Original article

Brain doping: stimulants use and misuse among a sample of Italian college students

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Keywords

Stimulants • Doping • College students

Summary

Introduction. *The non-medical use of prescription stimulants (NMUPS) has become the subject of great interest for its diffusion among university students, who abuse these substances to cope with the increasing load of academic stress. NMUPS has been widely investigated in the U.S. due to its increasing trend; this behavior, however, has also been reported in Europe. The aim of this cross-sectional study was to examine stimulants misuse in a Northern Italian geographic area, identifying possible developments of the phenomenon in Italy.*
Methods. *To evaluate academic and extra-academic NMUPS (Methylphenidate and Amphetamines), an anonymous multiple-choice questionnaire was administrated to a sample of Bachelor's and Master's degrees students attending a University North East of Italy. Data elaboration and CI 95% were performed with Excel software 2013. Fisher's exact tests were performed using GraphPad INSTAT software.*
Results. *Data from 899 correctly completed questionnaires were analyzed in this study. 11.3% of students reported NMUPS, with an apparent greater use by students aged 18-22 years (73.5%) and without any statistically significant gender predominance. Fifty-seven point eight percent of students used stimulants at most five times in six months, and the most frequent academic and extra-academic reasons to use them were respectively to improve concentration while studying (51.0%) and sports performance (25.5%). NMUPS was higher among working students than non-working ones ($p < 0.05$), suggesting a use of stimulants to cope with stress by the first ones.*
Conclusions. *These exploratory and preliminary data suggest that NMUPS is quite relevant in Northern Italy, suggesting a need for preventive and monitoring measures, as well as future analysis via a longitudinal multicenter study.*

Introduction

Pharmacological "cognitive enhancement" (CE) is defined as the use of any psychoactive drug by healthy individuals with the purpose of enhancing cognition by improving attention, vigilance, concentration, memory or mood [1, 2]. CE is also referred to as "Pharmacological Neuroenhancement", "Cosmetic Neurology", "Academic Performance Enhancement", "Academic Doping" or even "Brain Doping" [1, 3-8].
In this study, CE and "Brain Doping" are defined as the assumption of Methylphenidate (MPH) and Amphetamines (AMPH), either detected illegally or used off-label, by healthy students to improve their academic performances [1, 2, 9, 10, 11]. According to the literature [12-14], the terms "illicit use" and "non-medical use of prescription stimulants" (respectively IUPS and NMUPS) refer to the assumption of a psychotherapeutic stimulant medication, with or without a medical prescription, in larger amounts or for a period longer than the prescribed one. These psychoactive substances, also called "smart drugs", can increase brain functions in people with ADHD, but whether they can push a neurologically healthy individual onto a higher cognitive level is not yet clear [9].
University students are a population at risk for CE drugs misuse. These drugs are used to achieve a better academic performance or personal success. However, students are not aware ore deliberately ignore the fact that drug misuse can lead to addiction.
In the various studies conducted in the American continent, the prevalence rate of NMUPS in University students ranges from 8.1% (Midwestern University, U.S.) [12] to 27.6% (Puerto Rico) [17]. The prevalence of NMUPS (Methylphenidate and Amphetamines) has been found to range from 5% to 35% in surveys among young adult and adolescent populations of North America [18] and 25.6% and 8.3% in college students respectively in an University of the North West of Pacific [19] and in a University in the Midwest [20]. Other studies in in various areas of the United States showed similar results [13, 18, 21, 22].
NMUPS ranges among European university students from 0.78% (in Germany) [23] to 6.2% (in Switzerland) [24].
The most commonly reported reasons for NMUPS were to improve concentration (65.2%), studying performances (59.8%) and alertness (47.5%) [20]. Moreover, NMUPS is more frequently associated with male gender and linked to having experience with drugs. The most

common reasons reported to use stimulants are "to learn faster" and "to finish more work in less time" [24]. Other motivations included "getting high" (31.0%) and experimentation (29.9%) [20]. Additional relatively common motivation for use is weight loss [25].

Intrapersonal risk factors associated with NMUPS are Caucasian ethnicity, poor school performance, diagnosis of ADHD, and low self-esteem; interpersonal factors are off-campus residence, various sports participation, NMUPS perception as socializing agents. In addition, exposure to advertisements related to prescription drugs, knowledge of prescribed stimulants, and positive attitudes towards prescribed stimulants are environmental risk factors [19]. High levels of stress are also significantly correlated to high NMUPS as a strategy to cope with stress [17].

Adverse health effects associated to use or abuse of MPH are related to the cardiovascular system (*e.g.* angina, tachycardia, arrhythmia), the central nervous system (*e.g.* aggressiveness, agitation, confusion, headache, tremors and mood swings) and the gastrointestinal system (abdominal pain, loss of appetite, anorexia and nausea) [26]. Toxic manifestations of MPH are hyperthermia, euphoria, delirium, hallucinations and seizures [27]. It is interesting to note that in MPH-naive subjects, a toxic dose may be very close to the therapeutic dose when compared to patients undergoing long-term treatment [26]. Consumption of drugs containing amphetamines can cause similar side effects such as hyperactivity, hyperthermia, tachycardia, tachypnea, mydriasis, tremors and seizures [28].

Given that stimulant use among students in foreign countries is an established factor, we conducted a cross-sectional study to evaluate the phenomenon among students of a University North East of Italy and its correlation with academic stress.

In particular, the aim of this preliminary and exploratory study was to investigate the frequency of and the reasons for stimulants use and their effects on health.

Methods

This cross-sectional study was conducted during the 2014-2015 academic year and involved students from Bachelor's (three years of course) and Master's (six years of course) degrees of a University North East of Italy.

Bachelor's degrees sampled were Biomedical Laboratory Techniques, Cardiovascular Perfusion Techniques, Dental Hygiene, Imaging and Radiotherapy Techniques, Midwifery, Nursing, Physiotherapy, Psychiatric Rehabilitation Techniques, Speech and Language Therapy, while Master's degrees sampled were Medicine and Dentistry.

Data were collected through an anonymous multiple-choice questionnaire administrated to students attending the first and the third year of Bachelor's and Master's degrees as well as the fifth year of Master's degrees. Third year Physiotherapy, Dental Hygiene and Psychiatric Rehabilitation Techniques students were not sampled because during the period of our study their degree courses did not take place.

The validated questionnaire assessed information about personal socio-demographic characteristics such as age, sex, course degree, occupation (working student vs. non-working/unemployed student), nationality, Italian area of residence (Northern, Central-Southern).

Moreover, this survey investigated characteristics of the students' parents, such as current age, educational level (primary school, secondary school, high school, university) and occupation (self-employed, employee, unemployed, retiree, other). In order to detect the family's level of education, the highest educational level achieved by at least one parent was considered. Levels of education achieved were defined as "Low" for primary or secondary school or "High" for high school or university.

The final questions in the survey asked for information regarding the students' university track and their use of stimulants (Methylphenidate and Amphetamines).

Information on stimulant use was collected in the form of frequency of use (never, 1-5, 6-15, ≥ 16 times) within the 6 months prior to administration of the survey.

Psychophysical state post-use (condition unchanged, fatigue, satisfaction, guilt, depression, other) and side effects of stimulants (no side effects, insomnia, stomach pain, development of tics, loss of appetite, headache, else) were also investigated.

Some of the analysed reasons of stimulants use were related to academic field, such as improving in-classroom concentration, concentration while studying, exam performance, mental stamina for studying, self-confidence while studying, better grades than peers and better grades overall.

A positive response for at least one of the above reasons constituted an indicator of stimulants use to enhance cognitive performance (CE).

Extra-academics reasons were investigated as well: losing weight, improving social skills, driving, sports and working performances.

Finally, we added questions concerning whether stimulant were consumed alone or in combination with alcohol, illegal substances, or other medical drugs.

The data from this study were collected and processed in compliance with the national law on privacy (Law N. 196/2003).

All students were over 18 years old (legal age in Italy) and they were assured of the confidentiality of their responses. They were adequately informed about the survey and their participation only takes place if voluntary. To ensure a high response rate, the survey was brief, easy to complete (requiring less than 15 minutes) and administered at the beginning of a lecture. All questionnaires were immediately collected and their information was entered in a database.

Statistical and data analysis

The elaboration of results, the Confidence Interval (95%) of stimulants users, and the multiple logistic regression were calculated using Excel software 2013 and STATA 13.

Statistical analyses were carried out using Fisher's exact test or Chi-squared test with Yates correction, using GraphPad INSTAT software with significance of p <0.05.

Bonferroni's correction was implemented for the Chi-squared with Yates, and Fisher's exact test performed to compare the trends of stimulants use in the various years of the different degree courses to improve concentration while studying and practicing sports.

A multiple logistic regression was performed to evaluate the following variables as possible predictors of stimulants use by students: male gender, being a Bachelor's degree student, age, being a working student, coming from the North of Italy and parents' high educational level.

The prevalence rates of the socio-demographic and academic features in the different groups examined were calculated differently (non-recalculated prevalence rates, prevalence rates calculated on the total sample and prevalence rates calculated on stimulants users) as reported in text and tables.

Results

A total of 1107 questionnaires were administered and the response rate was 89.4%. Of the 990 questionnaires completed, 899 were properly compiled and analyzed.

Table 1 describes the distribution of the enrolled subjects in the study, evaluating the total sample and subgroups of working (21.9 %) and non-working (75.4%) students in relation to stimulant use, gender, age classes, residence and university track attended. Only 2.0 % of stimulants users did not report their employment status. Our survey showed that 11.3% (102/899; CI 95% 9.3%-13.6%) of all students consumed stimulants. Among them 2.3% and 9.0% used stimulants with and without a medical prescription respectively, showing that a large majority or users (79.4%) used stimulants without medical prescription.

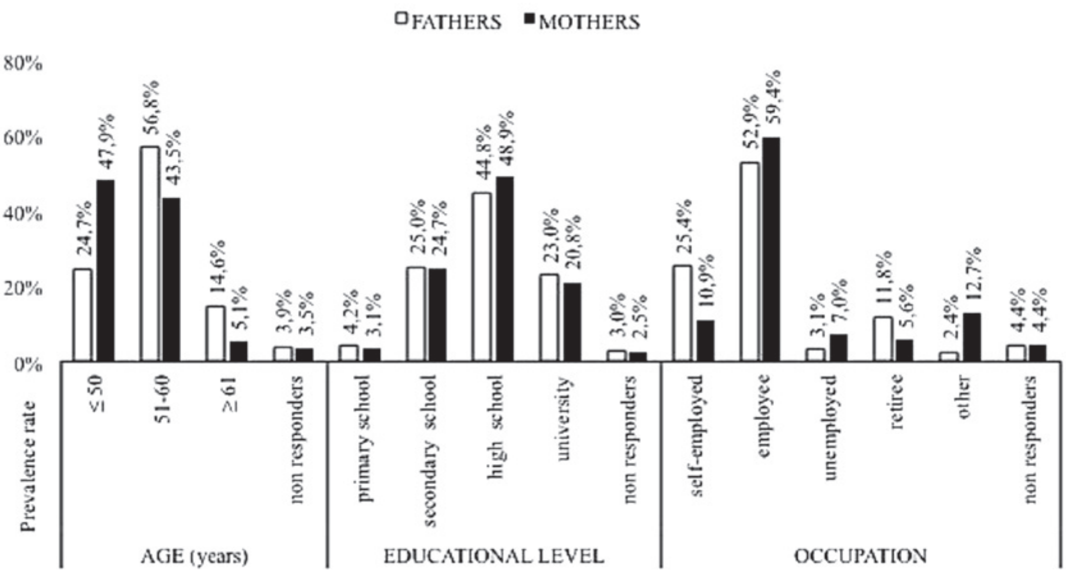
Tab. I. Socio-demographic features and description of stimulants users of the total sample and of its subpopulations (working and non-working students. (Prevalence rate).

	Total sample		Non working students			Working students		
Variables	Pop. (N = 899)	Stimulants users (N = 102)	Pop. (N = 678)	Stimulants users (N = 69)**		Pop. (N = 197)	Stimulants users (N = 31)**	
	A (%)	B (%)	B (%)	B (%)	C (%)	B (%)	B (%)	C (%)
Gender								
Female	68.9 (619/899)	11.0 (68/619)	75.4 (467/619)	6.8 (42/619)	61.8 (42/68)	22.1 (137/619)	3.9 (24/619)	35.3 (24/68)
Male	30.3 (272/899)	11.8 (32/272)	76.5 (208/272)	9.2 (25/272)	78.1 (25/32)	22.1 (60/272)	2.6 (7/272)	21.9 (7/32)
Non responders	0.9 (8/899)	25.0 (2/8)	37.5 (3/8)	25.0 (2/8)	100.0 (2/2)	0.0 (0/8)	0.0 (0/8)	0.0 (0/2)
Age (years)*								
18-22	74.9 (673/899)	73.5 (75/102)	78.0 (529/678)	73.9 (51/69)	73.9 (51/69)	66.0 (130/197)	71.0 (22/31)	71.0 (22/31)
23-27	17.7 (159/899)	21.6 (22/102)	16.1 (109/678)	23.2 (16/69)	23.2 (16/69)	23.9 (47/197)	19.4 (6/31)	19.4 (6 /31)
≥ 28	4.8 (43/899)	2.0 (2/102)	3.8 (26/678)	0.0 (0/69)	0.0 (0/69)	8.1 (16/197)	6.5 (2/31)	6.5 (2/31)
Non responders	2.7 (24/899)	2.9 (3/102)	2.1 (14/678)	2.9 (2/69)	2.9 (2/69)	2.0 (4/197)	3.2 (1/31)	3.2 (1/31)
Residence								
North	84.4 (759/899)	11.9 (90/759)	75.9 (576/759)	8.3 (63/759)	70.0 (63/90)	22.9^ (174/759)	3.4 (26/759)	28.9 (26/90)
Central-South	10.5 (94/899)	4.3 (4/94)	83.0^ (78/94)	4.3 (4/94)	100.0 (4/4)	12.8 (12/94)	0.0 (0/94)	0.0 (0/4)
Non responders	5.1 (46/899)	17.4 (8/46)	52.2 (24/46)	4.3 (2/46)	25.0 (2/8)	23.9 (11/46)	10.9 (5/46)	62.5 (5/8)
Courses								
Medicine	23.4 (210/899)	6.7 (14/210)	83.8 (176/210)	5.7 (12/210)	85.7 (12/14)	15.7 (33/210)	6.1 (2/33)	14.3 (2/14)
Dentistry	5.9 (53/899)	7.5 (4/53)	81.1 (43/53)	3.8 (2/53)	50.0 (2/4)	13.2 (7/53)	14.3 (1/7)	25.0 (1/4)
Nursing	47.3 (425/899)	14.8 (63/425)	70.8 (301/425)	9.2 (39/425)	61.9 (39/63)	24.9 (106/425)	5.4 (23/425)	36.5 (23/ 63)
B.L.T.	5.2 (47/899)	19.1 (9/47)	85.1 (40/47)	17.0 (8/47)	88.9 (8/9)	14.9 (7/47)	2.1 (1/47)	11.1 (1/9)
S.L.T.	4.2 (38/899)	2.6 (1/38)	73.7 (28/38)	2.6 (1/38)	100.0 (1/1)	23.7 (9/38)	0.0 (0/38)	0.0 (0/1)
Midwifery	4.2 (38/899)	2.6 (1/38)	78.9 (30/38)	0.0 (0/38)	0.0 (0/1)	21.1 (8/38)	2.6 (1/38)	100.0 (1/1)
I.R.T.	3.8 (34/899)	5.9 2/34)	67.6 (23/34)	5.9 (2/34)	100.0 (2/2)	32.4 (11/34)	0.0 (0/34)	0.0 (0 /2)
Physiotherapy	3.0 (27/899)	14.8 (4/27)	63.0 (17/27)	7.4 (2/27)	50.0 (2/4)	37.0 (10/27)	7.4 (2/27)	50.0 (2/4)
C.P.T.	1.3 (12/899)	8.3 (1/12)	100.0 (12/12)	8.3 (1/12)	100.0 (1/1)	0.0 (0/12)	0.0 (0/12)	0.0 (0/1)
Dental Hygiene	1.1 (10/899)	20.0 (2/10)	60.0 (6/10)	20.0 (2/10)	100.0 (2/2)	30.0 (3/10)	0.0 (0/10)	0.0 (0/2)
P.R.T.	0.6 (5/899)	20.0 (1/5)	40.0 (2/5)	0.0 (0/5)	0.0 (0/1)	60.0 (3/5)	20.0 (1/5)	100.0 (1/1)

* In every column age is reported as non-recalculated prevalence rate; POP. = population **,^ p < 0,05 (Chi-square with Yates' correction)
A= Non recalculated prevalence rate; B = Prevalence rate calculated on total sample; C = Prevalence rate calculated on stimulants users population
B.L.T.= Biomedical Laboratory Techniques; S.L.T.=Speech and Language Therapy; I.R.T.= Imaging and Radiotherapy Techniques;
C.P.T.= Cardiovascular Perfusion Techniques; P.R.T.=Psychiatric Rehabilitation Techniques

Working and non-working groups were homogeneous for gender composition (p > 0.05, Chi-squared with Yates' correction = 0.9936).
Stimulant users appeared to be homogeneous in terms gender composition (11.0% women and 11.8% men, p > 0.05, Chi-squared with Yates correction = 0.8227). Most of them were aged between 18 and 22 (73.5%), both in non-working students group (78.0%) and in working students (66.0%) group, and came from Northern Italy (11.9%).
Among working and non-working students the prevalence rate of stimulant use was respectively of 15.7% (31/197) and of 10.2% (69/678).
30.4% (31/102) of stimulants users were working students. Among all working students the prevalence rate of stimulants use was 15.7% (31/197).
67.6% (69/102) of stimulants users in our sample were non-working students and among all non-working students of the sample, the prevalence rate of stimulants use was 10.2% (69/678).
The comparison among stimulants users between working (15.7%) and non-working (10.2%) students showed a statistically significant difference (p < 0.05, Chi-squared with Yates correction).
The highest consumptions of stimulants were detected in younger students. At 19 years old: 25.5% in Bachelor's degrees *vs.* 3.9% in Master's degrees; at 20 years old: 15.7% in Bachelor's degrees *vs.* 2.0% in Master's degrees; at 21 years old: 13.7% in Bachelor's degrees *vs.* 4.9% in Master's degrees.
The lowest consumptions were detected at 27 years, 28 years and 39 years old, when the stimulants users were 1.0% in Bachelor's degrees and 0.0% in Master's degrees. This trend of reduction in stimulants use related to increasing age is not statistically significant when evaluated among students of 18-23 years and those aged ≥ 24 years (p > 0.05, Chi-squared with Yates' correction = 0.9031).
The majority of non-working students came from Central-Southern Italy (83.0%), while working students came principally from Northern Italy (22.9%), showing a statistically significant difference (p < 0.05, Chi-squared with Yates' correction).
The highest prevalence of students consuming stimulants was found in Dentistry (7.5%) among Master degree courses and in Dental Hygiene (20.0%) and Psychiatric Rehabilitation Techniques (20.0%) among Bachelor's degree courses.
Among non-working students the higher prevalence of stimulant users was found in Medicine (83.8%), Cardiovascular Perfusion Techniques (100.0%) and Psychiatric Rehabilitation Techniques (60.0%), and among working students was found in Psychiatric Rehabilitation Techniques (60.0%), Physiotherapy (37.0%), Imaging and Radiotherapy Techniques (32.4%) and Nursing (24.9%).
In each age group considered, the use of stimulants was significantly higher among students of Bachelor's degrees than in those of Master's degrees (p < 0.05, Chi-squared with Yates' correction).
On the total sample (N = 899), the prevalence rates of stimulants use to enhance cognitive performance with and without medical prescription were 1.9% *vs.* 6.2% respectively (p > 0.05, Fisher's exact test = 0.4167), while the prevalence rates of stimulants use for extra academic reasons with and without medical prescription were 0.8% and 4.6% (p > 0.05, Chi-squared with Yates' correction = 0.2425).
2% of total sample had used stimulants, for medical or personal reasons, only before the six months surveyed by our study.
The socio-demographic features of the 1798 students' parents are shown in Figure 1. Not every student who completed the questionnaire reported information on

Fig. 1. Socio-demographic characteristics of sample's parents. (Prevalence rate).



Tab. II. Stimulants use by associations, reasons (academic and extra-academic), psychophysical state, side effects and predictors of use. (Prevalence rate).

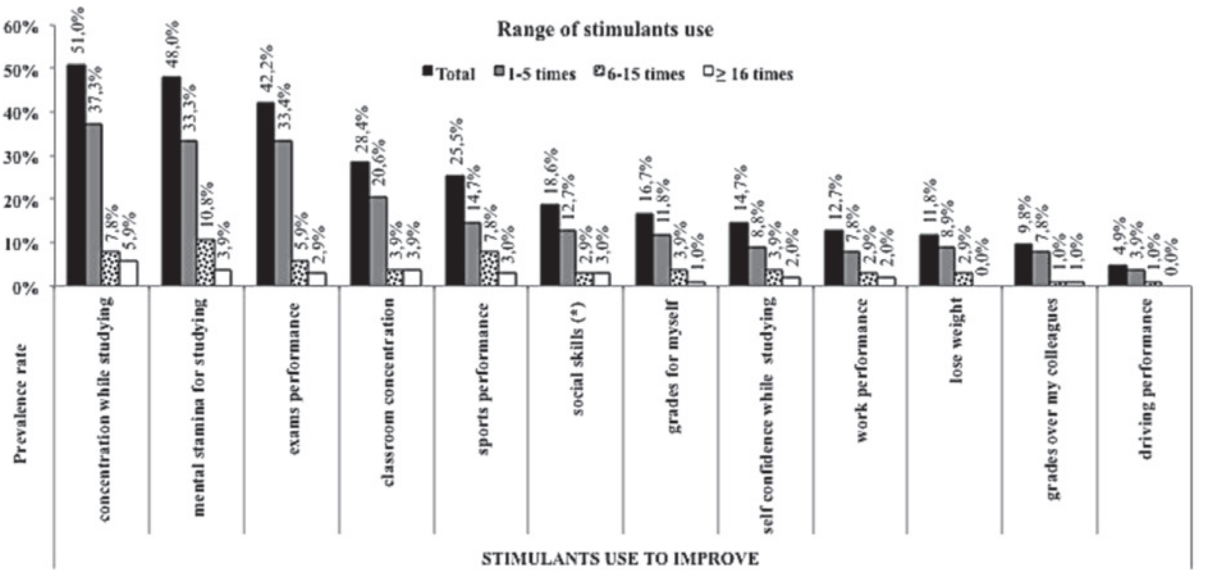
Variables	Prevalence rate
Associations	
No (stimulants alone)	51.0% (52/102)
Alcohol	12.7% (13/102)
Other medical drugs	5.9% (6/102)
Other drugs	2.9% (3/102)
Non responders	27.5% (28/102)
Academic reasons for use	
To improve concentration while studying	51.0% (52/102)
To improve mental stamina for studying	48.0% (49/102)
To improve exams performance	42.2% (43/102)
To improve classroom concentration	28.4% (29/102)
To get better grades for themselves	16.7% (17/102)
To improve self-confidence while studying	14.7% (15/102)
To get higher grades than peers	9.8% (10/102)
Extra-academic reasons for use	
To improve sports performance	25.5% (26/102)
To improve social skills (*)	18.6% (19/102)
To improve work performance	12.7% (13/102)
To lose weight	11.8% (12/102)
To improve driving performance	4.9% (5/102)
Psychophysical state post-use	
Condition unchanged	39.2% (40/102)
Fatigue	12.7% (13/102)
Satisfaction	6.9% (7/102)
Other	2.9% (3/102)
Guilt	2.0% (2/102)
Depression	1.0% (1/102)
Non responders	35.3% (36/102)
Side effects	
No side effects	55.9% (57/102)
Insomnia	6.9% (7/102)
Stomach pain	5.9% (6/102)
Else	2.0% (2/102)
Development of tics	2.0% (2/102)
Loss of appetite	2.0% (2/102)
Headache	1.0% (1/102)
Non responders	24.5% (25/102)

Model for stimulant's use predictors (Pseudo R2 = 0.0399, p < 0.05)	Odds ratio (95% CI)
Male gender	1.3 (0.8-2.1), p = 0.336
Being a Bachalor's Degree student	2.4 (1.3-4.4), p = 0.004
Student's age	0.9 (0.9-1.0), p = 0.124
Being a working student	1.3 (0.8-2.2), p = 0.273
Coming from the Northern of Italy	3.1 (1.1-9.0), p = 0.034
Parents' high educational level	0.6 (0.3-1.0) p = 0.059
* To improve alcohol or other substances effects, helping to socialize.	

both parents. The majority of them (50.2%) resulted in age class 51-60 years with a higher prevalence of high school level (46.9%) and of employment (74.3%). A statistically significant association between a low education level of family and stimulants use by students was found ($p < 0.05$, Chi-squared with Yates' correction).

Tab. II shows prevalence rates of stimulants use or misuse (alone or combined with other substances), academic and non-academic reasons for use, psychophysical state post-use and stimulants side effects referred among stimulants users (N = 102).

Fig. 2. Reasons for stimulants use (in academic and extra-academic fields) among stimulants users (N=102) by range of use. (Prevalence rate).



The frequency rates of use in the previous six months were: 7.8% 1 to 5 times, 2.9% 6 to 15 times, 2.0% ≥ 16 times.

The combination of stimulants and alcohol (12.7%) was the most common. However, the majority of respondents (51.0%) used stimulants alone.

Only a minority of subjects used stimulants combined with "medical drugs" (5.9%) with a frequency rate of 1 to 5 times (4.9%) and ≥ 16 times (1.0%), or with "other drugs" (2.9%, all of them with a frequency rate of 6 to 15 times).

Among stimulants users, stimulants consumption for at least one academic reason (72.5% = 74/102) was higher than the one for at least one extra-academic motive (47.1% = 48/102).

The questionnaire showed that 29.4% of consumers had at least one health consequence resulting from stimulants use, such as depression, loss of appetite, headaches, nervous tics development, fatigue, stomach pain, insomnia, and other not specified symptoms.

Table II includes the variables tested as predictors for stimulants use: male gender, being a Bachelor's degree student, age, being a working student, being from the North of Italy and parents' high educational level. According to multiple logistic regression, only the variables of being a Bachelor's degree student (OR 2.4, $p < 0.05$) and coming from Northern Italy (O.R 3.1, $p < 0.05$) were significantly positively associated to stimulants use.

Figure 2 shows the frequency rates of reasons for stimulant use (in academic and extra-academic fields) in the six months preceding this survey. The 57.8% of students used stimulants at most 5 times in 6 months and, among them, the most frequent reason for stimulant use was to improve concentration while studying (47.5%) and the less frequent one was to improve driving performance (1.7%), reflecting results detected among all stimulants users (considering all the frequencies of use). For each reason of stimulant use (academic and non-academic) the most recurrent frequency rate of use during the six previous months was 1 to 5 times.

The most common academic reason for stimulants use was "to obtain an extra improve concentration while studying" (51.0%), while the most non-academic reason was "to improve sports performance" (25.5%).

Table III shows the socio-demographic characteristics of stimulants users who reported the higher assumption respectively for academic and non-academic reasons (to improve concentration while studying and to improve sports performance).

Both among stimulant users to improve studying concentration and sport performances, a higher prevalence rate was found in younger age class, residence in North of Italy, and in Medicine, Dentistry, Nursing, Biomedical Laboratory Techniques, Physiotherapy and Dental Hygiene.

Females showed a higher prevalence rate for studying motivation (6.1% for females *vs*. 4.8% for males, $p > 0.05$, Chi-squared with Yates' correction = 0.571), while males mostly reported consumption to obtain better results in sports (4.0% for males *vs*. 2.4% for females, $p > 0.05$, Chi-squared with Yates' correction = 0.268).

Figure 3 shows the stimulants consumer trends in the various years of the different degree courses in order to increase the concentration in the study and to improve sports performance. The prevalence rates are obtained from the total sample (N = 899).

Stimulants use to improve concentration while studying:

- Among Medicine students, the stimulants use increased from the first academic year (2.9%) to the third (6.5%), and then decreased during the fifth year

Tab. III. Socio-demographic characteristics of stimulants users to improve concentration while studying (N=52) and sports performance (N = 26). (Prevalence rate).

Variables	Stimulants users to improve concentration while studying (N = 52)		Stimulants users to improve sports performance (N = 26)	
	A (%)	B (%)	A (%)	B (%)
Gender				
Female	6.1 (38/619)	55.9 (38/68)	2.4 (15/619)	22.1 (15/68)
Male	4.8 (13/272)	40.6 (13/32)	4.0 (11/272)	34.4 (11/32)
Non responders	12.5 (1/8)	50.0 (1/2)	0.0 (0/8)	0.0 (0/2)
Age (years)*				
18-22	71.2 (37/52)	71.2 (37/52)	73.1 (19/26)	73.1 (19/26)
23-27	21.2 (11/52)	21.2 (11/52)	23.1 (6/26)	23.1 (6/26)
≥ 28	1.9 (1/52)	1.9 (1/52)	3.8 (1/26)	3.8 (1/26)
Non responders	5.8 (3/52)	5.8 (3/52)	0.0 (0/26)	0.0 (0/26)
Residence				
North	6.1 (46/759)	51.1 (46/90)	3.2 (24/759)	26.7 (24/90)
Central-South	1.1 (1/94)	25.0 (1/4)	1.1 (1/94)	25.0 (1/4)
Non responders	10.9 (5/46)	62.5 (5/8)	2.2 (1/46)	12.5 (1/8)
Courses				
Medicine	3.3 (7/210)	50.0 (7/14)	2.4 (5/210)	35.7 (5/14)
Dentistry	5.7 (3/53)	75.0 (3/4)	1.9 (1/53)	25.0 (1/4)
Nursing	8.0 (34/425)	54.0 (34/63)	3.5 (15/425)	23.8 (15/63)
Biomedical Laboratory Techniques	10.6 (5/47)	55.6 (5/9)	4.3 (2/47)	22.2 (2/9)
Speech and Language Therapy	0.0 (0/38)	0.0 (0/1)	0.0 (0/38)	0.0 (0/1)
Midwifery	0.0 (0/38)	0.0 (0/1)	0.0 (0/38)	0.0 (0/1)
Imaging and Radiotherapy Techniques	0.0 (0/34)	0.0 (0 /2)	0.0 (0/34)	0.0 (0/2)
Physiotherapy	7.4 (2/27)	50.0 (2/4)	7.4 (2/27)	50.0 (2/4)
Cardiovascular Perfusion Techniques	0.0 (0/12)	0.0 (0/1)	0.0 (0/12)	0.0 (0/1)
Dental Hygiene	10.0 (1/10)	50.0 (1/2)	10.0 (1/10)	50.0 (1/2)
Psychiatric Rehabilitation Techniques	0.0 (0/5)	0.0 (0/1)	0.0 (0/5)	0.0 (0/1)

* In every column age is reported as non-recalculated prevalence rate
A= Prevalence rate calculated on total sample
B = Prevalence rate calculated on stimulants users population

(1.7%), although the differences between the various years were not statistically significant ($p > 0.05$, Fisher's exact test).

- Among Dentistry students, the stimulants use decreased from the first (4.0%) to the third year (0.0%) and then increased up to the fifth (16.7%), without a statistically significant difference across years ($p > 0.05$, Fisher's exact test).
- Among Bachelor's degree students the stimulant appears to be higher during the first year for Dental hygiene (10.0%), Physiotherapy (7.4%) and Nursing (9.7%), whereas for Biomedical Laboratory Techniques a rise in use is found during the third year (15.4%) without a significant difference from the first year (4.8%) of this degree course. There were no statistically significant differences between the various courses ($p > 0.05$, Fisher's exact test), except between the first (9.7%) and the third (6.4%) year of Nursing ($p < 0.05$).

Stimulants use to improve sports performance:

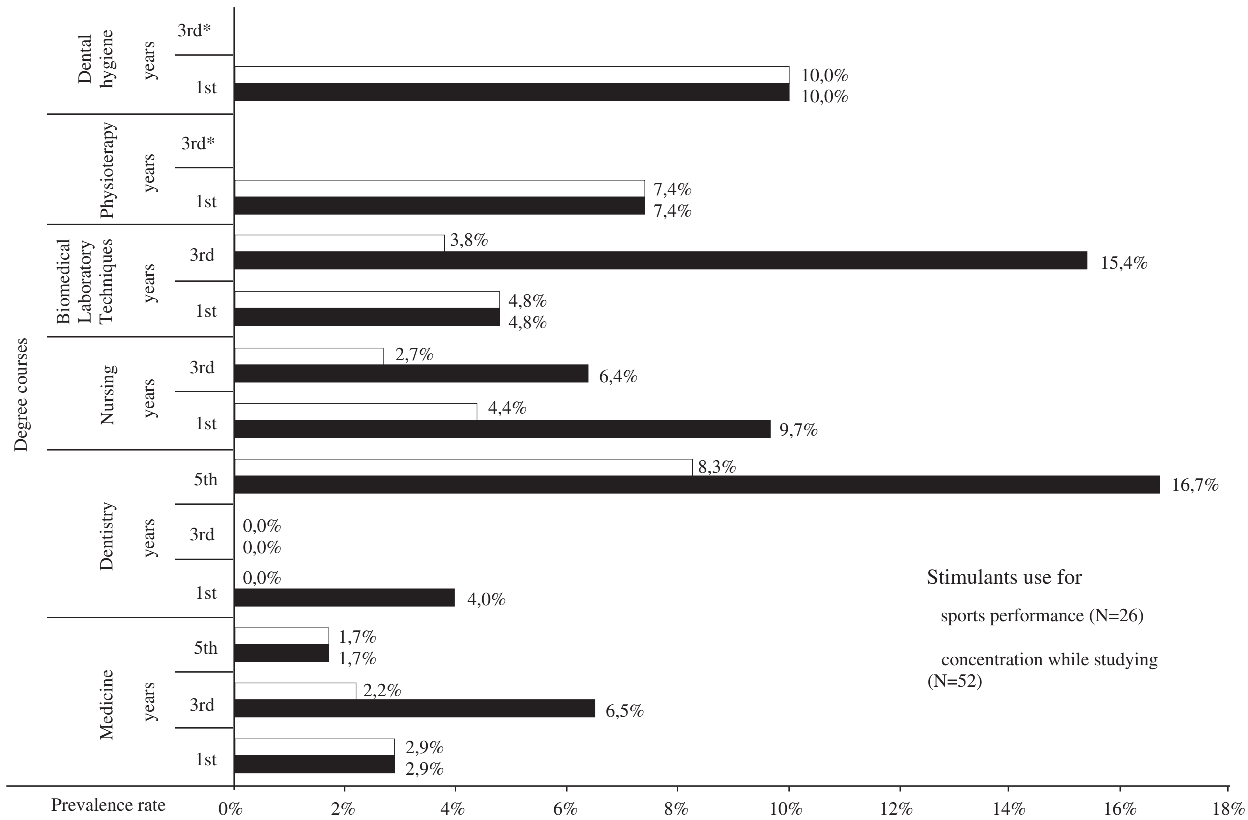
- Among students of Master's degree courses, from the first to the fifth year it was observed a decreasing trend in Medicine students and an increasing trend in Dentistry students, without a statistically significant difference across years ($p > 0.05$, Fisher's exact test).
- Among Bachelor degree students' stimulants use is greater during or even limited to their first academic year.

Overall, the difference in prevalence rates of stimulants use during each year of each degree course considered never showed a significant difference ($p>0.05$, Fisher's exact test and Chi-squared with Yates correction, with Bonferroni's correction).

Discussion

To our knowledge, this is the first report that has attempted to point out the prevalence rate of stimulants use among university students in the North-East of Italy. This cross-sectional study shows that a non-negligible portion (11.3%) of 899 sampled university students used stimulants – currently and/or in the past six months – and that a smaller proportion (2.0%) of the total sample had used stimulants in their lifetime (exclusively before the surveyed period).

Fig. 3. Prevalence rate of stimulants use for boosting concentration while studying and sports performance by year of degree courses.



* These years of courses were not surveyed; ** p < 0,05 (Fisher's exact test)

Teter *et al*. conducted a survey on 4580 college students and they found a prevalence rate of 5.9% for illicit use of prescription stimulants in the year before their survey [20].

The population of stimulant users of our survey was homogeneous for gender composition and the majority (73.5%) was aged between 18 and 22, not confirming the trends of a larger consumption of stimulants among males [13, 29-31] and older subjects [32-34] found in other studies. A statistically significant difference in stimulants use among students of 18-23 years old and older ones was not found.

We were able to detect a significant correlation between lower family educational level and stimulants use with Fisher's exact test; according to the multiple logistic regression, however, the family educational level was not significant as a predictor of stimulants use. Another European study [35] suggests an association between higher educational family level and the consumption of some type of drugs (alcohol, tobacco, cannabis) but not with prescription stimulants.

With regard to extra-academic benefits on NMUPS, the most frequent reason for stimulants use was to improve sports performance (25.5%). The second one was "to improve alcohol or other substances effects in helping to socialize" (18.6%) and, among all possible associations, the most common one was with alcohol (12.7%). Moreover, we found a prevalence rate of stimulants use to lose weight (11.8%) comparable to one detected in a study among US university students (11.1%) [19]. The use of stimulant drugs for dieting is reportedly also increasing in Asia [36].

These data are worthy of attention, suggesting an association between stimulants use and other harmful behaviors, such as alcohol abuse [37] and self-induced vomiting, use of laxatives, diuretics, and other pills for weight loss [25].

With regard to academic reasons for stimulants use, it is interesting to compare our results to those of an American study [19], which detected a prevalence of NMUPS of 25.6% during college and found that 26.4% of students engaging in NMUPS had a prescription for the drug. According to this data, NMUPS might be taking place among stimulants users with a medical prescription (2.3%), although it was not clearly declared. Moreover, the top four reasons for NMUPS detected in the US survey [19] were academic-related (to improve focus, to improve concentration, to stay awake and to make studying more enjoyable), resembling our identified primary reasons to improve concentration in studying (51.0%), mental stamina for studying (48.0%), exams performance (42.2%) and classroom concentration (28.4%).

Overall, we detected a prevalence of NUMPS for CE of 6.2%, which is greater than the one found by a study on 512 German university students (0.78%) [23] and comparable to two other surveys conducted on university students in Switzerland (6.2%) [24] and in Germany (5%) [28].
In New Zealand, the prevalence of use of NUMPS for CE in a population of university students is comparable to our results (6.6%) [38].
Our findings agree with the NMUPS for CE revealed by recent similar European studies [24, 33] and confirm that prevalence rates of stimulants use to practice CE are higher among American university students than European ones [1, 19, 23, 24, 33]. Easier access to stimulants, such as by using friends as a source or by simulating ADHD symptoms to obtain a false diagnosis [19, 39, 40], and an increasingly competitive and high pressure environment in the U.S. with fewer job opportunities after graduation [41] could explain the higher NMUPS among American students than European ones.
The use of a stimulant such as MPH, however, which has been available in the European Union (EU) since the 1950s, has markedly increased in Europe over the past decade [42], probably as a consequence of the modifications of the European lifestyle, with an increased load of stress and economic difficulties. We therefore cannot exclude that in the future the prevalence rates of stimulants use among European students will be comparable to those of American ones.
We found a statistically significant difference between stimulants use and being a working *vs.* a non-working student, probably due to the higher load of stress experienced by those who both work and study. Stress was in fact often associated with consumption of stimulants [17, 39-41] among medicine students [39], and several studies have suggested that NMUPS can be a strategy to cope with stress [17] and to try to reduce the negative effects of stress-related affective disorders [40, 41].
After calculating a multiple logistic regression, however, the variable of "being a working student" was not a significant predictor for stimulants use. Very serious side effects related to stimulant use have been reported in the literature [26], and in our survey almost one third (29.4%) of consumers had relatively serious health consequences. Side effects are important not only for acute and long-term health consequences, but also for their economic and social burden. Indeed, rising trends in emergency department admissions involving non-medical use of stimulants and adverse reactions to stimulants highlight the growing impact of NMUPS on public health and, in particular, on the health of young adults both males and females [43].
In the literature, suicidal ideation is described as a possible consequence of consumption of medications for ADHD in young populations [44, 45]; other potential side effects on the cardiovascular system or nervous system have been linked to use of stimulants [28].
Stimulant use is also related to important long-term problems such as dependence and cognitive dysfunction. An abrupt cessation after periods of regular use leads to psychiatric withdrawal symptoms, including depression, anxiety and cravings [46]. Pharmacotherapies aimed at treating addiction to stimulants are at in the early stages of development and testing [46], and together with psychotherapy they might lead to an increasing therapeutic success, improving the healthcare system. Furthermore, ADHD patients and relative prescriptions among school-aged students have continuously increased [47, 48] in the past few years, due to the improved ability of ADHD diagnosis [48]. However the possibility of over diagnosis or of misdiagnosis, implying the prescription of unnecessary medication or the absence of adequate ones, could lead to an increase in the need of medical services. This could cause an increase in social costs.
An important strength of this study is the large number of participants surveyed.
The present study shows some particularities in the population sampled: there were more women than men, reflecting the greater female presence in the Italian medical universities, and most of the surveyed people, because of the university location, came from the North of Italy. The results may therefore not be generalizable to university students in the rest of Italy. Moreover, collecting data at a single point in time through a longitudinal study would be a better design to support the study findings. For these reasons, it could be interesting to deepen the problem with further investigations, and future researches should examine stimulants use in a larger sample with a multicenter study.
Our study shows that abuse of stimulants in our geographic area is of some importance, and the higher consumption of stimulants among students from other countries might suggest a future increase in our country.
For these reasons, an educational health program should be planned and implemented to prevent stimulant abuse throughout the country and across all ages. Informing people by educating them as early as while they are attending elementary school (and by involving the children's parents) through the local health services would raise awareness about the phenomenon and would hopefully reverse it.

Conclusions

Stimulants use was relatively prevalent in this population (11.3%), with an apparent greater use by students aged 18-22 years (73.5%) and without any gender predominance. 57.8% of stimulants users consumed stimulants five times in six months at most, and 47.5% of them justified such use in order to improve concentration while studying.

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The authors declare no competing interest.

Authors' contributions

SM: design, organization and supervision of the study. Drafting of the text. DG: data analysis, participation in the drafting of the article, statistical analysis. SP: data analysis, participation in the drafting of the article, statistical analysis. JP: data analysis, participation in the drafting of the article. AS: preparation and validation of the questionnaire, distribution of the questionnaire, data collection and data entry in the database. SF: preparation and validation of the questionnaire, distribution of the questionnaire, data collection and data entry in the database. EC: preparation and validation of the questionnaire.

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