

Use of Cognitive Enhancers by Portuguese Medical Students: Do Academic Challenges Matter?



Estratégias de Aprimoramento Cognitivo em Estudantes de Medicina Portugueses: Qual a Relevância dos Desafios Acadêmicos?

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ABSTRACT

Introduction: Nonmedical use of prescription drugs and other substances for cognitive enhancement in the academic environment has been documented in several studies. However, the prevalence among Portuguese university students is unknown. We aimed to assess the prevalence and academic contexts of the use of cognitive enhancers of a sample of Portuguese medical students.

Material and Methods: An online questionnaire about the use of cognitive enhancers was completed by 1156 participants, who were either medical students (group 1) or newly qualified physicians applying for the Portuguese medical licensing exam (group 2).

Results: Coffee was the most frequently used substance for cognitive enhancement purposes in both groups, whereas nonmedical use of prescription drugs for cognitive enhancement was lower in undergraduate students (5%) and higher in licensing exam applicants (14%). Methylphenidate (35%) and modafinil (10%) were the most consumed prescription substances and they were mainly used to enhance attention (83%) and memory (44%). Use of prescription drugs for cognitive enhancement was mainly associated with studying for medical school exams and the medical licensing exam. Most prescription drugs for cognitive enhancement were obtained through medical prescription (54%).

Discussion: These results show a low consumption of prescription drugs for cognitive enhancement by Portuguese medical students. Licensing exam applicants show a higher consumption of almost every substance included in this study, which might be explained by the crucial role of the exam in defining their future career path and desire by students to improve the cognitive skills that determine exam success.

Conclusion: Studying drugtaking behaviors in medical students and young doctors is relevant for public health and medical education, since they will soon be in charge of drugs prescription. Therefore, ethical and medical concerns raised by off label consumption of prescription drugs for cognitive enhancement purposes must be openly addressed.

Keywords: Academic Performance; Central Nervous System Stimulants; Portugal; Prescription Drug Misuse; Students, Medical

RESUMO

Introdução: A utilização de substâncias sujeitas a receita médica para fins de aprimoramento cognitivo em contexto académico tem sido reportada em diversos estudos. Contudo, a prevalência destes consumos na comunidade de estudantes universitários portugueses é desconhecida. Neste sentido, pretendemos analisar as estratégias de aprimoramento cognitivo utilizadas por estudantes de Medicina portugueses, identificando a sua prevalência e os contextos académicos mais associados a estes consumos.

Material e Métodos: Um questionário online relativo à adoção de estratégias de aprimoramento cognitivo foi preenchido por 1156 participantes: estudantes de medicina (grupo 1) e médicos recém-graduados a estudar para a Prova Nacional de Seriação (grupo 2).

Resultados: O café foi a substância mais frequentemente utilizada para fins de aprimoramento cognitivo nos dois grupos. A utilização de medicamentos sujeitos a receita médica para aprimoramento cognitivo revelou-se mais baixa nos participantes pré-graduados (5%), tendo sido três vezes mais elevada nos participantes em preparação para a Prova Nacional de Seriação (14%). O metilfenidato (35%) e o modafinil (10%) foram as substâncias sujeitas a receita médica mais utilizadas. O melhoramento da capacidade de concentração (83%) e de memória (44%) foram os principais objetivos citados para justificar a utilização destas substâncias, as quais foram obtidas por prescrição médica em 54% dos casos.

Discussão: Os resultados deste estudo revelam uma utilização percentualmente baixa de neurofármacos. Os participantes da Prova Nacional de Seriação apresentaram taxas de consumo superiores em praticamente todas as substâncias estudadas, o que poderá ser explicado pelo desejo dos participantes em potenciar certas capacidades cognitivas determinantes de sucesso académico, bem como pelo papel crucial da Prova Nacional de Seriação na definição da futura carreira médica em Portugal.

Conclusão: Os estudantes de medicina e jovens médicos são os prescritores do futuro. Ao estudar o seu padrão de consumo medicamentoso, este estudo mostra-se relevante para a Saúde Pública e Educação Médica, estimulando um debate público sobre as questões éticas e médicas relativas à utilização destas substâncias em contexto off-label para fins de aprimoramento cognitivo.

Palavras-chave: Desempenho Académico; Estimulantes do Sistema Nervoso Central; Estudantes de Medicina; Portugal; Uso Indevido de Medicamentos

INTRODUCTION

Substance use for cognitive enhancement has been reported by university students who seek boosters for their academic performance.¹ These cognitive enhancers are consumed to improve cognitive functions, including memory,

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attention, vigilance, learning and executive functions of healthy individuals.² They include legal substances, like nutritional and dietary supplements and caffeinated products, as well as illicit substances, like recreational drugs and prescription drugs when used for nonmedical purposes.³

Epidemiological studies on the use of cognitive enhancers by university students have been conducted in various countries. However, fewer studies have been specifically focused on medical schools, where high academic demands⁴ and a competitive environment⁵ can lead to misuse of prescription drugs for cognitive enhancement (PCEs). Medical school can be very demanding and has been shown to have consequences for the mental health of students. For example, 10% of Portuguese medical students admit to having taken prescription drugs for mental health related symptoms without the supervision of a physician and 8.6% report having had regular mental health medical appointments.⁶ In fact, medical students are highly susceptible to physical and emotional exhaustion,⁴ and have higher burnout levels compared with the general population.^{7,8}

A study of Canadian medical students reported that 15% used one or more PCE, with senior medical students reporting recent consumption of these substances more often than junior students.⁴ Similarly, 16% of a pool of Italian medical students admitted to having used PCEs, mainly to maximize the efficiency of their studies outside classes.⁹ In contrast, in a study with Lithuanian medical students, Lengvenyte *et al* found a lower rate (8.1%) of PCEs consumption during medical school.¹⁰

The consumption of cognitive enhancers has been shown to be higher in medical students compared to other university students.⁴ Easier access to PCEs and deeper knowledge about drug efficacy and side effects could contribute to higher consumption rates.⁴ Furthermore, medical students are often subject to other factors that may contribute to higher consumption of these substances, including high levels of stress, being on call, sleep deprivation, psychological pressure to achieve excellent results and dealing with competition from peers.^{11,12} Given the lack of studies on the use of cognitive enhancers in Portuguese medical students, little is known about the prevalence of the use of cognitive enhancers by these students as well as the academic challenges that contribute to their use the most, or the cognitive functions that are targeted for enhancement.

The current study aimed to assess (1) the prevalence of substance use for cognitive enhancement by a sample of Portuguese medical students, (2) the motivations and academic contexts in which these substances are used, and (3) how students obtain prescription drugs for cognitive enhancement. Furthermore, this study also aimed to analyze the difference between the consumption rates of cognitive enhancers by undergraduate students and by newly qualified physicians studying for the Portuguese medical licensing exam (*Prova Nacional de Seriação*), a national examination undertaken at the end of the sixth year of medical school.

MATERIAL AND METHODS

Participants

The sample comprised Portuguese undergraduate medical students (group 1) and newly qualified physicians who applied for the medical licensing exam (group 2).

Undergraduate students were contacted via e-mail through mailing lists of local student committees. Postgraduate participants preparing for the medical licensing examination were contacted through a Facebook post on a private group for students taking the aforementioned examination. Participants were asked to complete an online questionnaire about the use of cognitive enhancers in the academic environment. The survey was available from the 18th October 2016 to 14th December 2016.

All procedures in this study were performed in accordance with the ethical standards of the institutional research committee and with the Helsinki declaration and its 2013 amendments or comparable ethical standards. This observational study focused on frequencies and motivations for the consumption of cognitive enhancers, was low-risk and did not require ethical review. Data was collected by resorting to an online survey, filled by volunteer medical students and doctors. Because the study includes human participants, respect for people and for their rights was ensured. Before participating in the study, volunteers were informed regarding the context of the study and its overall design. In the personal information section of the survey, only data on age, gender and institution was collected. Anonymity of answers was guaranteed. Furthermore, informed consent was obtained from all individual participants included in the study. The right to decline to take part in the study or to withdraw from the study at any time was explained and respected, including the right to decline to answer all or any questions in the survey.

Measures

Demographic information. Demographic characteristics including age, gender, academic year, and medical school were collected from all participants.

Cognitive enhancers. An original 21-item questionnaire about the use of cognitive enhancers was developed on Google Forms to assess: (1) the frequency of consumption of different substances for cognitive enhancement (10 questions were answered using a five-point Likert scale ranging from 1 - never to 5 - very frequently); (2) the cognitive functions

that students expected to enhance (e.g., attention, memory) from a list of nine cognitive functions in two questions covering non-prescription substances and PCEs, respectively; (3) the PCE used by students by selecting all PCEs used from a list of seven (e.g., methylphenidate, modafinil), with the possibility to add other options; (4) the academic context that led students to consume PCEs (including five contexts: during the period of classes; preparation and/or presentations in scientific conferences; clinical practice; studying for exams; or studying for the medical licensing examination. Items were rated using a five-point Likert scale ranging from 1 - never to 5 - very frequently); (5) the source from which students obtained PCEs by selecting one or more of the following options: general practitioner, psychiatrist, colleague, pharmacy/without prescription, internet, friend/relative with diagnosed condition; and (6) reasons for not using PCEs by selecting all reasons from a list of five, with the possibility to add other options. In order to avoid confusion between the use of some substances without cognitive enhancement purposes (e.g., recreational or medical purposes), all questions stressed that when completing the questionnaire, participants should exclusively consider the use of these substances as cognitive enhancers.

Statistical analysis

Descriptive data was obtained using frequency analysis. The independent samples *t*-test was used to compare the use of substances (1) for male and female participants and (2) for undergraduate students and licensing exam applicants. A one sample *t*-test was used to examine the mean difference between PCE consumption according to different academic contexts. One-way analysis of variance (ANOVA) was conducted to determine whether there were differences between the frequency of consumption of the different substances for cognitive enhancement according to each medical school. Pearson's correlation was used to investigate the associations between the frequency of substance use, students' age and academic year. Although the use of a multivariate analysis of covariance (MANCOVA) was considered to determine the rates of drug consumption and control for age, sex and medical school, the MANCOVA assumptions were not met for the age and medical school variables. All statistical analyses were carried out using SPSS for Windows, version 24.0 (SPSS Inc., Chicago, IL, USA). Findings were denoted as statistically significant using $p < 0.05$.

RESULTS

A total of 1156 answers were collected (Table 1).

Frequency of consumption of cognitive enhancers

The frequency of consumption of cognitive enhancers by undergraduate students (group 1) and licensing exam applicants (group 2) is shown in Table 2. Licensing exam applicants reported higher frequencies of consumption of coffee, caffeine capsules, energy drinks, food supplements, recreational drugs, over-the-counter medicines and PCEs than undergraduate students.

Concerning gender differences in both groups, female participants used tea ($M_{female} = 1.80$, $SD = 1.16$; $M_{male} = 1.50$; $SD = 0.97$, $t(1154) = 4.16$, $p < 0.001$), food ($M_{female} = 2.24$, $SD = 1.33$; $M_{male} = 1.91$, $SD = 1.24$, $t(1154) = 3.87$, $p < 0.001$) and food supplements ($M_{female} = 1.94$, $SD = 1.18$; $M_{male} = 1.64$, $SD = 1.07$, $t(604.67) = 3.95$, $p < 0.001$) more often than male participants, whereas male participants used energy drinks ($M_{male} = 1.65$, $SD = 0.95$; $M_{female} = 1.38$, $SD = 0.79$, $t(1154) = -4.75$, $p < 0.001$) and recreational drugs ($M_{male} = 1.09$, $SD = 0.43$; $M_{female} = 1.03$, $SD = 0.23$, $t(1154) = -3.08$, $p < 0.001$) more frequently than female participants.

Additionally, the ANOVA results revealed no statistically significant differences among medical schools on the frequency of consumption of cognitive enhancers.

No significant association was found between the frequency of substance use and students' age and academic year.

Cognitive functions targeted for cognitive enhancement

Fig. 1 shows the cognitive functions that participants aimed to enhance by resorting to cognitive enhancers. Attention/focus was the cognitive function that had the highest expectations of enhancement, followed by vigilance and memory.

Use of prescription drugs for cognitive enhancement (PCE)

Of the study sample, 48 undergraduate students (5.26%) from group 1 and 35 licensing exam applicants (14.40%) from group 2 had already used PCEs at least once (Fig. 2). Most participants had never used PCEs, because (1) they never had an interest or felt the need for them (73.23%); (2) they were afraid of the side effects of the drugs (37%); (3) they had never thought about it (34.42%); (4) they rejected PCEs for ethical reasons (27.25%); or (5) they had not been given access to the drugs (12.24%).

The most frequently used PCEs were methylphenidate (35.1%), modafinil (10.4%), citicoline (3.9%) and idebenone (2.6%).

PCEs were mainly used during preparation for the licensing exam ($M = 3.44$, $SD = 1.28$, $t(33) = t(5,299)$, $p < 0.001$) and during the medical school exam period ($M = 2.9$, $SD = 1.474$, $t(76) = t(3,608)$, $p < 0.001$) in comparison to every use of PCEs. They were used less frequently for preparation and/or presentations for scientific conferences ($M = 1.8$; $SD = 1.34$,

$t(69) = t(-3.068)$, $p < 0.003$) and regular clinical practice ($M = 1.24$, $SD = 0.74$, $t(44) = t(-9.436)$, $p < 0.001$). No significant difference was found regarding consumption of PCEs during classes.

Sources of PCE access

Just over half of the participants who used PCEs obtained them through a medical prescription despite the absence of a diagnosed condition, with the prescriptions coming from either a general practitioner (33%) or a psychiatrist (21%). Other sources were colleagues (18%), family or friends with a diagnosed condition (13%), over-the-counter from a pharmacy (9%) and other sources (6%), including the internet.

DISCUSSION

This study provides new epidemiological data regarding the use of cognitive enhancers by Portuguese medical students. Coffee is the most frequently used substance for cognitive enhancement purposes and the use of PCEs by undergraduate students is low compared to what is reported in studies from other countries,^{9,10,13} but higher in licensing exam applicants. The British Medical Association recognizes the desire of many students to enhance their cognitive capacities, but questions certain means to achieve this goal.³ Different substances raise different concerns, which might explain why PCEs are treated with caution by the general public compared with conventional means such as coffee, whose effects are well known and which does not require the mediation of a physician.³ The greater weight of risks versus benefits of PCE has shaped public opinion about the use of PCEs.³ The second reason why participants in this study did not use PCEs was, in fact, fear of their side effects. In addition, just over a quarter of the participants rejected PCEs for ethical reasons. From the ethical point of view, some participants might feel their achievements will lack authenticity if resorting to cognitive enhancement (accomplishment argument), while others may have concerns about distributive justice and the resulting inequalities.¹⁴ Additionally, other students might also feel that cognitive enhancement compromises their individual autonomy, due to peer-driven coercion, where one feels obliged to resort to these strategies in order to keep up with the rest of the colleagues (Red Queen evolutionary hypothesis).³

Differences in the use of cognitive enhancers between male and female participants show different means for cognitive enhancement and probably a distinct risk perception about these substances. Female participants more frequently used soft enhancers (e.g., teas, nutrition, food supplements) than male participants, who were more prone to use energy drinks and recreational drugs. This result is consistent with evidence from previous studies,^{1,15-17} which shows that this is a possible result of gender expectations regarding different substances.¹ For example, in a study with German students, male students were more curious about trying illicit drugs than female students, whereas female students preferred phytomedicine substances, especially those with relaxing properties, to alleviate fear regarding examinations and sleep problems during study periods.¹⁷

Nonmedical use of prescription drugs for cognitive enhancement

This study shows that a low percentage of the Portuguese undergraduate medical students' study group admits to resorting to PCEs, which are mainly associated with the challenges of academic assessment and the expectations of enhancing attention/focus, memory and vigilance. These cognitive functions are crucial to success in medical school, where students spend most of their time acquiring factual knowledge, which is tested in exams but tends to be poorly retained over the long term.¹⁸

Methylphenidate and modafinil were the most prevalent prescription drugs used for cognitive enhancement. This finding is consistent with previous studies with medical students.^{4,13} These substances are also highly used in other contexts as Maher showed in a study that included 1400 Nature readers from 60 countries, in which one in five respondents said they had used cognition-enhancing drugs (mainly methylphenidate and modafinil) for nonmedical reasons to stimulate their focus, concentration or memory.¹⁹

The lifetime consumption of PCEs in the current study is lower compared to the estimates reported in Canada,⁴ United States of America,¹³ Lithuania¹⁰ and Italy.⁹ However, the studies use different categorizations of substances consumed and different methods for quantifying frequencies of consumption, so comparisons must be made with caution. Furthermore, existing differences might be partially explained by distinct sociocultural contexts, since culture interacts with biology and psychology, influencing personal choices about drugs, their uses and outcomes of use.²⁰ Nevertheless, different medical curriculums and processes for accessing medical residency programs, as well as different competitive academic environments, peer pressure and the ease of obtaining prescription drugs might also explain differences in the use of PCEs across different countries.

Licensing exam applicants showed a higher consumption of PCEs and other cognitive enhancers (coffee, caffeine capsules, energy drinks, food supplements, recreational drugs, over-the-counter medicines) than undergraduate students. Their lifetime PCE consumption was three times higher compared to the undergraduate students group. These findings might be explained by the decisive impact of the licensing exam on the candidates' future professional careers, ranking every new physician according to their exam grade, determining the order by which new physicians choose a medical

specialty residency program from the available vacancies within the Portuguese national and private healthcare systems. Furthermore, these findings might also be explained by the characteristics of this controversial²¹ exam itself, in which the candidate's success was highly dependent on excellent memory skills rather than on clinical reasoning. As a result, these high-stakes exams expose candidates to high levels of stress and to a highly competitive assessment environment,²² which ultimately leads candidates to use different means to optimize study, cope with stress and gain advantage over other candidates, including resorting to cognitive enhancers.

This study also shows that 54% of PCE users have access to them via a legal medical prescription. Although the reasons that led these doctors to prescribe PCE are unknown in this study, it is possible that these doctors may have felt pressured by participants to prescribe PCE or that the participants had exaggerated or invented medical symptoms during clinical appointments in order to obtain a legal prescription.²³ Future studies should clarify the reasons and contexts in which these drugs are prescribed.

Limitations and future studies

Due to our participant recruitment strategy, a response rate cannot be precisely calculated, since we have no form to ensure that every undergraduate student (from a universe of 12 293 enrolled students in Portuguese medical schools in 2016) and every newly qualified physician applying for the exam (out of 2466 officially enrolled) received the questionnaire. Therefore, generalization of the data of this study to the entire population of Portuguese medical students and licensing exam applicants should be carefully interpreted. Certain population selection biases cannot be excluded. For example, the data obtained in this study do not allow to clarify whether students and newly qualified physicians who use PCEs avoid answering the questionnaire or whether newly qualified physicians who are less likely to use social media had access to the questionnaire.

Regarding the demographic characteristics of the sample, female participants were slightly oversampled²⁴ and the sample was not equally distributed across the medical schools included in the study. Although it was stressed in all questions that participants should only consider substance use as cognitive enhancers, the presence of participants' mental conditions was not controlled. Future studies should control for potential effects of current mental health. Furthermore, studies could assess whether the use of cognitive enhancers leads to better academic outcomes in medical school and in the licensing exam.

Finally, our findings refer to the 2016 licensing exam. Since it ranks all candidates for the available postgraduate residency vacancies (which, since 2015, have not been enough to accommodate every candidate), this exam was criticized for focusing excessively on memorization skills.²¹ On November 2019, a new licensing exam model, clinical cases-based, was applied for the first time. It would be interesting to repeat our study on applicants of the new exam model, determining how this model has impacted on the patterns of consumption of cognitive enhancement substances of applicants.

CONCLUSION

Despite the aforementioned limitations, this study reports a globally low consumption of prescription drugs for cognitive enhancement purposes by Portuguese medical students. Licensing exam applicants show a higher consumption of almost every substance included in this study, which might be explained by the crucial role of the exam in defining their future career path and desire by students to improve the cognitive skills that determine exam success.

Medical students will soon be in charge of medical prescription. Therefore, studying drugtaking behavior in this population is critical for Public Health and Medical Education, stimulating a public debate about the ethical and medical concerns of utilizing prescription drugs in off label settings for cognitive enhancement purposes.

PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

CONFLICTS OF INTEREST

The authors declare that there is no conflict of interests regarding the publication of this paper.

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REFERENCES

- Maier LJ, Liechti ME, Herzog F, Schaub MP. To dope or not to dope : neuroenhancement with prescription drugs and drugs of abuse among Swiss university students. *PLoS One*. 2013;8:e77967.
- Fond G, Micoulaud-Franchi JA, Macgregor A, Richier R, Miot S, Lopez R, et al. Neuroenhancement in healthy adults, part I: pharmaceutical cognitive enhancement: a systematic review. *J Clin Res Bioeth*. 2015;06:2.
- British Medical Association. Boosting your brainpower: ethical aspects of cognitive enhancements. A discussion paper from the British Medical Association. London: BMA. 2007.
- Kudlow P, Naylor K, Xie B, McIntyre R. Cognitive enhancement in Canadian medical students. *J Psychoactive Drugs*. 2013;45:360-5.
- Mccabe SE, Knight JR, Teter CJ, Wechsler H. Non-medical use of prescription stimulants among US college students : prevalence and correlates from a national survey. *Addiction*. 2005;100:96-106.
- Roberto A, Almeida A. A saúde mental de estudantes de Medicina. *Acta Med Port*. 2011;24:279-86.
- Dyrbye L, Thomas M, Massie S, Power D, Eacker A, Harper W, et al. Burnout and suicidal ideation among U.S. medical students. *Ann Intern Med*. 2008;149:334-41.
- Dyrbye L, West C, Satele D, Boone S, Tan L, Sloan J, et al. Burnout among U.S. medical students, residents, and early career physicians relative to the general U.S. population. *Acad Med*. 2014;89:443-51.
- Castaldi S, Gelatti U, Orizio G, Hartung U, Moreno-Londono AM, Nobile M, et al. Use of cognitive enhancement medication among Northern Italian university students. *J Addict Med*. 2012;6:112-7.
- Lengvenyte A, Strumila R, Grikinienė J. Use of cognitive enhancers among medical students in Lithuania. *Nord Stud Alcohol Drugs*. 2016;33:173-88.
- Fond G, Gavaret M, Vidal C, Brunel L, Riveline JP, Micoulaud-Franchi JA, et al. (Mis)use of prescribed stimulants in the medical student community : motives and behaviors. *Medicine*. 2016;95:1-8.
- Dyrbye LN, Thomas MR, Shanafelt TD. Medical student distress: causes, consequences, and proposed solutions. *Mayo Clin Proc*. 2005;80:1613-22.
- Emanuel RM, Frellsen SL, Kashima KJ, Sanguino SM, Sierles FS, Lazarus CJ. Cognitive enhancement drug use among future physicians: Findings from a multi-institutional census of medical students. *J Gen Intern Med*. 2013;28:1028-34.
- Bostrom N, Sandberg A. Cognitive enhancement: methods, ethics, regulatory challenges. *Sci Eng Ethics*. 2009;15:311-41.
- Hall KM, Irwin MM, Bowman KA, Frankenberger W, Jewett DC. Illicit use of prescribed stimulant medication among college students. *J Am Coll Heal*. 2005;53:167-74.
- Franke A, Bonertz C, Christmann M, Huss M, Fellgiebel A, Hildt E, et al. Non-medical use of prescription stimulants and illicit use of stimulants for cognitive enhancement in pupils and students in Germany. *Pharmacopsychiatry*. 2011;44:60-6.
- Mache S, Eickenhorst P, Vitzthum K, Klapp BF, Groneberg DA. Cognitive-enhancing substance use at German universities: Frequency, Reasons and gender differences. *Wien Med Wochenschr*. 2012;162:262-71.
- Augustin M. How to learn effectively in medical school: test yourself, learn actively, and repeat in intervals. *Yale J Biol Med*. 2014;87:207-12.
- Maher B. Poll results: look who's doping. *Nature*. 2008;452:674-5.
- Heath D. Cultural factors in the choice of drugs. *Recent Dev Alcohol*. 1990;8:245-54.
- Ribeiro JC, Villanueva T. The new medical licensing examination in Portugal. *Acta Med Port*. 2018;31:293-4.
- Hill MR, Goicochea S, Merlo LJ. In their own words: stressors facing medical students in the millennial generation. *Med Educ Online*. 2018;23:1530558.
- Lucke JC, Bell SK, Partridge BJ, Hall WD. Academic doping or Viagra for the brain? *Nat Publ Gr*. 2011;12:197-201.
- PORDATA. Alunos matriculados no ensino superior na área da Saúde: total, por área de educação e formação e sexo. Published 2019. [accessed 2020 Jan 13]. Available from: <https://www.pordata.pt/Portugal/Alunos+matriculados+no+ensino+superior+na+área+da+Saúde+total++por+área+de+educação+e+e+formação+e+sexo-802-6552>.

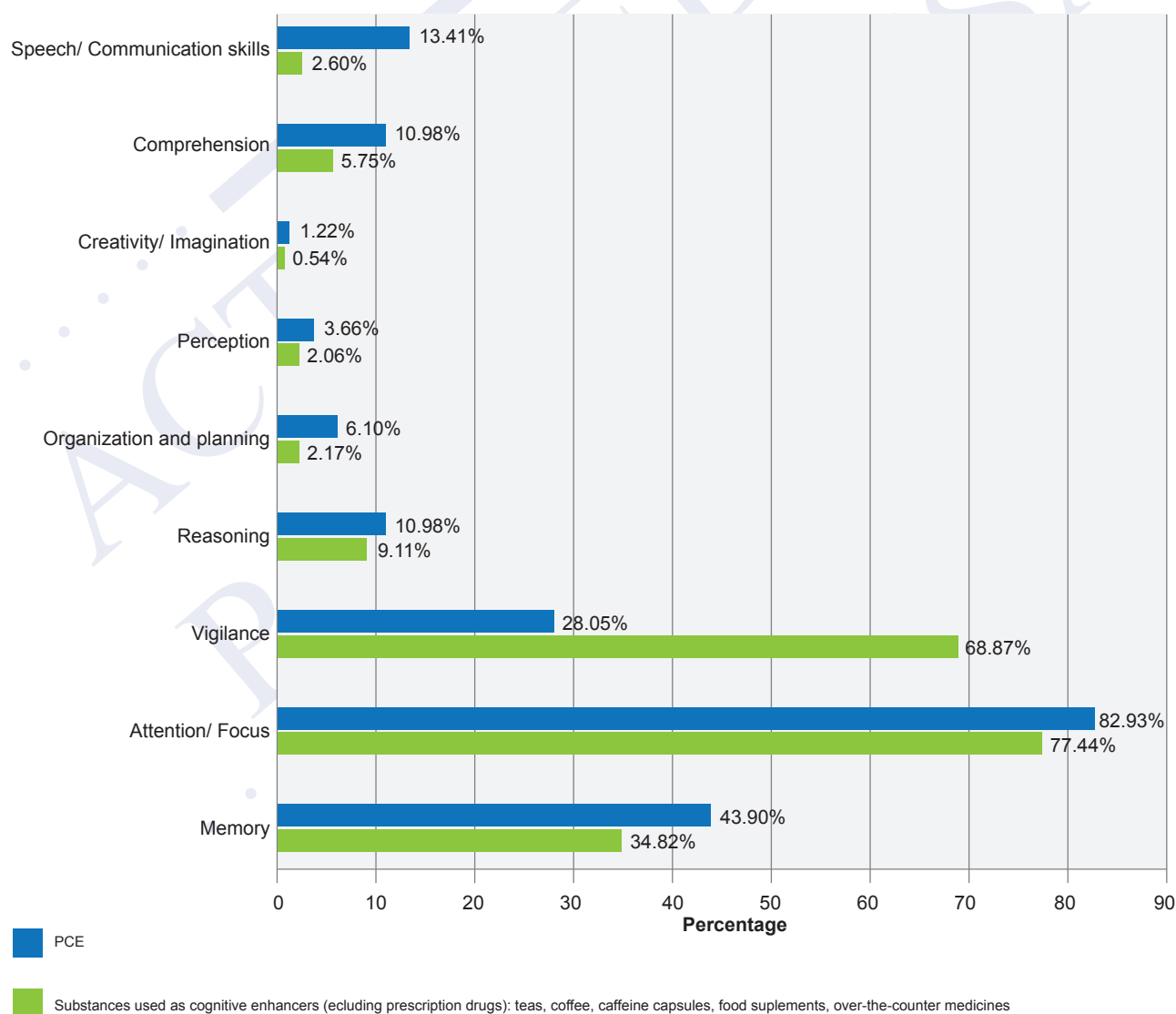
Table 1 – Demographic characteristics of the sample (n = 1156)

	Undergraduate students (group 1) n = 913	Licensing exam applicants (group 2) n = 243
Age in years, mean (SD)	21.60 (3.05)	25.23 (3.24)
Gender (%)		
Male	253 (27.7%)	58 (23.9%)
Female	660 (72.3%)	185 (76.1%)
Academic year		
1 st year	83 (9.1%)	
2 nd year	179 (19.6%)	
3 rd year	186 (20.4%)	
4 th year	83 (9.1)	
5 th year	218 (23.9%)	
6 th year	164 (18%)	
Faculty		
FMUL	454 (49.7%)	88 (36%)
FCMUNL	209 (22.9%)	30 (12.3%)
FMUP	48 (5.3%)	48 (19.8%)
ICBAS	10 (1.1%)	20 (8.2%)
FMUC	0 (0%)	0 (0%)
EMUM	84 (9.2%)	10 (4.1%)
FCSUBI	84 (9.2%)	15 (6.2%)
FMCBUA	3 (0.3%)	4 (1.6%)
Other (outside Portugal)	21 (2.3%)	28 (11.5%)

Medical Faculties in Portugal: Faculdade de Medicina da Universidade de Lisboa (FMUL), Faculdade de Ciências Médicas da Universidade Nova de Lisboa (FCMUNL), Faculdade de Medicina da Universidade do Porto (FMUP), Instituto de Ciências Biomédicas de Abel Salazar (ICBAS), Faculdade de Medicina da Universidade de Coimbra (FMUC), Escola de Medicina da Universidade do Minho (EMUM), Faculdade de Ciências da Saúde da Universidade da Beira Interior (FCSUBI), Faculdade de Medicina e Ciências Biomédicas da Universidade do Algarve (FMCBUA)

Table 2 – Means (*M*), standard deviations (*SD*) and *t*-test results for substances used by undergraduate students (group 1) and licensing exam applicants (group 2)

Substances	Undergraduate students (group 1)		Licensing exam applicants (group 2)		<i>t</i> (1154)	<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
Tea	1.71	1.11	1.76	1.15	-0.63	0.531
Food	2.15	1.29	2.18	1.40	-0.33	0.742
Coffee	3.39	1.33	3.78	1.31	-4.06	< 0.001
Caffeine capsules	1.14	0.58	1.23	0.71	-2.06	0.040
Energy drinks	1.41	0.82	1.62	0.89	-3.46	0.001
Food supplements	1.79	1.12	2.12	1.27	-3.97	< 0.001
Recreational drugs	1.03	0.24	1.09	0.46	-2.18	0.030
Over-the-counter medicines	1.23	0.68	1.40	0.89	-2.80	0.006
PCE	1.10	0.47	1.29	0.80	-3.62	< 0.001

**Figure 1** – Cognitive functions targeted when cognitive enhancers are used

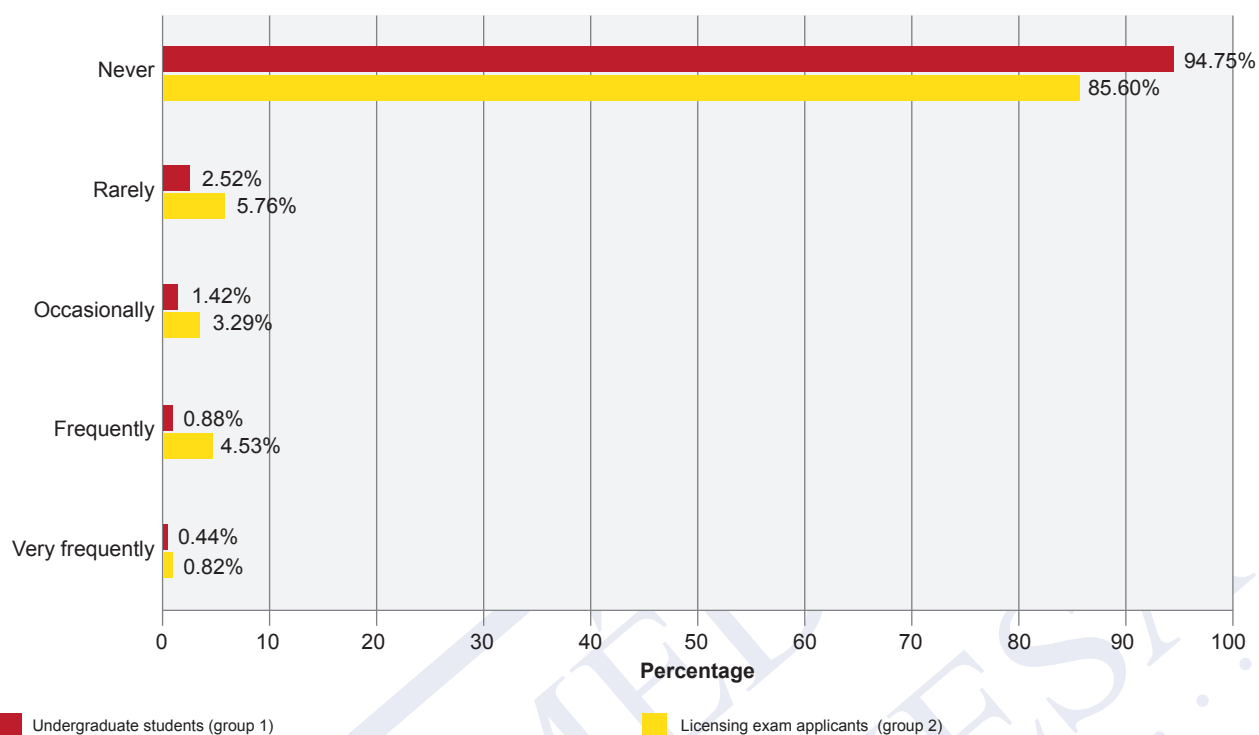


Figure 2 – Consumption of PCE according to undergraduate students (group 1) and licensing exam applicants (group 2)