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Ketamine use among regular tobacco and alcohol users as revealed by respondent driven sampling in Taipei: prevalence, expectancy, and users' risky decision making

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Abstract

The popularity of ketamine for recreational use among young people began to increase, particularly in Asia, in 2000. To gain more knowledge about the use of ketamine among high risk individuals, a respondent-driven sampling (RDS) was implemented among regular alcohol and tobacco users in the Taipei metropolitan area from 2007 to 2010. The sampling was initiated in three different settings (i.e., two in the community and one in a clinic) to recruit seed individuals. Each participant was asked to refer one to five friends known to be regular tobacco smokers and alcohol drinkers to participate in the present study. Incentives were offered differentially upon the completion of an interview and successful referral. Information pertaining to drug use experience was collected by an audio computer-assisted self-interview instrument. Software built for RDS analyses was used for data analyses. Of the 1,115 subjects recruited, about 11.7% of the RDS respondents reported ever having used ketamine. Positive expectancy of ketamine use was positively associated with ketamine use; in contrast, negative expectancy inversely associated with ketamine use. Decision-making characteristics as measured on the Iowa Gambling Task using reinforcement learning models revealed that ketamine users learned less from the most recent event than both tobacco- and drug-naïve controls and regular tobacco and alcohol users. These findings about ketamine use among young people have implications for its prevention and intervention.

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Disclosure

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Keywords

ketamine; respondent-driven sampling (RDS); expectancy; decision making

1. Increasing popularity of ketamine use among young people

Ketamine was initially used for war injuries in the early 1970s [1], and became a club drug in the 1990s [2]. Since 2000, the popularity of ketamine for recreational use among young people began to increase [3], particularly in Asia [4]. The consumption of ketamine can lead to a variety of health problems, such as cognition impairment, kidney dysfunction, and accidental deaths [2,5], and may result in even more severe health problems if used with other drugs simultaneously or in sequence [6,7].

The culture of illegal drug or inhalant use among young people in Taiwan underwent a major change in the past two decades. In national surveys from 1991 through 1996 among adolescent students aged 13 to 18 in Taiwan, the prevalence of any illegal drug or inhalant use ranged from 1.1% to 1.5%, with the most commonly consumed illegal drugs or inhalants being methamphetamine, glue sniffing, and flunitrazepam [8]. However, later surveys in the 2000s indicated that club drugs, which mainly consisted of ecstasy, ketamine, and marijuana, had emerged as the most commonly consumed illegal drugs among young people in Taiwan [9,10].

Early epidemiological evidence of the increasing popularity of ketamine in Taiwan was from a pilot outreach study. In a survey via a street outreach program among 2,126 adolescents aged 12 to 18 years recruited from Taipei street sites in 2002, ketamine was found to be the second most commonly consumed illegal drug for adolescents with truancy, with 12.1–14.5% reporting ecstasy use, 4.6–7.3% ketamine, and 3.5–8.8% marijuana, whereas the corresponding estimate was 3.1–3.4% for youths without truancy [9]. Later, more extensive, nationwide outreach programs across 26 cities/towns in Taiwan were conducted in the period of 2004 to 2006 with a total of 18,420 participants aged 12–18 years. For those who were living with their families but reported to have experience of running away from home (n = 1,626), ketamine (n = 75, 4.6%) was again found to be the second most common illegal drug ever used, next to ecstasy (n = 139, 8.5%) [11].

The popularity of ketamine as a recreational drug was further confirmed in national surveys among school-attending adolescents in grades 7, 9, 10, and 12, aged 11–19 years, in 2004, 2005, and 2006 [10]. Ecstasy and ketamine, by and large, remained the most and second most commonly used illegal drugs, respectively, during the 3-year period for both middle and high school students [10]. For middle school students, the prevalence of ecstasy use was 0.28% (2004), 0.25% (2005), and 0.07% (2006), and the corresponding figure for ketamine was 0.15% (2004), 0.18% (2005), and 0.15% (2006). For high school students, the prevalence of ecstasy use was 1.72% (2004), 0.82% (2005), and 0.52% (2006), and the prevalence for ketamine was 1.13% (2004), 0.61% (2005), and 0.44% (2006). Among ecstasy users, ketamine (41.4–53.5%) was the most common other drug used; meanwhile, ketamine continued to be initiated almost exclusively at the same age as ecstasy.

Nevertheless, the proportion of ecstasy-naïve ketamine users increased slightly but significantly from 0% in 2004 to 5.3% in 2006.

Based on these prevalence data, ketamine seemed to be becoming more popular within adolescent drug culture, particularly among middle school students, during the study period of 2004 to 2006. This switching of popularity between ecstasy and ketamine might be attributed to the harsher regulations on the use of ecstasy (with offenders being incarcerated for enforced detoxification and drug education) compared with that of ketamine (no incarceration for offenders) in Taiwan.

2. Using respondent-driven sampling (RDS) to reach high-risk subjects

Since illegal drug users are often clustered or connected in social networks, researchers have developed respondent-driven sampling (RDS) to explore this hidden population via probability-theoretical methods to compensate for nonrandom sampling [12-15]. Starting in 2008, a series of RDS implementations was undertaken in Taiwan, where the stigma against illegal drug use remains strong and severe punishment is stipulated by law [16,17]. The RDS was carried out among regular tobacco and alcohol users in the Taipei metropolitan area in 2008, 2009, and 2010. Through regular tobacco and alcohol users, who were shown to have an elevated risk of illegal drug use [10], the RDS procedures efficiently reached the sub-population of illegal drug users. The recruitment criteria and implementation of the RDS have been described in detail elsewhere (Ting T-T, Chen C-Y, Tsai Y-S, Chen Y-T, Su L-W, Chen WJ, unpublished data). Briefly, every seed was asked to recruit one to five friends who were regular tobacco and alcohol users and were 18 to 40 years old. When their peers were introduced to this study, these newly recruited subjects were also asked to refer their peers. Incentives were offered differentially upon the completion of an interview and successful referral.

Before beginning an interview, the interviewers took the respondent to a private place to provide informed consent using a nickname. The participants were reassured that their information was strictly confidential and that they only needed to give their nickname, the last four digits of a ten-digit national identification number, and a cell phone number for the researchers to follow-up with them annually via the Internet. Each participant underwent an audio computer-assisted self-interview regarding their experience with drug use, the expectancy of ketamine use, and other measurements. All of the information provided by the respondents was used only for data linkage and the creation of individual accounts for their questionnaires and neuropsychological tests, including the Iowa Gambling Task (IGT) [18]. This RDS sample thus provided a group of ketamine users whose network of relationships were known and can thus be subjected to estimation using social network-based methods.

3. Ketamine becoming the most commonly consumed illegal drug in the RDS sample

During the 3-year period from 2008 to 2010, 1,115 subjects were successfully recruited via RDS. Population prevalences adjusted for RDS (i.e., an estimate using both transition

probability and the network weighting system) were estimated using the RDS Analysis Tool (RDSAT) [15] and their standard errors were estimated using the bootstrapping method.

The results indicated that the weighted prevalence of lifetime use of three club drugs were 11.7 % for ketamine, 11.7% for ecstasy, and 10.5% for marijuana, the three most commonly consumed illegal drugs. Meanwhile, the prevalence of past-year use was 4.3% for ketamine, 4.0 for ecstasy, and 3.8% for marijuana. Thus, in this RDS sample of regular tobacco and alcohol users, ketamine has replaced ecstasy as the most commonly used illegal drug.

4. Expectancy and prevalence of ketamine use

Previous studies have indicated that understanding people's expectations of a particular drug use is important for developing interventions and prevention regarding the drug [19,20]. It has been found that a high positive expectancy is associated with strong endorsement or desire to use a drug and a high negative expectancy with the shunning of such use [21]. It remains that little is known about young people's expectancies regarding ketamine use and whether such expectancies are related to their ketamine-using behavior.

In the RDS study, each participant was asked to fill a ketamine expectancy questionnaire that was modified from the Adolescent Cannabis Expectancy Questionnaires [22] by replacing “cannabis” with “ketamine.” The results of both the internal consistencies and confirmatory factor analysis indicated good fits for this ketamine expectancy questionnaire. More details are described elsewhere (Chang C-M, Ting T-T, Chen C-Y, Su L-W, Chen WJ, unpublished data).

On the basis of ketamine-use experience, subjects were categorized into 3 groups: illegal drug naïve (N = 845, 83%), ketamine use only (N = 30, 3%) and ketamine use with other drugs (N = 137, 14%). The results of multinomial logistic regression analyses indicated that a continuous score on positive expectancy was positively associated with ketamine use only (OR = 1.51, $p < 0.01$) and ketamine use with other drugs (OR = 1.68, $p < 0.001$); in contrast, a continuous score on negative expectancy was inversely associated with ketamine use only (OR = 0.80, $p < 0.05$) and ketamine use with other drugs (OR = 0.70, $p < 0.001$).

We then used the median of positive and negative expectancy among the illegal drug naïve group, respectively, to dichotomize expectancy into high vs. low subgroups. Using the subgroup of low-positive plus high-negative as the reference, the results of multinomial logistic regression analysis revealed that the subgroup of high-positive and low-negative was positively associated with ketamine use only (OR = 3.28, $p < 0.05$) and ketamine use with other drugs (OR = 41.21, $p < 0.0001$).

5. Risky decision-making among ketamine users

Since substance users tend to be involved in risky behaviors, such as violence, gambling, drunk driving, and risky sexual behaviors [23], they may have deficient decision-making skills that can be measured using a psychological task such as the IGT, which was originally developed to examine decision-making deficits in patients with prefrontal cortex damage [18,24].

We hypothesized that people who have ever used illegal drugs would have more deficient decision-making skills than regular users of tobacco and alcohol who have never tried illegal drugs, on the basis of gateway development in substance use. More advanced substance use might be associated with worse parameters in the reinforcement learning models such as Prospect Valence Learning (PVL) models [25], which consist of parameters characterizing underlying decision features, including sensitivities to gains and losses, learning ability, and stability.

We administered a computerized version of the IGT to each member of the RDS-derived cohorts of 2008 and 2009 when they were followed-up yearly. More detail about the implementation of the IGT among the RDS cohorts is described elsewhere (Liu Y-C, Ting T-T, Wang S-H, Chen C-Y, Tsai Y-S, Chen Y-T, Chen WJ, unpublished data). A total of 240 regular tobacco and alcohol users from the RDS samples and 45 tobacco- and drug-naïve controls were included for the subsequent analyses. Among the 240 RDS participants, 55 were classified as illegal ($n = 42$; 20 of them having ever used ketamine) or non-prescription ($n = 13$) drug users, and the remaining 185 were classified as regular tobacco and alcohol users. A PVL model containing Utility Shape, Loss Aversion, Recency, and Consistency was fitted to each participant's trials on the IGT using the hierarchical Bayesian method.

Among the three groups, only the controls obtained a positive net score in the last block of 20 trials. The PVL model analyses revealed a prominent combination of high sensitivity to gains (Utility Shape) and insensitivity to losses (Loss Aversion) in illegal/non-prescription drug users, followed by regular tobacco and alcohol users, and a low sensitivity to gains and sensitivity to losses in the controls, especially for males. The other two parameters reflected substance-induced cognitive change (Recency) or parameterization of the model (Consistency).

6. Conclusion and Perspective

By means of a RDS-derived sample of regular tobacco and alcohol users, we recruited a group of ketamine users who were not in treatment for such drug use. The popularity of ketamine has surpassed ecstasy as the most commonly used illegal drug among these young tobacco and alcohol users in Taiwan during the study period of 2008–2010. These individuals' expectancy about ketamine was associated with their use, with those showing a high positive expectancy and low negative expectancy of using ketamine having the highest likelihood of using the drug, whereas those with a low positive expectancy and a high positive expectancy having the lowest likelihood of ever using of ketamine. These results help shed light on the relationship between different ketamine-using patterns and ketamine expectancy, and have important implications for understanding the cognitive processes underpinning decision-making by substance users at a relatively early stage of substance use. The information provides useful insights for the intervention or prevention of ketamine use.

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