

High sensation seeking as a risk factor for metamphetamine dependence in late adolescence

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Objective : *This study is aimed to identify sensation seeking temperament and other psychosocial factors as the risk factors of metamphetamine dependence in late adolescence*

Design : *Analytical matched case-control study.*

Method : *98 metamphetamine abusers randomly recruited from 5 healthcare centers were matched with 98 normal secondary school students randomly recruited from 10 secondary schools in Bangkok by multistage sampling technique for age, sex, socioeconomic status. All subjects were assessed for their demographic information: psycho-social and substance use history, sensation seeking temperament by SSS (Sensation Seeking Scale). Seekers of high sensation were defined in both groups. Univariate analysis was performed to identify other risk factors. Linear regression analysis was also done to adjust the odd ratio for high sensation seeking and other psychosocial factors.*

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Result : *The SSS scores of metamphetamine abusers were significantly higher in Experience Seeking, Disinhibition and Boredom Susceptibility sub-scores than in the controls. The univariate analysis showed that high sensation seeking, substance use of peers, substance use of mother, substance use of sibling, substance use in community, Grade Point Average less than 2.00; all these may be risk factors for metamphetamine dependence. In multivariate analysis, high sensation seeking remained as significant risk factor in metamphetamine dependence of this population with adjusted odd ratio = 2.59 (95 % CI = 1.07-6.18). Substance uses in peer group and community, Grade Point Average < 2.00 were also demonstrated as risk factors.*

Conclusion : *High sensation seeking, influence of peer group, household environment and low academic achievement were risk factors for metamphetamine use of late adolescence .*

Keywords : *Metamphetamine, dependence, sensation, seeking.*

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- วัตถุประสงค์** : เพื่อค้นหาว่าการมีความรู้สึกแสวงหาสิ่งตื่นเต้นเร้าใจในระดับสูงและมีปัจจัยทางจิตสังคมใดบ้างที่อาจเป็นปัจจัยเสี่ยงในการติดสารเมทแอมเฟตามีนของวัยรุ่น
- รูปแบบการศึกษา** : การศึกษาเปรียบเทียบแบบจับคู่
- วิธีการ** : สุ่มเลือกผู้ป่วยติดสารเมทแอมเฟตามีนที่ไปรับการรักษาที่ศูนย์บริการสาธารณสุข 5 แห่งในเขตกรุงเทพมหานครจำนวน 98 ราย จับคู่โดยใช้เกณฑ์อายุ เพศ และระดับเศรษฐฐานะกับนักเรียนระดับมัธยมศึกษาตอนปลายจากโรงเรียนมัธยมศึกษา 10 โรงเรียน จำนวน 98 คนผู้ถูกวิจัยทุกรายได้รับการประเมินด้วยการตอบแบบสอบถามด้วยตนเองเพื่อเก็บข้อมูลส่วนบุคคล ข้อมูลด้านจิตสังคม ประวัติเรื่องสารเสพติด ความรู้สึกแสวงหาสิ่งตื่นเต้นเร้าใจเพื่อค้นหาผู้ที่มีความรู้สึกแสวงหาสิ่งตื่นเต้นเร้าใจระดับสูงและนำผลที่ได้ไปวิเคราะห์ทางสถิติเพื่อหาความสัมพันธ์และคำนวณค่าความเสี่ยงodd ratio ของตัวแปรต่าง ๆ กับสภาวะการติดสารเมทแอมเฟตามีน พร้อมทั้งวิเคราะห์ linear regression analysis เพื่อหาค่า adjusted odd ratioของปัจจัยการมีความรู้สึกตื่นเต้นเร้าใจในระดับสูงและปัจจัยทางจิตสังคมที่เกี่ยวข้อง
- ผลการศึกษา** : ผู้ติดสารเมทแอมเฟตามีนมีค่าคะแนนความรู้สึกแสวงหาสิ่งตื่นเต้นเร้าใจสูงกว่ากลุ่มควบคุม อย่างมีนัยสำคัญทางสถิติในคะแนนรวมและคะแนนย่อยในหัวข้อการแสวงหาประสบการณ์ใหม่ (Experience Seeking) การขาดความยับยั้งชั่งใจ (Disinhibition) และแนวโน้มในการเกิดความเบื่อหน่าย (Boredom Susceptibility) และยังพบว่าการมีค่าคะแนนรวมของความรู้สึกแสวงหาสิ่งตื่นเต้นเร้าใจในระดับสูง การใช้สารเสพติดของกลุ่มเพื่อนและมารดาหรือพี่น้อง การแพร่หลายของการใช้สารเสพติดในแหล่งที่พักอาศัย การมีเกรดเฉลี่ยสะสมต่ำกว่า 2.00 เป็นปัจจัยเสี่ยงที่สำคัญของการติดสารเมทแอมเฟตามีน จากการวิเคราะห์เชิงพหุคูณพบว่าการมีความรู้สึกแสวงหาสิ่งตื่นเต้นเร้าใจในระดับสูงยังคงเป็นปัจจัยเสี่ยงที่มีความสำคัญต่อการติดสารเมทแอมเฟตามีนโดยมีค่า adjusted odd ratio เท่ากับ 2.59 (95 % CI = 1.07 - 6.18) นอกจากนี้การใช้สารเสพติดในกลุ่มเพื่อนและการใช้สารเสพติดอย่างแพร่หลายในชุมชนที่พักอาศัยอยู่ การมีเกรดเฉลี่ยสะสมต่ำกว่า 2 ยังคงเป็นปัจจัยเสี่ยงที่มีความสำคัญในประชากรกลุ่มที่ศึกษา
- สรุป** : ความรู้สึกแสวงหาสิ่งตื่นเต้นเร้าใจในระดับสูง การติดสารเสพติดของกลุ่มเพื่อน การแพร่ระบาดของสารเสพติดในชุมชนที่อาศัยอยู่และการมีสัมฤทธิ์ผลทางการการศึกษาในระดับต่ำอาจเป็นปัจจัยเสี่ยงที่สำคัญของการติดสารเมทแอมเฟตามีนในกลุ่มเด็กวัยรุ่นตอนปลาย

Substance abuses and dependences, especially metamphetamine related problems, have been one of the major health problems and concerns in Thai society. It causes individual and family dysfunction. Several national policies and strategies are launched and implemented to ameliorate the situation. In 2000, the total figure of subjects registered for drug treatment throughout the country was 41,746.⁽¹⁾ The estimated cases of amphetamine abusers from National household survey done during March to October 2001 reported by the Office of Narcotics Control Board (ONCB) of Thailand was about 1 million cases who were exposed to metamphetamine during the past 12 months. 490,300 cases were reported using metamphetamine during the past 30 days and more than half of the cases, 286,300 subjects, were between 12-24 years old. One year prevalence was estimated from this survey that 2-3 hundreds thousands individuals would be cases of metamphetamine dependence.⁽²⁾ The etiology of amphetamine dependency is cited to be multifactorial. Researches have been conducted to identify all possible risk factors for effective prevention and treatment programs. Psychosocial factors have been found to play crucial roles in metamphetamine dependence.⁽³⁻⁵⁾ Biological attributions also show particular influences as the vulnerable factors interacting with pharmacological effects of metamphetamine.

Personality and temperamental variables play a salient role in substance use disorder across age, sex and culture.⁽⁶⁾ Sensation seeking was defined by Zuckerman as "the need for varies, novel and complex sensation, and the willingness to take physical and social risks for the sake of such

experience" is well characterized by Sensation Seeking Scale, a self-report questionnaire.⁽⁷⁾ Sensation seeking is postulated to be a temperamental profile, a genetic attribution, rather than character trait, which is derived from childhood rearing.⁽⁸⁾ Seekers of high sensation have strong positive affective reaction to situations of novelty and risk. They are happiest and they function best at a high tonic level of arousal; and they behave in a way that would maintain their high level of arousal.⁽⁹⁾ High sensation seeking has been found to be risk factor for several kinds of illicit drug, alcohol use or dependence and smoking.⁽¹⁰⁻¹⁴⁾ Few literatures directly documented the relation between SSS and metamphetamine related problems. The primary objective of this study was to compare the SSS between metamphetamine abusers and normal controls in Bangkok metropolitan. We hypothesized that high sensation seeking would be one of the major risk factors for metamphetamine dependence. We also controlled the possible confounding factors in our matched case-control designs. Moreover, psychosocial factors that would attribute to the risk for metamphetamine dependence were also studied in this population.

Material and method

Subjects recruited in this study were adolescents in Bangkok metropolis. We selected this specific sample population, because this age group was found to have the highest prevalence of metamphetamine-related problems in Thailand. All subjects were recruited from December 2001 to February 2002 with written informed consents. Subjects were males and females, aged between 15–18 years old with no previous psychiatric history.

Matched-pair case-control design was used to control age, sex, and incomes of family and educational level of father and mother as indicators for socioeconomic status in the population. The prevalence of high sensation seeker in our first pilot study done with 143 secondary school students in Bangkok was estimated to be 0.37 %. 25 pairs of cases and non-cases were randomly selected and obtained for the SSS score. The estimation of odd ratio for high sensation seeking in metamphetamine dependence was found to be 3.86 (95 % CI = 1.18 – 12.61). β and α values were set as 5 and 10 % . The sample size was calculated to be 95 matched pairs case-control.

The cases were 98 amphetamine abusers seeking for treatment at 5 healthcare centers in Bangkok. To avoid having subjects with amphetamine withdrawal symptoms, all cases were abstinent by negative urine screening test and they had been already on treatment program for at least 1 week prior to their enrollment. Polysubstance abusers were excluded from the study, except for cigarette smoking which was common co-morbidity.

The control group composed of students enrolled by multi-stage cluster sampling technique from 10 secondary schools in Bangkok. All control subjects were screened by Drug Abuse Screening test Thai version (DAST) to exclude possible substance use; also for previous psychiatric history by self-reported screening questionnaires for psychiatric problems. 98 students were selected and matched with 98 subjects in metamphetamine abuser group.

Instruments and measurement

Before enrollment, the screening self-report questionnaire for psychiatric disorder was used to

exclude subjects with possible pre-morbid major psychiatric disorder which included psychosis, manic episode, depression, anxiety disorder, obsessive-compulsive disorder. The questionnaire comprised of 24 force dichotomous items, which was validated and used in Bangkok psychiatric epidemiologic survey by Thavichachart N. *et al.* with good sensitivity and specificity (0.96 and 0.93, respectively).⁽¹⁵⁾

In the process of including the control group, short version of Drug Abuse Screening Test (DAST) was used to screen out the possible substance abusers. DAST was a 28-item screening instrument developed by Skinner for clinical screening and treatment evaluation research in the field of substance abuse to measure a dominant single dimension of problem related to substance use and abuse.⁽¹⁶⁾ Short version of DAST (DAST-S) was a questionnaire comprised of 10 dichotomous items that was translated and validated in clinical population. DAST-S appeared to have good reliability and validity (kappa = 0.889; sensitivity = 0.94; specificity = 0.94).

All studied subjects were asked to fill up 2 more self-reported questionnaires. Firstly, all demographic and psychosocial information were obtained by using "Psycho-social and Substance Use History Questionnaire" developed by South Suburban Council on Alcoholic, and translated into Thai by Suwannachote K.⁽¹⁷⁾ Finally, Sensation Seeking Scale (SSS) – form V French version⁽¹⁸⁾ modified by Carton *et al.* from the classical form V of Zuckerman⁽⁶⁾ was used to identify high sensation seekers. SSS-form V was 40 items, dichotomous self-rated questionnaire, which was translated into Thai and validated by 2,930 adolescents aged between 12-18 years old.⁽⁴³⁾ The Kuder Richardson (KR 20)

internal consistency appeared to show the a coefficient = 0.83 in male and 0.89 in female. Test-retest reliability was 0.78. The upper quartile of scores obtained from subjects with the age of 15-18 years old in this population was defined as "high sensation seekers" which included any subjects who got the scores higher than 20 in male and 19 in female.

The modified SSS form V Thai version includes four sub-scales:

1. Thrill and Adventure Seeking (TAS): it involves seeking sensation through physically risky activities which provide unusual situations and novel experiences.

2. Experience Seeking (ES): it involves seeking sensation through a nonconforming lifestyle, travel, music, art, drug and unconventional friends.

3. Disinhibition (Dis): it involves seeking sensation through social stimulation, parties, social drinking and a variety of sex partners.

4. Boredom Susceptibility (BS): it involves aversion to boredom produced by unchanged conditions or person.

Data collection and statistical analysis

Demographic data, psychosocial information were obtained as independent variables, including income, family profile, family relationship, rearing pattern in family, history of substance use in family, substance use of girls or boyfriends and peer groups, educational history and achievement, legal and criminal history, household environment. High/low sensation seeking statuses were also obtained as independent variables. Statistical analysis was done by computer software SPSS for Windows version 10. Chi-square test and fisher exact test were performed

to demonstrate the association of certain risk factors and amphetamine dependence. The odd ratios were also calculated for each risk factor. The risk factors defined by univariate method would be used in linear regression analysis for the final adjusted odd ratio.

Result

According to the matched case-control design, the majority of subjects included in both groups were 79.9 % male subjects with the mean age of 16.38 ± 1.02 years old. There were more Buddhist in case group than in control group. 93 cases (94.9%) and 94 control subjects (95.9 %) stayed with their families or relatives. Control subjects were found to have statistically significant higher educational level and better Grade Point Average (GPA) than in the cases ($p < 0.001$), as showed in table 1.

The psychosocial profile showed that 15.3 % of control subjects and 17.3 % of cases came from single-parent families. They seemed to have quite stable relationships in 74.5 % of cases and in 90.8 % of control subjects. There were significantly more family members with history of substance use in the cases than in the control group as showed in table 2. Cigarette smoking was the most frequent substance use in their families. Half of the siblings of metamphetamine abusers also had history of metamphetamine use. It was also found that the cases had more friends or girl/boyfriends who abused substance. They also lived in communities with more use of substance or metamphetamine than the controls. Moreover, the cases had more histories of school probation, histories of being fired from school and histories of being arrested than the normal-controls as showed in table 2.

Table 1. Demographic characteristics of subjects.

Characteristic	Case (N=98)	Control (N=98)
	n (%)	n (%)
Sex		
Male	78 (79.6)	78 (79.6)
Female	20 (20.4)	20 (20.4)
Age(years)		
15	25 (25.5)	25 (25.5)
16	25 (25.5)	25 (25.5)
17	34 (34.7)	34 (34.7)
18	14 (14.3)	14 (14.3)
Religious *		
Buddhism	95 (96.9)	88 (89.8)
Others	3 (3.1)	10 (10.2)
Education level**		
≤ Grade 10	54 (55.2)	36 (36.7)
Grade 11	19 (19.4)	23 (23.5)
Grade 12	25 (25.4)	39 (39.8)
Grade point average (G.P.A) **		
≤ 2.00	57 (58.2)	25 (25.5)
2.01-2.99	37 (37.8)	45 (45.9)
≥3.00	4 (4.0)	28 (28.6)

* p < 0.05 ** p < 0.001

Table 2. Psychosocial characteristics of subjects.

Psychosocial Characteristic	Case (N=98)	Control (N=98)
	n (%)	n (%)
Family profile		
Single parent	17 (17.3)	15 (15.3)
Stable relationship within family	73 (74.5)	89 (90.8)
Substance use of father *	64 (65.3)	50 (51.0)
Substance use of mother *	16 (16.3)	5 (5.10)
Substance use of sibling *	29 (33.0)	10 (11.9)
Girl/boy friend, Peer group		
Have any girl/boy friend	56 (57.1)	15 (15.3)
Substance use of girl/boy friend	20 (20.4)	3 (3.06)
Substance use of peer**	94 (95.9)	28 (28.6)

Table 2. Continuous.

Psychosocial Characteristic	Case (N=98)	Control (N=98)
	n (%)	n (%)
<i>Substance use in community</i> **	82 (83.67)	52 (53.10)
Metamphetamine use in community	82 (83.67)	39 (39.79)
Other psychostimulant use in community	8 (8.16)	3 (3.06)
Opiate substance use in community	13 (13.26)	5 (5.10)
Marihuana use in community	31 (31.63)	7 (7.14)
Volatile substance use in community	19 (19.39)	16 (16.33)
<i>History of penalty and criminality</i>		
Probation from school **	20 (20.4)	2 (2)
Being Fired from school**	11 (11.2)	0 (0)
Being arrested **	31 (31.6)	0 (0)

*p < 0.05 ** p< 0.01

The metamphetamine abusers also had significantly higher scores in the total sum score of SSS and 3 out of 4 subscale scores, except for Thrill and Adventure subscales as seen in table 3. 50 metamphetamine abusers compared to 22 normal controls were found to be high sensation seekers. The odd ratio was calculated to determine the related risk factors and the result was found that 6 variables, as showed in table 4, remained the risk factors

for subjects with metamphetamine dependence. We performed linear regression analysis to keep all the significant risk factors in account for metamphetamine dependence in analysis of adjusted odd ratio. The result showed that only high sensation seeker, substance use of peers, living in community with widely use of metamphetamine, Grade Point Average under 2.00 remained statistically significant as risk factors for metamphetamine dependence.

Table 3. Sensation Seeking score of cases and controls.

Sensation Seeking Scale	Case (N =98)	Control (N=98)	Paired t-test
	(mean ± SD)	(mean ± SD)	
Thrill and adventure	5.19 ± 2.46	5.56 ± 2.58	0.983
Experience seeking*	4.52 ± 1.84	3.47 ± 1.72	4.09
Disinhibition*	5.04 ± 2.13	2.65 ± 1.92	8.28
Boredom susceptibility*	4.18 ± 1.99	2.79 ± 1.59	5.7
Total score*	18.93 ± 5.52	14.47 ± 5.37	5.79

*p < 0.001

Table 4. Univariate analysis of selected risk factors for Metamphetamine Dependence.

Risk factors	Matchd Odds ratio	95% CI	McNemar's Chi-square
High sensation seeking **	3.63	1.83-7.86	16.49
Substance use of peer group**	34.00	9.06-286.43	62.23
Substance use of mother*	3.20	1.12-11.17	5.76
Substance use of sibling**	3.50	1.55-8.89	11.11
Substance use in community**	4.33	2.06-10.17	18.75
Grade point average < 2.00**	5.57	2.46-14.76	22.26

* p < 0.05, ** p < 0.001

Table 5. Multivariate linear regression analysis of selected risk factors for Metamphetamine Dependence.

Risk factors	Adjusted Odds ratio	95% CI	P-value
High sensation seeking	2.57	1.07-6.18	0.035
Substance use of peer group	51.73	15.82-169.16	<0.001
Substance use in community	4.59	1.81-11.67	0.001
Grade Point Average < 2.00	4.12	1.67-10.05	0.002

Discussion

To examine the relation of metamphetamine dependence with high sensation seeking and certain psychosocial factors in this study, we conducted matched case-control study of 98 pair of adolescents in Bangkok metropolis. The SSS scores of metamphetamine abusers were significantly higher in Experience Seeking, Disinhibition and Boredom Susceptibility sub-scores than in the controls. The univariate analysis showed that high sensation seeking, substance use of peers, substance use of mother, substance use of sibling, living in community with widely uses of substance, having Grade Point

Average less than 2.00 may be risk factors for metamphetamine dependence. By performing linear regression analysis, high sensation seeking and certain psychosocial factors still remained significant risk factors in metamphetamine dependence of this population. This finding confirmed our hypothesis that temperamental profile of high sensation seeking may be one of the vulnerable factors for metamphetamine dependence in Bangkok adolescence.

Our finding was consistent with Zuckerman's report ⁽¹⁹⁾ that found high sensation seeking significantly correlated with uses of amphetamine and 3 more illicit drugs in college students. Simon TR

et al.⁽²⁰⁾ also found this correlation in 120 high school students in California by using 11 items sensation seeking portion of Zuckerman Kuhlman Personality Questionnaire. Most documented literature that reviewed the association between high sensation seeking and substance use and several other risk behaviors, as can be found in the reports of the following authors, namely: Comeau,⁽²¹⁾ Wagner,⁽²²⁾ Zuckerman and Kuhlman,⁽²³⁾ Framques,⁽²⁴⁾ Barnea,⁽²⁵⁾ Ball,⁽²⁶⁾ Andrucci,⁽²⁷⁾ Galizio,⁽²⁸⁾ and Forthun *et al.*⁽²⁹⁾ The majority of these reports were about alcohol and marijuana, and they were done in non-clinical population. None of the above was designed to demonstrate the relation between sensation seeking and amphetamine use.

Sensation Seeking Scale (SSS) was one of the most widely used instrument to assess novelty seeking or sensation seeking. Jaffe and Archer⁽³⁰⁾ also found that Sensation Seeking Scale of Zuckerman was one of the most sensitive predictor of the pattern of drug use. Thus SSS was suitable instrument to be used in addressing individual susceptibility for drug dependence. Since SSS may be influenced by age and gender that would be essential confounders of previous studies, the period of adolescence and male gender would show tendency to have higher scores of SSS.⁽³¹⁾ By matched case-control design of the present study, it would yield more confidence in correcting methodological confounder from other studies. Our study showed that high sensation seeking was one dominant risk factor that proved our prior hypothesis, but question still remains: in which way this temperament would associate with amphetamine use? Moreover, is high sensation seeking a state marker that pre-existing before the onset of

metamphetamine use or trait marker resulting from abusing the substance?

For Zuckerman's Sensation Seeking Scale was developed under biological basis, it was found to be quite stable temperamental profile in both normal individuals and drug abusers with high retest reliability from Zuckerman's original works.⁽⁴⁴⁾ The stability was also observed in Thai adolescence that 4-week test/re-test reliability coefficients for Thai-version Sensation Seeking Scale was 0.785.⁽⁴³⁾ Thus the high sensation seeking in our population would represented the trait marker rather than the effects from uses of metamphetamine. However, this hypothesis could not be definitely conclusive by our study design. Cohort study or repeated measurement for high sensation seeking in these samples would more accurately confirm this finding.

The relationship between high sensation seeking and metamphetamine abuse/dependence is actually under investigation. Although sensation seeking had been hypothesized, according to the Optimal level of Arousal theory as reviewed by Zuckerman,⁽³²⁾ several efforts failed to demonstrate the specific preference of substances of high sensation seeker who should theoretically preferred to use CNS stimulants than CNS depressants or hallucinogens. But high sensation seeking would rather be one vulnerable trait marker that related with any kind of substance to a specific kind of drug of abuse. Recent researches also found that the high sensation seeking is genetically inherited temperament in both animal model and human subjects. There were two theoretical formulations which attempted to explain the root of drug abuse known as "exposure" and "adaptive" theories. The exposure theory presumes that merely

exposing someone to a drug is a critical risk factor and emphasizes the role of drugs as rewarding stimuli resulting in stimulation of mesolimbic dopamine-reward circuit in the brain. Adaptive theory postulated that individual differences exist prior to the first drug exposure; both of them are genetically and environmentally determined.⁽³²⁾ High sensation seekers are found to be more sensitive to the euphoric effect of amphetamine administration⁽³³⁾ and to have more certain functional defects in the mesolimbic dopamine-reward circuit. The latter phenomenon was cited as "reward deficiency syndrome"⁽³⁴⁾ that made the high sensation seekers respond robustly to all novel stimulations and substances which activate the reward center in the brain. There were also indirect supports from peripheral marker that high sensation seekers had lower level of monoamine oxidase (MAO) in blood platelets.^(35, 36)

More evidences demonstrated the role of genetics in the expression of sensation seeking. Fulker *et al.*⁽³⁷⁾ studied the character of sensation seeking in pairs of monozygotic and dizygotic adult twins and found that genetics factors were accounted for 58 % of the variances in SSS scores. The genetic was influential in determining the vulnerability to drug abuse, such as in animal model using selective breeding and standard inbred mice and rats which provided a conclusion that behavioral sensitivity to various drug of abuse is under the effects of certain genes.⁽³⁸⁾ In human studies, in particular, the genetic link to alcoholism was proved the strongest⁽³⁹⁾ and its candidate genes would relate to dopamine receptor gene, especially D2 receptor gene.⁽⁴⁰⁾

When comparing the sub-scores from the present study, our result found that amphetamine

abuser scored high in the General sum scale and all sub-scores, except for Thrill and Adventure (TA) which were consistently compatible with the original conceptual construct of Zuckerman's SSS that Experience Seeking (ES) factor seemed to involve the seeking of arousal through non-conforming lifestyle and Disinhibition (Dis) which sought release through drinking, gambling and sex.⁽⁹⁾ This may be confirmed by the report of the original work of Zuckerman⁽¹⁹⁾ that showed the highest correlation of subscale scores and drug abuse was Experience Seeking (ES) and the General sum scale. Another finding of Pederson *et al.*⁽⁴¹⁾ also showed positive correlation between Experience Seeking (ES), Disinhibition (Dis) and illicit drug abuse in Norwegian adolescence.

The peer group influences demonstrated in our study were almost similar with the study of the risk factors related to the use of amphetamines in Chinese adolescent students conducted by Ko *et al.*⁽⁴²⁾ This may correlate with the availability of amphetamine that made abusers easily exposed to the drug. Although several studies found that family influence was a major risk factor, however, we could not identify similar significant effect in the multivariate analysis. It may be due to our cases and controls were already matched for socioeconomic status which would link to other family factor or family pattern of drug abuse which was genetically determined through high sensation seeking phenomenon. By all means, the family influence on amphetamine dependence may be much more complicated and need more precise methodological design to draw a reliable conclusion.

One questionable finding in our study was that the academic achievement which was found

to have an important effect on amphetamine dependence in this population. It was probable that it causes more than the consequence of drug dependence, because we asked GPA of all amphetamine abusers prior to the first exposure of metamphetamine. The low academic achievement may be related to the intellectual ability of metamphetamine abusers and linked to their poor life skills which have not been investigated in this study. Thus low academic achievement prior to the exposure of metamphetamine may relate to other factors that have not been investigated in this study or it may result from the direct effect of temperamental profile.

Because the etiology of amphetamine dependence is much more complicated, risk factors other than high sensation seeking—which were not demonstrated here—should not be definitely excluded. The present result represented only late adolescence in Bangkok metropolis and generalization should be done with caution.

To enrich more knowledge from our study, one can find other biological marker, which would correlate with high sensation seeking trait and proceed to postulate its etiological model in explaining the relation of biological and psychosocial determinants. Furthermore, high sensation seeking may be used as a screening method to identify for high risk adolescents who would prone to abuse metamphetamine and other substance. Specifically preventive strategies may be needed for these individuals.

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