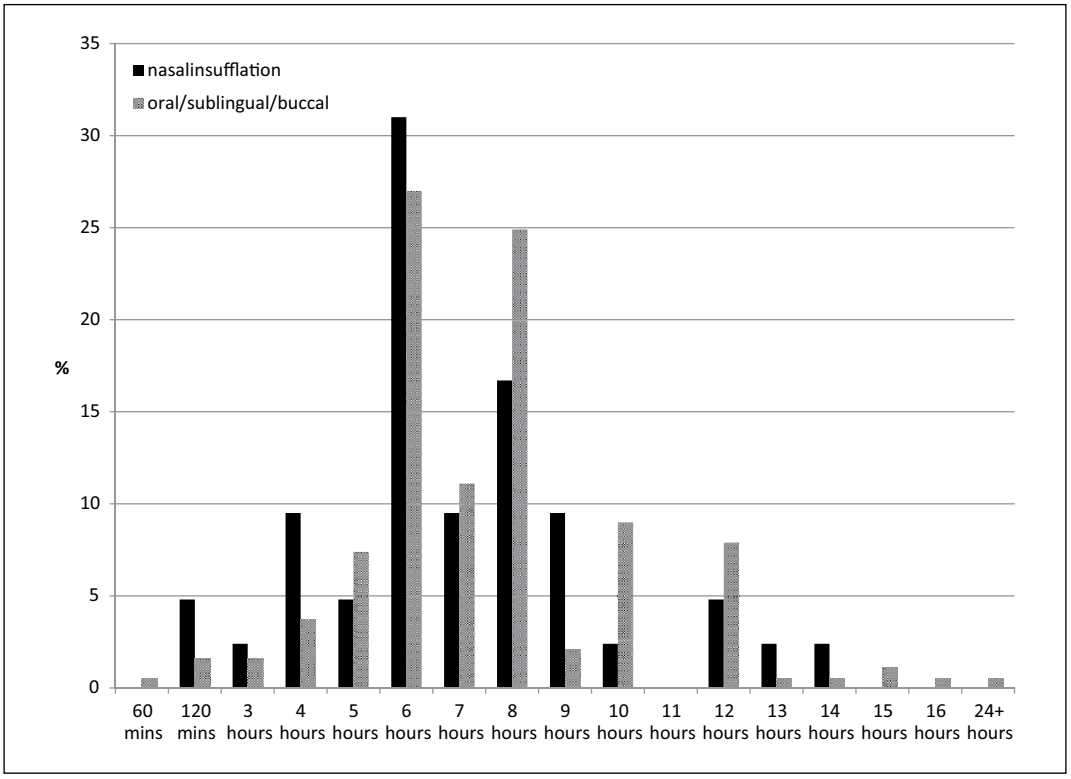

Figure 4. Duration of effect from an NBOMe drug for nasal and oral/sublingual/buccal administration.
NBOMe: hallucinogenic N-methoxybenzyl analogues of the 2C-X family of phenethylamines.

Table 3. Mean (SD) scores for subjective effects of the last new drug tried (with route of administration).

	The pleasurable high		Strength of the effect		Negative effects when high		Come-down after use		Value for money		Risk of harm following a session of use		Urge to use more drugs, when using	
Drug	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
NBOMe (Oral, *n* = 188)	6.4	2.0	7.1	2.1	3.6	2.4	2.7	2.3	7.8	2.5	2.5	2.6	1.4	2.1
NBOMe (Nasal, *n* = 42)	6.6	1.9	7.9	1.8	3.3	2.4	2.6	2.3	8.2	2.3	2.5	2.3	1.1	1.9
2C- X (Oral, *n* = 490)	6.3	2.3	6.9	2.1	2.8	2.7	2.5	2.2	6.8	2.2	1.8	2.3	1.6	2.6
LSD (Oral, *n* = 1130)	7.3	2.3	7.6	2.1	2.9	2.7	3.3	2.8	7.7	2.6	2.1	2.6	1.5	2.3
Mushrooms (Oral, *n* = 1030)	6.8	2.6	7.1	2.3	2.9	2.8	2.1	2.4	7.3	2.7	1.7	2.3	1.4	2.2
Ketamine (Nasal, *n* = 884)	5.4	2.6	7.2	2.2	3.6	2.8	2.4	2.4	5.7	2.9	3.2	2.9	3.0	3.0

LSD: lysergic acid diethylamide; NBOMe: hallucinogenic N-methoxybenzyl analogues of the 2C-X family of phenethylamines 2C-X: the generic name of a family of drugs called 2C, where an alphabetical letter replacing X would specify which one.

(SD = 2.0): see Table 3 for full subjective-effects statistics. Nasally administered NBOMe drugs were rated as having the strongest effect, with 7.9 (SD = 1.8). This was significantly larger than the effect associated with orally/sublingually/buccally-administered NBOMe drugs, which had a mean of 7.1 (SD = 2.1) ($t(228) = 2.434$; $p < 0.05$; $r = 0.16$). In terms of value for money, the nasally-administered NBOMe drugs were rated the best, with 8.2 (SD = 2.3).

However, the orally/sublingually/buccally-administered NBOME drugs had the greatest negative effects while the subject was high, with 3.6 (SD = 2.4); nasally administered ketamine was rated equally with 3.6 (SD = 2.9); but the three classical hallucinogens were rated as less bad. Furthermore, orally/sublingually/buccally- and nasally-administered NBOMe drugs were rated as having the second and third worst comedown, with ratings of 2.7 (SD = 2.3) and 2.6 (SD = 2.3), respectively. Both orally/sublingually/buccally- and nasally-administered NBOMe drugs were rated as having the same risk of harm, with 2.5 (SD = 2.6 and SD = 2.3, respectively). This was the second highest after ketamine, with 3.3 (SD = 3.9).

Discussion

This is the first report on patterns of use and associated psychological effects of the novel NBOMe drug series in a human population. We surveyed 582 people whom reported having ever used one of the three NBOMe drugs, with 25I-NBOMe being the most popular (*n* = 442). The popularity of these drugs is a recent phenomenon: 93.5% of those whose last new drug tried was a NBOMe drug, tried it in 2012. Furthermore, people who had used a NBOMe drug, but not a classical hallucinogen, in the last year were younger and more likely to be male than people who had used a classical hallucinogen, but not a NBOMe drug within the last year. NBOMe drugs were mostly taken orally or sublingually/buccally (81.2%), though a minority (17.9%) administered them nasally.

In terms of subjective effects, 93.5% of the group that had NBOMe as the last new drug tried described its predominant effect as 'psychedelic'. Furthermore, their 'pleasurable high', 'strength of effect', 'comedown after use', and 'urge to use more' ratings were very similar to the classical hallucinogens; however, their 'negative effects while high' and 'risk of harm following use' ratings were higher than the classical hallucinogens and were more similar to the dissociative drug ketamine.

Our findings that the group that stated that NBOMe was their last new drug tried, mostly tried it in 2012, and that 40.9% of lifetime NBOMe users reported NBOMe as their last new drug tried, suggests these drugs have emerged recently and rapidly. This supports the information on Erowid, which holds reports of NBOMe use from 2011 onwards (Erowid, 2011a).

The geographical distribution of NBOMe users, using currency as a proxy, should be interpreted cautiously. Although we found there were significantly more NBOMe users from the USA than in the non-NBOMe user group, this may well be due to the different ways that respondents were recruited between different countries. Across the whole survey, the mean age of US respondents was much lower than the mean age of respondents from Australia. Hence, this age difference, or other associated differences, could account for our results.

Nearly one-half of the 'NBOMe as last new drug' group sourced their drug from a website. This is unsurprising, given the drug's apparent legality in many countries, as websites can legally advertise the drugs as chemical that are 'not for human consumption'. This availability on the internet could be involved in the claims that NBOMe drugs are being sold as LSD (DrugsForum, 2013; Ninnemann and Stuart, 2013), as dealers could potentially buy NBOMe drugs cheaply and easily, and then make profits marketing it as LSD (Caldicott et al., 2013).

While most respondents reported oral or sublingual/buccal administration of NBOMe drugs, a minority reported intranasal administration. As with many other drugs, the desired effects of NBOMe drugs require smaller doses using this route of administration (Erowid, 2011b); therefore, the danger of over-dosing is higher and should potentially be advised against.

The variability in the time to reach peak effect reported by the group 'NBOMe as last new drug' was large, with people whom

administered the drug nasally reporting a faster onset than those taking it orally or sublingually/buccally. This was expected, given that nasal administration allows more direct access to the circulating blood than oral administration. Those who had nasally administered a NBOMe drug appeared to have a shorter duration of effects than those who swallowed it or took it sublingually; however, there was no significant difference between the proportions that reported a duration of < 6 hours. Given no data concerning the dose of drug taken nor frequency of re-dosing during the session, these results should be considered cautiously.

As predicted, the NBOMe drugs had a very similar profile of subjective effects, as compared with the classical hallucinogens LSD and magic mushrooms, with some less attractive aspects. The vast majority of people reported a predominantly 'psychedelic' effect, which was expected given the NBOMe drugs' stimulation of the 5-HT_{2A} receptor (Ettrup et al., 2011) and the well-substantiated claim that hallucinogenic effects are, at least in part, mediated through activity at this receptor (Marek et al., 1996). Furthermore, the 'pleasurable high', 'strength of effect', 'comedown after use' and 'urge to use more' ratings were similar for the four serotonergic hallucinogenic drug groups compared in this study. These findings conformed to the idea that serotonergic hallucinogenic drugs have low abuse liabilities (Morgenstern et al., 1994), with very little urge to use more. On the other hand, ketamine, primarily a glutamatergic drug, had higher 'urge to use more' ratings, which is concordant with reports of dependence (Morgan et al., 2012).

The NBOMe drugs were rated as the best value for money amongst the hallucinogenic drugs investigated. This is probably a consequence of the NBOMe drugs' apparent legal status and availability online; while the price of other illegal drugs may be driven up by prohibition (Mirron and Zwiebel, 1995). This price situation is undesirable, given the limited knowledge about these drugs and their potential dangers.

This study found a relatively low prevalence of NBOMe use, in comparison with other classical hallucinogens and traditional drugs, such as cannabis, MDMA and cocaine. Due to the self-nominating sample used, one cannot draw conclusions about the prevalence of use in the general population; however, it should be noted that even in a relatively frequent drug-using sample, NBOMe use has not reached the levels of more established drugs, although its last 12-month prevalence is fairly similar to other novel psychoactive substances such as mephedrone, methoxetamine and the synthetic cannabinoids.

With the temporary ban in the UK, a fall in usage and a rise in price may be expected; however, studies have contradictory findings about the effect of prohibition on previously-uncontrolled recreational drugs (Freeman et al., 2012; Winstock, 2010). The 2014 Global Drug Survey will provide data concerning the differential trends of NBOMe use in countries that prohibited the drugs and those that did not.

Limitations

To our knowledge, this is the first quantitative study of NBOMe drug use; however, our findings should be interpreted with caution until confirmed by subsequent research. The respondents in this survey may not be representative of NBOMe drug users as a whole, given that the sample was self-nominating. These findings are also limited by the self-reported nature of the data and our inability to confirm the true composition of the substances consumed. Furthermore, high levels of poly-drug use were expected and no data concerning the dose of the drug consumed were collected. These limitations and others are discussed more fully elsewhere (Winstock et al., 2001, 2011, 2013). Despite these limitations, we previously demonstrated that self-reported studies in this population can be valid and effective tools for describing the effects and emergence of novel drugs (Winstock et al., 2011).

Conclusions

The rapid, yet limited, emergence of NBOMe drugs around the world is likely a consequence of the ease of availability provided by the internet. These drugs seemed to have a very similar profile of effects as other classical hallucinogens, and were most frequently consumed orally or sublingually/buccally. NBOMe drugs have an extremely short history of human consumption, have been linked to deaths (Erowid, 2012b) and hospitalisations (Stellpflug et al., 2013; Hill et al., 2013; Rose et al., 2013), and had a higher rating of 'negative effects while high' than similar drugs.

Acknowledgements

We would like to thank everyone who completed the online survey for volunteering their time and expertise; our media partners Mixmag, The Guardian and Fairfax for their ongoing support; and Stuart Newman for designing and developing the survey.

Conflict of interest

AW is the founder of Global Drug Survey. MB serves on the expert advisory committee of Global Drug Survey.

Funding

This work was supported by Global Drug Survey (self-funded); the Biotechnology and Biological Sciences Research Council (BBSRC), London, UK (WL's PhD); the Australian Government (Substance Misuse Prevention and Service Improvement Grants Fund, to MB); and the National Drug Research Institute, Curtin University (MB's employment in the Faculty of Health Sciences). The funding bodies had no role in the design, interpretation or write-up of this paper.

References

Braden MR, Parrish JC, Naylor JC, et al. (2006) Molecular interaction of serotonin 5-Ht2a receptor residues Phe339(6.51) and Phe340(6.52) with superpotent N-benzyl phenethylamine agonists. *Mol Pharmacol* 70: 1956–1964.

Caldicott DG, Bright SJ and Barratt MJ (2013) Nbome: A very different kettle of fish. *Med J Aust* 199: 322–323.

Drugs-Forum (2013) Spanish batch alert: 25i-Nbome blotters sold as LSD. Available at: www.drugs-forum.con/forum/showthrewad.php?t=204870 (accessed 17 May 2013).

Erowid (2011a) Nbome series. Available at: http://erowid.org/chemicals/nbome (accessed 17 May 2013).

Erowid (2011b) Nbome series reports. Available at: http://erowid.org/experiences/subs/exp_NBOMe_Series.shtml (accessed 17 May 2013).

Erowid (2011c) Nbome series dose. Available at: http://erowid.org/chemicals/nbome/nbome_dose.shtml (accessed 17 May 2013).

Erowid (2012a) 25i-Nbome legal status Available at: http://erowid.org/chemicals/2ci_nbome/2ci_nbome_law.shtml (accessed 1 November 2013).

Erowid (2012b) 25i-Nbome (2c-I-Nbome) Fatalities/deaths. Available at: http://erowid.org/chemicals/2ci_nbome_death.shtml (accessed 17 May 2013).

Ettrup A, Hansen M, Santini MA, et al. (2011) Radiosynthesis and in vivo evaluation of a series of substituted 11c-phenethylamines as 5-Ht (2a) agonist pet tracers. *Eur J Nucl Med Molec Imag* 38: 681–693.

Fiorella D, Helsley S, Lorrain DS, et al. (1995) The role of the 5-Ht2a and 5-Ht2c receptors in the stimulus effects of hallucinogenic drugs. The mechanistic basis for supersensitivity to the LSD stimulus following serotonin depletion. *Psychopharmacology* 121: 364–372.

Freeman TP, Morgan CJ, Vaughn-Jones J, et al. (2012) Cognitive and subjective effects of mephedrone and factors influencing use of a 'new legal high'. *Addiction* 107: 792–800.

Geyer MA and Vollenweider FX (2008) Serotonin research: Contributions to understanding psychoses. *Trends Pharmacol Sci* 29: 445–453.

Halberstadt AL and Geyer MA (2014) Effects of the hallucinogen 2, 5-dimethoxy-4-iodophenethylamine (2C-I) and superpotent N-benzyl derivatives on the head twitch response. *Neuropharmacology* 77: 200–207.

Hill SL, Doris T, Gurung S, et al. (2013) Severe clinical toxicity associated with analytically confirmed recreational use of 25i-Nbome: Case series. *Clin Toxicol* 51: 487–492.

Home Office (2013) 'Nbome' and 'Benzofury' banned. Available at: www.gov.uk/government/news/nbome-and-benzofry-to-be-banned (accessed 1 November 2013).

McCambridge J, Winstock A, Hunt N, et al. (2007) 5-Year trends in use of hallucinogens and other adjunct drugs among UK dance drug users. *Eur Addiction Res* 13: 57–64.

Marek GJ and Aghajanian GK (1996) LSD and the phenethylamine hallucinogen Doi are potent partial agonists at 5-Ht2a receptors on interneurons in rat piriform cortex. *J Pharmacol Exp Ther* 278: 1373–1382.

Miron JA and Zwiebel J (1995) The economic case against drug prohibition. *The Journal of Economic Perspectives* 9: 175–192.

Morgan CJ and Curran HV (2012) Ketamine use: A review. *Addiction* 107: 27–38.

Morgenstern J, Langenbucher J and Labouvie EW (1994) The generalizability of the dependence syndrome across substances: An examination of some properties of the proposed DSM-IV Dependence Criteria. *Addiction* 89: 1105–1113.

Nichols DE (2004) Hallucinogens. *Pharmacol Ther* 101: 131–181.

Ninnemann A and Stuart GL (2013) The NBOMe series: A novel, dangerous group of hallucinogenic drugs. *J Studies Alcohol Drugs* 74: 977.

Passie T, Halpern JH, Stichtenoth DO, et al. (2008). The pharmacology of lysergic acid diethylamide: A review. *CNS Neurosci Therapeut* 14: 295–314.

Ralston N and Davies L (2013) Teen jumps to his death after $1.50 drug hit. *Sydney Morning Herald* (6 June 2013). Available at: www.smh.com.au/nsw/teen-jumps-to-his-death-after-150-drug-hit-20130606–2nrpe.html (accessed 1 August 2013).

Rose SR, Poklis JL and Poklis A (2013) A case of 25i-Nbome (25-I) intoxication: A new potent 5-Ht2a agonist designer drug. *Clin Toxicol* 51: 174–177.

Stellpflug SJ, Kealey SE, Hegarty CB, et al. (2013) 2-(4-Iodo-2, 5-dimethoxyphenyl)-N-[(2-methoxyphenyl) methyl] ethanamine (25I-NBOMe): Clinical case with unique confirmatory testing. *J Med Toxicol* : 1–6.

Winstock A, Mitcheson L and Marsden J (2010) Mephedrone: Still available and twice the price. *Addiction* 376: 1.

Winstock AR and Barratt MJ (2013) Synthetic Cannabis: A comparison of patterns of use and effect profile with natural Cannabis in a large global sample. *Drug Alcohol Depend* 131: 106–111.

Winstock AR, Griffiths P and Stewart D (2001) Drugs and the dance music scene: A survey of current drug use patterns among a sample of dance music enthusiasts in the UK. *Drug Alcohol Depend* 64: 9–17.

Winstock AR, Kaar S and Borschmann R (2013) Dimethyltryptamine (DMT): Prevalence, user characteristics and abuse liability in a large global sample. *J Psychopharmacol* 28: 49–54.

Winstock AR, Mitcheson LR, Deluca P, et al. (2011) Mephedrone, new kid for the chop? *Addiction* 106: 154–161.

Zuba D and Sekula K (2012) Analytical characterization of three hallucinogenic N-(2-methoxy)benzyl derivatives of the 2c-Series of phenethylamine drugs. *Drug Test Analysis* 5: 634–645.

Zuba D, Sekula K and Buczek A (2013) 25c-Nbome: New potent hallucinogenic substance identified on the drug market. *Forensic Sci Int* 227: 7–14.