A questionnaire study investigating future pharmacists' use of, and views on cognitive enhancers

LEZLEY-ANNE HANNA*, JUDITH RAINEY, MAURICE HALL

Queen's University Belfast, School of Pharmacy, Belfast, United Kingdom

Abstract

Introduction: This work aimed to ascertain future pharmacists' use of, and attitudes towards cognitive enhancers (CEs).

Methods: Following ethical approval, all first and final year pharmacy students at Queen's University Belfast (QUB) were invited to complete a pre-piloted, non-identifiable, paper-based questionnaire during a compulsory class. Descriptive statistics were undertaken; non-parametric tests were used for comparisons with significance set at $p<0.05$ *a priori*.

Results: The response rates were 89.3% (Level 1) and 89.0% (Level 4) with 48.0% of respondents reporting they were CE users (largely caffeine). Additionally, 42.4% thought using pharmaceutical CEs for improving academic grades breached their Code of Conduct. Level 4 students were more likely to associate over-the-counter (OTC) and prescription-only medicines (POM) CEs with side effects than Level 1 [OTC statement $p=0.001$ and POM statement $p=0.016$].

Discussion: CE use among future pharmacists seems quite high; Level 1 students appear more naïve about safety concerns. Educational workshops could further explore ethical issues.

Keywords: *Cognitive Enhancers, Pharmacy Students, Questionnaire*

Introduction

Cognitive enhancers (also known as 'smart drugs', 'study aids' or 'nootropics') are used to improve cognitive function, particularly functions such as memory, alertness, creativity and motivation (Smith & Farah, 2011; Ragan *et al*., 2013). For the purposes of this study, cognitive enhancers (CEs) are substances which provide cognitive enhancement to an otherwise healthy individual who does not have cognitive impairment or a medical need (*i.e.,* this work does not relate to cognitive enhancing medicines for treating cognitive impairment due to a medical condition such as dementia).

Researchers have tried to classify CEs but their efforts have been pampered by the plethora of substances claiming to have cognitive enhancing properties (Nutt *et al*., 2007; Academy of Medical Sciences, 2008). Commonly recognised CEs are caffeine (found in numerous products including coffee and energy drinks), ephedrine and pseudoephedrine (over-the-counter [OTC] medicines found in cough and cold products), prescription-only medicines (POMs) such as methylphenidate indicated for attention deficit hyperactivity disorder (ADHD) (Ragan *et al*., 2013; Linssen *et al*., 2014; Weyandt *et al*., 2016; Jain *et al*., 2017) and modafinil indicated for narcolepsy (Turner *et al*., 2004; Minzenberg & Carter, 2008; Ragan *et al*., 2013). Alcohol and illegal drugs such as cocaine may

also be used for cognitive enhancement purposes (Franke *et al*., 2011). Much of the existing literature focusses on drugs with past or present medical uses *i.e.* caffeine, amphetamines, methylphenidate and modafinil, since their effects on cognitive function have been evaluated via randomised controlled trials (Arnold, 2000; Faraone *et al*., 2004; Turner *et al*., 2004; Minzenberg & Carter, 2008).

CEs may be used within the university student population to enhance academic performance, such as meeting assignment deadlines and examination revision (Ragan *et al*., 2013). Typically, as stress levels among university students increases, the use of CEs appears to increase too (Ragan *et al*., 2013). In terms of the existing body of literature, results are difficult to decipher due to the variety of study designs, drugs investigated and definitions/categories employed. CE prevalence data largely relates to research conducted among United States (US) university students (see for example, Wilens *et al*., 2008; Smith & Farah, 2011) with fraternity and sorority members showing high rates of use (DeSantis *et al*., 2010). CE prevalence data in Europe is less comprehensive (studies include: Franke *et al*., 2011; Castaldi *et al*., 2012; Eickenhorst *et al*., 2012; Maier *et al*., 2013; Singh *et al*., 2013; Ott & Biller-Andorno, 2014; Maier *et al*., 2015; Santacroce *et al*., 2016). Research on CE use in the United Kingdom (UK)

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*Correspondence: Lezley-Anne Hanna, *Senior Lecturer (Education) Queen's University Belfast, School of Pharmacy, 97 Lisburn Road, BT9 7BL, Belfast, United Kingdom. Tel: +44 (0) 2890972731; Fax: +44 (0) 2890972155. Email: l.hanna@qub.ac.uk*

university student population is sparse in comparison, although it has been mentioned in the media as a rapidly growing problem. A large-scale questionnaire study of CE use among students in the UK and Ireland (n=877 students) found lifetime prevalence of CE using modafinil or methylphenidate to be under 10%, with CE users more likely to be male (Singh *et al.*, 2014).

It would perhaps be expected that there would be substantial CE use among pharmacy students, given the high workload and academically challenging Master of Pharmacy (M.Pharm.) degree programme. However, since such students are being trained to be experts in medicines, and future healthcare professionals bound by a professional code, perhaps safety and ethical concerns may limit CE use (particularly CEs such as amphetamines, methylphenidate and modafinil) among this population. Safety concerns for certain CEs include side-effects of the individual drugs and risks associated with online purchasing (British Medical Association, 2015). Some pharmacy students may consider use of certain CEs for enhancing academic performance to be in opposition to aspects of the 'Professional Standards' (General Pharmaceutical Council, 2017) as it may suggest students are not taking appropriate responsibility for their working practices or respecting others (General Pharmaceutical Council, 2017). However, others may consider CE use to be ethical since it enhances performance and may be necessary when patient safety would otherwise be compromised (for example, when working long hours in a busy pharmacy).

To the best of our knowledge, there has been limited work involving pharmacy students conducted in the UK and none specifically in Northern Ireland. This work adds to the field because it will provide data relating to future pharmacists in the UK. It is important to ascertain pharmacy students' use and opinions on CEs, given that they are being trained to be experts in medicines. Furthermore, it was anticipated that the findings of this research would inform future teaching of the subject matter within the School and contribute to richer discussions around professionalism, ethics, and the safe and effective use of medicines (including personal use).

Aims and objectives

The overall aim was to investigate QUB 'Level 1' and 'Level 4' pharmacy students' use of, and views on CEs (NB: 'Level 1' students, also known as 'Year 1' students, represent students who are enrolled on the first year of the M.Pharm. degree programme). 'Level 4' students, also known as 'Year 4' students, represent students who are enrolled on the final year of the M.Pharm. degree programme.

The objectives were to:

· investigate students' personal use of CEs

· obtain students' views on safety and risks associated with CEs

· establish students' attitudes towards CE use for enhancing academic and professional performance

· determine whether certain factors (use, gender, and level of study) affected responses

Method

Ethical approval for this study was obtained from QUB School of Pharmacy Ethics Committee (Ref 024PMY2016).

Study participants

All currently enrolled Level 1 and Level 4 M.Pharm. students at QUB were invited to participate in the study. The Level 1 cohort was selected to represent new university students. These students had not undertaken any written M.Pharm. examinations at the time of data collection and none had previously completed a university degree. The Level 4 cohort was selected to represent students at the other end of the spectrum *i.e.* students who had completed at least three years of the M.Pharm. degree course and were approaching completion and graduation.

Data collection

Data were collected by means of a paper-based, self-completed questionnaire.

Questionnaire development

The questionnaire was developed with reference to the wider literature (General Pharmaceutical Council, 2010; Smith & Farah, 2011; Costaldi *et al.*, 2012; Eickenhorst *et al.*, 2012; Maier *et al.*, 2013; Ragan *et al.*, 2013; Singh *et al.*, 2013; Ott & Biller-Andorno, 2014; Singh *et al.*, 2014; Maier *et al.*, 2015; Jensen *et al.*, 2016). The questionnaire had three sections: Section A (four questions in total, closed and open-response) related to personal use of CEs and included a question on use of modafinil and methylphenidate for their licensed indications since this may affect the likelihood of using certain substances for cognitive enhancement purposes (Ragan *et al.*, 2013), Section B (two closed questions with multiple statements measured using a 5-point Likert scale from Strongly Agree, Agree, Neither Agree nor Disagree, Disagree, Strongly Disagree) focussed on attitudes towards CEs in relation to safety, risk and ethics and Section C (four questions, largely closed) collected non-identifiable demographic information.

Please note that at the time of conducting the study, M.Pharm. students in the UK were bound by a professional code known as the 'Code of Conduct' (General Pharmaceutical Council, 2010) which is referred to in several statements within the questionnaire. However, this 'Code of Conduct' has since been replaced by 'Professional Standards' (General Pharmaceutical Council, 2017).

A cover sheet was prepared which outlined the purpose of the research and explained how the data would be used, included an explanation and examples of CEs and defined 'off-label' use, gave a predicted time required to complete the questionnaire and provided assurance that participation was voluntary. Reassurances about anonymity (and that no identifiable information was being collected) were also provided. This was particularly important for the questionnaire study, given the potentially sensitive nature of the topic. The questionnaire was piloted with ten pharmacist postgraduate students at QUB. As a result, an estimated completion time of eight minutes was added to the cover sheet and minor amendments were made (Question 3 was re-formatted so that it was not split across two pages).

Questionnaire distribution

This took place during in Semester 1 (December 2016). The researcher (Judith Rainey) went to scheduled Level 1 and Level 4 classes, having agreed this in advance with the lecturer in charge. The researcher distributed the questionnaires, and directed the students to read the information on the cover sheet. Students were also asked to place completed questionnaires into a specific receptacle prior to vacating the venue. There was one distribution only (*i.e.* there was no follow-up) which occurred when the majority of students were anticipated to be present in class, given attendance was compulsory.

Maximising the response rate

The authors anticipated, based on previous work, that manually distributing paper-based questionnaires to students in a compulsory class would enhance the response rate over online distribution. Other ways to maximise the response rate included having a relatively short questionnaire with questions largely in a closed-question format (Dillman, 2008).

Data analysis

The responses from the completed questionnaires were coded and entered into a customised database developed on SPSS (v. 22) for statistical analysis in January 2017. The analysis of the data largely took the form of descriptive statistics. Comparisons were done on male versus female responses as previous studies revealed gender differences in relation to usage of CEs (Dietz *et al.*, 2013; Kudlow *et al.*, 2013). The authors also investigated whether personal use of CEs influences responses, as this had been reported in other studies (Ott & Biller-Andorno, 2014). Level 1 and Level 4 responses were compared; it was hypothesised that CE use would be greater among Level 4 than Level 1 students (Emanuel *et al.*, 2013; Kudlow *et al.*, 2013) since they have had more exposure to M.Pharm. assessments and stressors associated with undertaking a university degree. Appropriate statistical tests (Mann-Whitney U-test and *Chi*-squared) were conducted with significance set at $p<0.05$ a priori. Therefore, p values <0.05 are reported throughout the Results section.

Results

The response rate was 89.6% (198/221); Level 4 had a response rate of 89.0% (97/109) and Level 1 had a response rate of 89.3% (100/112) but one respondent failed to provide details about their level of study. While the majority of respondents completed the questionnaire in its entirety (n=181), seventeen students left a few questions unanswered. The questionnaires from these seventeen students were included in the data analysis. The number of respondents who answered the question has been provided (in addition to the %). For example, stating "137/197 'strongly agreed' or 'agreed'…" means that 197 provided a response to the statement and of those, 137 'strongly agreed' or 'agreed' with it. In terms of statistical significance, only p values <0.05 are reported throughout the Results section (rather than all p values for all parts).

Demographic information (Section C of the questionnaire)

Of the 198 respondents, 71 (35.9%) were males, 123 (62.1%) females, 3 (1.5%) 'Preferred not to say' and one (0.5%) did not select any of the three options. There were 97 (49.0%) Level 4 students, 100 (50.5%) Level 1 students and one (0.5%) respondent who did not select either option. The mean age of the Level 4 students was 22.8 years and the mean age of the Level 1 students was 19.4 years. Moreover, 162 (81.8%) respondents received the majority of their education inside the European Union (EU) prior to coming to QUB, 28 (14.1%) received it outside the EU, and eight respondents (4.0%) did not provide an answer.

Personal use of CEs (Section A of the questionnaire)

The proportion of students who reported using CEs [48.0% (95/198)] was similar to those reporting non-use [52.0% (103/198)].

· Gender split - Males: 42.3% (30/71) were users and 57.7% (41/71) non-users; females: 51.2% (63/123) were users and 48.8% (60/123) non-users

· Level split - Level 4: 49.5% (48/97) were users and 50.5% (49/97) non-users; Level 1: 46.0% (46/100) were users and 54.0% (54/100) non-users

None of the respondents reported currently taking (or ever taking) methylphenidate for attention-deficit hyperactivity disorder (ADHD) or modafinil for narcolepsy.

Users were asked about what substances (up to a maximum of five) they used and the results are provided in Figure 1.

When asked (via an open-response question) when they were likely to use CEs, the majority of users [72.6 % (69/95)] reported it was around exam time or when studying. Moreover, 30.5 % (29/95) of users stated that they did so on a daily basis. Students were asked (again, via an open-response question) why they opted to use CEs. Reasons provided by users are outlined in Figure 2.

Figure 1: Substances used by respondents for CE (n=95; users could provide up to 5 substances)
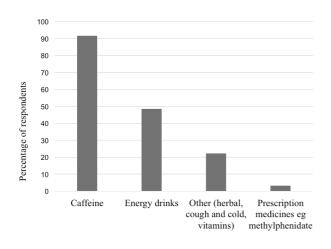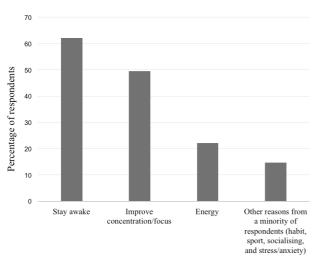

Figure 2: Reasons respondents used cognitive enhances (n=95)

Reasons why non-users abstained from CEs were also investigated via an open-response question. The most commonly reported reason was that they considered use of CEs unnecessary [53.4 % (55/103)]. Other reasons were: lack of awareness of CEs [18.4% (19/103)], perceived lack of effectiveness [13.6% (14/103)], safety concerns [12.6% (13/103)], ethical concerns [8.7% (9/103)] and for other reasons [4.9% (5/103)] such as getting into trouble.

Of the non-users, 9.7 % (10/103) stated that they would consider using CEs in the future, 62.1% (64/103) said they would not, and the remainder [28.2% (29/103)] were unsure. Females were more likely to state that they would not use CEs in the future than males [70.0 % (42/60) females versus 53.7% (22/41) males; *p*=0.012].

Table I: Respondents' views on CE safety and risk (n=196)

	SD	D	NA nor D	A	SA
	n (%)	n (%)	n (%)	n (%)	n (%)
a. *Natural* substances (such as caffeine) used for cognitive enhancement purposes are not associated with many side-effects	4 (2.0)	62 (31.6)	22 (11.2)	80 (40.8)	28 (14.3)
b. *Over-the-counter* medicines (such as ephedrine and pseudoephedrine) used for cognitive enhancement purposes are not associated with many side-effects	25 (12.8)	88 (44.9)	57 (29.1)	25 (12.8)	1 (0.5)
c. *Prescription-only* medicines (such as methylphenidate and modafinil) used for cognitive enhancement purposes are not associated with many side-effects	46 (23.5)	101 (51.5)	35 (17.9)	13 (6.6)	1 (0.5)
d. Long-term CE use can lead to dependence	3 (1.5)	8 (4.1)	17 (8.7)	91 (46.4)	76 (38.8)
e. Using CEs puts students at risk of not developing key skills (such as time management)	7 (3.6)	39 (19.9)	56 (28.6)	68 (34.7)	26 (13.3)
f. The University has a responsibility to inform students about CEs and associated risks	6 (3.1)	17 (8.7)	48 (24.5)	91 (46.4)	34 (17.3)

SD=Strongly Disagree; D=Disagree NA nor D=Neither Agree nor Disagree; A=Agree; SA=Strongly Agree

Attitudes towards safety and risk (part of Section B of the questionnaire)

Respondents were asked about their views on safety and risks associated with CE use (see Table I for responses).

Level 4 students were more likely to associate OTC and POM CEs with side effects than Level 1 [OTC statement *p*=0.001 and POM statement *p*=0.016].

Users were significantly more likely to "strongly disagree" or "disagree" that using CEs put students at risk of not developing key skills than non-users [34.0% (32/94) users versus 13.7% (14/102) non-users; *p*=0.003].

Attitudes towards CE use in the context of professionalism and ethics (part of Section B of the questionnaire)

Respondents were asked about their views on ethics associated with CE use (see Table II for responses). It is worth noting the differences in opinion in relation to natural (*i.e.* non-pharmaceutical) versus pharmaceutical CEs:

· For the statements about CEs being ethical to use, 76.3% (151/198) of respondents 'Strongly Agreed' or

'Agreed' in relation to natural CEs but this figure decreased to 26.8% (53/198) for the OTC statement and 26.3% (52/198) for the POM statement.

- Similarly, for the statements about CE use breaching the students' Code of Conduct, only 13.1% (26/198) of respondents 'Strongly agreed' or 'Agreed' for natural CEs whereas 42.4% (84/198) 'Strongly Agreed' or 'Agreed' in relation to pharmaceutical CEs.

- Finally, for the statements about CE use breaching the pharmacist's code of ethics, only 15.2% (30/198) 'Strongly agreed' or 'Agreed' for natural CEs whereas 44.9% (89/198) 'Strongly Agreed' or 'Agreed' in relation to pharmaceutical CEs.

Level 4 students, in comparison to Level 1 students, were more likely to consider using natural substances as CEs was ethical [85.6% (83/97) Level 4 versus 67.0% (67/100) Level 1; $p=0.022$]. Furthermore, they were less likely to think that using natural substances to improve patient safety would breach the pharmacist's ethical code [64.9% (63/97) Level 4 versus 46.0% (46/100) Level 1; $p=0.011$]. However, the reverse was seen with OTC medicines and POMs: Level 1 students were more likely to consider OTC CE use was ethical compared with Level 4 students [34.0% (34/100) Level 1 versus 18.6 % (18/97) Level 4; $p<0.001$]. Similarly, Level 1 students were more likely to consider that POM CE use was ethical [33.0% (33/100) Level 1 versus 18.6% (18/97) Level 4; $p=0.044$)].

CE users, compared with non-users, were more likely to be in disagreement that using natural substances as CEs to improve academic grades was a breach of the Code of Conduct [83.2% (79/95) users versus 45.6% (47/103) non-users; $p<0.001$]. CE users were more likely to be in disagreement that using natural CEs to potentially enhance patient safety in practice (for example, to improve concentration during long hours) breached the pharmacist's ethical code [66.3% (63/95) users versus 44.7% (46/103) non-users; $p=0.006$]. Interestingly, there were no significant differences between user and non-user responses about the ethics of using OTC and POM CEs for these reasons (*i.e.* it was only in relation to natural CEs).

Females, in comparison to males, were more likely to consider that pharmaceutical CE use in academia was similar to doping in sports [48.8% (60/123) females versus 35.2% (25/71) males; $p=0.037$]. Males were more likely to "strongly agree" or "agree" with the statement "Mankind has always used substances to enhance performance; pharmaceutical CEs are just the most recent form of this phenomenon," [63.4% (45/71) males versus 42.6% (52/122) females; $p=0.003$]. Additionally, males were more likely to 'strongly agree' or 'agree' with the statement "I do not care if others use substances for cognitive enhancement purposes whilst studying," [67.6% (48/71) males versus 53.3% (65/122) females; $p=0.014$].

Table II: Respondents' opinions on the ethics of CE use (n=198 for statements a-h and n=197 for statements i-k)

	SD n (%)	D n (%)	NA nor D n (%)	A n (%)	SA n (%)
a. It is ethical to use a ***natural*** substance such as caffeine for cognitive enhancement purposes	1 (0.5)	5 (2.5)	41 (20.7)	98 (49.5)	53 (26.8)
b. It is ethical to use ***over-the-counter*** products such as ephedrine or pseudoephedrine off-label for cognitive enhancement purposes	16 (8.1)	70 (35.4)	59 (29.8)	43 (21.7)	10 (5.1)
c. It is ethical to use ***prescription-only*** medicines such as methylphenidate or modafinil off-label for cognitive enhancement purposes	36 (18.2)	72 (36.4)	38 (19.2)	42 (21.2)	10 (5.1)
d. Using ***natural*** CEs for the purpose of improving assessment grades breaches the Code of Conduct for Pharmacy Students	49 (24.7)	77 (38.9)	46 (23.2)	19 (9.6)	7 (3.5)
e. Using ***pharmaceutical*** CEs (over-the-counter medicines or prescription-only medicines) for the purpose of improving assessment grades breaches the Code of Conduct for Pharmacy Students	13 (6.6)	43 (21.7)	57 (28.8)	58 (29.3)	26 (13.1)
f. Using ***natural*** CEs for the purpose of improving patient safety in practice (for example, to improve concentration during long working hours) breaches the pharmacist's ethical code	27 (13.6)	82 (41.4)	59 (29.8)	25 (12.6)	5 (2.5)
g. Using ***pharmaceutical*** CEs for the purpose of improving patient safety in practice (for example, to improve concentration during long hours) breaches the pharmacist's ethical code	8 (4.0)	43 (21.7)	57 (28.8)	64 (32.3)	25 (12.6)
h. Using pharmaceutical CEs in academia is similar to doping in sports	16 (8.1)	54 (27.3)	40 (20.2)	66 (33.3)	21 (10.6)
i. Mankind has always used substances to enhance performance; pharmaceutical CEs are just the most recent form of this phenomenon	2 (1.0)	21 (10.7)	74 (37.6)	82 (41.6)	17 (8.6)
j. I do not care if others use substances for cognitive enhancement purposes whilst studying	13 (6.6)	35 (17.8)	33 (16.8)	83 (42.1)	32 (16.2)
k. It is of greater ethical concern if pharmacy students use pharmaceutical CEs in comparison to other university students	26 (13.2)	54 (27.4)	58 (29.4)	42 (21.3)	16 (8.1)

SD=Strongly Disagree; D=Disagree NA nor D=Neither Agree nor Disagree; A=Agree; SA=Strongly Agree

Discussion

This study has revealed interesting findings about pharmacy students' use of, and views on, CEs. In summary, while one in every two pharmacy students reported using CEs, the most commonly used substance was caffeine. Users were equally likely to be first year as final year students. There was a slightly greater proportion of female than male users (but this was not significant). The main reasons for CE use centred on staying awake and to improve concentration. In terms of future pharmacists' views on safety and ethics of CEs, opinions differed depending on whether the CE was a natural substance (*i.e.* a non-pharmaceutical product) or a pharmaceutical (OTC or POM) product.

In terms of gender, other researchers have reported a higher proportion of male than female users (Dietz *et al.*, 2013; Kudlow *et al.*, 2013; Singh *et al.*, 2014). However, it must be noted that these studies focused more on pharmaceutical CE use rather than CE use in general and our work did reveal that male non-users were more likely to consider trying CEs in the future than female non-users. Furthermore, unlike other published research (Emanuel *et al.*, 2013; Kudlow *et al.*, 2013), non-users were equally likely to be senior as junior students.

Regarding personal use, it was somewhat reassuring to find the majority of users in this current study reported taking "soft enhancers" (Maier *et al.*, 2013) rather than POMs or illicit drugs. Only 3.2% of students reported using POM CEs which is low compared to other studies across the globe involving university students (Mache *et al.*, 2012; Dietz *et al.*, 2013; Singh *et al.*, 2014; Maier *et al.*, 2015; Bennett & Holloway, 2017; Rathbone, 2017), pharmacy students (Bossaer *et al.*, 2013) and medical students (Habibzadeh *et al.*, 2011; Kudlow *et al.*, 2013; Emanuel *et al.*, 2013; Micoulaud-Franchi *et al.*, 2014). Moreover, in line with other studies (Mache *et al.*, 2012; Micoulaud-Franchi *et al.*, 2014), the majority of respondents who used CEs did so to stay awake and/or enhance concentration during examination preparation or studying. Additionally, some students took them for energy and a minority took CEs for stress and anxiety relief. There are some concerns that millennial students are unable to withstand hard work, social pressure, and are not as resilient as they should be, hence their 'strawberry generation' classification. They appear to experience more stress and anxiety than previous generations (Peterson & Brommelsiek, 2017). Perhaps wider skills and personal development, encompassing resilience training, could be valuable.

The majority of respondents had some awareness of safety and risk associated with CE use, and many considered the University had a responsibility to inform students about CE safety. Unsurprisingly, users had fewer concerns than non-users. Respondents distinguished being natural and pharmaceutical products and deemed natural substances to be associated with fewer side effects. Similarly, other authors have reported perceptions that non-prescription medicines are safe and "too weak to cause any real harm," (Roumie & Griffin, 2004), that complementary and alternative medicine (CAM) is a safer alternative to conventional pharmaceutical medicine (Hall *et al.*, 2011) and that plant-based products are 'natural' and therefore assumed to be safe (Chouakea & Friedman, 2012). Level 4 students had greater general awareness about potential side-effects of CEs (and ethical concerns) than Level 1 students. This is likely to be because they had gained knowledge about medicines, including OTC and CAM at the time of data collection whereas the Level 1 students had not. In light of these findings, the school should consider explicitly teaching about CEs early in the M.Pharm. programme so that all students are fully cognizant of the risks and safety concerns from the outset. The British Medical Association has produced guidance on the use of CEs which could be useful for M.Pharm. students. It states that there is an uncertain long term risk profile in healthy individuals and that high cognitively performing individuals, and those with higher IQs, are unlikely to derive any benefit from pharmaceutical CEs. It does not support the use of pharmaceutical CEs and warns that use may be associated with a negative effect on self-control, and may give rise to overconfidence (British Medical Association, 2015).

Students seemed to have more ethical concerns about the type of CE rather than the concept of using CEs and held similar views about use when qualified as when a student. Further research should be conducted before conclusions could be reached. Around half of the respondents seemed to be broadly accepting of CEs by agreeing that mankind has always used substances to enhance performance. Moreover, this cohort of students were ambivalent about future pharmacists using CEs being worse than other university students using CEs. Females seemed more concerned about fairness than males, and males were less likely than females to consider pharmaceutical CE use in academia as being similar to doping in sports. Perhaps this is because males are more likely to use doping in sports (Bloodworth et al., 2012) and have a greater acceptance of, and likelihood to partake in, risk-taking behaviours (Harris *et al.*, 2006; Hall *et al.*, 2013; 2015).

Regarding strengths and weaknesses, this was the first study in the UK to explore first and final year pharmacy students' use and views on CEs, with particular emphasis on natural versus pharmaceutical products. It was timely due to the increasing level of concern over CE activity among university students in recent years. Secondly, non-response bias was not overly concerning, given the high response rate. The questionnaire could be readily utilised by other schools of pharmacy and healthcare disciplines. However, the opinions were captured at one point in time, data were self-reported, and the findings are not generalisable. It is plausible that pharmacy students did not want to admit to using POMs off-label (or illicit drugs) for cognitive enhancement purposes, although having a non-identifiable questionnaire should have minimised this reluctance. Furthermore, the timing of data collection could have influenced results. Perhaps if the study had been conducted immediately before the written examinations, prevalence of CE use would have been higher.

Conclusions

Personal use of CEs appears prevalent among these future pharmacists but largely unrelated to seniority on the M.Pharm. degree programme or to gender. The substances used did not seem to be particularly potent, which is reassuring. Reasons for CE use raise questions about time management and organisational skills in these students. Finally, the distinction in views between natural substances and pharmaceutical products is noteworthy and worth further exploration.

Educational recommendations and future research ideas

As some of our findings may be unique to the UK, to the discipline of pharmacy, and to our school, we invite readers to contextualise these results to their own degree programmes or settings

This study provides the impetus for QUB to explicitly address the subject area of CEs and to do so at an early stage within the M.Pharm. degree programme. Students should be encouraged and supported to develop key skills and knowledge using risk-free methods and by having a healthy lifestyle

Workshops and debates could investigate the ethics of using non-pharmaceutical and pharmaceutical CE in greater depth, given the many possible ways to gain an 'unfair' advantage over peers within education

Since the subject area has relevance to many university students, discussions around CE use could become an inter-professional or inter-disciplinary learning opportunity

It would be worthwhile to explore CE use from undergraduate level to when these students are healthcare professionals

Conflicts of interest

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References

Academy of Medical Sciences. (2008). Brain science, addiction and drugs (online). Available at: https://acmedsci.ac.uk/file-download/34265-524414fc8746a.pdf. Accessed 22nd June, 2017.

Arnold, L.E. (2000). Methylphenidate vs. amphetamine: comparative review. *Journal of Attention Disorders*, **3**(4), 200-211.

Bennett, T. & Holloway, K. (2017). Motives for illicit prescription drug use among university students: a systematic review and meta-analysis. *International Journal of Drug Policy*, **44**, 12-22.

Bloodworth, A.J., Petróczi, A., Bailey, R., Pearce, G. & McNamee, M.J. (2012). Doping and supplementation: the attitudes of talented young athletes. *Scandinavian Journal of Medicine and Science in Sports*, **22**(2), 293-301.

Bossaer, J.B., Gray, J.A., Miller, S.E., Enck, G., Gaddipati, V.C. & Enck, R.E. (2013). The use and misuse of prescription stimulants as "cognitive enhancers" by students at one academic health sciences center. *Academic Medicine*, **88**(7), 967-971.

British Medical Association. (2015, updated 2017). Employment and career advice. Cognitive enhancing drugs and the workplace (online). Available at: https://www.bma.org.uk/advice/employment/occupational-health/cognitive-enhancing-drugs. Accessed 22nd June, 2017.

Castaldi, S., Gelatti, U., Orizio, G., Hartung, U., Moreno-Londono, A.M., Nobile, M. & Schulz, P.J. (2012). Use of cognitive enhancement medication among northern Italian university students. *Journal of Addiction Medicine*, **6**(2), 112-117.

Chouakea, J. & Friedman, A. (2012). Herbal medicine in dermatology: does natural = safe? *Journal of Drugs in Dermatology*, **11**(6), 774.

DeSantis, A., Noar, S.M. & Webb, E.M. (2010). Speeding through the frat house: A qualitative exploration of nonmedical ADHD stimulant use in fraternities. *Journal of Drug Education*, **40**(2), 157-171.

Dietz, P., Striegel, H., Franke, A.G., Lieb, K., Simon, P. & Ulrich, R. (2013). Randomized response estimates for the 12-month prevalence of cognitive-enhancing drug use in university students. *Pharmacotherapy*, **33**(1), 44-50.

Dillman D.A. (2008). Internet, mail, and mixed-mode surveys: the tailored design method, 3rd ed. New Jersey: John Wiley & Sons, Inc.

Eickenhorst, P., Vitzthum, K., Klapp, B.F., Groneberg, D. & Mache, S. (2012). Neuroenhancement among German university students: motives, expectations, and relationship with psychoactive lifestyle drugs. *Journal of Psychoactive Drugs*, **44**(5), 418-427.

Emanuel, R.M., Frellsen, S.L., Kashima, K.J., Sanguino, S.M., Sierles, F.S. & Lazarus, C.J. (2013). Cognitive enhancement drug use among future physicians: Findings from a multi-institutional census of medical students. *Journal of General Internal Medicine*, **28**(8), 1028-1034.

Faraone, S.V., Spencer, T., Aleardi, M., Pagano, C. & Biederman, J. (2004). Meta-analysis of the efficacy of methylphenidate for treating adult attention-deficit/hyperactivity disorder. Journal of Clinical Psychopharmacology, **24**(1), 24-29.

Franke, A.G., Bonertz, C., Christmann, M., Huss, M., Fellgiebel, A., Hildt, E. & Lieb, K. (2011). Non-medical use of prescription stimulants and illicit use of stimulants for cognitive enhancement in pupils and students in Germany. *Pharmacopsychiatry*, **44**(2), 60-66.

General Pharmaceutical Council. (2010). Code of Conduct for Pharmacy Students. Available at: https://www.pharmacyregulation.org/sites/default/files/Code%20of%20conduct%20for%20phamacy%20students%20s.pdf. Accessed 3rd November, 2016.

General Pharmaceutical Council. (2017). Standards for Pharmacy Professionals, May 2017 (online). Available at: https://www.pharmacyregulation.org/sites/default/files/standards_for_pharmacy_professionals_may_2017_0.pdf. Accessed 22nd June, 2017.

Habibzadeh, A., Alizadeh, M., Malek, A., Maghbooli, L., Shoja, M.M., Ghabili, K. (2011). Illicit methylphenidate use among Iranian medical students: prevalence and knowledge. *Drug Design, Development and Therapy*, **5**, 71-76.

Hall, H.G., Griffiths, D.L. & McKenna, L.G. (2011). The use of complementary and alternative medicine by pregnant women: a literature review. *Midwifery*, **27**(6), 817-824.

Hall, M., Hanna, L.A., Huey, G. (2013). Use and Views on Social Networking Sites of Pharmacy Students in the United Kingdom. American Journal of Pharmaceutical Education, 77(1), Article 9.

Hall, M., Hanna, L.A., Nixon, R. & Hanna, A. (2015). Alcohol, tobacco, and pharmacy students: Usage and views on professional issues. *Currents in Pharmacy Teaching and Learning*, **7**(4), 476-483.

Hanna, L.A., Barry, J., Donnelly, R., Hughes, F., Jones, D., Laverty, G., Parsons, C. & Ryan, C. (2014). Using debate to teach pharmacy students about ethical issues. *American Journal of Pharmaceutical Education*, **78**(3), Article 57

Harris, C.R., Jenkins, M. & Glaser, D. (2006). Gender differences in risk assessment: why do women take fewer risks than men? *Judgment and Decision Making*, **1**(1), 48.

Jain, R., Chang, C., Koto, M., Geldenhuys, A., Nichol, R. & Joubert, G. (2017). Non-medical use of methylphenidate among medical students of the University of the Free State. *South African Journal of Psychiatry*, **23**(1), 1-5.

Jensen, C., Forlini, C., Partridge, B. & Hall, W. (2016). Australian university students' coping strategies and use of pharmaceutical stimulants as cognitive enhancers. *Frontiers in Psychology*, **7**. 277.

Kudlow, P.A., Treurnicht Naylor, K., Xie, B. & McIntyre, R.S. (2013). Cognitive enhancement in Canadian medical students. *Journal of Psychoactive Drugs*, **45**(4), 360-365.

Linssen, A.M.W., Sambeth, A., Vuurman, E.F.P.M. & Riedel, W.J. (2014). Cognitive effects of methylphenidate in healthy volunteers: a review of single dose studies. *International Journal of Neuropsychopharmacology*, **17**(6), 961-977.

Mache, S., Eickenhorst, P., Vitzthum, K., Klapp, B.F. & Groneberg, D.A. (2012). Cognitive-enhancing substance use at German universities: frequency, reasons and gender differences. *Wiener Medizinische Wochenschrift*, **162**(11-12), 262-271.

Maier, L.J., Liechti, M.E., Herzig, F. & Schaub, M.P. (2013). To dope or not to dope: neuroenhancement with prescription drugs and drugs of abuse among Swiss university students. *PloS One*, **8**(11), 77967.

Maier, L.J., Liakoni, E., Schildmann, J., Schaub, M.P. & Liechti, M.E. (2015). Swiss university students' attitudes toward pharmacological cognitive enhancement. *PloS One*, **10**(12), 0144402.

Micoulaud-Franchi, J.A., MacGregor, A. & Fond, G. (2014). A preliminary study on cognitive enhancer consumption behaviors and motives of French Medicine and Pharmacology students. *European Review for Medical and Pharmacological Sciences*, **18**(13), 1875-1878.

Minzenberg, M.J. & Carter, C.S. (2008). Modafinil: a review of neurochemical actions and effects on cognition. *Neuropsychopharmacology*, **33**(7), 1477-1502.

Nutt, D.J., King, L.A., Saulsbury, W. & Blakemore, C. (2007). Development of a rational scale to assess the harm of drugs of potential misuse. *The Lancet*, **369**(9566), 1047-53.

Ott, R. & Biller-Andorno, N. (2014). Neuroenhancement among Swiss students–a comparison of users and non-users. *Pharmacopsychiatry*, **47**(1), 22-28.

Peterson, J.A. & Brommelsiek, M. (2017). Interprofessional education to foster communication and resilience among health professional students. *Journal of Interprofessional Education and Practice*, **7**(1), 1-3.

Ram, S., Hussainy, S., Henning, M., Stewart, K., Jensen, M. & Russell, B. (2017). Attitudes toward cognitive enhancer use among New Zealand tertiary students. *Substance Use and Misuse*, 1-6, doi: 10.1080/10826084.2017.1281313 [Epub ahead of print].

Ragan, C.I., Bard, I. & Singh, I. (2013). What should we do about student use of cognitive enhancers? An analysis of current evidence. *Neuropharmacology*, **64**, 588-595.

Rathbone, A. (2017). What is the situation with "smart drugs" use among UK university students? *Management*, **12**, 17.

Roumie, C.L. & Griffin, M.R. (2004). Over-the-counter analgesics in older adults. *Drugs and Aging*, **21**(8), 485-498.

Santacroce, R., Sarchione, F., Corazza, O., Lupi, M., Cinosi, E., Di Giannantonio, M. & Martinotti, G. (2016). The art of being smart: cognitive enhancement in a population of Italian university students. *European Neuropsychopharmacology*, **26**, S697-S698.

Singh, I., Filipe, A.M., Bard, I., Bergey, M. & Baker, L. (2013). Globalization and cognitive enhancement: emerging social and ethical challenges for ADHD clinicians. *Current Psychiatry Reports*, **15**(9), 385.

Singh, I., Bard, I. & Jackson, J. (2014). Robust resilience and substantial interest: a survey of pharmacological cognitive enhancement among university students in the UK and Ireland. *PloS One*, **9**(10), 105969.

Smith, M.E. & Farah, M.J. (2011). Are prescription stimulants "smart pills"? The epidemiology and cognitive neuroscience of prescription stimulant use by normal healthy individuals. *Psychological Bulletin*, **137**(5), 717.

Turner, D.C., Clark, L., Dowson, J., Robbins, T.W. & Sahakian, B.J. (2004). Modafinil improves cognition and response inhibition in adult attention-deficit/hyperactivity disorder. *Biological Psychiatry*, **55**(10), 1031-1040.

Weyandt, L.L., Oster, D.R., Marraccini, M.E., Gudmundsdottir, B.G., Munro, B.A., Rathkey, E.S. & McCallum, A. (2016). Prescription stimulant medication misuse: Where are we and where do we go from here? *Experimental and Clinical Psychopharmacology*, **24**(5), 400.

Wilens, T.E., Adler, L.A., Adams, J., Sgambati, S., Rotrosen, J., Sawtelle, R., Utzinger, L. & Fusillo, S. (2008). Misuse and diversion of stimulants prescribed for ADHD: a systematic review of the literature. *Journal of the American Academy of Child and Adolescent Psychiatry*, **47**(1), 21-31.