Research Square

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A study on ‘energy boosting’ substance/nootropics consumption by medical trainees during examinations in India.

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Abstract

Background:

Examinations represent a stressful period among medical trainees, during which 'energy boosting' substances and nootropics may be used for neuroenhancement. Prior literature has examined these categories separately; this study evaluated both in conjunction due to overlapping usage during examinations.

Methods*:*

A cross-sectional survey was conducted throughone-on-one interviews using a piloted digital questionnaire with informed consent and confidentiality ensured. Data from 245 medical trainees, aged 18–30 years were analyzed using MedCalc and R. Neuroenhancing substance use was assessed based on intent : concentration enhancement and/or wakefulness.

Findings*:*

Most respondents (79.1%, n=245) felt examinations contributed to substance use habits. Considering intent at point of use, the most consumed neuroenhancing substances were coffee (79.18% for wakefulness, 65.71% for concentration), tea (42.04%, 26.53%), caffeine-based energy drinks (42.04%, 30.2%), and modafinil/armodafinil (14.28%, 2.04%). Coffee (54.59%), caffeine-based energy drinks (17.85%), and modafinil/armodafinil (13.77%) were linked to the most adverse effects (total instances = 196). Among 94 users who specified duration, 61 reported effects after prolonged use and 33 after single use.

Interpretation*:*

Adverse effects alignedwith prolonged use, as most users (intent to stay awake n=127, to boost concentration n=109) relied on these substances for over 3 years. Dorms/hostels, friends/colleagues and seniors were key reported influences. Convenience was the most cited reason for usage during exams, over alternative methods. Concerns were raised about potential dependence and adverse effects, especially with prolonged use. In a Type 2 DM-prone population such as India, the authors highlighted the added risk from high sugar content in caffeine-based energy drinks.

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Introduction

'Neuroenhancement' is defined as the consumption of substances by a healthy individual to enhance cognitive aspects such as memory, attention, concentration and intelligence. [1]

Caffeine is one of the most widely used pharmacologically active substances across the world, which is available in many forms such as coffee, tea, energy drinks, among others. [2] Energy Drinks are

substances designed to give the consumer a "jolt" of energy provided by the combination of stimulants and "energy boosters" that they provide, including substances having vast troves of evidence such as caffeine, as well as others such as herbal extracts such as ginseng, B vitamins, amino acids such as taurine and amino acid derivatives such as carnitine, and sugar derivatives, like ribose. [3]

Another psychoactive substance has recently gained attention, namely ‘Modafinil’, which is a wake-promoting agent that is pharmacologically different from other stimulants. [4] The United States Food and Drug Administration has approved its use for Narcolepsy and sleep disorders; however, presently in India, it has been misused as an "over-the-counter" drug. [5]

Over 500 mg of caffeine per day is considered an unsafe daily dose. Low levels of caffeine ingestion, or at most 500 mg of caffeine per day, should be considered by individuals, particularly those with heart disease or liver disease. [6] Anxiety, frequent urination, muscle twitches, nausea, restlessness, stomachache, sweating, talkativeness and tinnitus are some common dose-dependent adverse effects of caffeine. [7]

Modafinil has been associated with adverse effects such as headache, GI disturbances, dizziness, increased diuresis, tachycardia, palpitations, nervousness, restlessness, and sleep disturbances. [8–19] Its waking mechanism is not fully revealed, with some studies reporting that Modafinil may also be subject to abuse, and addiction. In addition, prolonged sleeplessness could induce stress responses, and impair immune function. [20] There is a documented moderate positive effect in regards to attention after Modafinil consumption in a Systematic Review by Repantis et. al. [21]

Multiple studies have consistently linked examinations as a situational reason for which students engage in the consumption of caffeine-based products. [22–25] Caffeine-based products and neuroenhancers such as modafinil share several similarities in their effects on cognitive performance and alertness. Both substances are used to enhance wakefulness, attention, and cognitive function, particularly in situations involving sleep

Previous studies have examined caffeine-based energy drinks and Modafinil consumption, but largely as separate entities. Our study assessed individual associations of both with examinations. College students are an interesting demographic to explore in this regard. In an attempt to not only gauge substance consumption prevalence, but also the intention behind consuming neuroenhancing substances, our study contained two sections; one section was associated with substance consumption with an intent to boost concentration, and the other with an intent to promote wakefulness.

Additionally, focusing on the Indian population helped elucidate regional intake patterns and quantify consumption prevalence.

Methodology

Ethical Clearance

Ethical clearance for the study was obtained from the Institutional Ethics Sub-Committee of Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pimpri, Pune, India on 17/02/2022. (Reference Number I.E.S.C./41/2022)

Informed Consent

Informed consent was digitally documented from all participants through individual Google Forms. Participants were briefed regarding the study objectives, confidentiality and their right to refusal. Consent was documented by the interviewing investigators.A non-response rate of 2% was observed.

Confidentiality*:*

Confidentiality and anonymity of participants has been maintained, and the identity of participants will not be disclosed. Additionally, participants were also provided the option to only input their initials as opposed to their name.

Type of study:

Observational

A cross-sectional survey was conducted from April 2022 to February 2023 through one-on-one interviews. Investigators administered a researcher-developed, piloted questionnaire on Google Form and documented participant responses in real time. Investigators remained present during the process to address participant queries, ensure clarity, and maintain the integrity of informed,unbiased responses. The data collecting investigators were briefed beforehand on the aims, structure of the study, substance definitions and potential areas of confusion in regard to the questions participants that warranted clear explanation before recording their responses.

Definitions*:*

We operationally define ‘energy boosting substances’ as any substances that, upon consumption, are perceived to boost energy, cognition, alertness/attention, and/or ward off fatigue to any degree.

A nootropic agent is any substance that may alter, improve, or augment cognitive performance, mainly through the stimulation or inhibition of certain neurotransmitters.

In instances where we have broadly discussed both the above mentioned categories, the term ‘neuroenhancing substances’ has been used as an umbrella term for both ‘energy boosting substances’ (as defined above) and nootropics. In other instances, both these terms have been used separately to succinctly highlight the differences between the two terms wherever relevant.

Structure of Study

The consumption of neuroenhancing substances (i.e. 'energy boosting' substances and nootropics) could be with two intentions, namely, to boost concentration levels and/or to promote wakefulness/ward away sleepiness. Our study hence contained two sections divided based on the intention behind neuroenhancing substance consumption (to boost concentration and/or to promote wakefulness). In our questionnaire, participants were allowed to select the same substances when responding within both sections in situations where a neuroenhancing substance was consumed with both intentions. Thus, this provided us with a holistic perspective based not only on prevalence, but also on the intention behind the consumption of said substances.

Inclusion Criteria*:*

Volunteering medical trainees, i.e. individuals currently enrolled in any medical undergraduate or postgraduate (residency) training programs in India. Participants included were between the ages of 18 and 30.

Sample Size:

Assuming the prevalence of energy boosting substances by students is 50%. At 95% Confidence Interval and an absolute allowable error of 7%, the minimum sample size was calculated to be 218. However, we have taken 245 participants. The software used was WinPepi v11.65.

Data analysis*:*

The data was collected using one on one interviews, and responses were logged on by the investigators onto Google Forms (Google Form, March 15, 2025) and analyzed using, MedCalc v18.2.1 (MedCalc Statistical Software version 18.2.1 (MedCalc Software, Ostend, Belgium; http://www.medcalc.org; 2018) and R (R Core Team (2024). _R: A Language and Environment for Statistical Computing_. R Foundation for Statistical Computing, Vienna, Austria. <https://www.R-project.org/>).

Categorical variables were expressed in terms of frequency and percentages with 95% Confidence Interval, Continuous variables expressed as mean/SD, & Median and IQR (where applicable). Normal distribution was verified by Shapiro-Wilk's test.

Research In Context:

Evidence before this study:

The authors searched the Google Scholar database to review existing literature pertaining to the area of the study (energy boosting/nootropics consumptions during examinations), and sourced articles from multiple journals. Most studies exhibited/spoke of a positive correlation between neuroenhancing substance consumption and examinations. However, they examined either 'energy boosting' substances OR nootropics, in isolation. Relevant points from searched articles were taken into consideration for both

sections respectively in our discussion. Search terms were as follows: Energy Drinks, Modafinil, Nootropics, Exams, Medical Students

Added value of this study:

What sets this study apart is its dual focus: rather than isolating nootropics or stimulants as most existing studies do, we examine both together within the specific use context of exams in Indian medical education. This more integrated approach better reflects real-life usage and helps fill a significant gap in current research. The study also provides rare data on modafinil consumption rates—a controlled medication in India—raising important questions around its accessibility without prescription. Beyond just quantifying use, we explore the perceptions, social influences, and environmental factors driving these habits. We also differentiate between adverse effects following single use versus long-term use—an aspect that tends to be overlooked in similar studies. While the findings are centered on India, they have broader relevance for other South-East Asian settings, given cultural and systemic overlaps. Overall, we hope this work serves as a meaningful contribution and a useful starting point for future research and policy discussions around substance use in high-stakes academic environments.

Implications of all the available evidence:

The study provides rare data on modafinil consumption rates—a controlled medication in India—raising important questions around its accessibility without prescription. Beyond just quantifying use, we explore the perceptions, social influences, and environmental factors driving these habits. We also differentiate between adverse effects following single use versus long-term use—an aspect that tends to be overlooked in similar studies. While the findings are centered on India, they have broader relevance for other South-East Asian settings, given cultural and systemic overlaps. Overall, this work serves as a meaningful contribution and a useful starting point for future research and policy discussions around substance use in high-stakes academic environments.

Results

Of the 250 medical trainees approached, 245 gave their consent to be a part of our study. The study population consisted mostly of females, accounting for 60·82% (n= 149) females and 39·18% (n= 96) males (Table 1). The average respondent age was 21·56 years (SD= 2.77), Median (IQR) age being 21 (20-22). Out of the 245, 88·98% (n= 218) individuals were undergraduate students, whereas the students from postgraduate courses were only 11·02% (n= 27).

(Table 1 goes here)

The prevalence of various substances covered under the ambit of our study, both with the intent to stay awake during exams and with the intent of boosting concentration, has been represented in the form of a graph in Figure 1. The prevalence of coffee consumption was the highest across both the categories covered under our study, it accounted for 77·9% (n= 194) and 64·7% (n= 161) with the intent to stay

awake and boost concentration during exams respectively, this was followed by tea (42·04% with n= 103 and 26·53% with n= 65) and caffeine-based energy drinks (42·04% with n= 103 and 30·20% with n= 74) (Table 2). Table 3 shows the prevalence of substance consumption patterns for both undergraduate and postgraduate students.

(Figure 1 goes here)

(Table 2 goes here)

(Table 3 goes here)

The period of reliance of the substances consumed with the intent of staying awake and boosting concentration have been depicted using a graph in Figure 2, most users among them being reliant for a period of more than 3 years amounting at 39·2% (n= 51) to boost wakefulness and 38·7% (n= 43) to boost concentration.

(Figure 2 goes here)

There were 196 instances of adverse effects reported due to the consumption of neuroenhancing substances (Table 4). The majority of users who experienced adverse effects reported experiencing them after prolonged use, 45·25% (n= 81) as opposed to 26·25% (n= 47) who experienced adverse effect(s) after a single use. The adverse effect(s) reported have been presented in table 5.

(Table 4 goes here.)

(Table 5 goes here.)

Out of all our respondents, 79·1% felt that examinations can play a role in developing a habit of consuming neuroenhancement substances.

Figure 3 showcases reported influences promoting neuroenhancing substance consumption, while figure 4 exhibits environments perceived to promote neuroenhancing substance consumption.

(Figure 3 goes here)

(Figure 4 goes here)

Discussion

Amongst 245 individuals, the prevalence of coffee consumption was the highest, both with an intent to ‘stay awake’ (77·9%) and ‘boost concentration’ (64·7%) during exams. This is likely because coffee is easily available, convenient to consume and has a perception of boosting concentration and warding away sleep associated with it. Another substance not regularly taken into account under the umbrella of caffeine-based products used to boost concentration/stay awake is tea, which is a widely popular

beverage in India. The prevalence of tea consumption in our study was found to be 41·4% and 26·1% for staying awake and boosting concentration, respectively. In a study by Hassan et al., within a demographic similar to ours, it was found that the majority (62%) were unaware of the adverse effects of caffeine products. This is of note, considering a cup of tea typically contains 35–61 mg of caffeine. [26] The above-stated caffeine content would explain its concentration/energy boosting effects, and hence, tea warrants more attention within the discussion of concentration boosting substances, particularly when consumed in conjunction with other 'mainstream' caffeine-based substances with a higher caffeine content.

The prevalence of caffeine-based energy drinks consumption came to the 41·4% mark with an intent to stay awake during exams and 29·7% with an intent to boost concentration during exams. This is in line with findings in a study by Aslam et. al, where they determined a prevalence of energy drink consumption amongst similar age demographics to range between 30 to 50%.

Sugar content as high as 35 grams/236 ml in most caffeine-based energy drinks[27] makes the consumption patterns and perceptions surrounding such energy drinks worth exploring, particularly in a Type II Diabetes prone setting such as in India. Of late, energy drinks have emerged in the Indian market with prices as low as INR 20-40 (roughly 0·24–0·48 US Dollars), with caffeine content close to 80-90 mg per serve of 250 ml. Due to low prices, easy availability, and a strong concentration boost owing to the caffeine content in a relatively small serve, drinks such as these are popular amongst college-going students, both within and outside an examination setting. This could be a contributing factor to the high prevalence of energy drink consumption, particularly with the intent to stay awake during exams.

The prevalence of consumption of modafinil/armodafinil in this study was 14% out of 245 participants. Modafinil/Armodafinil were offered as choices in the questionnaire owing to their popularity within our demographic, with participants also having the option to state the name of other cognitive enhancers consumed under the ambit of the 'other' category in the questionnaire. Responses within the 'other' category were not statistically significant. Comparing our prevalence of cognitive enhancing substances with existing literature is challenging, owing to different substances being considered under the ambit of cognitive enhancers in different papers, however, close prevalence percentages do emerge when comparing broadly. A study in the UK with 612 participants reported a 17% prevalence of cognitive enhancers (Modafinil, Amphetamine, Methylphenidate and Beta Blockers).[28] A study from Iran reported 17·6% prevalence of cognitive enhancer consumption (Modafinil, Methylphenidate, Amphetamine, Piracetam, and Vinpocetine) out of 579 students at a medical school.[29]

When consumed with an intent to stay awake/boost concentration, Modafinil may be more effective than caffeine owing to their significant differences in peak drug concentration (Modafinil T_{max} - 2 to 4 hours, Modafinil half-life $T_{1/2}$ - 12 to 15 hours) (Caffeine T_{max} - 30 to 120 minutes, caffeine Half-life $T_{1/2}$ - 4 to 6 hours).[30] Hence, the longer period of effect of the drug could explain its popularity among college students in the background of the stress of examinations.

In comparison with students of other disciplines, most existing literature points towards higher modafinil consumption prevalence among students in the field of medicine and allied healthcare.[31] This could be attributed to high levels of examination stress and knowledge, awareness about pharmaceutical drugs and their effects within the healthcare fraternity.

A finding of note in our study was that the majority of users that were 'reliant' on energy boosting substances to 'stay awake' (n=127) and 'boost concentration' (n=109) were reliant on said substances for more than 3 years, with >3 year reliance at the 20% and 17·14% mark for each category respectively. This is of note considering that when adverse effects were taken into consideration, most users also reported adverse effects over prolonged use as opposed to single use. In retrospect, the authors also feel that higher dose consumption over prolonged periods due to potential desensitisation would be an important point to consider for future studies.

Out of 245 participants in our study, 68·57% of individuals felt that the consumption of energy boosting substances can lead to increased productivity on a day-to-day basis. Some studies on nootropics[32–35] citing the brain mechanism 'inverse U-function', state that cognitive performance improves only in subjects with 'low baseline capacities', which means sub-optimal levels of arousal, vigilance, or neurotransmitter concentrations.[36–38]

The fact that 79·1% of individuals believe that examinations play a role in developing habits of energy boosting substance consumption, which would explain the extremely high prevalence of coffee consumption both to stay awake and boost concentration.

138 individuals felt that their surroundings played a role in the development of energy boosting substance consumption habits. Out of these, 76·8% (n=138) of individuals felt that a dorm/hostel-based setting was more prone to consumption of neuroenhancing substances, while 21% felt there was no difference between dorms and homes, followed by 0·02% felt that home-based settings were more prone to consuming neuroenhancing substances. These findings complement the responses to another question, where out of 245 individuals, 40·81% reported being influenced by friends/colleagues and 15·10% of being influenced by seniors to consume energy boosting substances. Hence, dorms seem to be more of a catalyst to develop habits of energy boosting substance consumption, considering the nature of the population within these settings. When asked for the reason behind consuming neuroenhancing substances to boost concentration/promote wakefulness over other methods, varying answers were recorded, with convenience being the most common theme amongst these responses.

Conclusion

Our study shows that examinations of medical trainees contribute to the consumption of neuroenhancing substances, with their perceived convenience being a catalyst in the background of stress. To illustrate, during exams, the prevalence of coffee consumption was at 79·18% and modafinil consumption was at 14·28%, both with the intent to stay awake. These intake patterns establish coffee

as a go-to choice of examinees (with nearly 4 out of every 5 students consuming it), followed by other caffeine-based products. Existing literature cited in our discussion points to 62% being unaware of the side effects of caffeine-based products. Meanwhile, the high prevalence of modafinil consumption is of note, especially considering its designation as a prescription-only substance in India.

The consumption of neuroenhancing substances could hence be concerning, depending on the frequency/quantity of consumption of said substances. Consumption of higher frequencies and quantities could lead to dependence and precipitate adverse effects, especially over prolonged periods, as documented in our study.

Limitations

1. Not all individuals may have answered truthfully owing to a social desirability bias, leading to lower prevalence figures.
2. Although efforts were made to differentiate the two sections of the questionnaire; there may still have been some confusion in regard to them potentially due to some overlap in their nature.

Declarations

Data Availability:

Deidentified participant survey data may be made available upon request on a case-by-case basis citing the reason. Data sharing requests may be put forth via email to the corresponding author for up to a year after the date of publication.

Contributors:

AD: Conceptualisation, Data curation, Investigation, Methodology, Project administration, Supervision, Literature search, Writing – original draft, Writing – review & editing.

PG: Data curation, Investigation, Methodology, Project administration, Supervision, Literature search, Writing – original draft, Writing – review & editing.

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All authors reviewed and approved the final version of the manuscript.

Declaration of interests:

We declare no competing interests.

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Tables

Table 1
Demographic Details

Characteristic	**N = 245**[1]
Age	21.00 (20.00, 22.00)
Gender	
Female	149 (61%)
Male	96 (39%)
Level of Education	
Postgraduate student	27 (11%)
Undergraduate student	218 (89%)
Year of Study	
1st MBBS	76 (31%)
2nd MBBS	34 (14%)
3rd MBBS	61 (25%)
4th MBBS	30 (12%)
Intern	17 (6.9%)
PGY1	18 (7.3%)
PGY2	5 (2.0%)
PGY3	4 (1.6%)
[1] Median (Q1, Q3); n (%)	

Table 2

Neuroenhancing substance consumption prevalence with intentions of staying awake and boosting concentration

Neuroenhancing Substance use				
	to Stay Awake		**to Boost Concentration**	
Substances	Undergraduates (n = 218)	Postgraduates (n = 27)	Undergraduates (n = 218)	Postgraduates (n = 27)
Coffee	172(78.89%)	19(70.37%)	144(66.05%)	14(51.85%)
Tea	85(38.89%)	14(51.85%)	53(24.31%)	8(29.62%)
Caffeine Based Energy Drinks	97(44.49%)	7(25.92%)	70(32.11%)	5(18.51%)
Modafinil/Armodafinil	31(14.22%)	1(3.70%)	5(2.29%)	1(3.70%)
Caffeine Based Tablets or Powders	9(4.12%)	0(0%)	8(3.66%)	0(0%)
Adderall	4(1.83%)	0(0%)	0(0%)	0(0%)
Cigarettes/Nicotine	5(2.29%)	0(0%)	3(1.37%)	0(0%)

Table 3

Neuroenhancing substance consumption prevalence amongst medical undergraduates and medical postgraduates with intentions of staying awake and boosting concentration

Prevalence of Neuroenhancing substance Usage				
	To Stay Awake		**To Boost Concentration**	
Substance	Frequency(%)	CI	Frequency(%)	CI
Coffee	194(79.18%)	73.76–83.92	161(65.71%)	59.6–71.46
Tea	103(42.04%)	35.97–48.3	65(26.53%)	21.29–32.33
Caffeine Based Energy Drinks	103(42.04%)	35.97–48.3	74(30.20%)	24.7–36.17
Modafinil/Armodafinil	35(14.28%)	10.32–19.1	5(2.04%)	0.75–4.46
Caffeine Based Tablets or Powders	9(3.67%)	1.80–6.63	8(3.26%)	1.52–6.10
Adderall	4(1.63%)	0.52–3.89	0(0%)	0–1.21
Cigarettes/Nicotine	4(1.63%)	0.52–3.89	2(0.81%)	0.13–2.67
None	39(15.91%)	11.73–20.91	60(24.48)	19.41–30.17

Table 4

Instances of adverse effects reported owing to consumption of neuroenhancing substances

Instances of adverse effects owing to the consumption of neuroenhancing substances (n = 196)		
Substance	n	Percent
Coffee	107	54.59%
Caffeine-based Energy Drinks	35	17.86%
Modafinil/Armodafinil	27	13.78%
Tea	21	10.71%
Caffeine-based Tablets	3	1.53%
Adderall	3	1.53%

Table 5

Reported adverse effects experienced from various neuroenhancing substance(s) consumption.

Reported Adverse Effects experienced from various neuroenhancing substance(s) consumption		
Adverse Effect	Frequency(n)	Percent
Anxiety	78	18.66%
Restlessness	68	16.27%
Insomnia	48	11.48%
Frequent Urination	38	9.09%
Dehydration	37	8.85%
Nausea	29	6.94%
Sweating	25	5.98%
Muscle twitching	25	5.98%
Stomach Ache	18	4.31%
Vomiting	12	2.87%
Dizziness	11	2.63%
Lethargy	11	2.63%
Palpitations	7	1.67%
Tinnitus	6	1.44%
Diarrhoea	3	0.72%
Constipations	2	0.48%

Figures

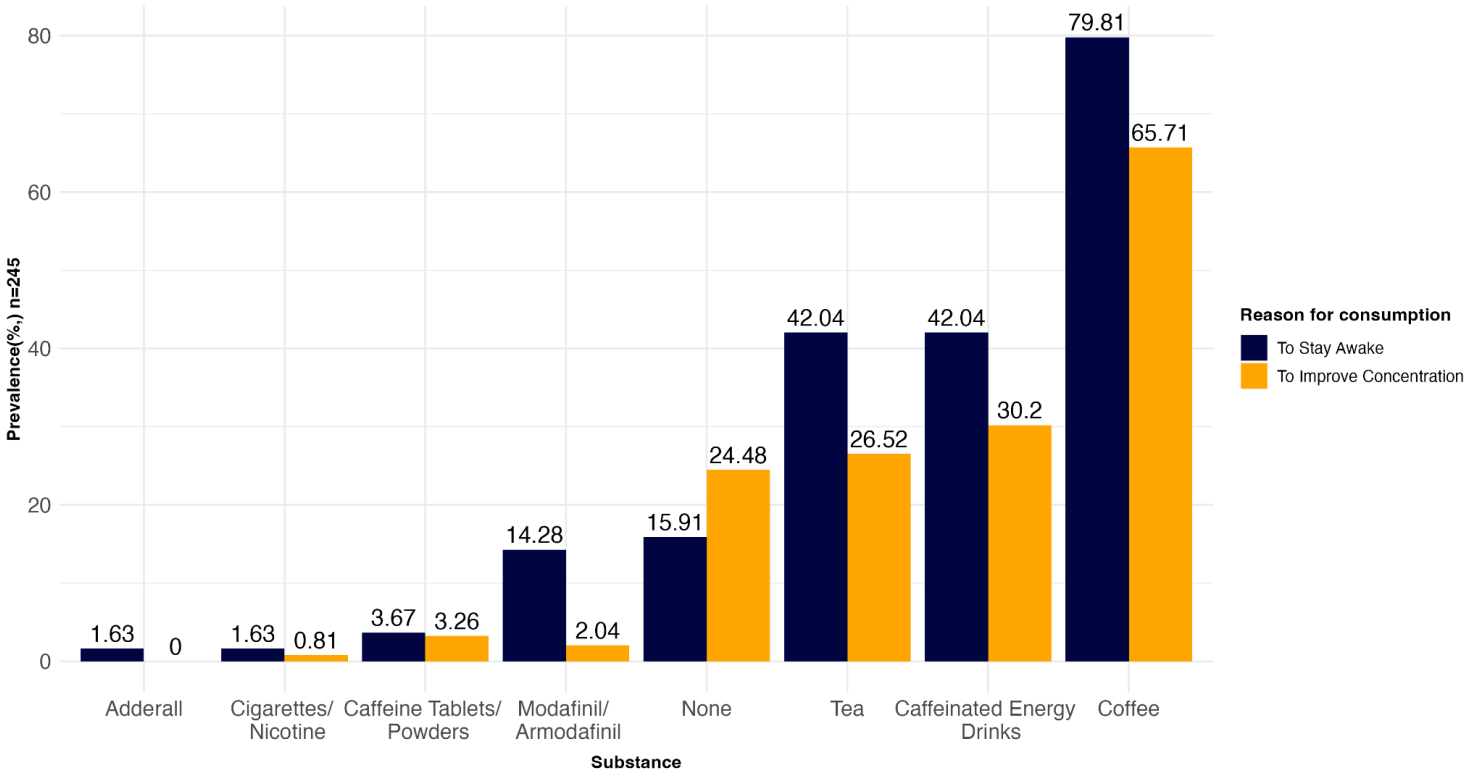


Figure 1

Neuroenhancing substance consumption prevalence with intentions of staying awake and boosting concentration

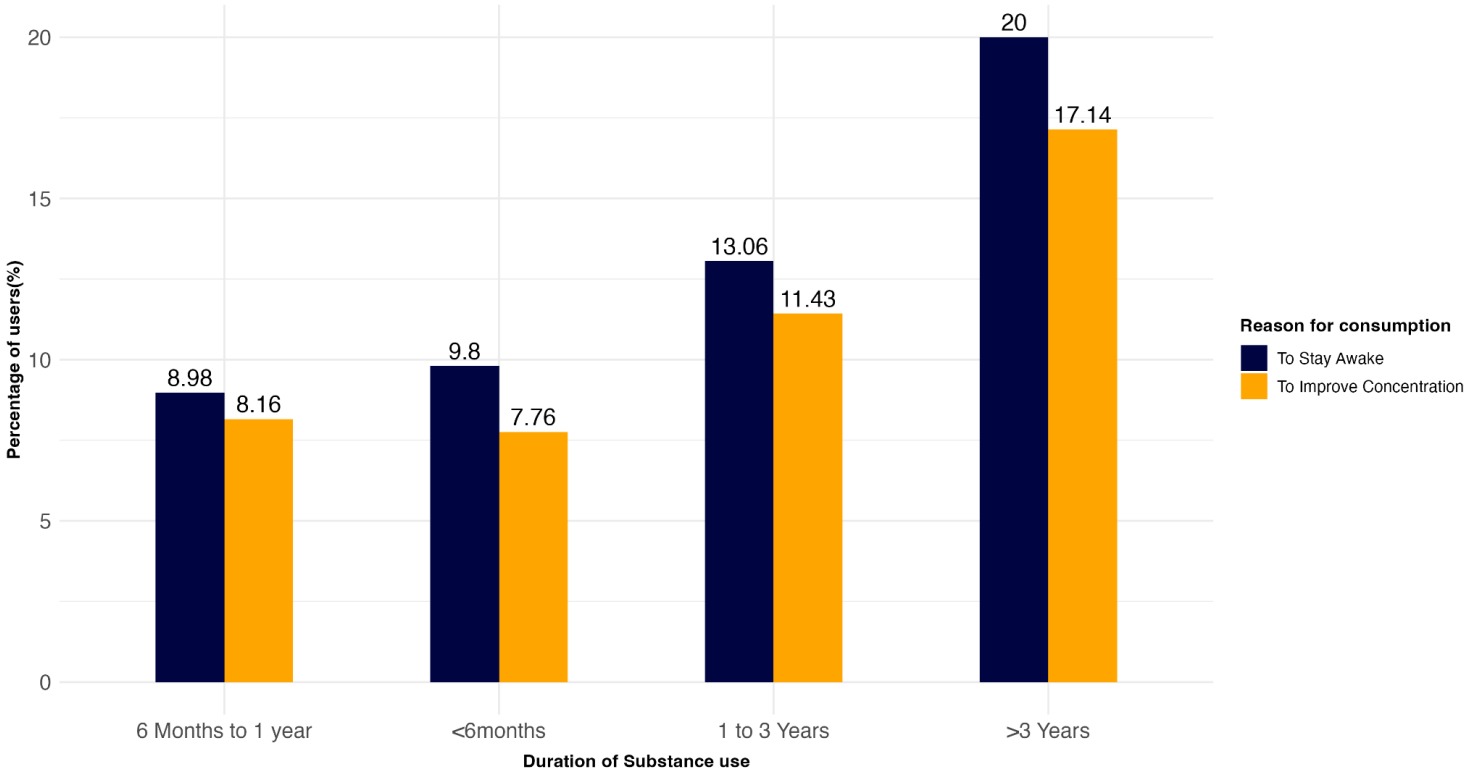


Figure 2

Period of reliance on neuroenhancing substance(s) with intentions of staying awake and boosting concentration

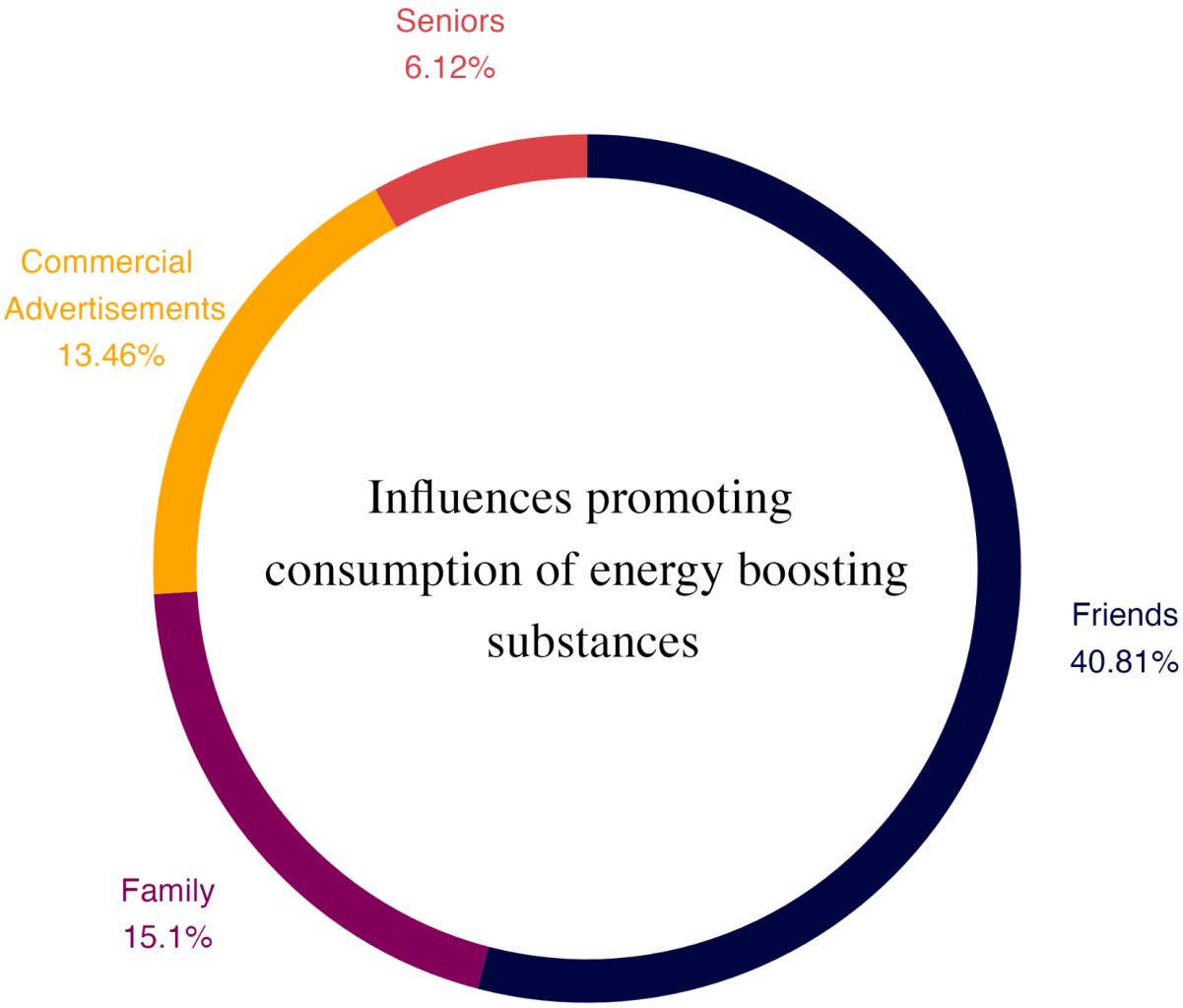


Figure 3

Perception of environments promoting neuroenhancing substance consumption

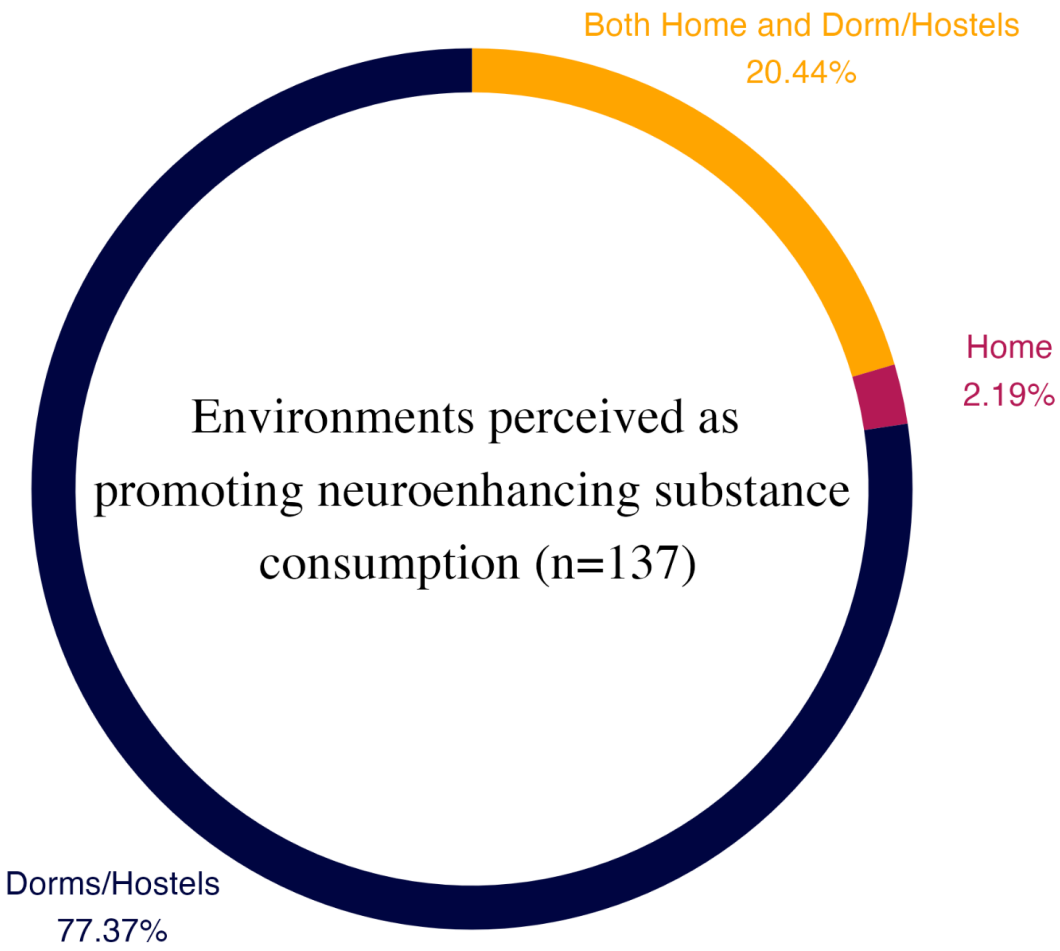


Figure 4

Perception of influences persuading neuroenhancing substance consumption

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Questionnaire.pdf