Community-based Assessment for Memory and Motor Impairment Among Young Substance Abusers Using Standardised Instruments: A Hong Kong Experience

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Abstract

Sixty-three substance users aged between 12 and 25 were recruited into a community health evaluation programme. Use of ketamine, ecstasy and cocaine was prevalent. Neuropsychiatric symptoms were common. With the Rivermead Behavioural Memory Test, 79% of the clients were assessed to have impaired memory. Memory impairment was more pronounced among those using more types of drugs at high frequency, and having started drug use before the age of 15. The Bruininks-Oseretsky Test identified 72.4% of the clients with impairment in at least one of the three aspects defining motor proficiency – manual dexterity, fine-motor precision and fine-motor integration. Motor impairment could follow a period of substance use of less than one year. These findings revealed the high prevalence of memory and motor impairments among young substance users and the pressing need for prompt identification and intervention.

Key words   Ecstasy; Ketamine; Memory impairment; Motor dysfunction; Substance use

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Introduction

Substance abuse has become a serious problem among youth in Hong Kong. Official statistics have revealed a rising trend of the number of young psychotropic substance users under 21 since 2006.[1] Moreover there is a tendency of substance users starting using drugs at younger age. Cross-sectional surveys of drug prevalence among secondary school students revealed a lowering age of drug taking. In the 2008/09 Narcotics Division Survey, drug prevalence among secondary students for the age group of 12 or below was 4.6%, compared with 2.4% in the 2004/05 Survey. In the 2008/09 Survey, 15.6% of drug-taking students claimed to have first taken drugs at the age of 10 or below, compared with 13.4% in the 2004/05 Survey.[2,3]

Ketamine and ecstasy (3,4-methylenedioxymethamphetamine, MDMA) are the two most commonly used psychotropic substances among young people in Hong Kong. According to the Narcotics Division Statistics 2009, 83.5% and 12.0% of newly reported substance abusers aged under

21 reported use of ketamine and ecstasy, respectively. Corresponding figures for 2006 were 73.7% and 38.4% respectively.[1] The rising predominance of ketamine over ecstasy was apparent.

The adverse effects of psychotropic substances have been extensively documented in literature.[4-7] Ketamine and ecstasy are associated with a wide range of cognitive dysfunction and neuropsychiatric disturbances.[8,9] Repeated use of ecstasy appears to be associated with sleep, mood, and anxiety disturbances, elevated impulsiveness, memory deficits, and attention problems that may persist for up to two years after cessation.[9] Ketamine appears to induce acute and severe impairments of working, episodic, and semantic memory as well as psychotogenic and dissociative effects.[10] The chronic effects of ketamine abuse is more elusive, though preliminary research data suggest it may be associated with a more specific pattern of memory decrements and with episodic impairment which may not abate following abstinence.[11,12]

Local studies on cognitive and motor impairment among young street drug users employing standardised assessment tools were scarce. This study, started as part of a voluntary anti-drugs health-awareness project, aims at evaluating the degree of functional impairment in the cognitive and motor faculties among young psychotropic drug users in the community.

Hypotheses

The working hypotheses of this study are: 1) Young substance abusers in Hong Kong are at risk of memory and motor impairment, as evaluated by standardised tools, and 2) an innovative interventional approach incorporating functional assessment and health-oriented counseling can help motivate the abusers to reduce substance abusing behaviour.

Methods

The study initially commenced as part of a community voluntary project organised by the Hong Kong Society for Adolescent Health (HKSAH) in collaboration with the Evangelical Lutheran Church of Hong Kong Social Services (ELCHK) and Hong Kong Occupational Therapy

Association (HKOTA). During the period from September 2007 to June 2009, a team of professional volunteers of doctors, occupational therapists and nurses paid visits at three- to four-month intervals to the ELCHK Youth Centres in Tin Shui Wai and North District to conduct a health-awareness programme targeted to substance-using youths followed up by the centres. Participation of these youths was on a voluntary basis. The programme consisted of three parts: a) interview, b) cognitive and motor function testing, and c) debriefing and counseling. They were briefed on the use of the schedule prior to an interview.

The interview was conducted for each participant using a self-developed interviewing schedule. It explored the participants' personal demographic details, history of substance use (including age of first-time use, number of substances used in the past 6 months, types of substance use, etc.); self-reported symptoms related to substance use (in particular cognitive-motor deficits and psychiatric symptoms) and other high-risk behaviours (smoking, unprotected sex, violence), and family risk factors (e.g. family history of substance use, alcoholism, domestic violence, parental marital problem). The interviewers were paediatricians, child psychiatrists and nurse specialists experienced in managing adolescent behavioural problems.

The participants were then assessed for cognitive function and motor function by a group of occupational therapists. The Rivermead Behavioral Memory Test (RBMT) was used to assess the cognitive function and the Bruininks-Oseretsky Test second edition (BOT2) was used to assess the motor proficiency function. All the therapists had received prior training for administering the tests. A senior occupational therapist presided over the performance of the assessors to ensure the implementation and scoring of the tests was conducted in the standardised manner.

The debriefing session was conducted at the end of each session. Each participant would meet the interviewer and assessor again, accompanied by his/her social worker. Results of the functional tests were explained to increase the awareness of their existing health condition and well-being. Health-oriented counseling was given and their motivation of substance abstinence was assessed. Referral of the participant to the healthcare system would be made when indicated. A follow up review on the clients' status of substance use was done by the agency social workers 6 month after.

Instrumentation

Bruininks-Oseretsky Test of Motor Proficiency (BOT) was developed in 1978. It has been the most widely used standardised measure of motor proficiency.[13] It assesses three major areas of motor proficiency, i.e., manual dexterity, fine motor precision and fine motor integration. A major revision (BOT2) was made in 2002, with expanding coverage of both fine and gross motor skills, extension of norms through age 21 and improvement in the measurement and quality. The current standardisation involved 1520 examinees from the United States.[14]

Reliability. For subjects aged 12 or above, the internal consistency reliability coefficient of the three sub-tests ranges from 0.74 to 0.93. The correlation coefficients range from 0.46 to 0.69. The inter-rater reliability ranges from 0.86 to 0.98.

Validity. The test can successfully identify the motor performance deficits in individuals with developmental coordination disorder, mild to moderate mental retardation and high functioning autism.[13] There was a local study of 297 normal subjects from 11 to 22 years old in 2008 by Hong Kong Occupational Therapy Association (unpublished data). All the subjects' performance was within the normal range of the US norm.

Rivermead Behavioural Memory Test-Chinese Version (RBMT) was translated and validated in 1998.[15] It consists of eleven subtests, which cover verbal, visual and visuospatial memory. It includes tests of semantic memory: recall of names, date, orientation and recognition of pictures and human faces. The ability to recall a short story, a route and a hidden belonging is tested, as well as prospective memory for an appointment. The standardised scores for the test allow categorisation into normal, poor, moderately impaired and severely impaired memory.

Reliability. Inter-rater reliability was tested of high correlation (Cronbach's alpha p=0.859); and test-retest reliability in a group of stroke patients was proven to be high (t=-3.4, p=0.002).[16]

Validity. The test can successfully identify the memory deficits in individuals with brain damage and memory loss (Wilk's Lambda=8.34, F=8.80, p<0.005). Besides, the concurrent validity of RBMT was high (r=0.860, p=0.000) when comparing with mini-mental state examination-Chinese version.[16]

Results

Client Demographics
Sixty-three youths (77.7% male) participated and completed the assessment (Table 1). The mean age was 16.9 years (range 12-25years). Thirty-five (55.6%) of the participants resided in the North District of the New Territories, 21 (31.7%) in the Yuen Long-Tin Shui Wai area, four (6.4%) in other areas, three did not provide clear information regarding their residence. Half of them (32, 50.7%) reported themselves as students, 17.5% as employed, and 27.0% as school drop-outs or unemployed.

Substance Use Profile
The average age of reported first-time substance use was 14.3 years (range 11-20 years). Female clients started substance use at a younger age than their male counterparts (12.9 years vs. 14.5 years). The average length of substance use was 2.8 years, 53.2% of them used drugs for two years or less (Table 1).

Forty-seven clients (74.6%) reported use of two drugs or more over the past six months; use of more than four drugs was not uncommon (16 clients, 25.4%). Ketamine was the most commonly used drug (60 clients, 95.2%), followed by ecstasy (29, 46.0%), methamphetamine or 'ice' (27, 42.9%), marijuana (23, 35.5%), and cocaine (18, 28.6%); use of benzodiazepines and cough mixtures was also

Table 1 Demographic characteristics

Number of clients	63
Mean age, year	16.9
Age range, year	12-25
Gender	
Male (%)	49 (77.8)
Female (%)	14 (22.2)
Age at first-time drug use, year	
All	14.3
Male	12.9
Female	14.5
Mean duration of drug use, year	2.8

reported, but relatively uncommon (20.6% and 11.1% respectively). Reported reasons of drug use included alleviating boredom (60.3%), curiosity (50.8%), celebrations (e.g. birthday) (44.4%), seeking excitement (36.5%), relieving stress (30.2%) and weight reduction (7.9%).

Thirty-five (55.6%) reported their frequencies of substance use to be twice a week or more, of these, 19 (30.2%) used drugs four times a week or more. The number of drugs used during the past six months were also correlated with the frequency of drug use during the same period (Pearson's correlation r^2=0.996 p<0.001). The length of substance use was significantly correlated with number of drugs used (r^2=0.255, p=0.046) in the last six months but not frequency of use (r^2=0.243, p=0.057). No significant correlation could be drawn between either frequency of use (r^2=-0.196, p=0.127) or number of drugs used (r^2=-0.200, p=0.119) with age starting substance use .

When asked to self-appraise substance use, 55.5% of the clients felt that they did not have significant dependence on drugs, and they believed they could quit anytime at their will. Only 6 of them (9.5%) admitted significant dependency and felt difficult to quit. In response to the question asking what aspects in life had been negatively affected by their drug-using behaviour, a great majority of subjects (81.0%) thought that drug use had exerted negative impact on their health. Other aspects perceived to be adversely affected were finance (55.6%), study/work (52.4%), relationship with family (34.9%), relationship with friends (28.6%), and intimate relationships (include sex) (19.0%).

Symptomatology

Neurological – More than two-thirds (67.7%) of the subjects reported they suffered from memory impairment during the past 1 month prior to assessment, slurring of speech in 51.6%, 50% hand tremor, 38.7% impaired comprehension, 30.6% clumsiness. *Psychiatric* – Hallucinations were the most commonly reported psychiatric symptoms of the clients (43.5%), followed by fluctuating mood (38.7%), low mood (38.7%), paranoid ideation (37.1%) and panic anxiety (21.0%).

The odds ratios of developing neurological and psychiatric symptoms between clients exposed to substances before 15 and those exposed at 15 or after were calculated. Sixty-

two clients had data complete for evaluation. Over an average period of substance exposure of 2.8 years, those who were first exposed before their 15th birthday had a higher risk of developing more neurological and psychiatric symptoms than those exposed after 15 (Table 2),

Memory Functional Level

Of the 62 (98.4%) clients who produced data fit for analysis, the mean profile score (standard deviation) of the entire cohort was 17.63 (3.85), within the poor memory range (see below). Only 13 (21%) of them had normal memory (profile score 22-24) as assessed by RBMT, 28 (45.2%) fell into the poor memory category (score 17-21), 19 (30.6%) were classified as moderately impaired memory (score 10-16), and two (3.2%) had severely impaired memory (score 0-9). It was also found that among those who were currently using ≥2 drugs at a frequency twice-a-week or more (49 clients), the prevalence of moderate (17, 34.7%) and severe memory impairment (2, 4.1%) was higher, and such an observation was even more obvious in those who started using drugs before their 15th birthday (29 clients, 11 moderately impaired, 2 severely impaired) (Table 3).

Among the 42 participants reporting subjective 'impaired memory' in the interview, 33 (78.6%) were assessed to have memory deficit. Seventeen (40.5%) of them fell into 'poor memory' category; 14 (33.3%) and two (4.8%) were respectively classified as moderately and severely impaired. Only nine (21.4%) of them had normal memory assessed by RBMT. For the 21 participants who reported no subjective impairment in memory, 11 (52.3%) got poor memory and six (28.6%) had even moderate impairment.

Table 2   Odds Ratios for developing multiple neurological and psychiatric symptoms: clients compared by age of first-time substance use

	<15 years (n=36)	≥15 years (n=26)	Odds ratio
Neurologic symptoms ≥3	26	11	1.71
≥2	29	17	1.23
≥1	31	22	1.02
Psychiatric symptoms ≥3	14	6	1.68
≥2	20	10	1.44
≥1	27	19	1.02

Motor Proficiency

All the 63 clients were tested for motor proficiency by BOT2. The mean standard deviation scores (SD) of fine motor integration, fine motor precision and manual dexterity were -0.711, -0.565 and -0.578 respectively. Only 18 (28.6%) achieved SD score > -1.0 in all three faculties (fine motor integration, fine motor precision and manual dexterity) of motor function. It follows that 72.4% (45 clients) had deficit in at least one functional aspect; whereas 42.9% (27) had two dysfunctions, 7.9% (5) were deficient in all three faculties.

Conventionally SD of -1.0 is defined as the cut-off level below which rehabilitative training is required. Almost one-half (31 clients, 49.2%) of the clients had fine motor integration SD < -1.0. The corresponding percentage for fine motor precision and manual dexterity was 39.7% and 34.9% respectively (Table 4),

If borderline performance is defined as an SD between -0.6 and -0.9, for which reassessment would deem desirable, then a considerable percentage of clients would require follow-up (Table 4). Only nine (14.3%) clients had achieved SD scores greater than -0.6 in all three functional faculties. This means an overwhelming majority (85.7%) of the clients would require intervention, i.e. reassessment with or without rehabilitative training.

Among the 22 clients with definite deficit (SD <-1.0) in manual dexterity who were indicated for training, only five (22.7%) reported clumsiness and 13 (59.1%) reported hand tremor. The result revealed that a considerable number of clients were not aware of their motor deficits.

Subgroup Analysis of Clients Reporting Habitual Alcohol Consumption

As habitual alcohol drinking can be a potential confounding factor affecting motor and cognitive performances, a subgroup analysis was conducted to compare the test performances between clients with habitual alcohol consumption (≥2 times/week in the past 3 months) and those without. Thirty-seven (58.7%) participants reported habitual alcohol consumption. There was no significant difference in age (SD) between the habitual drinkers and non-habitual drinkers 16.70 (2.23) years vs 17.10 (3.26) years. Their duration of substance use (2.757 years vs 2.760 years) and

Table 3 Memory impairment by level of substance use and age at first-time exposure

Frequency of drug use in a week	2 drugs & more & > twice/wk		1 drug & once/wk	
	Age at first-time drug Use		Age at first-time drug use	
Memory functional level	Before 15 (n=29)	15 and after (n=20)	All ages (n = 13)	Total
Normal (score 22-24)	7 (24.1%)	4 (20%)	2 (15.4%)	13 (21.0%)
Poor memory (score 17-21)	9 (31.0%)	10 (50%)	9 (69.2%)	28 (45.2%)
Moderately impaired (score 10-16)	11 (37.9%)	6 (30%)	2 (15.4%)	19 (30.6%)
Severely impaired (score 0-9)	2 (6.9.%)	0 (0%)	0 (0%)	2 (3.2%)
Total	29 (100%)	20 (100%)	13 (100%)	62 (100%)

Table 4 Summary of motor impairments in three functional faculties

BOT 2 performance	FM Precision	FM integration	Manual dexterity
Definite impairment SD ≤ -1.0 (%)	25 (39.7)	31 (49.2)	22 (34.9)
Borderline performance SD between -0.6 and -0.9 (%)	13 (20.6)	8 (12.7)	16 (25.4)
Definite plus borderline SD ≤ -0.6 (%)	38 (60.3)	39 (61.9)	38 (60.3)

age starting substance use (14.2 years vs 14.6 years) were similar. There was also no significant difference in the three functional faculties of BOT2 between habitual drinkers and non-habitual drinkers – fine motor integration SD score: -0.649 vs -0.800; fine motor precision SD score:-0.530 vs -0.615; manual dexterity SD score: -0.578 vs -0.577. Interestingly, there was a significant difference (p= 0.035 and 0.033 by ANOVA) in RBMT profile score (SD) in favour of the habitual drinkers: 18.49 (4.16) vs 16.42 (3.05), although such difference was slight

Motivation to Abstinence

Assessing motivation to abstinence was not a major objective of this study. The investigators did enquire about the motivation of the clients at the end of the functional tests. Of the 51 clients (80.9% of total) who gave clear response to the question, 18 were in pre-contemplation (S1) or contemplation (S2) stage; 33 were in preparation (S3)/ action (S4)/maintenance (S5) stage. Those who were in more advanced motivational stage (S3 through S5) were older than their S1/S2 counterparts (17.8 vs 16.3 years), and there was no gender difference in the two groups.

Follow-up

The social workers of ELCHK Outreach Teams conducted a follow-up survey in early 2010 on the participants. They were able to contact 52 (82.5%) of the original 63 clients who participated the programme. Among them 45 (86.5%) had decreased their frequency of substance use after the

programme, 27 (51.9%) had been able to abstain from substances for at least three months. Forty-two (80.7%) clients reported that the programme did enhance their motivation to stop or reduce substance use.

Discussion

Compared with earlier local surveys,[3,17,18] prevalence of ketamine use among our sample was much higher, suggesting an increasing trend of preference for ketamine to other substances like ecstasy and cocaine has occurred over the past few years. Although no correlations could be drawn between occurrence of neurological or psychiatric symptoms and duration of substance use, the investigators noted that these symptoms could develop following a brief period of initial exposure, as soon as less than one year. Furthermore, the data demonstrated that subjects who started using psychotropic substances before age 15 had a higher risk of developing more neurological and psychiatric symptoms than those who started later. The findings may suggest that earlier exposure to these drugs may lead to more severe damage to the brain.

The results of the functional assessments clearly revealed that cognitive and motor impairments were common among our substance-using clients. BOT2 identified more than 70% of the clients with motor functional deficits indicated for immediate rehabilitative training. The RBMT assessment
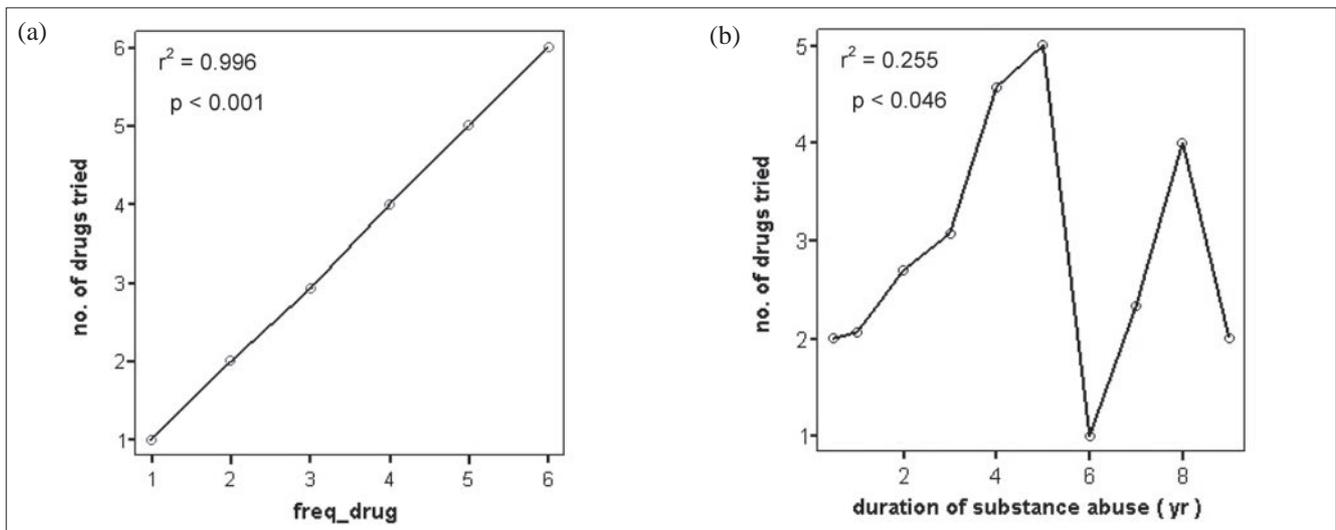

Figure 1   Correlations: (a) number of drugs used and frequency of use over past 6 months; (b) number of drugs used and duration of substance use.

showed that only about one-fifth of the subjects had normal memory, and about one-third had either moderate or severe memory impairment.

Whilst a correlation between 'cumulative dose' of substance use, in terms of duration and frequency of consumption, and functional impairment is yet to be established, the observation of significant functional impairment in some of those with a relatively shorter history and lower frequency of substance use was disturbing.

Cognitive and motor impairment during young adulthood is devastating. It will affect all occupational roles and functions of the individual throughout his life. Previous laboratory studies found that partial memory recovery could be found after cessation of substance use for subjects having taken ketamine for a few days.[19] However, no investigation has been done to assess the long term effect of the memory recovery after stopping substance use. In addition, there is no research studying the effect of cognitive training on these subjects. Similarly, although it has been known that ecstasy and ketamine affect motor function of the user, their long term effect on human being and potential recovery are yet to be explored.

The authors recommend that those clients classified as borderline in performance and who did not need training at the moment to have reevaluation later to closely monitor for functional deterioration. Special attention should be paid for those aged below 15. Furthermore, for those who were noted having impairment, follow up assessment should be done to monitor their functioning in these two aspects, and to trace their most recent status in drug use.

This study has a number of limitations. In the first place, data collection on substance use information relied on clients' self-reporting. Data depending heavily on clients' recall, such as age at first-time use, types of drugs used over the past 6 months, and symptoms experienced, are particularly susceptible to inaccuracies. Furthermore, accurate quantification of psychotropic substance consumption is extremely difficult, in contrast to tobacco or alcohol. Street drugs are notoriously laden with impurities. The content of active substance can vary substantially from one 'take' of ketamine from another. Even were the information of substance consumption reliably reported by the participants, their cumulated dose of substances consumed still cannot be estimated with

certainty. Thus a convincing correlation between cumulative dose and functional impairment cannot be established in this study.

This study was conducted in the context of a community outreach project, in which the assessors met the participants in a 'one-go, one-off' encounter. In such setting, it is very difficult to eliminate the effects of potential confounding variables such as co-existing morbidities (e.g. specific learning difficulties and attention-deficit hyperactivity disorder) and alcohol consumption. A hospital or institution-based sample could have allowed a more controlled study environment and enabled capture of relevant information concerning comorbidities.

For obvious reasons, the clients could only be tested for their functional impairments post-exposure. The extent of the revealed impairment attributable to the substance using behaviour among these clients could not be firmly established. Moreover, it was possible that some clients attended the assessment under the acute effect of drugs. It was another shortcoming of the study that no mechanism was devised to exclude clients who took drugs right before coming to assessment. On-site urine test, now made possible with the increased availability of the commercial test-kits, can be incorporated into future studies to help pick up these clients. That said, this study is still the first local attempt to assess the cognitive and motor impairment of a sample of young substance users with standardised instruments.

Of note, co-existing high-risk behaviours, such as habitual alcohol consumption, unprotected sex, involvement in violence, were prevalent among this group of clients. Although not reported in this paper, our questionnaire did reveal adverse family factors like domestic violence, parental marital problem, family history of substance abuse, mental illness and suicide, were common among these clients. Frontline healthcare professionals should be aware of these co-existing health risks and equipped with skills in handling family and individual psychosocial issues when working with substance using young people.

Conclusions

This is one of the first local studies investigating the effect of substance use in the motor and memory functioning on youngsters. Results indicate that their subjective self-reports

coincide with the objective assessments in the functional deteriorations upon substance use. Most alarming is the deleterious effect of psychotropic substances on young adolescents and that these presenting problems can be found within one year of starting substance use. More extensive investigations and follow up for functional impairments should be conducted. Furthermore, both clinicians and the general public should be aware of these problems and actively participate in preventing further harm to our new generation.

Acknowledgements

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