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Assessment of knowledge, perception, attitude, and use of performance-enhancing substances among students of Faculty of Medicine, Alexandria University, Egypt: a pilot study

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Abstract

Background: The market for performance enhancement substances (PESs) is currently one of the fastest expanding sectors. Most studies have always concentrated on athletes in terms of PESs' misuse, ignoring a critical segment of the community: the future health-care workers. Thus, the aim of the study was to probe the knowledge, perception, and attitude of medical students regarding the misuse of PESs in sports and medical academic study. A cross-sectional study was conducted among students of Alexandria Faculty of Medicine, Egypt. Data were collected via self-administered electronic survey from 208 students of both sexes (aged from 18 to 26 years old). Analysis of factors affecting the consumption of PESs like gender differences, and their prior knowledge and perception was performed using logistic regression models.

Results: More than half of the participants have no idea about law concerning the use of doping substances. There were no significant disparities in knowledge and perception between males and females. Female students, on the other hand, consistently reported having a better understanding of the negative impacts of PESs' misuse. Surprisingly, females are more prone to consume PESs for cognitive enhancement rather than the physical performance.

Conclusions: The study is the first to explore the awareness of the medical students, their attitude, and perception towards different ethical scenarios confronted in the daily practice. This finding pinpoints that the common trend of striving for fitness and an ideal body shape and weight has produced a shift in the prevalence of the PESs use according to gender in Egypt. Moreover, females in medicine academics are more prone to use PESs to improve the cognitive functions albeit it is nonsignificant statistically. Therefore, efforts should be directed to raise the awareness of medical practitioners of diverse categories of these substances, health hazards, laws, and penalties. More importantly, policy measures for their production, marketing, and misuse among university students should be reconsidered by the government.

Keywords: Doping agents, Females in STEM, Energy drinks, Medical students, Adolescents

Background

Today individuals continue to employ a wide variety of drugs in the hope of improving both performance and appearance (body image). With the widespread of commercial fitness centers, recreational athletes are

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searching to enhance their muscular build-up (Cascais 2019). Physical doping is defined as the use of illicit or prohibited chemicals to increase physical performance in sports, whereas "physical enhancement" refers to the use of legal or readily available substances to boost sports performance (Dietz et al. 2013). Doping substances are defined by the World Anti-Doping Agency (WADA) as "any substance that meets at least two of the three criteria: it enhances athletic performance; it violates what WADA calls 'the spirit of sport' or it presents a health risk to athletes" (WADA 2021). According to the recent update announced by the World Anti-Doping Agency (WADA) in 2021, stimulants (amphetamines), androgenic-anabolic steroids, synthetic peptide hormones (growth hormone releasers), beta 2 agonists, narcotics, and diuretics (masking agents) are among the list of prohibited substances in and outside competitions (World anti-doping code international standard prohibited list 2021).

The performance-enhancing substances (PESs) have the potential to drastically pose health hazards especially if misused, without medical supervision. Cases with cardiovascular and hepatic adverse health consequences have been reported (Vanberg and Atar 2010; Solimini et al. 2017). Aggression/violent behavior, suicidal attempts, and even sudden death have been reported following the nonprescribed use of anabolic androgenic steroids (Klötz et al. 2006). Exogenous anabolic steroids have negative impact on the male reproductive function, by direct testicular damage (Nieschlag and Vorona 2015; Sansone et al. 2018).

Energy drinks are caffeinated beverages that contain additional ingredients such as taurine, vitamins (B3 niacin, B6, B 12 and folic acid), herbal extract, minerals, and simple sugars (glucose or inositol). They are advertised as both mental and physical stimulants. These beverages are popular in the Egyptian market, and a range of brands are available for purchase by people of all ages (Clauson et al. 2008; Higgins et al. 2010). The use of energy drinks, often known as "energy shots," has expanded dramatically, particularly among young people, with the age group 18 to 35 years being the most targeted, as younger consumers are often more attentive to global trends (Reissig et al. 2009).

Further, doing sport by non-athlete people in the form of recreation or physical fitness sports is associated with using doping substances for achieving the so-called the ideals of health and fitness in today's society (Ljungqvist 2016).

Due to the widespread use of these substances among diverse socioeconomic levels, the problem has been changed from an issue restricted to athlete category to a one of public health concerns. The research has been always focusing on the athletes, sport players, in terms of their awareness, abuse of doping agents, and neglecting one of the most crucial sectors in the health care system, the physicians (Whitaker et al. 2012; Kim and Kim 2017). In their everyday practice, health practitioners are confronted with medicolegal situations related to prescription of nutritional supplements, hormones, and recreational substances and giving some advice regarding specific class of PESs. In certain cases, they are not aware that certain pharmaceutical compounds are prohibited in competitions, or they wrote a prescription that is misused in doping (Auersperger et al. 2012; Prakash 2013). Physicians can be accused of malpractice concerning prescription of one of the banned substances like masking drugs triggered by poor knowledge from their part, facilitating the acquisition of doping substances, or occurrence of toxicities on long term exposure (Laure et al. 2003).

Cognitive enhancement may be described as "the improvement or augmentation of internal or external information processing systems to amplify or extend essential mental skills." The general population seeks both non-pharmacological and pharmaceutical enhancers to boost performance when studying and at work by enhancing focus, motivation, and accuracy through physical, behavioral, and biochemical processes (Bostrom and Sandberg 2009; Dresler et al. 2019).

Cognitive enhancers and performance-enhancing substances in sports shared numerous characteristics with regard to "enhancement" and "doping." While the former may be more socially acceptable, but the latter is considered unlawful and is closely controlled by organizations such as the World Anti-Doping Agency (WADA). It has been discovered that the use of readily available cognitive enhancers, such as caffeinated beverages and vitamins, among athletes can act as a "gateway" and "predictor" for the use of physically enhancing substances (Barkoukis et al. 2015).

Foremost, it is important to establish a definition for cognitive enhancement and/or doping. The term "cognitive doping" refers to the misuse of prescription cognitive enhancers for nonmedical purposes or to the use of other illicit substances by students in the competitive school environment in order to pass exams or get a higher grade. In contrast, cognitive enhancement refers to the legal use of these drugs or other legal and freely available cognitive enhancement agents, like caffeine which is in certain cases justifiable (Kodelja 2021). Thus, all forms of competition among students or athletes share some similarities despite the fact that doping in school is unregulated and doping in sport is officially forbidden due to their known drastic side effects, cheating in competition, and unfairness.

Nevertheless, the efficiency of the cognitive enhancement preparations is modest degrees at best, depending on individual baseline performance (Husain and Mehta 2011, Caviola and Faber 2015). The unequal access to smart drugs is not the problem because when equal access to smart drugs for all students would be granted, there is a possibility of occurrence of indirect coercion on students to use them in order to be able to compete (Kodelja 2021). Therefore, those students are taking unnecessary risks associated with the long-term use of these drugs on their health. Another drawback might be the "over-emphasis" on intellectual performance and exam results (Schermer 2008) in school.

It is conceivable now that under the stress of exams in medical faculties, some university students feel pressured to achieve high scores and enhance their mental and cognitive power by using "smart medicines" due to the competitive nature of the study for better job opportunities (Carton et al. 2018, Kusturica et al. 2019). Generally, the proportion of doping abusers reported in medical students in developed and developing countries has been considered low in different studies (Papadopoulos et al. 2006). There is a gap of knowledge in the literature analyzing the effect of gender on the use of PESs and the differences in the circumstances of use between both sexes have not been explored yet (Teetzel 2008). Several studies have neglected the effect of gender particularly females in science, technology, engineering, and mathematics (STEM) fields that may play in PESs use (Hyde et al. 2008; Yücel and Koç 2011; Chachra 2017). Anxiety levels in females' STEM may be higher than males in science and mathematics fields (Halpern et al. 2007).

The study was conducted for three reasons; it is the first one to probe the knowledge of medical students being part of the community fabric regarding performance-enhancing substances including energy drinks as well as their attitude and lifestyle in terms of consuming these substances/products. The second reason was to evaluate their perception of the role of physician, ethical aspect, in giving advice to family members, or prescribing the illegal substances to friends. The last reason was to propose recommendations to boost the community awareness and regulatory laws.

Methods

Study design, sampling, and settings

The research is a cross-sectional study delivered as an electronic survey conducted in the Faculty of Medicine, Alexandria University, Egypt. The sample of students was representative of students in the 4th years of the academic year 2019/2020. Students of a clinical round (n=286) were invited to participate in the online questionnaire. The number of participants was 208 and the response rate was 72.37% which is fairly good rate regarding an online survey, desirable and achievable (Nulty 2008). To avoid bias, the participant students (either in piloting or in the research afterwards) filled the questionnaire before the lecture of doping provided by the Forensic Medicine & Clinical Toxicology department.

Ethical approval and consent

The ethical committee of Alexandria University approved the study protocol (the serial number is 0304323). After explaining the study's goal and nature to participants, agreeing to participate in the questionnaire is regarded as an implied consent. Voluntarity, confidentiality, and anonymity were ensured and preserved.

Questionnaire (instrument) development

The questionnaire is a self-administrated one. It was constructed by the authors, after review of literature, then revised by experts for the construction and validity and clarity of the questions. First, a pilot study was performed on 30 participants, those were not included after that in the total number of medical students sharing in the study. Then, the questionnaire was modified accordingly, taking in considerations comments and suggestions and the time allocated to fill it. Any ambiguous question was clarified. The questionnaire was provided in English as the teaching in the faculty is in that language. The questionnaire was presented on the official web site of the faculty, using survey monkey to create it. The link was available for 1 month during the clinical round. It was closed after that time.

In addition to the first portion, which contains the participants' biosocial data (age and sex), the questionnaire has four main sections. *Knowledge assessment* in section two was evaluated by ten questions. Section three is specific for *perception of the participants* and entails nine questions. Regarding the fourth section, *attitude of the participants* was measured by nine questions. For the last part of the questionnaire, three different medicolegal situations were provided to probe the recommendations of the medical students. Attitude score was not calculated as questions in that section are variable, between open ended and yes/ no.

Statistical analysis

Data were transferred to Excel sheet and then to IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) for analysis. Pearson's chi-square test was used to evaluate the association between sex and response to the survey (Yes/No). Logistic regression analysis was applied to the variables showing significant association with PESs consumption. Variables in the study included the

following: *independent variables*: sex, knowledge score percent, and perception score percent, and *dependent variable*: use of any performance-enhancing substances. Internal validity/ consistency was evaluated by using Cronbach's alpha (Santos 1999). The responses were captured by using the 5-point Likert scale (Robinson 2014).

Results

Descriptive statistics: age and sex (mean, SD)

More than half of the participants were females (n=113, 54.5%), and males represented 45.5% (n=94). This was dependent on the students' distribution in that clinical training. The age ranged from 18 to 26 years old, with a mean of 22.04 ±1.08 years. One student preferred not to mention his/her sex (making the number 207); however, the participant answered all the items. All participants had completed the questionnaire (all items were answered) *except* in Q6 in attitude section, 2 items were missing.

The internal reliability or consistency of the scale using Cronbach's Alpha/alpha coefficient: a value equal to 0.7 or above is statistically accepted. Cronbach's alpha for the Knowledge section is 0.850 and for perception is 0.756 Attitude section was not assessed as questions are open ended. As regards the recommendation, it is 0.523 (lower, number of items to be assessed are only 3 questions). Reverse score was done for the knowledge section, those with correct answers is no, and it was recorded as no=1 and yes=0, question 5 "Which of the following substances are among the list of prohibited substances in Competition? Caffeine and Panadol. In addition to question 10 "Do you think that energy drinks are prohibited in competition? No".

Knowledge section

A scoring system was adopted to quantify respondents. Knowledge section included ten questions: Students' responses concerning their awareness and understanding of *doping types, hazards, and sanctions* are displayed in Table 1. For the first question "Have you heard about performance enhancing substances?" one quarter of the participants answered "no" (males 25.5% and 24.8% females), same percentage among both genders. The second question "Do you have any idea about the law concerning the use of doping agents?"; more than half of the students deny any idea about that issue (57.4% of males and 56.6% of females). Regarding the third query "Do you know what WADA is?" 78.7% of male participants and 84.1% of females picked the "No" choice. Coming to the fourth question "Do you have any idea about National Anti-Doping Organizations (NADO)?" nearly similar percentage of both sexes have reported no idea regarding this query (81.9% males and 82.3% females). No significant association was detected between sex and any of the above questions (p= 0.9, p=0.9. p=0.32, and p=0.94 respectively).

Table 1 Knowledge first 4 questions about PESs and regulations of their use in sports

Knowledge questions 1-4	Males	Females	No (%)	χ^2 (p)
Have you heard about performance-enhancing substances?				
Yes	70 (74.5)	85 (75.2)	155 (74.9)	
No	24 (25.5)	28 (24.8)	52 (25.1)	0.015 (0.901)
Total	94 (100)	113 (100)	207 (100)	
Do you have any idea about the law concerning the use of doping agents?				
Yes	40 (42.6)	49 (43.4)	89 (43)	
No	54 (57.4)	64 (56.6)	118 (57)	0.014 (0.907)
Total	94 (100)	113 (100)	207 (100)	
Do you know what WADA is?				
Yes	20 (21.3)	18 (15.9)	38 (18.4)	0.979 (0.322)
No	74 (78.7)	95 (84.1)	169 (81.6)	
Total	94 (100)	113 (100)	207 (100)	
Do you have any idea about NADO?				
Yes	17 (18.1)	20 (17.7)	37 (17.9)	
No	77 (81.9)	93 (82.3)	170 (82.1)	0.005 (0.942)
Total	94 (100)	113 (100)	207 (100)	

Person's chi-square test

Regarding the students' knowledge about *the list of prohibited substances in competition*, Table 2 summarizes the response of the participants and the prohibition status according to the (World anti-doping code international standard prohibited list 2021). More than half of the participants are aware about anabolic steroids (58.7%) and stimulants (50.5%). On the other hand, nearly three quarters of the students have no idea about other included prohibited agents: amino acid supplements (73.6%), diuretics (78.4%), and erythropoiesis stimulation (72.1%). *Caffeine and Panadol* were added to the list, being not prohibited, 23.1% and 11.1% of the students chose them as prohibited (Table 2).

Table 3 illustrates the gender variation in terms of their knowledge of PESs. By analyzing the answers concerning the side effects of anabolic steroids, more than half of the participants are aware of the side effects. Question 7 related to the *supplementation of growth hormone* side effects; 70% of participants are aware of the risk of glucose intolerance and hyperglycemia, and 63.3% are also oriented about the higher probability of coronary artery disease. However, more than half ignored the risk of cancer prostate (51.7%).

Table 2 Knowledge of list of prohibited substances (PESs) in sports among participants

List of prohibited substances in sports	True answer (Yes)	False answer (No)	Prohibition status
Anabolic steroids	122 (58.7%)	86 (41.3%)	Yes
Peptide hormones	66 (31.7%)	142 (68.3%)	Yes
Erythropoiesis stimulation agents	58 (27.9%)	150 (72.1%)	Yes
Amino Acid supplements	55 (26.4%)	153 (73.6%)	No
Diuretics	45 (21.6%)	163 (78.4%)	Yes
Caffeine	160 (76.9%)	48 (23.1%)	No
Stimulants	105 (50.5%)	103 (49.5%)	Yes
Panadol	185 (88.9%)	23 (11.1%)	No
Nutritional supplements	107 (51.4%)	101 (48.6%)	No
Energy drinks	81 (39.1)	126 (60.9)	No

Question 8 was designed to probe the knowledge about the side effects of *creatine supplementation*; "whether it is safe and legal?" same percentage was detected in the two categories. Regarding the *nutritional supplements*, most students 81.2% are aware about the components of these supplements, vitamins, proteins, and different minerals. As a surprise, 75.4% of the students ignore the use of these supplementations to increase muscle mass.

Coming to the consumption of energy drinks, more than two thirds of the students have no idea regarding the ingredients as only 27.7% give a positive response. "Do you think it is prohibited in competition?" 60.9% denied this statement. "Is it associated with adverse effects on the cardiovascular system?" more than half of the participants (57.5%) give a positive response on that point. "Do it enhance both physical and mental performance?" more than half of the students approved (51.7%) (Table 4).

Regarding the *knowledge score*, it was calculated as the sum of total 33 items included in knowledge section divided by maximum total (which is 33). Then, it is presented as a percentage (which is also the percent of correct answers), and the median was 57% so it was categorized as good: ≥57 and bad: below 57. Minimum score was 12% and the maximum was 87%. The average (mean) was 54.4% and the confidence interval at 95% (52.4–56.4).

Perception analysis

Table 5 illustrates the students' responses concerning their perception about the PESs, as a problem and their dangers. More than 75% of the students declare that doping substances are posing health hazards, and more than half think that it is a new problem in Egyptian community. Moreover, 65.2% of the participants perceived PESs as a drug addiction problem. Approximately equal proportion of the participants (62.3%) agreed that critical events in the athlete's career such as selection/ de-selection, recovery from injury or illness, and negotiating crucial sponsorship deals are posing psychological stresses and can increase the risk of doping. However, only 31.9% opined that doctor engaged in medically assisted doping should not be punished.

Perception score was calculated as sum of total 9 items divided by maximum total. 33 items included in the nine questions and divided by the total. Medium was 43%, minimum was 0%, and the maximum was 86.6%. There was no evidence of relationship between sexes and any of the perception questions.

Attitude and use evaluation

Table 6 displays the attitude of the students and the use doping substances. For the athlete medical students, males were significantly more frequently going to gym (p= 0.012). Only 13.8% of males used one of the PESs and less than 10% of female students had consumed in the past to enhance their physical performance. *Regarding the use of performance-enhancing substances, some students claim using Apifortyl* (is a multivitamin). Other mentioned the use of Strattera (generic name: atomoxetine hydrochloride) is an alternative to the stimulant attention-deficit hyperactive disorder (ADHD) medications most used to treat symptoms of attention-deficit hyperactivity disorder; it is a selective norepinephrine reuptake inhibitor (SNRI) medicine. Ginkovit (magnesium orotate) is a nutritional supplement. However, these compounds are classified as nutritional supplements but not classified as doping. *Recommendation analysis*, concerning reporting any non-medical use of doping substances to health authority, around 50% of the participants agree. Regarding adolescent education about the health dangers of the doping procedure, nearly 75% of the students agree (agree and strongly agree). There was no significant difference

Table 3 Knowledge of PESs among participants. The frequency of correct and incorrect answers for questions 5–9 in the knowledge section of the questionnaire for each sex (total 207)

Knowledge questions	Males	Females	No (%)	χ^2 (*p*)
List of prohibited substances in Competition				
Anabolic steroids				
Yes	**54 (57.4)**	**67 (59.3)**	**121 (58.5)**	**0.072 (0.789)**
No	**40 (42.6)**	**46 (40.7)**	**86 (41.5)**	
Peptide hormones				**5.701 (0.017) ***
Yes	**22 (23.4)**	**44 (38.9)**	**66 (31.9)**	
No	**72 (76.6)**	**69 (61.1)**	**141 (68.1)**	
Erythropoiesis stimulation agents				**5.203 (0.023) ***
Yes	**19 (20.2)**	**39 (34.5)**	**58 (28)**	
No	**75 (79.8)**	**74 (65.5)**	**149 (72)**	
Amino acid supplements				**2.521 (0.112)**
Yes	**30 (31.9)**	**25 (22.1)**	**55 (26.6)**	
No	**64 (68.1)**	**88 (77.9)**	**152 (73.4)**	
Diuretics				**4.743 (0.029) ***
Yes	**14 (14.9)**	**31 (27.4)**	**45 (21.7)**	
No	**80 (85.1)**	**82 (72.6)**	**162 (78.3)**	
Caffeine				**0.856 (0.355)**
Yes	**19 (20.2)**	**29 (25.7)**	**48 (23.2)**	
No	**75 (79.8)**	**84 (74.3)**	**159 (76.8)**	
Stimulants				**4.072 (0.044) ***
Yes	**40 (42.6)**	**64 (56.6)**	**104 (50.2)**	
No	**54 (57.4)**	**49 (43.4)**	**103 (49.8)**	
Panadol				**1.289 (0.256)**
Yes	**13 (13.8)**	**10 (8.8)**	**23 (11.1)**	
No	**81 (86.2)**	**103 (91.2)**	**184 (88.9)**	
Nutritional supplements				**3.971 (0.046) ***
Yes	**41 (43.6)**	**65 (57.5)**	**106 (51.2)**	
No	**53 (56.4)**	**48 (42.5)**	**101 (48.8)**	
Among Anabolic Androgenic Steroids side effects				
Anger and mood liability				**1.816 (0.178)**
Yes	**75 (79.8)**	**81 (71.7)**	**156 (75.4)**	
No	**19 (20.2)**	**32 (28.3)**	**51 (24.6)**	
Diminished spermatogenesis and fertility				**0.053 (0.818)**
Yes	**72 (76.6)**	**85 (75.2)**	**157 (75.8)**	
No	**22 (23.4)**	**28 (24.8)**	**50 (24.2)**	
Virializing effects in females				**3.726 (0.054)**
Yes	**50 (53.2)**	**75 (66.4)**	**125 (60.4)**	
No	**44 (46.8)**	**38 (33.6)**	**82 (39.6)**	
Hepatic problems up to liver tumors				**0.181 (0.671)**
Yes	**65 (69.1)**	**75 (66.4)**	**140 (67.6)**	
No	**29 (30.9)**	**38 (33.6)**	**67 (32.4)**	
Psychological as anxiety and major depression				**0.042 (0.837)**
Yes	**67 (71.3)**	**82 (72.6)**	**149 (72)**	
No	**27 (28.7)**	**31 (27.4)**	**58 (28)**	
Growth hormone side effects				
Glucose intolerance and hyperglycemia.				**2.468 (0.116)**
Yes	**71 (75.5)**	**74 (65.5)**	**145 (70)**	
No	**23 (24.5)**	**39 (34.5)**	**62 (30)**	

Table 3 (continued)

Knowledge questions	Males	Females	No (%)	χ^2 (*p*)
Increased risk of coronary artery disease				**1.035 (0.309)**
Yes	**63 (67)**	**68 (60.2)**	**131 (63.3)**	
No	**31 (33)**	**45 (39.8)**	**76 (36.7)**	
Increased risk of prostate cancer				**0.013 (0.909)**
Yes	**45 (47.9)**	**55 (48.7)**	**100 (48.3)**	
No	**49 (52.1)**	**58 (51.3)**	**107 (51.7)**	
Altered skin texture				**0.931 (0.335)**
Yes	**52 (55.3)**	**70 (61.9)**	**122 (58.9)**	
No	**42 (44.7)**	**43 (38.1)**	**85 (41.1)**	
Risk of infection transmission				**5.153 (0.023) ***
Yes	**48 (51.1)**	**40 (35.4)**	**88 (42.5)**	
No	**46 (48.9)**	**73 (64.6)**	**119 (57.5)**	
Creatine supplementation				
Associated with weight gain				**5.477 (0.019) ***
Yes	**68 (72.3)**	**64 (56.6)**	**132 (63.8)**	
No	**26 (27.7)**	**49 (43.4)**	**75 (36.2)**	
Unsafe in the age group <18 years				**1.048 (0.306)**
Yes	**74 (78.7)**	**82 (72.6)**	**156 (75.4)**	
No	**20 (21.3)**	**31 (27.4)**	**51 (24.6)**	
Has a positive effect on the strength power				**1.284 (0.257)**
Yes	**70 (74.5)**	**76 (67.3)**	**146 (70.5)**	
No	**24 (25.5)**	**37 (32.7)**	**61 (29.5)**	
Creatine supplements are safe and legal				
Yes	**50 (53.2)**	**54 (47.8)**	**104 (50.2)**	**0.599 (0.439)**
No	**44 (46.8)**	**59 (52.2)**	**103 (49.8)**	
Nutritional supplements				
Used to increase muscle mass and quality				**0.003 (0.959)**
Yes	**23 (24.5)**	**28 (24.8)**	**51 (24.6)**	
No	**71 (75.5)**	**85 (75.2)**	**156 (75.4)**	
Nutritional supplements include vitamins, proteins and minerals				**0.668 (0.414)**
Yes	**74 (78.7)**	**94 (83.2)**	**168 (81.2)**	
No	**20 (21.3)**	**19 (16.8)**	**39 (18.8)**	

Person's chi-square test, *significant if $p \leq 0.05$

between both sexes (p=0.245, p=0.808, and p=0.459, respectively (Table 7). The last question is open ended to encourage the participants to give suggestions and more advice.

Logistic regression to predict attitude towards performance-enhancing agents among medical students

The knowledge and perception scores were used as an independent variable each in the univariate equations to predict the attitudes of medical students towards the use of performance-enhancing agents in the gym for physical enhancement (Q2) versus improving the mental performance during academic study (Q4). Surprisingly, a statistically significant relation (p=0.048) was found only between knowledge score and usage of doping substances for physical enhancement with odds ratio of 1.034 and 95% CI (1.00 to 1.069). Although it has not been shown in this study that sex is a contributing factor to increase use of PESs in cognitive enhancement, the reported Nagelkerke R^2 for group 2 model was double its value in group 1 model indicating that sex can explain 16% of the variance in using PESs for the academic performance versus 8% in the physical performance. The coefficients and values of R^2 are displayed in Table 7.

Table 4 Knowledge of participants regarding Energy drinks

	Males	Females	No (%)	χ^2 (*p*)
Are you aware about ED ingredients?				
True	26 (27.7)	32 (28.3)	58 (28)	
False	68 (72.3)	81 (71.7)	149 (72)	0.933 (0.627)
Total	94 (100)	113 (100)	207 (100)	
Do you think it is prohibited in competition?				
True	39 (41.5)	42 (37.2)	81 (39.1)	
False	55 (58.5)	71 (62.8)	126 (60.9)	0.402 (0.526)
Total	94 (100)	113 (100)	207 (100)	
Is it associated with adverse effects on the CVS?				
True	50 (53.2)	69 (61.1)	119 (57.5)	
False	44 (46.8)	44 (38.9)	88 (42.5)	1.301 (0.254)
Total	94 (100)	113 (100)	207 (100)	
Does it enhance both physical and mental performance?				
True	47 (50)	60 (53.1)	107 (51.7)	
False	47 (50)	53 (46.9)	100 (48.3)	0.197 (0.657)
Total	94 (100)	113 (100)	207 (100)	

Person's chi-square test

Discussion

The current study's primary purpose is to furnish some information regarding the potential role of medical students in doping regulation and their use of the PESs in physical as well as academic enhancement. Given this, it is critical for students to obtain enough understanding about drugs used in sport and favorable attitudes about doping and its prevention through well-tailored curriculum.

Knowledge and perception of the participants

To measure students' understanding of the doping concept, both well-known performance-enhancing chemicals, such as anabolic steroids, growth hormone, and stimulants, as well as less-well-known banned doping agents, such as diuretics, opioids, and blockers, were used. Additionally, the list contained several non-prohibited substances and food supplements, such as amino acids (AAs), vitamins, and energy drinks. Students did not appear to possess a thorough and complete comprehension of doping. While many students were aware that anabolic steroids, growth hormone, and stimulants were doping agents, most of them were unable to recognize less often used agents, such as diuretics, opioids, and blockers. On the other hand, a sizable proportion of respondents believed non-doping drugs, such as AAs, vitamins, and energy drinks, to be doping agents. Additionally, there was little evidence that students get a greater understanding of doping substances as they go through their studies.

In a similar study conducted in Japan, most pharmacy students who responded claimed to understand doping in detail. This finding, however, is debatable, as a sizable proportion of participants did not appear to be aware that some over-the-counter (OTC) medications may contain doping agents or that supplements were originally foods (Shibata et al. 2017).

There were no significant differences between males and females regarding their knowledge. This result is in agreement with the Syrian study on pharmacy students by El-Hammadi and Hunien (2013). However, in the present study, females consistently reported higher knowledge of side effects of PESs albeit they were twice more prone to use these substances for academic performance enhancement rather than during sport (nearly equal proportions of both sexes).

Male students are expected to have more knowledge than the females, as they are interested more in sports and attend frequently gym centers. Males seem to be more familiar with the words "WADA" and "NADO," hearing the words through the media, TV channels, and sport news. However, great percentage of participants have no idea regarding WADA (81.6%); the percentage of both sexes denying any idea about the meaning of both words were nearly the same. Subsequently, only 43% of the respondents stated that they are aware of existence of law to fight against doping. The results were in contrary with that declared by Yee et al. (2020) about pharmacists in Australia (50 % have not heard about WADA).

Regarding knowledge of medical students for diuretics and peptide hormones, amino acid supplements as prohibited substances in sports are poor (21.6%, 31.7% and 26.4% respectively). However, more than half 58.7%

Table 5 Perception of performance-enhancing substances: hazards and sanctions

Perception queries	Males	Females	No (%)	χ^2 (*P*)
Do you think doping substances are posing health hazards?				
Yes	51 (71.8)	76 (83.5)	127 (78.4)	
No	20 (28.2)	15 (16.5)	35 (21.6)	3.215 (0.073)
Total	71 (100)	91 (100)	162 (100)	
Do you think doping substances are a serious problem in Egypt?				
Yes	53 (56.4)	63 (55.8)	116 (56)	
No	17 (18.1)	23 (20.4)	40 (19.3)	**0.196 (0.907)**
Do not know	24 (25.5)	27 (23.9)	52 (24.6)	
Total	94 (100)	113 (100)	207 (100)	
Do you think doping is a form of drug addiction?				
Agree	45 (47.9)	65 (57.5)	110 (53.1)	
Strongly agree	8 (8.5)	17 (15)	25 (12.1)	**7.312 (0.120)**
Disagree	20 (21.3)	12 (10.6)	32 (15.5)	
Strongly disagree	3 (3.2)	3 (2.7)	6 (2.9)	
Do not know	18 (19.1)	16 (14.2)	34 (16.4)	
Total	94 (100)	113 (100)	207 (100)	
Critical events in an athlete's career such as selection / de-selection, recovery from injury or illness and negotiating crucial sponsorship deals can increase the risk of doping.				
Agree	40 (42.6)	46 (40.7)	86 (41.5)	3.213 (0.523)
Strongly agree	20 (21.3)	23 (20.4)	43 (20.8)	
Disagree	13 (13.8)	9 (8)	22 (10.6)	
Strongly disagree	3 (3.2)	6 (5.3)	9 (4.3)	
Do not know	18 (19.1)	29 (25.7)	47 (22.7)	
Total	94 (100)	113 (100)	207 (100)	
Do you think that nutritional supplements as vitamins, minerals and herbs are safe?				
Yes	60 (63.8)	72 (63.7)	132 (63.8)	
No	14 (14.9)	24 (21.2)	38 (18.4)	2.241 (0.326)
Do not know	20 (21.3)	17 (15)	37 (17.9)	
Total	94 (100)	113 (100)	207 (100)	
Do you think that Amino acid supplements are safe in recommended dosages?				
Yes	56 (59.6)	68 (60.2)	124 (59.9)	0.054 (0.973)
No	22 (23.4)	25 (22.1)	47 (22.7)	
Do not know	16 (17)	20 (17.7)	36 (17.4)	
Total	94 (100)	113 (100)	207 (100)	
Do you think that doctors engaged in medically assisted doping should be punished?				
Yes	37 (39.4)	50 (44.2)	87 (42)	
No	33 (35.1)	33 (29.2)	66 (31.9)	0.873 (0.646)
Do not know	24 (25.5)	30 (26.5)	54 (26.1)	
Total	94 (100)	113 (100)	207 (100)	
Doping agents are used to get a more muscular body?				
Yes	55 (58.5)	58 (51.3)	113 (54.6)	1.087 (0.581)
No	19 (20.2)	26 (23)	45 (21.7)	
Do not know	20 (21.3)	29 (25.7)	49 (23.7)	
Total	94 (100)	113 (100)	207 (100)	

Person chi-square test

are aware of anabolic steroids. By comparing the level of knowledge to those in Australia, wide gap was still there (anabolic steroids 99%, diuretics 84%) (Yee et al. 2020). This necessitates a great effort to raise the awareness of the medical students, and hence their crucial role in the community giving advice upon PES. Deficient

Table 6 Attitude of the students towards the use of performance-enhancing substances and their recommendations regarding dealing with the use of performance-enhancing substances

Attitude queries	Males	Females	No (%)	χ^2 (*P*)
Do you go to gym?				
Yes	46 (48.9)	36 (31.9)	82 (39.6)	6.256 (0.012)
No	48 (51.1)	77 (68.1)	125 (60.4)	
Total	94 (100)	113 (100)	207 (100)	
Did you ever use one of the doping substances at any previous time to improve physical performance?				
Yes	13 (13.8)	11 (9.7)	24 (11.6)	
No	81 (86.2)	102 (90.3)	184 (88.5)	0.840 (0.360)
Total	94 (100)	113 (100)	207 (100)	
Did you consume any of energy drinks?				
Yes	14 (14.9)	14 (12.4)	28 (13.5)	0.275 (0.600)
No	80 (85.1)	99 (87.6)	179 (86.5)	
Total	94 (100)	113 (100)	207 (100)	
Did you ever use one of the doping substances at any previous time for enhancement of academic study (e.g., exams)?				
Yes	4 (4.3)	9 (8)	13 (6.3)	
No	89 (95.7)	103 (92)	192 (93.7)	1.193 (0.275)
Total	93 (100)	112 (100)	205 (100)	
Did you at any time asked about your advice concerning the use of doping substances?				
Yes	41 (43.6)	38 (33.6)	79 (38.2)	
No	53 (56.4)	75 (66.4)	128 (61.8)	2.169 (0.141)
Total	94 (100)	113 (100)	207 (100)	
When faced with a case pressuring for a prescription of one of the prohibited substances for non-medical use, would you prescribe to keep the physician-patient relationship?				
Yes	15 (16)	13 (11.5)	28 (13.5)	0.870 (0.351)
No	79 (84)	100 (88.5)	179 (86.5)	
Total	94 (100)	113 (100)	207 (100)	
Recommendation				
Reporting to health authority any non-medical use of doping substances is a suitable option to combat doping.				
Agree	41 (43.6)	59 (52.2)	100 (48.3)	
Strongly agree	22 (23.4)	26 (23)	48 (23.2)	5.442 (0.245)
Disagree	8 (8.5)	7 (6.2)	15 (7.2)	
Strongly disagree	9 (9.6)	3 (2.7)	12 (5.8)	
Do not know	14 (14.9)	18 (15.9)	32 (15.5)	
Adolescents' education about the health dangers of the doping procedures is the suitable way to combat doping.				1.604 (0.808)
Agree	42 (44.7)	53 (46.9)	95 (45.9)	
Strongly agree	24 (25.5)	34 (30.1)	58 (28)	
Disagree	12 (12.8)	10 (8.8)	22 (10.6)	
Strongly disagree	4 (4.3)	5 (4.4)	9 (4.3)	
Do not know	12 (12.8)	11 (9.7)	23 (11.1)	
The role of medical doctors in the prevention of doping is by reporting any case of doping to the authorities.				3.623 (0.459)
Agree	42 (44.7)	58 (51.3)	100 (48.3)	
Strongly agree	21 (22.3)	23 (20.4)	44 (21.3)	
Disagree	18 (19.1)	12 (10.6)	30 (14.5)	
Strongly disagree	2 (2.1)	3 (2.7)	5 (2.4)	
Do not know	11 (11.7)	17 (15)	28 (13.5)	

Person's chi-square test

Table 7 Logistic regression models for analysis of attitude towards performance-enhancing substances

	Predictor	B	S.E.	Wald	Sig.	-2 LL	Cox & Snell R^2	Nagelkerke R^2
Group 1 physical performance enhancement								
Knowledge	Knowledge score	0.034	0.017	3.908	.048*	144.506	0.020	0.040
	Constant	-3.954	1.032	14.668	0.000			
Perception	perception_score	0.012	0.011	1.268	0.260	147.484	0.006	0.012
	Constant	-2.566	0.537	22.866	0.000			
Sex	Sex	-.398	0.436	0.832	0.362	147.691	0.004	0.008
	Constant	-1.829	0.299	37.494	0.000			
Group 2 cognitive performance enhancement								
Knowledge	Knowledge score	0.026	0.022	1.389	0.239	95.520	0.007	0.019
	Constant	-4.149-	1.309	10.053	0.002			
Perception	perception_score	0.021	0.015	2.114	0.146	94.813	0.011	0.028
	Constant	-3.664-	0.773	22.440	0.000			
Sex	Sex	0.665	0.618	1.157	0.282	95.635	0.006	0.016
	Constant	-3.102-	0.511	36.842	0.000			

S.E standard error, *significant if $p \leq 0.05$

students' knowledge needs increasing the awareness and implementation of more lectures concerning doping substances in the teaching curriculum.

In a study conducted among Syrian pharmacy students, more than 90% did not appear to know that narcotics, β-blockers, and diuretics were used in sport as doping agents (El-Hammadi and Hunien 2013). Concerning nutritional supplements, a sizable proportion of students in the current study were unaware of their benefits in terms of muscle strength. Similar findings were obtained in a study done among intern physicians enrolled in the 2019–2020 academic year in Turkey (Ercan et al. 2021).

A study conducted in Qatar, the average knowledge score was 53.2% among health field practitioners (pharmacists) (Mottram et al. 2016). In the present study, the knowledge score is 54.4% which is a nearby figure.

When asking the students about the side effects of anabolic androgenic steroids, more than half give a true answer (ranging from 60.6 to 75%), giving a high average in comparison to the other questions in the knowledge section (70.1%).

Sporting activities are not a leading cause of sudden cardiac mortality. However, it was believed that excessive training, the use of illicit (anabolic steroids, growth hormone, and amphetamines) and illegal drugs, and undetected or underestimated heart disorders are the primary causes of cardiac arrest and, consequently, sudden cardiac death (Ghorayeb et al. 2019).

Myocardial bridge (MB) is reported recently in the sport society as a risk factor of SCD. It is the term applied to a segment of left anterior descending coronary artery (the most frequently affected coronary artery in more than 70% of autopsies) running intramurally through the myocardium, resulting in a hemodynamic disturbance during the cardiac cycle. Although this congenital anomaly variant was previously known as benign, with null clinical significance, nowadays, cases of SCD among asymptomatic athletes have been reported. Malignant ventricular arrythmia and myocardial ischemia and spasm of the coronary artery were identified as underlying causes of death (Zerbo et al. 2020, De Giorgio et al. 2014).

However, anabolic androgenic steroids and peptides are used to enhance growth and strength of skeletal muscles; their negative consequences on cardiac muscles are of important notice. Androgens promote hypertrophic changes through the androgenic receptors within cardiac myocytes ending by left ventricular hypertrophy and decreasing ejection fraction. Moreover, alteration in the lipoprotein metabolism and thrombus formation represent a substrate for myocardial ischemia and death. A similar pathological condition hypertrophic obstructive cardiomyopathy (HOCM) is on the top of sudden deaths in athletes precipitated by the impaired diastolic function and the restricted left ventricular cavity. Nevertheless, the differentiation between the pathological HOCM and the normal athlete heart, physically enlarged by training, is still challenging on autopsy. Furthermore, exercise-related sympathetic activity sensitizes vulnerable myocardium to ischemia and arrhythmia with electrolyte abnormalities during prolonged strenuous exercise posing additional risk (Vanberg and Atar 2010, Fineschi et al. 2007).

The toxic effects are not limited to the cardiovascular system where the misuse and prolonged use of exogenous AAS (in particular the oral 17 alpha alkylated AAS) result in hepatoxicity. Cholestatic jaundice, hepatic peliosis,

and hepatocellular neoplasms (hepatic adenoma and hepatocellular carcinoma) have been reported. Several underlying mechanisms are claimed: oxidative stress in the hepatic cells, increase in the reactive oxygen species ROS associated with androgen receptors activation, and enhancement of mitochondrial B-oxidation (Bond et al. 2016, van Amsterdam et al. 2010).

Further, the undesirable mental health outcomes up to successful suicide, uncontrolled aggressive behavior, or even criminal offenses have been linked to the continuous nontherapeutic use of anabolic androgenic steroids as well as withdrawal (Klötz et al. 2006). The uncontrolled consumption of these substances is involving different types of crimes that are not totally impulsive and require complex pre-planning. The psychological autopsy of medicolegal cases revealed that the act of suicide and the suicidal risk factors were independent of the use of AAS. Psychiatric disorders may be hidden (mainly personality disorders) and interpersonal conflicts in conjunction with the long-term use of AAS may lead to criminal behavior and suicide in predisposed case (Thiblin et al. 2000).

In the current survey, it was expected to record statistically significant differences between male and female participants in terms of knowledge and awareness. However, this relation was not detected in the overall knowledge score. It was an interesting finding that females have the same level of awareness as males. The result was in accordance with Franke et al. (2011) in Germany. Based on the responses of this survey, females seem to possess much more knowledge on specific doping agents compared to males for example peptide hormones, stimulants, and diuretics. This could be explained by gender differences in the perception of these agents as masculine and feminine substances. On the other hand, energy drinks are considered as gender neutral (Teetzel 2008).

Although medical students are expected to be aware of the health hazards of Energy drinks, less than one third of the participants have any idea about its ingredients, and more than half of them knew their benefits of enhancing mental and physical performance together with the drastic effects CVS. By contrast, the proportion of participants who related their use in sports as doping agents was down these figures by ~12%. In the current survey, more than three quarters of the students were conscious about the harmful effects of doping agents on abusers' health; the same results were declared by El-Hammadi and Hunien (2013).

Attitude and use of PESs by the medical students

In medical faculty, achieving high scores are fundamental, to have good specifications late on after graduation, some students feel pressured to enhance their mental, cognitive power. Students in the faculty found themselves pressured to achieve good marks, stressful environments, and pressure from their families.

A Syrian study was conducted among pharmacy students of different academic years; it reported that students who had taken a prohibited PESs represented only (13; 4.6%) with significantly higher number of males than females ($p < 0.001$). Furthermore, there was a significantly higher proportion of males than females who explicitly showed potential interest in trying doping drug someday ($p = 0.001$) regardless the study year (El-Hammadi and Hunien 2013).

Even though knowledge of the hazards of PESs was high among the participants, still a small percentage of students affirmed the use of any of these neurocognitive stimulants (6.3%) with females reported two times higher than males in using these substances. The participants listed energy drinks and multivitamins as potential doping agents. This finding might coincide with the nonsignificant effect of the perception of PESs on their use among the medical students.

However, our findings indicate that the true prevalence of PESs may be underestimated in the developing countries due to the nature of the community, socioeconomic status, and their culture; therefore, students particularly females may find it shameful to declare the usage of any of the prohibited drugs.

A nearby percentage was declared by Emanuel et al. 2013 in the USA, where 11% of students reported the non-medical use of prescription-grade stimulant medical school. Moreover, medical students in the UK showed lower prevalence (14%) of neuro-enhancing drugs use (Ridgway et al. 2015) than other European countries for example France (54%) (Laure 2000) and Italy (74.7%) (Pighi et al. 2018).

A 2018 study by Pighi et al. (2018) among Italian medical students stated that they had used readily available drinks and substances (such as coffee and caffeine) as cognitive enhancers, in addition to psychostimulants, whereas British medical students reported the use of beta blockers, Modafinil, benzodiazepines/sedatives, and Ritalin (Ridgway et al. 2015).

In contrast to the present study, previously published studies have declared that males are more likely to use enhancing substances (physically /mentally) than females; in a study conducted in Lithuania in 2016, male students reported three times higher prevalence rates than females (Lengvenyte et al. 2017).

Despite the non-significant differences between males and females, a higher incidence of PESs' consumption (8%) for academic performance enhancing was detected among females. This may refer to the underlying differences in PESs' use among males and females for example muscular body appearance is more appealing

to males as compared to females (Mallia et al. 2013). Females in STEM fields are likely to be encountered in academic performance-enhancing situations. Although the female to male ratio was biased towards females, it is unlikely that this has negatively impacted the interpretation of this result because similar responses of the questions were obtained by both sexes in many questions and the inflation of the calculated percentages is more expected in the smaller sample size. In agreement with our findings, Gao et al. (2020) reported higher scores for anxiety in female students than males in the first two academic years despite the insignificant gender-based differences in the average depression and stress magnitude. They emphasized on the reasons being related to the body image and academic performance.

Moreover, a similar percentage of the prevalence of illicit substance abuse (9.8%) was detected in medical and non-medical female Cairo university students (El-Ghonemy et al. 2021). Furthermore, more than half of the students agreed that use of PESs is another form of substance abuse which could be a starting point for health education in Egypt. In a study of prevalence of substances of abuse in medical students of Cairo (Shalaby and Soliman 2019). Cigarette and shisha smoking (13.5–15.2%) and addictive substances abuse (2–6.4%) were comparable to the use of doping agents for physical performance and academic performance enhancing as well as energy drinks being (6.3 to 11.6% and 13.5%, respectively).

Recently, several studies (Plescia et al. 2021; Ramaci et al. 2020; Mohamed et al. 2020) indicated that anxiety disorders and substance use disorders can concomitantly occur. However, the interaction between the causative factors is bidirectional. The presence of disturbed sleep-awake cycle has been implicated to the development of psychiatric disorders and different diseases (Angarita et al. 2016).

As regards the regulations and anti-doping efforts in Egypt, the Egyptian National Anti-Doping Organization (EGY-NADO) is the only independent body responsible for combating doping, raising public and athletes' awareness against it, and performing the related tests for detection. It is also a member of WADA and is empowered by the International Convention against Doping in Sport since 2007. According to the recent reports, the WADA has ranked Egypt in the first tiers of effective anti-doping efforts (Egy-NADO, WADA).

Moreover, the newly issued "Sports Law" brings the EGY-NADO under the legal framework. According to Article 34 of the Law, this organization will supervise the enforcement of the applicable international anti-doping codes in Egypt. According to the code "EGY-NADO may, in its discretion and subject to the principle of proportionality, elect to a) recover from the athlete or other person costs associated with the anti-doping rule violation, regardless of the period of ineligibility imposed and b) fine the athlete or other person in an amount of 10000 to 30000 E.P., only in cases where the maximum period of ineligibility otherwise applicable has already been imposed…." Nevertheless, doping offenses, as defined, and explained in article 1 and article 2.1 to 2.10 of the WADA Code, respectively, have no secondary liability within the Egyptian Civil or Criminal Codes laws. Moreover, the Egyptian government has several actions towards the substance abuse among employees. Law No. 73 for 2021 on dismissing drug addicts was enforced in December after the end of a 6-month grace period given to employees to confidentially report their addiction and receive free of charge treatment (EGY-NADO 2022; Egypt Independent 2022; Sports law in Egypt 2022).

In general, medical students valued increasing the awareness and the eminent role of physicians could play in doping prevention and reporting. The ethical obligations may contribute to the governmental anti-doping efforts in absence of a strict comprehensive system for doping detection and control (El-Hammadi and Hunien 2013). It seems that the role of future physicians in controlling the use of doping agents is clear from the medical ethical point of view. More than half of the participants agreed not only to notify authorities about these violations but also educating the youth about the side effects of these substances. Since the rate of substance abuse increases by age, thus, preventive actions and programs should be mainly directed towards youth and young adults in order to combat these deleterious phenomena (Rabie et al. 2020).

Logistic regression analysis of the effect of knowledge and perception of PESs on the intake of these substances among medical students of both sexes

In contrast to previous studies, we did not find significant differences between both sexes regarding the use of PESs in both sports and academic study. We also identified a dissociation between knowledge and perception in both situations. This observation indicates that increasing the awareness only is not sufficient to reduce the burden of this problem. Despite the higher frequency of males going to gym, there was no significant association between male and female medical students regarding the use of PESs in the gym. This finding pinpoints that the common trend of striving for fitness and an ideal body shape and weight has produced a shift in the prevalence of the PESs' use according to gender in Egypt. Moreover, STEM-related anxiety affects females' students more frequently than males and the manifestations include unease, avoidance, or fear of learning science or math topics (Gao et al. 2020; Gonzalez et al. 2019).

Limitations

The present study is the first to assess the knowledge and attitude of the students in the Faculty of Medicine concerning the performance-enhancing substances; however, some limitations were there. It would be better to make a comparison between the level of knowledge and perception of the students before and after the lecture of doping in the faculty, or to conduct the survey on older students in the terminal years of the faculty, to probe the effect of the lecture on their behavior and attitude. Moreover, the sources of knowledge prior to lecture were not analyzed in the participants.

Although the intake of different types of performance-enhancing substances for the physical versus cognitive enhancement to boost the academic performance of the students (academic grades) was assessed in the present study, the psychological factors and other personality risk factors were not included. Further, this study represents a single population of one medical school and the results may not be generalizable to other medical schools in the country.

Conclusions

The present study is the first to evaluate the level of knowledge and perception among Egyptian medical students of both sexes in addition to their attitude towards the growing market of performance enhancements. We have also analyzed the effect of knowledge and perception on refraining medical students from using these substances and we found a dissociation between the effects of these factors in the use of the PESs in different situations of sports versus study. Doping prevention and control should consider the role of gender differences and preferences when formulating policies and educational programs. It might be dangerous to assume that males and females are exposed equally to protective or risk factors for PESs use (Teetzel 2008). Therefore, it is necessary to tailor educational and preventive plans for each sex. A future survey should be constructed concerning the recent rise of neuroenhancement substances in the market, and their use among faculty students, to enhance their mental power, concentration before the exams. Therefore, it may be appropriate to train students about stress management skills through organizing regular "stress coping strategies" sessions to assist them to cope with various stressors and consider implementing counseling programs to support medical students to handle exam stress.

In situations where physicians are confronted with PESs abusers, he/she should be able to recognize the associated pathognomonic skin lesions for example the bodybuilding acne, address the non-medical abuse of doping substances, and warn the patient about other potential hazards in over-the-counter preparations (Melnik et al. 2007). Teaching integrated curricula should foster a positive attitude towards their influences in helping their patients/relatives to avoid the use of doping agents. Several curricular courses, such as clinical toxicology, pharmacology, biochemistry, and dermatology, may introduce students to a variety of doping substances and their biological effects in undergraduate programs.

All the forms of consumption of such substances should be regulated and treated as doping in sports. Government should supervise the markets and pharmacies and put regulations and penalties on those distributing these substances outside the medical facilities. The study also recommended raising the awareness of adolescent on the health hazards of performance enhancement substances. Families and friends can give great support, and they are an important reinforcing factor. So, when we cannot reach doping agents' users, we can convince their friends to support them and give reports to the doctor.

Abbreviations

AAs: Amino acids; ADHD: Attention-deficit hyperactive disorder; Eds: Energy drinks; HOCM: Hypertrophic obstructive cardiomyopathy.; MB: Myocardial bridge; NADO: National Anti-Doping Organizations; PESs: Performance enhancement substances; SCD: Sudden cardiac death; STEM: Science, technology, engineering, and mathematics; SNRI: Selective norepinephrine reuptake inhibitor; UK: United Kingdom; WADA: World Anti-Doping Agency.

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Authors' contributions

FB: concept of the study and designing the questionnaire, analysis, and interpretation of the results; drafting the manuscript; reviewing of literature; and editing the final manuscript. MA: interpretation of the data, sharing in the statistical analysis, reviewing of literature, drafting the manuscript, and performing the critical final revision of the work. All authors read and approved the final manuscript.

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Availability of data and materials

The dataset used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was approved by the local ethical Committee of Alexandria University (Reference number is 0304323). After explaining the study's goal and advantages to participants, the participation in the questionnaire is regarded as an implied consent.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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