

## Methylphenidate and cognitive enhancement in university students: a systematic review<sup>1</sup>

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**Objective:** There are a lot of information circulating through the non-scientific literature of the so called “intelligence pill”, name used to designate methylphenidate. Thus, the present systematic review gathered studies about the motivations, expectations, effects and damages of the non-prescribed use of methylphenidate by university students. **Methodology:** Systematic review between 2008 and 2015's years. **Results:** It is tough to get scientific data about the real motivations for methylphenidate's use, especially due to study's methodological limitations. **Research tools** have few investigations on the use of substances for cognitive enhancement. There have been found term effects, such as keeping alert state and increasing energy levels. These findings, in association with easily medication's access have been becoming university student's methylphenidate use a growing practice.

**Descriptors:** Students; University; Methylphenidate; Intelligence; Cognition.

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## Metilfenidato e melhoramento cognitivo em universitários: um estudo de revisão sistemática

**Objetivo:** Muitas informações circulam na literatura não científica a respeito da “pílula da inteligência”, termo utilizado para designar o metilfenidato. Assim, a presente revisão sistemática reúne dados sobre as motivações, expectativas, efeitos e prejuízos do uso não prescrito de metilfenidato por universitários. **Metodologia:** Revisão sistemática no período de 2008 a 2015. **Resultados:** Há escassez de dados científicos sobre as reais motivações desse uso devido especialmente às limitações metodológicas dos estudos. Os instrumentos de pesquisa pouco investigam o uso de substâncias voltado para melhoramento cognitivo. O uso está relacionado à manutenção do estado de alerta e aumento de energia. Tais achados aliado ao fácil acesso à medicação tem tornado o uso do metilfenidato, pelos universitários, uma prática crescente.

**Descritores:** Estudantes; Universidade; Metilfenidato; Inteligência; Cognição.

## El metilfenidato y la mejora cognitiva en los universitarios: un estudio de revisión sistemática

**Objetivo:** Hay una gran cantidad de información circulando en la literatura no científica sobre la “píldora de la inteligencia”, término usado para el metilfenidato. Por lo tanto, este estudio reúne datos sobre las motivaciones, expectativas, efectos y daños del uso no prescrito del metilfenidato por universitarios. **Métodos:** Revisión sistemática entre 2008 y 2015. **Resultados:** Hay falta de datos científicos sobre las motivaciones reales de este uso, principalmente debido a limitaciones metodológicas de los estudios. Los instrumentos de investigación poco profundizan sobre el uso de sustancias dirigidas a la mejora cognitiva. O uso está relacionado con la manutención del estado de alerta y aumento de energía. Estos resultados combinados con el fácil acceso a la medicación han hecho que el uso de metilfenidato, entre los universitarios sea una práctica creciente.

**Descriptores:** Estudiantes; Universidad; Metilfenidato; Inteligencia; Cognición.

### Introduction

Medicalization is a complex phenomenon present in modern society, characterized by the spread of medical influence in the different spheres of everyday life(1). Unpleasure, weariness and malaise prevent the pleasures of life, and medicines are advertised, with the participation of advertising industry, as saving and quick-resolving goods for any problem(2). The term neuroenhancement denotes interventions of targeted enhancement and extension of cognitive abilities in healthy people(3). In most cases these

interventions are made with licit or illicit substances called psychoactive substances (PASs). The use of PASs among university students has been widely publicized and debated because it involves economic interests of the pharmaceutical industry as well as ethical and legal issues(4). The academic environment requires high levels of dedication and work(5), and each student deals differently with the imposed stress load(6).

Methylphenidate, known by the trade names Ritalina® (Novartis) and Concerta® (Janssen-Cilag), is subject to special control due to the risk of abuse and

dependence(7) and is accompanied by notification of prescription A. In Brazil, it is prescribed to treat people with a diagnosis of attention deficit hyperactivity disorder (ADHD), narcolepsy or cataplexy(8). Its use outside such indications does not have its safety and efficacy recognized by regulatory entities(9). Methylphenidate in ADHD patients was associated with a statistically significant reduction in symptoms of inattention(10).

This effect, coupled with the increase of waking hours resulting from the psychostimulant activity of this drug(11), has motivated students from all over the world to use it as an aid in the studies, but the effectiveness of this use in healthy people has been questioned by the scientific literature for lack of evidence of the real effect in this population(6,12-14). According to US records, the production of methylphenidate increased by 298% from 1996 to 2006(15). In Brazil, from 2002 to 2006, the production increased about fivefold, from approximately 40 kg to 226 kg. In 2011, global consumption reached 52 tonnes, with the United States, Canada, Germany, Spain, the Netherlands, Israel, Sweden and Australia being the main consumers(5). The growth of methylphenidate production and consumption points to the need for a better understanding of its use, especially for the establishment of health actions(16). Studies showing the real use and abuse of methylphenidate among university students are sorely needed. They are relevant for the possibility to foster discussions about the medicalization of society. The present review sought to analyze the information available in the scientific literature about the non-prescribed use of methylphenidate by university students, especially considering the motivation, expectations, general e negative effects.

## Method

This is a systematic review(17-18) of the literature under the following guiding question: as there is a lot of talk in the lay media about the "smart pill" (methylphenidate), what have scientific studies indicated about the motivations, expectations, effects and damages of the non-prescribed use of methylphenidate by university students worldwide?

We used the PubMed, ScienceDirect, Scopus, LILACS, IBECs, MEDLINE, Cochrane and Scielo databases and the following descriptors or combinations of words, in English or Portuguese: "Neuroenhancement", "College Students", "Methylphenidate", "Ritalin", "Metilfenidato", "Universitários" and "Ritalina". The following criteria were adopted to include articles: original articles or reviews with abstracts and full

texts available for analysis, published in the English or Portuguese languages between the years of 2008 and 2015. Articles carried out with university students and the research done in animals or people on the risks and benefits of using methylphenidate were also considered. The searches were performed by six reviewers, following the same procedure, with the purpose of validating the results found. Articles that did not meet the proposed objectives were excluded, specifically those that did not address methylphenidate or those that addressed its prescribed use. Initially, all titles that appeared in all the databases chosen for the research using the descriptors or their combinations and filtered by the period and languages previously mentioned were read. The articles whose titles indicated that they met exclusion criteria were not selected; the others had their abstracts read. Those that met the objectives of the present study were read in full length. At the end, 126 articles were read, and of these, 24 original articles and 10 review articles were included in the final sample of the present systematic review. Based on the evaluation of the contents of the chosen references, four categories of analysis and discussion were created according to thematic or categorical analysis(17,19), namely, Potential risks and benefits of the use of methylphenidate by healthy individuals/ animal models; Motivation and expectations of use; Strategies for obtaining methylphenidate and Comparison between national and international researches.

## Results

Thirty-four articles met the established inclusion criteria, including ten review articles and twenty-four original articles. The predominant language of publication was English (26), followed by Portuguese (8). Most studies were published in the last three years: 2015 (0), 2014 (11), 2013 (9), 2012 (2), 2011 (5), 2010 (4), 2009 (2), 2008 (1). As for the methodological design, the original studies had different approaches: quantitative (10), qualitative (7) and qualitative-quantitative (7). The reviews varied between: systematic (5), integrative (2) and narrative (3). From the twenty-four original studies, three had been conducted with animals - rats or mice - and twenty-one with human beings. Of the twenty-one last ones, fourteen had been carried out with university students, one with physicians and six with healthy people. The studies were developed in several countries: the United States (12); United Kingdom (4); Germany (3); Canada (1); Iran (1); Belgium (1); Switzerland (1) and Australia

(1). A total of 10 Brazilian publications were identified, including 2 narrative reviews, 1 systematic review and 7 original articles. Among the Brazilian publications studies, the systematic review and one original article had been published in English, and the remaining eight studies in Portuguese, as can be seen in Figure 1.

Figure 1 - General characteristics of the included studies (Subtitles: UK = UK; BRA = Brazil; USA = United States; GER = Germany; SWI = Switzerland; AUS = Australia; BEL = Belgium; CAN = Canada).

Author	Country/ language	Study/Method	Sample
Robinson et al. 2008	UK/English	Original/Experimental/Quantitative	32 rats
Dantas 2009	BRA/Portuguese	Narrative Review	-----
Ortega et al. 2009	BRA/Portuguese	Narrative Review	-----
Advokat 2010	USA/English	Integrative Review	-----
Andrade et al.2010	BRA/Portuguese	Original/Questionnaire/Quantitative	12.711 university students
Crockett et al.2010	UK/English	Original/Experimental/Quantitative	13 healthy young people
Repantis et al.2010	GER/English	Systematic review	-----
Barros&Ortega 2011	BRA/Portuguese	Original/Exploratory - focus groups/Qualitative	20 university students
Cruz et al. 2011	BRA/Portuguese	Original/Questionnaire closed/Qualitative	1025 Medicine students
Habibzadeh et al. 2011	Iran/English	Original/Self-administered questionnaire/ Qualitative-quantitative	310 Medicine students
Reske et al. 2011	USA/English	Original/Experimental/Quantitative	155 university students
Smith&Farah 2011	USA/English	Systematic review	-----
Cesar et al. 2012	BRA/Portuguese	Original/Data from the "I National Survey On the Use of Alcohol, Tobacco, and Other Drugs among University Students of the 27 Brazilian Capitals"/Qualitative-quantitative	12.711 university students
Salek et al. 2012	USA/English	Original/Experimental/Quantitative	Rats
Carneiro et al.2013	BRA/Portuguese	Original/Questionnaire/Qualitative	160 Medicine students
Finger et al. 2013	BRA/English	Systematic review	-----
Ilieva et al. 2013	USA/English	Original/Experimental/Quantitative	46 Healthy young people
Lustig et al. 2013	USA /English	Integrative Review	-----
Maier at al. 2013	SWI/English	Original/Questionnaire online/Qualitative- quantitative	28.118 students
Mazanov et al. 2013	AUS/English	Original/Exploratory - online/Quantitative	1729 university students
Mommaerts et al. 2013	BEL/English	Original/Experimental/Quantitative	21 students
Ragan et al. 2013	UK/English	Systematic review	-----
Urban & Gao 2013	USA/English	Narrative Review	-----
Brandt et al. 2014	USA/English	Original/Questionnaire online/Qualitative	2600 university students
Carmack et al. 2014	USA/English	Original/Experimental/Quantitative	51 rats
Chen et al.a 2014	USA/English	Original/Data from the national survey on drug use and health/Qualitative-quantitative	170.042 teenagers and young adults
Chen et al.b 2014	USA/English	Original/Data from the national survey on drug use and health/Qualitative-quantitative	1173 teenagers and 3772 young adults
Gahr et al. 2014	GER/ English	Original/Data from the German Federal Institute linked to medicines and medical devices/ Qualitative	1190 patient records
Hidt et al. 2014	GER/English	Original/Interview/Qualitative	18 university students
Mota & Pessanha 2014	BRA/Português	Original/Descriptive/Qualitative	150 university students
Ponnet et al. 2014	UK/English	Original/Questionnaire/Quantitative	130 physicians
Romach et al. 2014	CAN/English	Systematic review	-----
Silveira et al. 2014	BRA/English	Original/Questionnaire/Qualitative-quantitative	152 Medicine students from 5th and 6th years
Wu et al. 2014	USA/English	Original/Data from the national survey on drug use and health/Qualitative-quantitative	229.705 teenagers and young adults

Among the original studies, only one(36) evaluated the adverse reactions of the use of methylphenidate. The risks and benefits of methylphenidate were tested in animals in three studies(37,42,47) and with healthy people in six studies(41,43-47,49). The evaluation of motivations and expectations of use by university students was investigated in ten studies (12-13, 36, 50, 52-57) and the way to obtain the medication was evaluated in seven studies(50,53-54, 57-60).

## Discussion

Modern society has adopted a set of practices that end up consolidating use of drugs as quick solutions for every problem(2). Students across the world have used various substances to enhance their academic performance and help with concentration, attention and focus(50). There is thus an increasing need for educational regulation and research to investigate the impact of such use on the health of healthy individuals. After reading the articles, extracting and analyzing relevant information to answer the guiding question, the information was organized into four categories: Potential risks and benefits of the use of methylphenidate by healthy individuals/animal models; Motivations and expectations of use; Strategies for obtaining methylphenidate and Comparison between national and international researches.

### Potential risks and benefits of the use of methylphenidate by healthy individuals/animal models

The researches that comprised this category focused on the analysis of risks and benefits of a fundamentally biological nature, not focusing on the discussion of the subjective dimension of the risk-benefit analysis. Moreover, it is important to point out that some articles mention that the sample studied was composed of healthy individuals/animals. In this context, the term "healthy" refers to individuals or animal models free of any known disease that could justify the medical use of a PAS. Specifically regarding methylphenidate, the term "healthy" excludes ADHD, narcolepsy, and cataplexy(8-9). To date, there is insufficient data to conclude that the use of methylphenidate can significantly improve the cognitive abilities in healthy individuals, but nonetheless its non-prescribed use has been an increasingly common practice, especially among college students. One possible explanation for the increase in the prevalence rates of this use is that university students seem to ignore the negative

effects and overestimate the possible positive effects. There are indications that methylphenidate causes effects similar to those caused by illicit PASs, such as cocaine, causing feelings of euphoria, stimulation and alertness, which in the long term may trigger disorders such as paranoia and schizophrenia(20-22). Several studies(23-35) found the following adverse reactions of the use of methylphenidate: discreet increase in heart rate, headache, anxiety, nervousness, dizziness, drowsiness and insomnia. In general, such effects were infrequent and well tolerated. However, most of the studies were conducted in the short term or analyzed the effects of a single dose, hindering the evaluation of the development of dependence and tolerance(7). In contrast, a study investigating databases of a German Federal Institute for medicines and medical devices between 1999 and 2012 identified 23 reports of abuse and dependence on methylphenidate. Among these 23 cases, there were 5 reports of adverse reactions, such as major depression, personality disorder and the association of both. However, such findings are limited by the small sample size of the study(36).

A study with mice showed that the use of methylphenidate in low doses was able to improve memory in a fear conditioning task, but became harmful to this type of memory when used in high doses, despite the improved spatial memory. This finding is based on the fact that different doses of methylphenidate were able to potentiate different neural substrates, which are in turn activated in different types of memory(37). In healthy humans, the effects of methylphenidate also appear to be dose-dependent. Higher doses (greater than those indicated for the treatment of ADHD) increase locomotor activity and impair attention and working memory(38-39). Lower doses (equivalent to those prescribed for ADHD patients) improve cognitive performance and reduce locomotor activity(40). This is because at lower doses, the neurotransmitters dopamine and noradrenaline selectively bind to receptors present in the prefrontal cortex resulting in the intensification of executive functions without alteration in locomotor function; however, higher doses (above 5-19mg/Kg) cause neurotransmitters to bind indiscriminately to other cortical areas resulting in depression of the prefrontal cortex function by activation of inhibitory receptors and induction of locomotor hyperactivity(41). Besides the dose of methylphenidate, its acute or chronic use also appears to influence the results of the studies. A research conducted with mice investigated the effect of acute and chronic use of methylphenidate on the prefrontal cortex through electroencephalic records. The acute use led to an increased neuronal activity in comparison with basal activity, but the chronic use generated divergent

responses in animals. Some records were of increase while others were of reduction of the neuronal response, a fact explained by the cerebral modifications induced by prolonged use(42). A study conducted with 155 youths applied the Delis-Kaplan Verbal Fluency Test and found that acute use leads to improvement in verbal fluency already learned, while chronic use leads to greater cognitive rigidity and less flexibility, identified by the higher rate of error repetition(43). These findings are important because they address both the chronic use, common in treatments such as that of ADHD, and the acute use, usually adopted by healthy students.

The results of the effects of methylphenidate on cognition of healthy volunteers are still inconclusive and conflicting. In some studies, its use seemed to reduce impulsivity and improve attention(44-47), but these changes were not always found. A double-blind study of 36 healthy young people using multiple doses of methylphenidate (10, 20 and 40 mg) versus placebo (starch) found no difference in performance in any of the tests used to assess both memory and attention(48). Another study pointed out that the use of stimulants in adults without ADHD can impair performance in tasks that require adaptation, flexibility and planning(49). A number of factors need to be considered when evaluating cognitive responses in healthy individuals, and the first one is the difficulty to find tests that are sensitive enough to detect a significant difference between basal cognition and a certain enhancement, because healthy individuals do not present cognitive deficits(3-4,48). Moreover, neuropsychological research in humans should consist of tests that evaluate more than one single cognitive process. Mood, motivation, alertness, attention, memory, and executive functions should also be assessed(3,48). It also seems that the effects are varied, depending on individual doses, genetic characteristics and the personality of the subject, and on skill levels and specific tasks, which go beyond the cognitive effects themselves(4). Overall, the analyses of the existing studies do not provide any consistent evidence in terms of benefits of the use of methylphenidate by healthy individuals.

### Motivations and expectations of use

Students across the world have used various substances to improve academic performance(50). There is therefore an increasing need for critical discussions and research to investigate the impact of such use on the health of such individuals. The motivations for abusive use of PASs are multifactorial. Regarding methylphenidate, three reasons for non-prescribed

use (non-medical use) are known: recreational - energy during leisure activities; aesthetic - weight loss; and cognitive enhancement(51). Cognitive enhancement is related to the expansion of psychic abilities such as perception, attention and memory, and executive functions such as planning and problem solving(52). The reasons most often found in studies and reported by students for the non-prescribed use of methylphenidate were: to aid in concentration or to study, followed by the enhance of recreational moments(36, 50, 53-54). A study with 1729 Australian college students found that 116 of them had taken methylphenidate, 46 of modafinil and 1232 of caffeine, and its derivatives with the justification of better "studying". They reported that they wanted to stay awake and improve their concentration and focus(52). Among Iranian medical students, the highest consumption rate was among students with lowest grades that sought to improve school performance(12). Another study pointed out that of 6,275 Swiss students, 868 (13.8%) had already used PASs at least once in their lives, with 5.8% of students reporting having used methylphenidate without prescription for cognitive or recreational use(13). Some motivations cited were: increasing learning, performance, alertness, and relaxation, improving sleep, helping to deal with pressure, improving memory, reducing fatigue and managing the limited time available to complete tasks(13). A research carried out with 18 students from the University of Mainz (Germany) to detect those who had already made non-medical use of PASs for cognitive improvement found that 8 of them had already used methylphenidate and 4 had used both methylphenidate and other illicit stimulants for this purpose. Most college students began using it for recreational and, secondly, cognitive purposes. The students reported that the main objective was not to improve school grades, but to have more energy, concentration, attention and willingness to study and to reconcile studies with an active social life(55). From the 152 students in a medical school in Brazil, 35 had already made non-prescribed use of methylphenidate, including 16 that reported using it daily or weekly, and the motivations cited were: to help in studies, to improve concentration, to stay awake and to go to parties(56).

Few data exist on the effects perceived by students in relation to their cognitive and academic performance. A review of the literature(4) cited 7 studies investigating the use of PASs in university students, but none of them asked students about the perceived effects and effectiveness of the use. The difficulty in obtaining such data is closely linked to the methodological limitations of the studies. Research instruments do little to directly investigate the use of substances for

cognitive enhancement, and when they do, they differ in the way the questions are made. This variability can lead to non-homogeneous responses and data. Questions about improvement of cognitive performance are not always explicit; sometimes they are indirect such as "use to help with work" and "use related to study." In a study with healthy university students who had already made licit or unlawful use of PASs (including methylphenidate), the expectations of use reported by students were: being able to study longer without feeling bored - a student reported that he was able to study for 12 hours with no letup; not feeling sleepy even after an entire night studying under the effect of methylphenidate; improving memory, concentration and attention, and facilitating the learning of what is read(55). A study with 160 students from the medical school of a university center in the state of Rio de Janeiro found that 13.51% of the students reported using methylphenidate to study for all the tests of the academic semesters and that 86.49% of those who used methylphenidate, indiscriminately reported an increase in the power of concentration and 54.05% observed an improvement in academic performance, reaching their expectations(57). The expectations reached involve the belief in the capacity of methylphenidate to directly reinforce cognitive ability despite the lack of support for this effect in healthy individuals(55,48). This shows that the mere suggestion, whose perception is based on the individual's faith, can generate positive results for the subject without there being clear scientific demonstration of such effects; this is known as placebo effect. Placebo effect is one of the factors that may explain the inconsistency between beliefs that stimulant drugs improve cognitive performance and the lack of objective evidence in the studies. The subjective perception of cognitive potentiation may explain the fact that individuals feel improvements in their performance, although without real measurable evidence(45). The use of methylphenidate for only one week was enough to significantly increase the subjective feelings of energy in healthy individuals; however, the analyses of the studies found no explanation for such potentiating effect on neuronal activity. Most evaluations involve subjective judgments of the effects of substances, but it should be noted that most of the times, subjective effects are what motivate people, and not the apparently objective results of the studies(3).

### Strategies for obtaining methylphenidate

The purchase of methylphenidate without a prescription is certainly not legal and there are penalties

ranging from fines to prison depending on the country. In the UK, the resale of prescribed drugs can lead to 14 years in prison and despite of this, there are several online pharmacies that provide these drugs(4). The most common source to illegally obtain PASs is through friends or relatives who purchase the medication with prescription(50,53-54,57-60). A study of 1253 American students found that 61.7% of college students diagnosed with ADHD reported having passed their prescriptions to others(53). Although there are reports of purchase of non-prescribed stimulant drugs through the internet, this is still the least used mean for this purpose(53). One study found that 20% of individuals who misused ADHD medications were able to obtain fraudulent prescriptions by simulating symptoms or seeking doctors who were known to not question patients(50). Among Swiss university students who used PASs for cognitive improvement purposes, 15.4% received the medication through medical prescription, 14.7% obtained it from other students, and 12.9% obtained the drug through people with prescription; from the participants, 5.9% reported that their parents were the source of the prescribed drugs or the illicit PASs for the purpose of cognitive improvement(13).

### Comparison between national and international researches

Data on the prevalence of use of PASs are crucial to guiding measures to regulate such use and to obtain a balanced view of risks and benefits for individuals and for society(4). Any future regulation would have to weigh the minimization of risks and damages and maximization of benefits, especially for cognitive enhancement. The Israeli Medical Agency, for example, has launched a guideline with official guidelines on prescription by doctors and dispensing of substances used for cognitive enhancement for non-therapeutic purposes(4). There are controversial issues that guide the discussion of the use of PASs by healthy people. The director of the National Institute of Drug Abuse of the United States comments on the perspective of developing a drug to improve the memory that would work in healthy people and present no side effects. She sees this as something positive(61). In turn, the professor and director of the Neuropsychopharmacology Unit of the Brain Science division of the Hammersmith Hospital raised a debate on political, moral and equity issues. People who would have access to these medications would probably be the ones with the highest purchasing power, thus posing those who might not have access to such drugs in an unfavorable position, besides the fact that this idea characterizes a kind of "cognitive doping".

In his introduction, he even extrapolated the fact to a context of worldwide dimension and importance, where countries with greater economic power, in which the population would have more access to medication, would probably stand out even more economically, increasing the inequalities in relation to others countries. However, he emphasized that the development of this type of substance should be supported and encouraged(61). Some neuroscientists have published in a journal of great scientific relevance an article where they discussed the possibility of society accepting the benefits of pharmacological cognitive enhancement and explained that if such effectiveness is proven and well regulated, it would have much to offer individuals and society. According to them, PASs would contribute to scientific and technological advancement in search for cognitive improvement. However, they argue that everything must be done with proper user safety through well-conducted, evidence-based studies that address short- and long-term risks and benefits. They also discuss the issue of access equity and cognitive doping by proposing an investment in studies in this area(62).

In Brazil, the discussions about use and abuse of PASs are usually held in the lay media and not in the scientific literature. National scientific production on the uses of methylphenidate is largely linked to research on ADHD. Other diagnoses and other uses, such as non-prescribed (non-medical) use, are somewhat neglected by Brazilian research(16). In 2010, a bibliographical review on methylphenidate systematically analyzed all the Brazilian psychiatry journals indexed in the Scielo database between 1998 and 2008 and the newspapers and magazines with the largest national circulation, aimed at the lay public. Altogether, 103 publications were identified, 72 of which had been published in newspapers and periodicals of great circulation and 31 in journals of psychiatry. The non-prescribed use of the drug was not addressed in any of the scientific publications surveyed(16). In the current systematic review that covered the period from 2008 to 2015, 7 national publications were found on the subject researched(8,15-16,51,56-57,63). One study (15) used data from the "First national survey on the use of alcohol, tobacco and other drugs among university students from 27 Brazilian capitals"(64) and elaborated the first Brazilian manuscript that investigated the prevalence of methylphenidate use in a sample of Brazilian university students. The national survey was conducted between 2009 and 2010, with 12,294 university students from 27 Brazilian capitals, and found that only 110 university students (0.9%) used methylphenidate in their lives, showing that contrary to the reported in lay media and in international studies, the use of methylphenidate by

university students seemed to be rare(15,64). The social representations that Brazilian university students have about the use of methylphenidate to improve academic performance was investigated. All participants stated that they had never used methylphenidate, and only two had had contact with the theme before the survey. Although the interviewees had little information about methylphenidate, they were aware of the practice of cognitive enhancement with the use of coffee and other medicines. The majority of respondents considered that use of a "cognitive enhancer" could be allowed if certain "conditions" such as biosafety, large public awareness, and the actual availability of the drug for all were guaranteed(51). A study conducted to verify the frequency of non-prescribed use of methylphenidate among medical students in a public college in Brazil found that less than 10% of students (16 of 186 participants) reported having used methylphenidate without prescription at some point in life. About 35% of the students reported that they knew someone who had the habit of using non-prescribed methylphenidate and 32.8% thought that the use of this PAS in medical school was abusive. The study was important because it was one of the first to address this theme in the national literature(63). In a cross-sectional study, from the 160 students in the 1st to 8th semesters of the course of medicine at a university in the south of Brazil, 33 reported that they had or did non-medical use of methylphenidate, 10 of whom said that even having side effects, they continued using it according to their academic needs. An increase in use was observed along the course, because there was a greater distribution of participants in the last semesters analyzed(57). Prevalence, main reasons for use, forms of acquisition and possible side effects were investigated in pharmacy and medical students. Among a total of 150 university students, 60%, or 90 university students, answered that they already used methylphenidate during the course, and among those who had already used, 87% bought the drug without medical prescription; 92% used it during test seasons; 8% used it to improve classroom and traineeship performance, and 57.7% stated that at the end of the course, they intended to continue using methylphenidate(8). A study conducted at a private university in southern Brazil with 152 students in the 5th and 6th year of a medical school found that 34.2% of the students had already used methylphenidate, and of these, 23.02% reported using it for non-medical purposes. A percentage of 85% of students started using the drug in college, what is in accordance with a study done at an American public university, where 79% of students began using methylphenidate in college. Among medical graduates, 44.7% said they agreed



with the use methylphenidate by healthy people, and 20.4% said they would prescribe the drug to improve concentration in healthy students. Furthermore, the number of students of the 6th year who reported using methylphenidate was more than twice as high as the number of fifth-year users. According to the authors, this increase in the use of methylphenidate in the last year of the university may be related to the exams for medical residency, leading to the conclusion that the non-prescribed use of methylphenidate may increase in more competitive situations(56).

## Conclusion

In recent years, non-prescribed use of methylphenidate among undergraduates has been the subject of a number of studies worldwide. However, while this widespread and indiscriminate use has extensively been approached by international research, national surveys are still at an early stage. It is necessary to investigate the real risks and benefits that non-prescribed use can offer to the health of healthy individuals. Current data are still inconclusive to indicate or disprove the use of methylphenidate and other PASs for cognitive enhancement purposes. The non-prescribed use of methylphenidate goes far beyond an epidemiological survey, touching medical, social, ethical, legal and public health issues that should be debated in the scientific, political, academic environments and general society.

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