**School of Pharmacy**

# Use of Cognitive Enhancing Substances by University Students: A Cross-Sectional Study.

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## Declaration

This thesis titled “Use of Cognitive Enhancing Substances by University Students: a Cross-Sectional Study” was conducted at Curtin University Bentley Campus from September to October 2010. This project was done by the candidate with appropriate supervision.

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature: ............................

(Paliza Joshi)

Date: March 2011

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# Abstract

**Objectives:** The purpose of this study was to determine the prevalence and patterns of use of cognitive enhancing substances (such as caffeine containing products and beverages and prescription stimulant drugs) amongst students at Curtin University. Further, to determine the potential for adverse effects from their use.

**Method:** A cross-sectional study was conducted involving students attending the Curtin University. A sample of students was randomly selected and students were presented with an information sheet explaining the purpose and design of the study as well as their role in the study. Once they gave verbal consent to participate, they were requested to complete a questionnaire. All the completed questionnaires were entered into a dataset on a computer using the SPSS software, and analysis of the data was performed using the SPSS version 17 and SAS statistical software packages for Microsoft Windows. Statistical analysis included descriptive statistics such as frequencies and percentages or means and standard deviations. The cross-tabulation, chi-square statistic and ANOVA were used to assess the statistical significance of difference.

The survey included questions regarding demographics, caffeine (consumption, reasons for use, side effects following its consumption) and prescription stimulants (use, reason for use and side effects following consumption). Further, data was collected on the perceived effectiveness of the cognitive enhancing substances by students and their level of caffeine consumption.

**Results:** The final dataset included 526 students out of which 94.5% of surveyed students reported that they drank caffeine containing beverages. Tea and coffee were found to be the most common sources of caffeine followed by soft drinks and energy drinks. The average daily caffeine intake was estimated to be 3.0mg/Kg/day on normal days and 3.8mg/Kg/day on exam days. Females were found to consume slightly more caffeine than males. Also, there was higher caffeine intake by smokers than non-smokers.

Regarding energy drinks, a greater percentage of males than females were found to consume energy drinks. The students studying health related courses were less likely than those from other faculties to consume energy drinks. Similarly, there was significant association between the smoking status and energy drinks consumption.

The most frequent adverse effects experienced by students were jolt and crash followed by insomnia, and headache following caffeine intake. Moreover, more students experienced side effects following high doses of caffeine as compared to moderate and low doses. The most common self-reported reasons for consuming caffeine containing products were: to boost their energy and while studying for exams or completing major projects, and to counteract lack of sleep.

Of all the respondents only 4% (n=21) reported that they used prescription stimulants (other than caffeine). Approximately 3% used stimulants together with caffeine on both normal and exam days. The prevalence of taking prescription stimulants was higher in students consuming higher doses of caffeine. The most common reported reasons for use were to improve concentration and to get high (equal percentage of 66.7% students). Most of the students stated that they experienced insomnia after the prescription stimulants intake. They also reported experiencing jolt and crash. Most of the students perceived that cognitive enhancing substances are effective in improving their energy levels.

**Conclusion:** A substantial proportion of students in this sample were found to consume caffeine containing products. The study demonstrated that cognitive enhancing substance use was increased around times of academic stress. The students taking high doses were at higher risk to side effects. As a greater proportion of students consumed high doses of caffeine during exam period, more were at risk of adverse effects. Only a small percentage of students reported use of other stimulants, but importantly, this was more common amongst high consumers of caffeine. Further studies at other universities are required to confirm the findings of this study.

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# 1 INTRODUCTION

Cognitive enhancing substances enhance mental function such as cognition, memory, intelligence, motivation, attention and concentration [1]. There are various types of cognitive enhancing substances available on the market. The most common are the stimulant drugs such as amphetamines, methylphenidate, modafinil and caffeine [2]. These stimulants, with exceptions, are prescribed by doctors for the treatment of cognitive disabilities and neuropsychiatric disorders and brain injury [1]. However, there are a number of people who use these drugs just to improve their overall brain function. An online survey conducted by the journal Nature in over sixty countries, which included people of all age groups, found that one in five used prescription drugs to improve focus, concentration and memory [3]. The prevalence of non-medical use of these enhancers is increasing, especially in the academic field [4]. There are many studies reporting students taking these enhancers to improve their concentration, increase their alertness and to improve their grades and sometimes for recreational purposes [4]. Scotter et al conducted a survey of university students and found that only seven out of 58 (12.5%) use stimulants for medical purposes, however most of the students (70.9%) used them without a valid prescription [5]. McCabe et al reported in a survey conducted in 2005 that 6.9% of college students used prescription stimulants for non-medical purposes [6].

Cognitive enhancers are considered safe and effective for therapeutic use, however there are very few studies looking at their off-label use [2]. A study of university students in the United States found that 50% of frequent non-medical users of stimulants reported depressed mood [7]. Additionally there were reports of aggressive behaviour, mental health risk and depression among stimulant user high school students in Cape Town [8]. It showed that off-label use of stimulants was more in males than females (10% vs 8%) [8]. Associations have also been reported between the non-medical use of prescription stimulants and demographic, psychosocial and behavioral factors [9, 10].

Caffeine acts as a stimulant by primarily holding back the body's tendency to rest [11]. It also enhances mental performance [11]. It has been reported that low doses of caffeine (12.5 to 50mg) can improve cognitive performance and mood whereas larger doses (200mg) can improve cognitive task, speed and accuracy, and increase alertness [12].

However, higher doses of caffeine can lead to intoxication termed as caffeinism that is characterized by nervousness, anxiety, restlessness, insomnia, gastrointestinal upset, tremors, tachycardia, and psychomotor agitation and in rare cases death [13].

According to a survey conducted by McCabe and Boyd [14], there were as many as 18 sources from which college students received cognitive enhancers. They divided these sources into three main categories: peers, family and other sources, identifying the major source to be their peers [14]. Whilst some students obtained the cognitive enhancers via a prescription, most found it easier to do so from a friend or roommate. Another survey which sought information about the students' knowledge of the effects of stimulants found that those non-users whose peers used stimulants were more knowledgeable about the effects of stimulants use than those whose peers who did not [15].

# 2 BACKGROUND

## 2.1 Cognitive enhancing substance

The substances or medications that enhance cognitive processes such as thought, perception and memory are termed as cognitive enhancing substances [16]. Bostrom and Sandberg [17] defined cognitive enhancement as "the amplification or extension of core capacities of the mind through improvement or augmentation of internal or external information processing system." Some of the cognitive enhancing substances are the prescription stimulants and other stimulants such as caffeine and nicotine. Stimulants have been used for a long time to improve attention or memory and to improve productivity [17]. Nowadays, these stimulants are gaining popularity amongst students to sharpen their memory, concentration and are often taken before examinations [18].

## 2.2 Stimulants

Stimulants are a group of drugs that act on the central nervous system and excite body function, behavior and cognition. These drugs tend to stimulate alertness, elevated mood, wakefulness, increased speech and motor activity and decrease appetite [19, 20].

They act either as an agonist or an antagonist. As agonists, these substances aid physiologic activities by increasing or decreasing the effectiveness or production of hormones or neurotransmitters. As an antagonists, they bind to cell receptors and block the action of drug or physiological activities by inhibiting the uptake of neurotransmitters [21].

They are also known as psychostimulants [22]. Stimulants enhance attention and memory by increasing neuronal activation or by releasing neuromodulators which cause synaptic changes and stimulation of cholinergic systems [17]. Among the most common stimulants are modafinil, methylphenidate, amphetamine, dexamphetamine and caffeine.

#### *2.2.1 Caffeine*

Caffeine is a naturally occurring alkaloid found in more than 60 plants [23]. Methylxanthine caffeine is one of the most widely consumed stimulants in the world. It is a mild central nervous system stimulant, a vasodilator, and a diuretic [22]. Caffeine is present in wide range of dietary products such as coffee, tea, coca, candy bars, soft drinks and energy drinks. In addition, a number of prescription and over-the-counter drugs (OTCs), which are used for headache, cold, allergy, and pain relief and alerting drugs, are often combined with caffeine. Some examples of these drugs are as follows: No-Doz, No-Doz Plus and Cafergot [24, 25].

##### *2.2.1.1 Pharmacokinetics of caffeine*

After oral ingestion, caffeine is rapidly and almost completely absorbed from the gastrointestinal tract and reaches peak plasma concentrations in about 30-60 mins after consumption. The volume of distribution is 0.6L/Kg and 36% is protein bound. It passes through the blood brain barrier and all biological membranes. It is metabolized in the liver by the cytochrome P450 (CYP) system to dimethylxanthine stimulants theobromine and theophylline. The elimination half-life is 4.5 hours in healthy nonsmoking adults [26-28].

#### *2.2.1.2 Mechanism of action*

Adenosine $A_1$ and $A_{2A}$ receptors are present in the basal ganglia. Basal ganglia are a group of structures which help in various motor controls. As shown in Table 1, adenosine $A_1$ receptors are present in all brain areas whereas $A_{2A}$ receptors are found more in the dopamine rich regions of the brain. There is evidence that $A_{2A}$ receptors interact with the dopamine system, which is involved in reward and arousal effects [27].

Caffeine acts as an antagonist to both types of the receptors. The overall psychostimulant properties of caffeine in brain are mediated by its ability to interact with neurotransmission in different regions of the brain. It has been indicated that caffeine particularly affects a group of projection neurons located in the striatum, which is the main receiving area of the basal ganglia [29]. Thus, caffeine blocks the inhibitory neurotransmitter adenosine, inhibits phosphodiesterase and increases intracellular cyclic adenosine monophosphate (cAMP) [28]. At low concentration, it blocks adenosine receptors however, at higher concentration, it is found to inhibit phosphodiesterase and calcium mobilization [27].

**Table 1: Central adenosine receptors affected by typical human caffeine exposure[27]**

| RECEPTOR | LOCALIZATION | TYPES OF NEURONS | EFFECT OF CAFFEINE | CAFFEINE ACTION |
|---|---|---|---|---|
| $A_1$ | Almost all brain areas, especially hippocampus, cerebral and cerebellar cortex, certain thalamic nuclei | All types of neurons (aspecific)<br>Especially linked to dopamine D1 receptors | Antagonistic | Disinhibition of transmitter release |
| $A_{2A}$ | Dopamine rich regions: striatum, nucleus accumbens, tuberculum olfactorium, hippocampus, cortex | Co-localized with dopamine D2 receptors | Antagonistic | Increase transmission via dopamine D2 receptors |

#### *2.2.1.3 Physiological effects*

In a literature review by Glade, caffeine at moderate amounts was found to increase energy, decrease fatigue, enhance physical, motor and cognitive performances, increase alertness, decrease mental fatigue, increase the accuracy of reaction and enhance cognitive functioning capabilities and neuromuscular coordination [30]. The author did not specify the effective dose in the study. However, the medical website Rx-list has mentioned that doses of 100-200 mg caffeine can increase alertness, relieve drowsiness and improve thinking and at doses of 250-700 mg/day, caffeine can cause anxiety, insomnia, nervousness, hypertension, and insomnia [31]. Moreover, an article by Pohler mentions that caffeine can affect all the organ systems in the body if taken in excess amounts (Table 2) [32].

**Table 2: Caffeine Clinical Effects[32]**

| SYSTEM | CLINICAL EFFECTS |
|---|---|
| CNS | Agitation, irritability, headache, restlessness, insomnia, delirium, hallucinations |
| Cardiovascular | Vasodilatation, increased cardiac output, angina, flushing, palpitation, sinus tachycardia |
| Gastrointestinal | Gastritis |
| Neuromuscular | Fasciculation |
| Bronchi | Smooth muscle relaxation |
| Skeletal | Evidence suggests decreased bone mineral density and accelerated bone loss |

#### *2.2.1.4 Caffeine content and Regulatory Aspects in Australia*

Most of the caffeine consumption is through beverages such as coffee, tea, soft drinks and energy drinks, and less commonly through caffeine containing tablets. These drinks and tablets contain caffeine in varying amounts. A standard cup of coffee of 180mL[33] contains 75-110mg of caffeine depending upon the strength and method of preparation. Decaffeinated coffee contains 3.5mg per cup. Generally, caffeine content in tea per serving is lower as compared to coffee. Caffeinated tea contains about 70mg per cup and decaffeinated contains 3.1 mg per cup [33-38]. Some of the over-the counter medicines and prescription medications contain up to 100mg of caffeine per tablet. Caffeine is also added to many soft drinks. Energy drinks contain caffeine in varying amounts (Table 3) [33-38].

**Table 3: Caffeine Contents of Selected Beverages and Medications** [33-38]

| CAFFEINE CONTENTS OF SELECTED BEVERAGES | |
|---|---|
| **Substance** | **Amount of Caffeine** |
| **Brewed Coffee** | 110mg per cup |
| **Decaffeinated Coffee** | 3.5mg per cup |
| **Caffeinated Tea** | 70mg per cup |
| **Decaffeinated Tea** | 3.1mg per cup |
| **CAFFEINE CONTENTS OF SELECTED OTC MEDICATIONS** | |
| **OTC medication** | **Caffeine per tablet** |
| **No-Doz** | 100mg |
| **No-Doz Plus** | 100mg |
| **CAFFEINE CONTENTS OF SELECTED PRESCRIPTION MEDICATIONS** | |
| **Prescription Medication** | **Amount of caffeine** |
| **Cafergot** | 100mg per tablet or suppository |
| **CAFFEINE CONTENT OF SOFT DRINKS AND ENERGY DRINKS** | |
| **Trade Name** | **Approximate amount of caffeine** |
| **Diet Coke** | 48mg/375mL |
| **Coca-Cola** | 48mg/375mL |
| **Pepsi-Cola** | 40.5mg/375mL |
| **Mountain-Dew** | 58mg/375mL |
| **Coke-Zero** | 34.5mg/375mL |
| **Red Bull** | 80mg per 250mL |
| **V** | 78mg/250mL |
| **Monster** | 80mg/250mL |
| **Rockstar** | 80mg/250mL |
| **Mother** | 106mg/250mL |

1 Cup = 180mL

In Australia, under the Standard for Formulated Caffeinated Beverages caffeine is permitted for use as stimulant at dose range of 145-320mg/L. In addition, it is mandatory for the manufacturers to enlist the caffeine content in milligrams and place an advisory statement on the label of the beverages. The New South Wales Food Authority (NSWFA) has formed a council called the Australia New Zealand Food Regulation Ministerial Council, which is responsible to review and update the policy and guidelines on the addition of caffeine to food. Moreover, the council amends the present caffeine permission in the Food Standards Code [39].

Under Standard 1.31.1 "Food Additives" of the Australia New Zealand Food Standards Code, the maximum amount of caffeine allowed to be added to soft drinks is 145mg/L. Energy drinks are regulated under Standard 1.31.1 "Food Additives" and Standard 2.6.4 "Formulated Caffeinated Beverages" of the Australia New Zealand Food Standard Code. This code permits a caffeine total in range of 145mg/L to 320mg/L including guarana [40].

#### *2.2.1.5 Caffeine consumption and Effects*

Coffee is the primary source of dietary caffeine in adults [41]. It has been estimated that caffeine consumption per capita in the world is 70mg per day. In a 1980 survey conducted in Sydney, Australia, it was found that average intake of caffeine was about 240mg per day [42].

Caffeine has both favorable and unfavorable effects. Caffeine consumption by healthy adults at low to moderate doses (50-300mg) produces mild positive effects on performance such as alertness, increased energy, motivation and ability to concentrate. However, higher doses of caffeine (300-800mg) lead to adverse effects associated with excessive stimulation such as anxiety, nervousness and insomnia [43]. WHO has termed "acute or chronic intake of caffeine (i.e daily dose of 500mg or more) with resultant toxic effect as Caffenism". The symptoms include restlessness, insomnia, flushed face, muscle twitching, tachycardia, gastrointestinal disturbances including abdominal pain, pressured or rambling thought and speech and sometimes exacerbation of pre-existing anxiety or panic states, depression or schizophrenia [22]. Nevertheless, caffeine sensitivity, defined as amount of caffeine needed to produce these effects, varies amongst individuals. Generally, it is related to the size of the person, the smaller the person the smaller the amount of caffeine required to produce side effects [44].

Pollack and Bright examined the effect of caffeine consumption and its effect on sleep. They found that higher intake of caffeine is significantly associated with shorter and interrupted nocturnal sleep and increased daytime sleepiness [45]. After regular use of caffeine, tolerance and physical dependence develops [46].

#### *2.2.1.6 Energy drinks and Cola Soft drinks*

The beverages that contain caffeine or guarana as the main ingredient and other legal stimulant ingredients such as taurine, carbohydrates, ephedrine, ginseng, glucuronolactone, inositol, niacin, panthenol and B-complex vitamins are known as energy drinks [47, 48]. Cola soft drinks are caffeine containing soft drinks. In the United States, more than 60% soft drinks contain caffeine as flavor additive [49]. These drinks contain caffeine in the range of 40-50mg per 375mL can. Energy drinks have higher caffeine content than cola soft drinks. Energy drinks contain 80-120mg per can [44]. It is reported that most energy drinks do not have caffeine content in excess of 80mg/250mL [50]. However, an investigation by the New South Wales Food Authority (NSWFA) found 77% of caffeinated energy drinks contained more than the amount of caffeine permitted by the Food Standards Code [39].

In 2006 Australian Convenience Store News reported that energy drinks market was growing dramatically and already accounted for 22% of total share of market sales. Most consumers were in the 15-39 age groups and consumption was slightly skewed towards males. It was also reported that the energy drink market share is growing rapidly: 21% faster than other drinks [51]. In 2006, nearly 500 brands of energy drinks were introduced into the market worldwide and the consumer numbers were more than 7 million adolescents in the United States [52].

Generally, energy drinks claim to increase attention and performance and improve “having fun and kicking butt”[13]. Red Bull® is the most popular energy drink in the world. The manufacturer claims it improves performance, increases endurance and concentration, and improves reaction speed and stimulates metabolism [53]. There are some reports which show that consumption of energy drinks can lead to caffeine intoxication or caffeinism. The stimulating effect of energy drinks ingredients can increase heart rate, blood pressure and palpitations. Also, they can cause dehydration and insomnia resulting in excessive daytime sleepiness [54]. Reissig and colleagues noted a number of reasons which can lead to an increase in the risk for caffeine overdose, which include lack of adequate labeling of the amount of caffeine, lack of warning labels advising about proper use, and lack of restrictions on the sale of energy drinks to children and adolescents [13].

#### *2.2.1.7 Caffeine consumption by Students*

High caffeine containing energy drink marketing is targeted specifically at young people. Some studies have reported that energy drinks have positive effects on both cognitive and physical performance [55]. In a study on energy drinks by Alford et al it was reported that consumption of Red Bull® at moderate levels can improve psychomotor performance, subjective perceptions of alertness, and physical endurance in non-athletes. The psychomotor performances are defined as concentration, reaction time and short-term memory [56]. Moreover, in a study conducted by Warburton et al, after controlling for the possible effect of glucose present in the energy drinks, they found that the main ingredients of Red Bull® i.e. caffeine and taurine improved accuracy and reaction time in visual information processing as well as attention and verbal reasoning [57]. These performance enhancing effects in the academic field are due to its psychostimulant effects. However, in a different study James and Rogers showed that improvement in performance following caffeine consumption is due to the reversal of withdrawal effects of caffeine [58]. The withdrawal effect of caffeine includes sleepiness, lethargy, lack of attention and decreased cognitive performance. These effects may appear as little 6-8 hours after the last time caffeine was consumed [59].

In a cross-sectional survey conducted in Iceland among 9$^{th}$ and 10$^{th}$ grade secondary school students, 75.8% were found to consume caffeine daily in cola soft drinks and energy drinks as the primary source followed by tea and coffee as secondary source of caffeine [59]. Similarly, Taiwanese college students consumed packed coffee drinks at least once a week to boost their energy levels and to stay awake [60].

In a survey on physical education students, 39.4% of students reported that they had used energy drinks more than six times in the last one month and only 2.2% said they had used these drinks once in their life time. Further they added the reasons for consumption as: to improve the taste of alcoholic drinks (54%), extend their evening leisure periods (27.7%), improve sports performance (13.9%), for stimulation (9.5%), to enjoy the taste (8.8%), for curiosity (6.6%) and to study (4.4%) [61]. Similarly in a study conducted in college students, 48.3% students used energy drinks for different reasons as "curiosity of its taste/effects", "for energy" and "to boost performance" [48]. Among 795 undergraduate students, 39% were said to have consumed energy drink in the past month with males more frequent users than females. Moreover, the side effect experiences by these students were related to their frequency of energy drink consumption [55].

A study by Jones et al conducted on university students reported that the caffeine consumption is related to the scores on self-reported measure of sensation seeking and impulsivity [62]. A 2007 survey of 496 students revealed that 51% consumed more than one energy drink in an average month. It also revealed that the majority of students consumed these drinks for the following reasons: insufficient sleep (67%), to increase energy (65%) and to drink with alcohol while partying (54%). Among those, 29% reported "weekly jolt and crash episodes", 22% reported headaches and 19% reported heart palpitations from drinking the energy drinks [12]. Here jolt and crash was defined as increase in energy followed by sudden drop in energy. Similarly, two surveys conducted on college students indicated that energy drink consumption was associated with subsequent non-medical prescription stimulant use and increased intake of alcohol [63, 64]. There are reports that energy drinks have caused seizures [65], reduced insulin sensitivity [66], caused cardiac arrest [67] , acute mania [13] and increased platelet aggregation and impaired endothelial function [68]. Moreover, in a systematic literature review by Clauson and colleagues from 1980 to 2007, they found four documented case reports of caffeine-associated deaths [69].

There are various studies which report that frequent energy drink consumption is related to risk taking behavior. In a study conducted by Miller, the frequency of energy drink consumption was associated with risk taking behaviors such as excessive alcohol intake, smoking and use of non-medical prescription drugs [70]. In a study conducted in 156 university students in Turkey, a significant increase in headache, fatigue, irritability and sleepiness/drowsiness was reported with >200mg daily caffeine consumption [71].

### *2.2.2 Prescription Stimulants*

Some of the prescription stimulants used as cognitive enhancers includes modafinil, methylphenidate and dextroamphetamine. Modafinil, brand name Modavigil, and methylphenidate, brand names Ritalin and Concerta, were developed originally to improve executive function or memory in persons diagnosed with disorders such as attention deficit disorder or Alzheimer disease [72, 73]. However, these cognitive enhancers are also being used to improve memory, concentration, planning and reduce impulsive behaviour and risky decision making [74].

#### *2.2.2.1 Mechanism of Action*

Amphetamines and methamphetamines are noradrenergic agonists and exert effects on CNS by releasing nitrogen-containing organic compounds or amines from their storage sites in the nerve terminals. The effect on attention or alertness and muscle stimulation of amphetamines is due to the release of the hormone noradrenalin by the brain. In addition, it also can release the neurotransmitter dopamine and cause other motor stimulation [21]. Modafinil is a non-amphetamine psychostimulant. Its mode of action is unknown [75].

#### *2.2.2.2 Effects of prescription stimulants*

Stimulants help to increase alertness, focus and improve memory. In a TIME magazine article, it has been mentioned that stimulants consistently and significantly improve learning of material and helps to recall the material someday later [76]. Some can enhance "executive function" or "problem-solving ability" [72]. It has been stated that "modafinil enhances adaptive response inhibition, making the subjects evaluate a problem more thoroughly before responding, thereby improving performance accuracy" [17]. The effect of modafinil on enhanced working memory in healthy test subjects has been mentioned in one study with more beneficial effects shown at harder task difficulties and on lower performing subjects [77]. In another study modafinil has shown to increase forward and backward digit span, visual pattern recognition memory, spatial planning, and reaction time/latency on different working memory tasks [78].

The therapeutic use of prescription stimulants has not been shown to be problematic. However, there is a risk of increased blood pressure, increasing the chance of heart attack and stroke [76]. The overuse or non-prescription use of these medications can impact risk on health and result in addiction [76]. About 10% to 20% of people who use amphetamines to get high can end up being addicted to the drugs [76]. Signs and symptoms of intoxication include tachycardia, papillary dilatation, elevated blood pressure, hyperreflexia, sweating, chills, anorexia, nausea or vomiting, insomnia, and abnormal behaviours such as aggression, grandiosity, hypervigilance, agitation and impaired judgment. Chronic use can lead to personality and behaviour changes such as impulsivity, aggressivity, irritability, suspiciousness and paranoid psychosis [22].

#### *2.2.2.3 Responsible use of prescription stimulants*

The American Academy of Neurology (AAN) has reported that there are growing numbers of people without diagnosed medical or mental health conditions who believe that they can improve their memory, cognitive focus and attention by taking prescription stimulants. The users ask for prescriptions for these stimulants. Further, AAN mentioned that "the drugs most commonly used for cognitive enhancement at present are stimulants namely Ritalin® (methylphenidate) and Adderall® (mixed amphetamine salts) which are prescribed mainly for the treatment of attention deficit hyperactivity disorder (ADHD)" [73]. There is a report that people get the prescription for these stimulants by fraud as well. In a study by Harrison and colleagues, students were found to demonstrate fake ADHD patterns of symptoms. They concluded that "clinicians should use caution when diagnosing ADHD in adults, and should not base their diagnosis solely on the results of symptom checklist data." [79]. The safety and effectiveness of these prescription stimulants in therapeutic use has been stated but the effect of long tern use of these substances by the healthy person is still unknown [72].

#### *2.2.2.4 Use of stimulants in academic field*

A study has mentioned that many students use stimulants legally or illegally to improve their grades, particularly to increase concentration, organization, and the ability to remain alert at night to study [74]. In a 2008 survey of 2,087 college students, 5.3% students reported nonmedical use of methylphenidate, mainly for recreational purposes or to improve academic performance. Moreover, the study also found that the prevalence of using methylphenidate was equal in gender and age groups and the use tended to mask the abnormal behaviour which could be risky [80]. According to a web survey, 31% of college students with a prescription for ADHD had misused the medication by taking larger or more frequent doses and their primary reason was to enhance their academic performance [81]. In a web based survey conducted among 4580 college students, the lifetime and past year prevalence rate for illicit use of prescription stimulants were 8.3% and 5.9% respectively. Mostly they used these medications to increase concentration, to help in study and to increase alertness and to lesser extent to get high and as an experiment. The mixture of amphetamine-dexamphetamine was more prevalent than methylphenidate [82].

Teter and colleagues [83] reported findings from a large study done on 9,161 undergraduate college students. Their results suggested that 8.1% reported lifetime and 5.4% reported past-year illicit use of prescription stimulants. The most common reason for stimulant use was help with concentration, increase alertness and to provide a high. Men were more likely to use drugs than women with no gender differences in the reason to use them. Overall, they concluded that students used these prescription drugs nonmedically mainly to enhance performance or get high [83]. But in another study by the same researchers, they found no gender difference in misuse and abuse histories of methylphenidate non-medical use [84]. Similarly, research by Hall et al, found approximately 14% female and male university students misused or abused stimulants medications[85]. Similar results were found in another study done involving undergraduate and graduate students where 16% reported misuse of the stimulant medications, with Ritalin® as the most abused drug. The study also found no difference in gender regarding the misuse and the prevalent motives were to improve attention, partying, reducing hyperactivity and improving grades[86].

As stated above, the prevalence of non-medical use of these cognitive enhancers is increasing in the academic field. High caffeine containing energy drinks are specifically targeted at young people. Other caffeine containing drinks like coffee and tea are also popular among the students. Many studies have been conducted involving university and college students in the United States. These studies, as mentioned above, revealed different findings on the use of these enhancers. But little research has been done in Australia.  Therefore, this study was undertaken to determine the prevalence of use of prescription stimulants and the intake of caffeine containing drinks amongst university students at Curtin University. Moreover, it aimed to quantify the level of consumption of caffeine containing products and the side effects associated with their use. It is hope that this research will increase awareness regarding the use of cognitive enhancing substances and their potential abuse among university students.

# 3 OBJECTIVES

The main objectives of this study were:

i) To determine the prevalence of use and "overuse" of cognitive enhancing substances e.g. stimulants drugs (dexamphetamine, methylphenidate, modafinil) and caffeine containing products and beverages (energy drinks, soft drinks, coffee and tea) amongst university students.

ii) To determine the reason for consumption of these substances.

iii) To estimate the average daily dose of caffeine consumed by university students in the form of energy drinks and other beverages, and hence the potential for harm.

iv) To investigate any association between the consumption of these substances and potential side effects.

# 4 METHODOLOGY

## 4.1 Sample Selection

The target population was students studying at the Curtin University, Bentley Campus in Perth, Western Australia. Students studying full time or part time from five faculties were eligible for inclusion in the study. The five faculties were Center for Aboriginal Studies, Curtin Business School, Health Sciences, Science and Engineering, and Humanities. Students studying in all years of their undergraduate and postgraduate degree were eligible to participate in the study. However, people known to the researcher were deemed ineligible to take part in order to avoid any possible bias. Students were approached by the researcher and after explanation of the purpose of the study and what it entailed were invited to participate and complete a standardized questionnaire. The following six locations in the university were chosen for sample collection and each location was used 15 times on different days and at different times:

i. The library
ii. Coffee shop near Guild
iii. Cafeteria in physiotherapy building
iv. Cafeteria near the Elizabeth Jolly theatre
v. Cafeteria near Bankwest
vi. Abacus lab

#### 4.1.1 ***Sample Size***

The larger the sample size, the estimation of prevalence of substance use would be more precise. Precision is usually assessed using the width of the 95% confidence interval (CI) for the prevalence estimate. With the increase in sample size, the width of confidence interval reduces (precision improves) as follows:

| **Sample size** | **Width of 95% confidence interval** |
|---|---|
| 150 | +/- 8.0% |
| 300 | +/- 5.6% |
| 500 | +/- 4.4% |
| 750 | +/- 3.6% |
| 1000 | +/- 3.1% |

In addition to the improvement in precision, a larger sample size allowed the development of regression models to identify any possible association of use of cognitive enhancing substances with other variables (such as demographics, possible side effects). The minimum number of survey forms which would be required for this type of regression analysis was difficult to estimate. However, to approximate sample sizes required for regression analyses; N should be at least 104+m where m is the number of independent variables in the regression model. This sample size should be adequate to identify any independent variables exhibiting at least a moderate effect size. In this case, it was estimated to be in the region of 120. Note that this was regarded as a minimum sample size able to detect variables demonstrating a moderate relationship with the outcome (substance use). As a larger sample would have more power to detect a relationship with variables exhibiting a weaker association, it was decided that recruitment would continue until approximately 500 completed survey forms were collected. This would lead to moderately precise estimates of prevalence, and permit the development of models to identify associations.

## 4.2 Procedure

A cross-sectional study was conducted on students attending the Curtin University, Bentley campus in Perth, Western Australia following the granting of ethics and candidacy approval. The questionnaire was amended and formulated as per the ethics and candidacy comments and also after it was pilot tested on 20 students. The questionnaire was reviewed for face validity to ensure that it was collecting information relevant to the question under investigation. In addition, the questionnaire was assessed for content validity to ensure its completeness for the purpose. No explicit test-retest assessment of reliability was conducted. However, the purpose of the pilot study was to identify and correct any problematic areas on the questionnaire, which would be expected to influence the reliability. After the questionnaire was finalized, the recruitment phase of the study was commenced. A sample of students was randomly selected as follows: firstly the researcher positioned herself at pre-specified locations around the Bentley campus on different days and at various times. Every fifth person passing the location was identified and was invited to take part in the survey. The students were presented with an information sheet explaining the purpose and design of the study as well as their role in the study, (Appendix1). In addition, terms used in the study were explained to them. It was not mandatory for them to take part in the study, but, they could not withdraw from the study after they had completed the questionnaire. They could ask questions regarding the study during the data collection.

Once they gave verbal consent to participate, they were requested to complete a questionnaire. They were allowed to complete the questionnaire on the same day or on any other day either at the university or outside the university. After, they completed the questionnaire, they were asked to return it in a blank prepaid envelope (provided). They could return the questionnaire by hand or by post. No identifying information was obtained. After the data collection was completed, all the completed questionnaires were entered into a dataset on a computer using the SPSS software, in preparation for data analysis. Incomplete questionnaires were excluded from the data analysis.

## 4.3 Data collection

Data were collected via a self-administered questionnaire. The questionnaire consisted of questions on students' demographic parameters such as age, gender, weight, area of study and any medical conditions they suffer from; together with questions particularly related to their total intake of cognitive enhancing substances (e.g. energy drinks, soft drinks, tea, coffee, and stimulants), reasons for consuming these products and any side effects experienced following consumption. A verbal consent was received from each participant. Participation was totally voluntary and no incentives were provided to participants.

In the study, students were first asked whether they had ever consumed cognitive enhancing substances. Before they answer this question, the term "cognitive enhancing substances" was explained to them. Cognitive enhancing substances were explained as those substances that enhance mental function such as cognition, memory, intelligence, motivation, attention and concentration [1]. Even if they had not had any of these products, they were given the standardized questionnaire to complete. They were requested to circle the appropriate option in the questionnaire and provide the quantity of caffeine containing products such as coffee, tea, soft drinks, energy drinks and some OTC and prescription medication consumed during normal days and during exam days. The prevalence of cognitive enhancing substance use in this report is based on these questions.

### *<u>4.3.1 Measures</u>*

#### ***4.3.1.1 Demographic Data***

Students were requested to provide their age, sex, weight, faculty of study, degree type, enrolment status, year of study, current medical conditions and whether they were international or local students. In addition, they were asked to provide information on their smoking history.

#### ***4.3.1.2 Caffeine Use***

Students were asked about their daily caffeine consumption with the question, "If you use the caffeine containing beverages, please provide how much quantity per day you consume normally and during the exam period." Response options for the students were; total number of 180mL cup of coffee and tea; total number of 250mL of energy drinks' can, total number of 375mL of soft drinks' can and total number of tablets for OTC medications.

#### *4.3.1.3 Reasons for caffeine use*

Students were provided with six possible reasons for using caffeine and were asked to circle on a scale of 1 to 5 on how likely they were to consume caffeine for each of these reasons. The scale was defined as 1=Never, 2= Rarely, 3=Sometimes, 4=Often and 5=Always. The six reasons mentioned were 1) to counteract lack of sleep 2) to boost energy (generally) 3) to study for an exam or to complete a major project 4) to reduce fatigue 5) to increase concentration 6) to help me relax during study.

#### *4.3.1.4 Side effects following caffeine consumption*

Students were requested to provide the frequency of symptoms they experienced after caffeine intake on scale of 1 to 5 where 1=Never and 5= Always (as above). The different symptoms mentioned in the questionnaire were anxiety, insomnia, gastrointestinal upset, headache, heart palpitation, jolt and crash (increase energy followed by sudden drop in energy), raised blood pressure, aggressive behavior and depression.

#### *4.3.1.5 Prescription Stimulants Use*

The prevalence of prescription stimulant use was evaluated by asking students the question "do you take stimulants" and then listing the common stimulants: methylphenidate (Ritalin, Concerta), Modafinil (Modavigil), Amphetamines and Methamphetamines.

#### *4.3.1.6 Reasons for Prescription Stimulant use (other than caffeine)*

If they tick "yes" to the above question, the students were then asked how likely they were to take prescription stimulants for a number of specified reasons. Again a scale of 1 to 5 was used where 1=Never, 2= Rarely, 3=Sometimes, 4=Often and 5=Always. The six reasons for use specified were 1) To improve alertness 2) to improve concentration 3) to improve exam performance 4) to improve memory 5) to get high 6) to relax.

#### *4.3.1.7 Side effects following Prescription stimulant use (other than caffeine)*

Students were asked to document the frequency of a range of symptoms they experienced after taking prescription stimulants (other than stimulants) on scale of 1 to 5 where 1= Never and 5= Always. The symptoms listed in the questionnaire were anxiety, insomnia, gastrointestinal upset, headache, heart palpitation, jolt and crash (increase energy followed by sudden drop in energy), raised blood pressure, aggressive behaviour and depression.

#### *4.3.1.8 Effectiveness of cognitive enhancing substances*

Students were requested to provide their opinion regarding the effectiveness of the cognitive enhancing substances during exam period on a scale of 1 to 5 on improving different states. The scale was defined as 1=Very Ineffective, 2=Ineffective, 3=Neither Effective or Ineffective, 4=Effective and 5=Very Effective. The different states were concentration, memory, alertness, energy level, stamina and academic performance.

### 4.4 Statistical Analysis

Statistical analysis of the data was performed using the SPSS version 17 and SAS statistical software packages for Microsoft Windows. Statistical analysis included descriptive statistics such as frequencies and percentages or means and standard deviations. The main aims of the study are to estimate the prevalence of consumption of cognitive enhancing substances and the possible harmful effects and the reasons for the intake. The cognitive enhancing substances prevalence, side effects and the reasons were analyzed for caffeine and prescription stimulants (other than caffeine) separately.

Firstly, the percentages of caffeine and prescription stimulant (other than caffeine) were calculated overall, and within groups defined by demographic parameters such as sex, student (local/international), faculty, degree type, year of study, smoking status, and enrolment status (full-time/part-time). This provided an estimate of the use of caffeine containing beverages and OTC and prescription medications among the student population. Any differences in use between the groups described above were assessed for statistical significance using the Chi-square statistic. Secondly, the average daily dosage of caffeine consumed per person was calculated from the volume and the caffeine content of each drink consumed and/or the number and dose of caffeine for solid dosage forms. An Analysis of variance (ANOVA) model was used to assess the statistical significance of differences in consumption dosage (only for those students who were consumers) between groups defined above. If necessary, a logarithmic transformation was applied to the consumption data to make them more normally distributed, prior to ANOVA. The median consumption and ANOVA analyses were performed using data collected on normal days and exam days separately. For ANOVA analyses, a p-value $<0.05$ was taken to indicate a statistically significant association.

An analysis was done to estimate the prevalence of different reasons for using caffeine containing products. The 95% confidence interval for the different situations was also calculated. The prevalence of any association between caffeine consumption and occurrence of any symptoms reported was also estimated with 95% confidence interval.

Similarly, the analysis was repeated to estimate the prevalence of stimulant use and the different reasons for the consumption and the possible harmful effects experience due to its consumption.

### 4.5 Study Period

This study was conducted between September 2010 and October 2010

# 5 ETHICAL ISSUES

All responses were anonymous, and no personal information was collected.. Anonymity was ensured by presenting only aggregated data in all reports and publications. The data were kept in a secure place, with only the investigator and her supervisor having data access. After five years, all datasets (paper forms and computer databases) will be destroyed.

# 6 DATA STORAGE

During the study all hard copy of the records were held in a locked cupboard in the researcher's office in the School of Pharmacy, access to the questionnaires was restricted to the researcher and her supervisor. At the completion of the study the questionnaires and all electronic records will be archived in the School of Pharmacy for a minimum of 5 years. The electronic data will be stored on a password protected DVD.

# 7 RESULTS

The final dataset included 526 students. Nine hundred students had to be approached in order to obtain the final numbers with 59% response rate. Five records were excluded from the analysis because they were incomplete.

## 7.1 Measures

### *7.1.1 Demographic Profile*

Of the respondents, 232 were males and 294 were female students. The age varied from 17 to 42 years, with a mean ± standard deviation of 21.96 ± 4.15 years, and a median 21 years. Table 4 presents the demographic profile of the participants. The sample included students from five faculties: Centre for Aboriginal Studies (0.4%), Curtin Business School (24.9%), Health Sciences (27.6%), Science and Engineering (28.3%) and Humanities (18.8%). Respondents from the Health Sciences and Humanities were predominantly females with 70.3% and 74.7% respectively while those from Science and Engineering were predominantly males (67.1%). In addition, 38.6% were first year students, 26.2% were second year students, 25.5% were third year students and 9.7% were fourth year students. The majority of students were studying undergraduate courses (80.4%) while the remainders were postgraduates (19.6%). Of the study participants, 67.3% were local students and 32.7% were international students. Almost all respondents were full time students (95.6%) as opposed to part time students (4.4%).

**Table 4: Demographic profiles**

| VARIABLES | NUMBER OF STUDENTS | PERCENTAGE |
|---|---|---|
| **Gender:** | | |
| Male | 232 | 44.1% |
| Female | 294 | 55.9% |
| **Student:** | | |
| International | 172 | 32.7% |
| Local | 354 | 67.3% |
| **Faculty** | | |
| Centre for Aboriginal Studies | 2 | 0.4% |
| Curtin Business School | 131 | 24.9% |
| Health Science | 145 | 27.6% |
| Science and Engineering | 149 | 28.3% |
| Humanities | 99 | 18.8% |
| **Degree** | | |
| Undergraduate | 423 | 80.4% |
| Postgraduate | 103 | 19.6% |
| **Year of study** | | |
| 1 | 203 | 38.6% |
| 2 | 138 | 26.2% |
| 3 | 134 | 25.5% |
| 4 | 51 | 9.7% |
| **Smoking** | | |
| No | 490 | 93.2% |
| Yes | 36 | 6.8% |
| **Enrolment** | | |
| Full-time | 503 | 95.6% |
| Part-time | 23 | 4.4% |

### *7.1.2 Caffeine Use*

Among the 526 respondents, 29 reported that they had never had caffeine in any form, leaving 94.5% of students (n=497) as consumers of caffeine in some form. Assuming that this sample is representative of the larger student population, it is estimated that the prevalence of caffeine use for students lies within the range: 92.5% to 96.4% (95% confidence interval). Table 5 shows how caffeine use among the participants is associated with their demographic profile.

The cross-tabulation showed equal proportion of males and females who had never used caffeine. Of all the participants, Chi-square analysis showed no difference in percentage of caffeine users according to gender, year of study, student type (international/local), smoking status, enrolment status (full/part time) ($p>0.05$). In terms of faculty, due to the small number of students, those from the Centre for Aboriginal Studies were not included during Chi-square analysis. Caffeine use was highest amongst Humanities (97%) students followed by the Curtin Business School (96.2%), then Health Science students (94.5%) and Science and Engineering (92.6%). However, Chi square testing revealed no association between the students' faculty of study and rates of caffeine use. However, significant differences were observed between degree type (undergraduate/postgraduate) in relation to caffeine consumers ($p<0.05$).

**Table 5: Demographic profile and caffeine use**

| VARIABLE | NUMBER OF STUDENTS | CAFFEINE USE (%) | p-VALUE (Chi-Square test) |
|---|---|---|---|
| **Gender** | | | |
| Male | 232 | 94.0% | 0.642 |
| Female | 294 | 94.9% | |
| **Student** | | | |
| International | 172 | 95.4% | 0.546 |
| Local | 354 | 94.1% | |
| **Faculty** | | | |
| Centre for Aboriginal Studies | 2 | 50.0% | |
| Curtin Business School | 131 | 96.2% | 0.2812* |
| Health Science | 145 | 94.5% | |
| Science and Engineering | 149 | 92.0% | |
| Humanities | 99 | 97.0% | |
| **Degree** | | | |
| Undergraduate | 423 | 93.4% | 0.024 |
| Postgraduate | 103 | 99.0% | |
| **Year of study** | | | |
| 1 | 203 | 95.1% | 0.974 |
| 2 | 138 | 94.2% | |
| 3 | 134 | 94.0% | |
| 4 | 51 | 94.1% | |
| **Smoking** | | | |
| No | 490 | 94.1% | 0.133 |
| Yes | 36 | 100% | |
| **Enrolment** | | | |
| Full-time | 503 | 94.4% | 0.802 |
| Part-time | 23 | 95.7% | |

***** Centre for Aboriginal Studies faculty was not included during chi-square test due to small number of students.

The study analysis found that, among 526 respondents, there were 487 students taking products containing caffeine on normal days and 465 students during exam periods. When examining the contribution of each of the products to the total daily caffeine consumption, tea and coffee were found to be the most common sources of caffeine amongst the students on both exam and non-exam days, followed by soft drinks and energy drinks. OTC medications formed a very minor contribution to the daily caffeine intake. Table 6 shows the distribution of caffeine intake between the various caffeine containing drinks and OTC products.

**Table 6: Distribution of caffeine intake between the various caffeine-containing products; numbers quoted are the average percentage of total consumption from the given source**

| TIMING | COFFEE | TEA | ENERGY DRINK | SOFT DRINK * | OTC |
|---|---|---|---|---|---|
| Normal day | 35.5% | 28.6% | 13.1% | 23.0% | 0.4% |
| Exam day | 43.8% | 31.4% | 23.3% | | 0.9% |

* A formatting error in the final questionnaire meant that it was not possible to determine the difference in use of soft drinks between normal and exam days, as the two were not differentiated.

#### *7.1.2.1 Caffeine consumption related to demographic profile*

Of the 497 students who consumed caffeine in the form of coffee, tea, energy drinks, soft drinks or OTC preparations, the median total amount consumed per Kg body weight per day on normal days was: 3.0mg/Kg/day ($25^{th}$ and $75^{th}$ quartiles: 1.6 to 4.6). The mean consumption of 3.9mg/Kg/day being considerably higher than the median indicates that the data were skewed by some high values. For this reason, in the descriptive table below (Table 7), the median values are quoted to give a fairer indication of the consumption within each group, while the p-values were obtained from an ANOVA model of the Logarithm of the total consumption (in order to compensate for the skewness in the data). Similarly, on exam days the median total amount consumed was 3.8mg/Kg/day which is slightly greater than on normal days. The mean consumption was 5.1mg/Kg/day which is also noticeably higher than the median value indicating the skewness as in the normal days.

Table 7 indicates the average consumption of caffeine as per the different demographic profile on normal and exam days. The association between caffeine consumption and different demographic profile is indicated by the different p-values. Among all the different demographic variables, only year of study on normal days and smoking status during exam periods were significantly associated with the average caffeine consumption ($p<0.05$). The average caffeine consumption was found to increase in all the demographic profiles during exam period as compared to normal days. Females (3.2mg/Kg/day on normal days and 4.1mg/Kg/day on exam days) consumed greater caffeine than the male (2.8mg/Kg/day on normal days and 3.4mg/Kg/day on exam days). Similarly, local students were found to consume caffeine slightly more than international students.  Comparison between faculties demonstrated that Humanities students (3.5mg/Kg/day) were the highest consumers of caffeine on normal days, however, Curtin Business School students (4.2mg/Kg/day) were found to consume more caffeine on exam days. Similarly, postgraduate students consumed greater amounts of caffeine than undergraduate with 3.1mg/Kg/day and 3.8mg/Kg/day on normal and exam days, respectively. The analysis also showed second year students took more caffeine than other years of study on both exam and normal days. Smoking was associated with a significantly higher consumption of caffeine on exam days; in addition, smokers' intake was higher than non-smokers on normal days. Further, part-time students consumed greater amounts of caffeine than full time students.

**Table 7: Comparison of caffeine consumption (mg/Kg/day) between various groups, for normal and exam days**

| VARIABLE | NUMBER OF STUDENTS | NORMAL DAYS (mg/Kg/day) | | EXAM DAYS (mg/Kg/day) | |
|---|---|---|---|---|---|
| | | Median | p-value | Median | p-value |
| **Gender** | | | | | |
| Male | 232 | 2.77 | 0.26 | 3.39 | 0.068 |
| Female | 294 | 3.17 | | 4.12 | |
| **Student** | | | | | |
| International | 172 | 2.55 | 0.06 | 3.67 | 0.52 |
| Local | 354 | 3.18 | | 3.87 | |
| **Faculty** | | | | | |
| Curtin Business School | 131 | 2.91 | | 4.17 | |
| Health Science | 145 | 3.15 | 0.08 | 4.00 | 0.15 |
| Science and Engineering | 149 | 2.63 | | 3.33 | |
| Humanities | 99 | 3.50 | | 3.75 | |
| **Degree** | | | | | |
| Undergraduate | 423 | 2.93 | 0.68 | 3.79 | 0.57 |
| Postgraduate | 103 | 3.14 | | 3.88 | |
| **Year of study** | | | | | |
| 1 | 203 | 3.14 | 0.005* | 3.75 | 0.17 |
| 2 | 138 | 3.25 | | 4.12 | |
| 3 | 134 | 2.49 | | 3.68 | |
| 4 | 51 | 3.20 | | 3.89 | |
| **Smoking** | | | | | |
| No | 490 | 3.01 | 0.11 | 3.75 | 0.01* |
| Yes | 36 | 3.92 | | 5.49 | |
| **Enrolment** | | | | | |
| Full-time | 503 | 3.00 | 0.07 | 3.79 | 0.50 |
| Part-time | 23 | 4.23 | | 4.12 | |

* Indicates that there is significant association between the variables and average caffeine consumption.

#### *7.1.2.2 Energy drinks consumption*

Of all the participants, 43.7% reported they use caffeine in the form of energy drinks whilst 56.3% reported they never consumed energy drinks. In Chi square analysis, “yes” for energy drinks (versus “no”) was found to be associated with the faculty of study, gender, degree type (undergraduate/postgraduate) and smoking status with $p<0.05$. The study found significant differences between gender and energy drink consumption with males (49.6%) more frequent consumers than female (39.1%). Similarly, Curtin Business School (55.7%) and Science and Engineering (47.7%) students were more likely to consume energy drinks than those from the other two faculties. Also, consumption rates amongst smokers (72.2%) were almost twice that of non-smokers (41.6%). Table 8 shows the rates energy drinks consumption amongst the different cohorts of students.

**Table 8: Demographic profile and energy drink use**

| VARIABLE | NUMBER OF STUDENTS | ENERGY DRINK USE (%) | p-VALUE (Chi-Square test) |
|---|---|---|---|
| **Gender** | | | |
| Male | 232 | 49.6% | 0.0164* |
| Female | 294 | 39.1% | |
| **Student** | | | |
| International | 172 | 39.5% | 0.1768 |
| Local | 354 | 45.8% | |
| **Faculty** | | | |
| Curtin Business School | 131 | 55.7% | 0.0009* |
| Health Science | 145 | 33.8% | |
| Science and Engineering | 149 | 47.6% | |
| Humanities | 99 | 36.4% | |
| **Degree** | | | |
| Undergraduate | 423 | 46.1% | 0.0262* |
| Postgraduate | 103 | 34.0% | |
| **Year of study** | | | |
| 1 | 203 | 40.9% | 0.6601 |
| 2 | 138 | 45.6% | |
| 3 | 134 | 47.0% | |
| 4 | 51 | 41.2% | |
| **Smoking** | | | |
| No | 490 | 41.6% | 0.0004* |
| Yes | 36 | 72.2% | |
| **Enrolment** | | | |
| Full-time | 503 | 42.9% | 0.0901 |
| Part-time | 23 | 61.00% | |

* Indicates that there is significant association between the variables and energy drink consumption.

### *7.1.3 Reasons for consumption of caffeine*

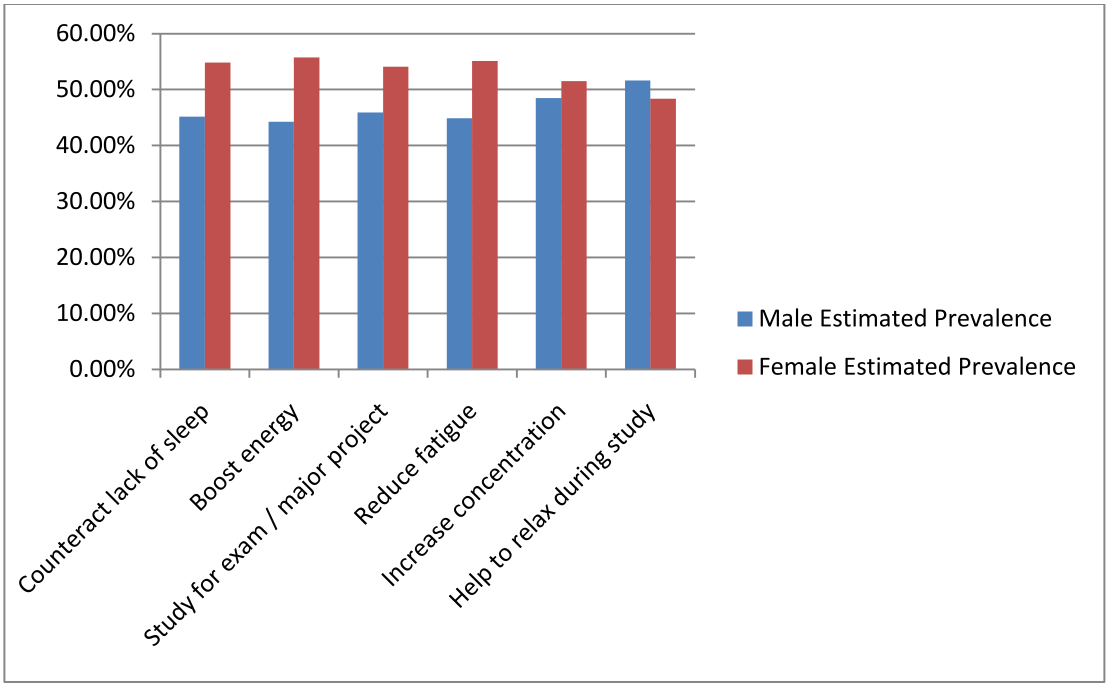
The study collected data on the different reasons the students were likely to consume caffeine containing products. Table 9 presents the prevalence of students' reasons for caffeine use. Based on the 497 students' self-reports (i.e. those who took some caffeine), 63.2% consumed caffeine to boost energy, 61.8% to study for exams/major projects, 60.6% to counteract lack of sleep, 52.9% to reduce fatigue, 46.1% to increase concentration and 25.0% to help relax during study. Hence, the most popular reasons for taking caffeine were counteracting lack of sleep, boosting energy and studying for an exam/major project, while the least likely reason was to help to relax during study.

**Table 9: Prevalence of students' reasons for caffeine use (n = 497)**

| REASON FOR USE | ESTIMATED PREVALENCE | 95% CONFIDENCE INTERVAL |
|---|---|---|
| **Counteract lack of sleep** | **60.6%** | **56.3% to 64.9%** |
| **Boost energy** | **63.2%** | **58.9% to 67.4%** |
| **Study for exam / major project** | **61.8%** | **57.5% to 66.0%** |
| **Reduce fatigue** | **52.9%** | **48.5% to 57.3%** |
| **Increase concentration** | **46.1%** | **41.7% to 50.5%** |
| **Help to relax during study** | **25.0%** | **21.2% to 28.8%** |

Among the 497 caffeine consumers, females were more likely to consume caffeine for the reasons mentioned above with the exception of "to help relax during study". Figure 1 shows the comparison between males and females on how likely they consumed caffeine for different reasons. Overall, there was no significant difference between the genders based on reasons for caffeine use ($p>0.05$), however, the use of caffeine to relax during study was more commonly reported by males ($p<0.05$).

**Figure 1: Reasons for use of caffeine for males and females**




### *7.1.4 <u>Side Effects following caffeine consumption</u>*

Students were asked to report whether they experienced any of the following nine side effects and the prevalence of side effects they experienced was calculated following caffeine consumption. Of all the participants, almost equal percentages of males and females reported they experienced side effects (approximately 56%). Among the 497 caffeine users, the most commonly reported adverse effects were jolts and crash (28.8%) following caffeine consumption which was followed by insomnia (28.6%) and headache (21.3%). Fewer students reported anxiety (16.7%), gastrointestinal tract upset (17.5%), heart palpitation (17.9%), hypertension (11.3%), aggression (7.1%) and depression (7.9%). Table 10 shows the estimated prevalence of the various side effects with confidence intervals.

**Table 10: Side effects following caffeine use (n= 497)**

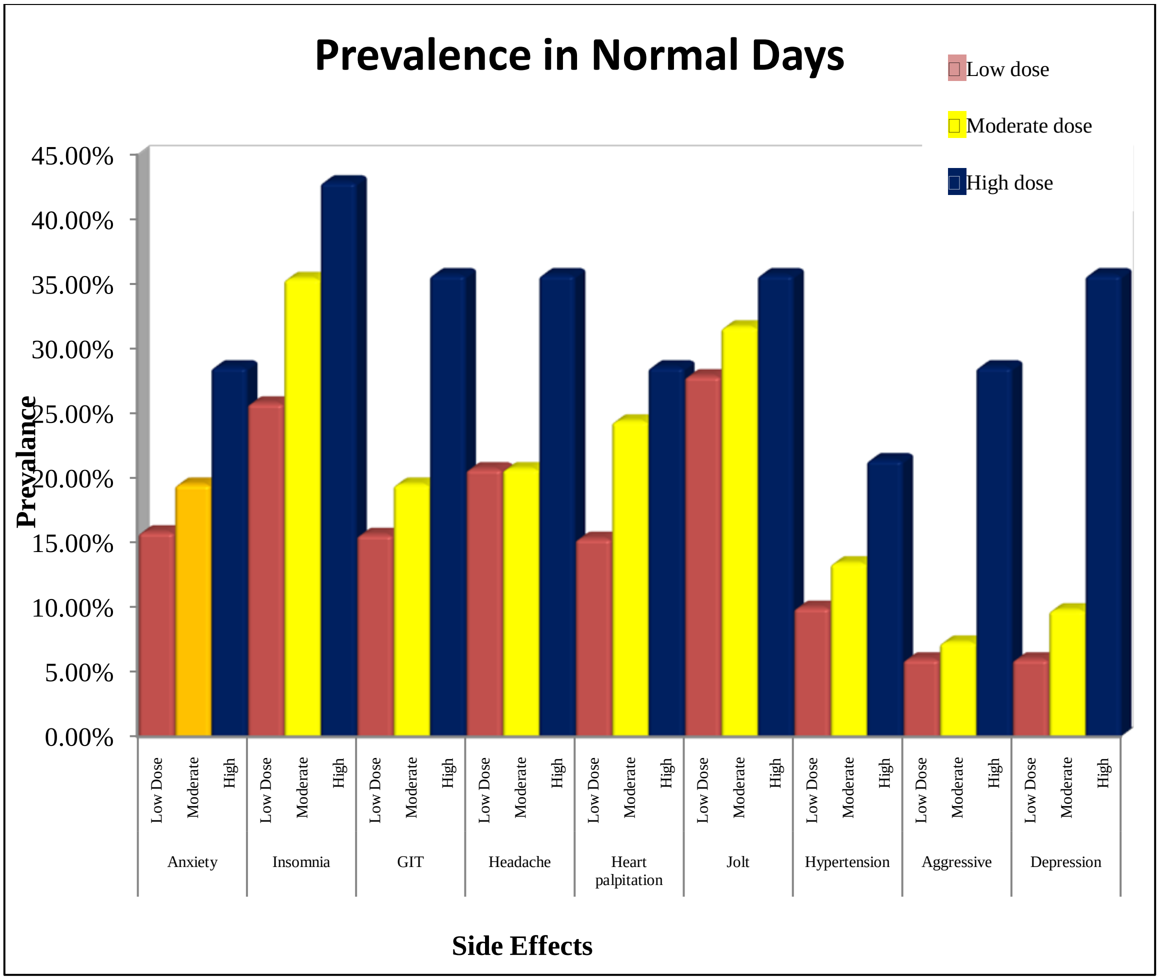
| SIDE EFFECT | ESTIMATED PREVALENCE | 95% CONFIDENCE INTERVAL |
|---|---|---|
| **Anxiety** | **16.7%** | **13.4% to 20.0%** |
| **Insomnia** | **28.6%** | **24.6% to 32.5%** |
| **GIT** | **17.5%** | **14.2% to 20.9%** |
| **Headache** | **21.3%** | **17.7% to 24.9%** |
| **Heart palpitation** | **17.9%** | **14.5% to 21.3%** |
| **Jolt** | **28.8%** | **24.8% to 32.8%** |
| **Hypertension** | **11.3%** | **8.5% to 14.1%** |
| **Aggressive** | **7.1%** | **4.8% to 9.3%** |
| **Depression** | **7.9%** | **5.5% to 10.2%** |

### *7.1.4.1 Side Effects in relation to total dose per kg*

Caffeine total dose (mg/Kg) consumed daily by the respondents was grouped into three categories; Low dose defined as ≤ 5mg/Kg, Moderate Dose >5mg/Kg but <10mg/Kg and High dose ≥ 10mg/Kg. Then, the prevalence of side effects was estimated in relation to the three dosage categories. The students were also asked to report their daily consumption of caffeine in any form on normal days and exam days. Therefore, as per dose on normal and exam days the side effects were classified and prevalence was estimated.

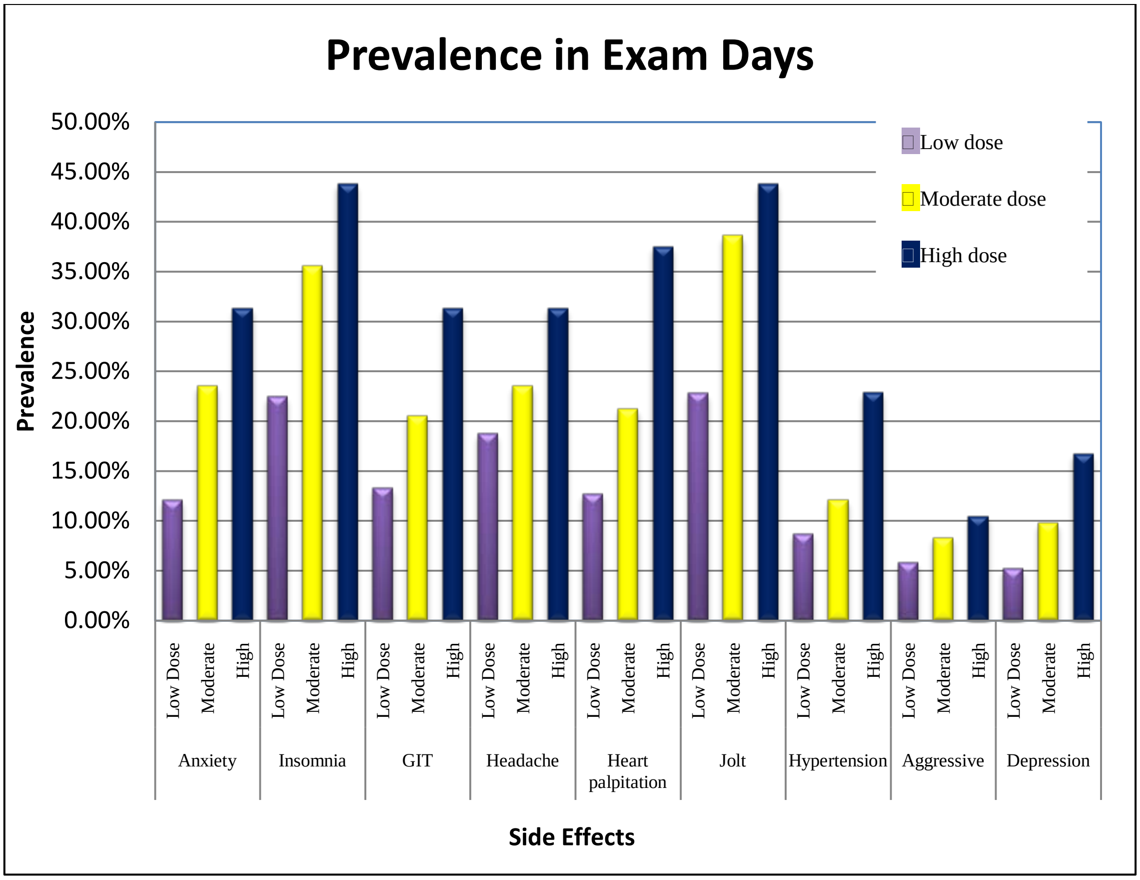
Figure 2 shows the prevalence of side effects on normal days related to the dose. As the dose increased, side effects were reported to more frequently. There were 430 students taking low dose, 82 students taking moderate dose and a small number of 14 students taking high dose during normal days. The Chi-square test and Fisher's exact test found only feeling aggressive and depression to be significantly associated with total dose per Kg intake on normal days ($p<0.05$). Among the entire dose range, insomnia is the most dominant side effects as mentioned above. The frequency of insomnia appeared to be dose dependent with rates of 25.8%, 35.4% and 42.9% reported amongst students taking low, moderate and high doses, respectively.

**Figure 2: Prevalence of side effect on normal days related to caffeine dose**




Similarly, Figure 3 shows the prevalence of side effects on exam days which were also reported more commonly with increasing daily doses of caffeine. There were 346 students, 132 students and 48 students consuming low, moderate and high doses, respectively. During exam days, there was a three-fold increase in number of students taking high doses of caffeine. Moreover, there was a significant association between the different dosages and the reported side effects during exam period except for headache and aggressive side effects. As compared to normal days, jolt and crash was experienced by greater percentage of people taking low dose (22.8%) and moderate dose (38.6%). However, equal percentage of students (43.8%) reported that they experienced insomnia and jolt and crash. Moreover, a smaller number of students experienced feeling aggressive and depression on exam days than on normal days.

**Figure 3: Prevalence of side effects on exam days related to caffeine dose**




### *7.1.5 __Stimulant Use__*

Of all the respondents only 4% (n=21) reported that they used prescription stimulants (other than caffeine). The students were also asked to provide information whether they used those stimulants during normal days or during exam days.

#### *7.1.5.1 Relationship of stimulant use and caffeine use*

Out of all the respondents, 2.7% reported that they consumed stimulants along with caffeine on normal days and slightly greater percentage of students (3.6%) reported they took the combination on exam days. There was one student who reported taking stimulants but not consuming caffeine during the exam period.

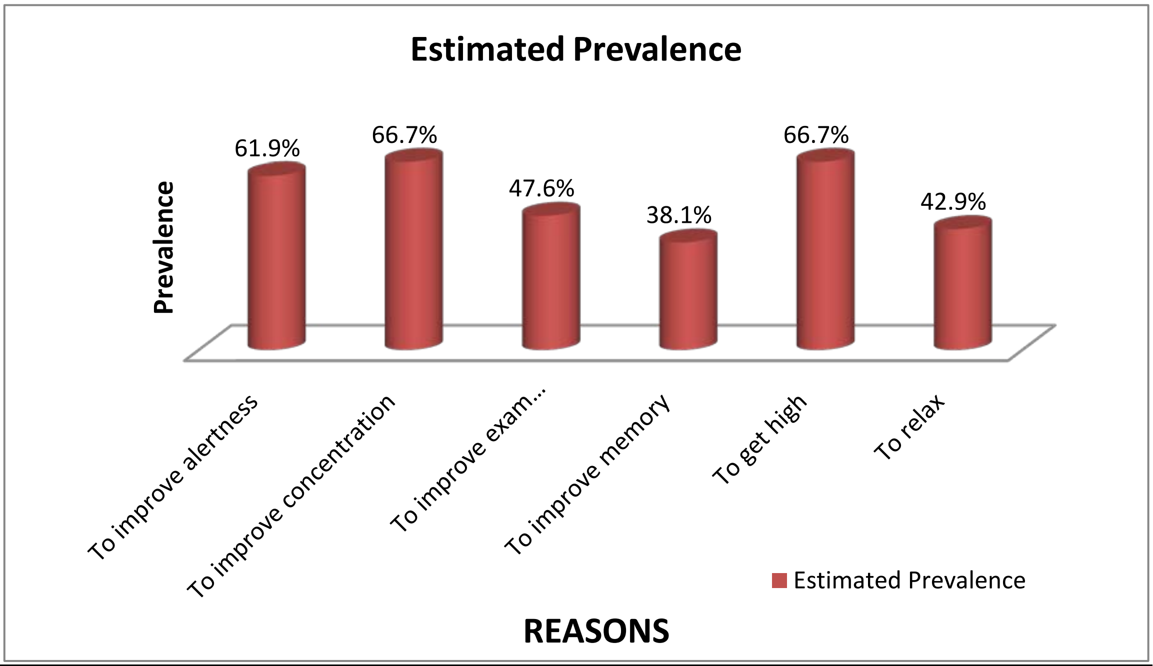
#### *7.1.5.2 Relationship of stimulant use to the caffeine dose*

Among 526 participants, Fisher exact test revealed there were significant difference in terms of use other prescription stimulants and the dose of caffeine consumption. Students taking higher doses of caffeine were found to use prescription stimulants more than those who were taking lower doses of caffeine. On normal days: 3.3%, 6.1%, 14% said “yes” to the stimulants who were taking low, moderate and high dose of caffeine respectively. Similarly, during exam period 2.0%, 6.1% and 12.5% took stimulants that were on low, moderate and high dose of caffeine.

### *7.1.6 Reasons for Stimulant use*

The students were asked to provide responses on how likely they use stimulants on the basis of the different reasons provided to them. Among the six reasons suggested, to improve concentration and to get high were the most common reasons for the consumption of stimulants (equal percentage of 66.7% students). The smallest proportion of students (38.1%) used stimulants to improve memory with slightly more (47.6%) of respondents to improve exam performance (Figure 4).

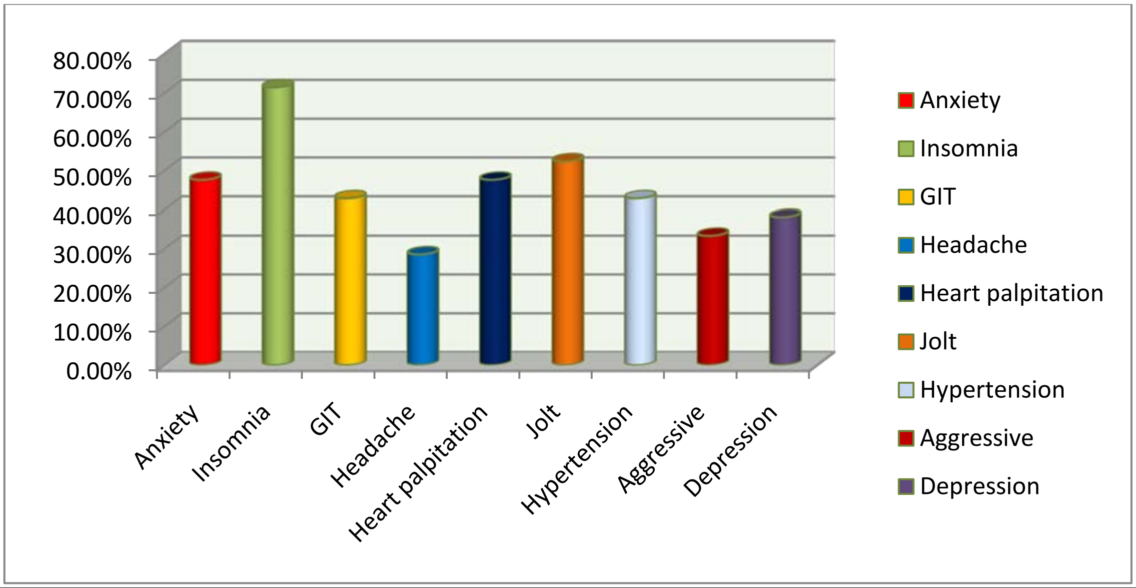
**Figure 4: Reasons for stimulant use (n=21)**




### *7.1.7 Side Effects*

Of the 21 participants who reported that they took stimulants, analysis showed that almost 70% of participants experience insomnia and 52.4% jolt and crash. About half percent of these students (47.6%) reported they had symptoms of anxiety and heart palpitation, 42.9% reported that they had symptoms of gastrointestinal upset and hypertension. Less reported they experience headache (28.6%), feeling aggressive (33.3%) and depression (38.1%) following stimulants use. Figure 5 shows the prevalence of the side effects.

**Figure 5: Prevalence of side effects (n=21)**




### *7.1.8 Effectiveness of cognitive enhancing substances:*

The perceived effectiveness of cognitive enhancing substances was calculated among those students who took caffeine as well as other prescription stimulants (n=501). As shown in Table 11, 34.1% of the students reported that cognitive enhancing substances were effective in improving their energy levels, whilst a very small number of respondents thought it helped to improve academic performance (18.0%) and memory (18.4%). Nevertheless, there were 29.9% students who reported that it could improve alertness and 26.8% reported an improvement in concentration following intake.

**Table 11: Estimation of effectiveness of cognitive enhancing substances**

| SITUATIONS | NUMBERS | ESTIMATED EFFECTIVENESS |
|---|---|---|
| **Concentration** | **134** | **26.8%** |
| **Memory** | **92** | **18.4%** |
| **Alertness** | **150** | **29.9%** |
| **Energy level** | **171** | **34.1%** |
| **Stamina** | **104** | **20.8%** |
| **Academic Performance** | **90** | **18.0%** |

# 8 DISCUSSION

The most commonly used cognitive enhancing substances are amphetamines, methylphenidate, modafinil and caffeine [2]. The prevalence of use of these enhancers is increasing in the academic field. There are studies involving universities and college students in the United States reporting the different reasons for the consumption of these substances by students. They have mentioned that the students used these substances to improve their concentration, increase their alertness and to improve their grades, and sometimes for recreational purposes. The results of this study demonstrate a number of similar findings as discussed below.

## 8.1 Caffeine use and average intake

A large percentage (94.5%) of surveyed students reported that they drank caffeine containing beverages which was similar to studies done on Taiwanese students (76%) [60] and high school students where only 10% did not consume caffeine [23] . This study found tea and coffee as the most common sources of caffeine amongst the students followed by soft drinks and energy drinks which was not in line with the previous two studies [23, 59]. In those studies, soft drinks were the major source of caffeine intake.

In the present study the average daily caffeine intake was estimated to be 3.0mg/Kg/day during normal days and 3.8mg/Kg/day during exam days. Similar to the mean daily caffeine consumption of 2.4–4.0 mg/Kg calculated for all adult consumers from all sources in United States, UK and Canada, but much less than 7.0 mg/Kg in Scandinavia [43]. Moreover, the average daily intake calculated in this study was slightly less than in previous study by Bernstein and colleagues [87]. This may be due to difference in body weight and age as the previous study was done in adolescents aged 13-17years of age [87].

There was no statistically significant difference among genders in the average daily caffeine intake, which is consistent with the report of Kristi [88]. However, there was slight difference in total amount of caffeine consumed between males and females. The female students had a higher caffeine intake per Kg (3.17mg/Kg/day) than male students (2.77mg/Kg/day) on normal days, similar to study by Valek et al [23] . In that research, 1.0±0.9mg/Kg and 1.1±1.4mg/Kg was the average intake of caffeine for boys and girls respectively. However, the difference was not statistically significant and could be due to the lower body weight of females.

This study reproduces the previous finding that under stress caffeine consumers tend to intake a greater quantity of caffeine than on normal days [89]. The reasons for the increased intake were cited as increasing energy, combating tiredness and fatigue and improving study performance. The average intake of caffeine was found to increase when compared between normal days and exam days. However, there was no significant association between different demographic profiles and caffeine consumption except in terms of the year of study (normal days) and smoking status (exam days). The higher caffeine intake by smokers than non-smokers was in line with other studies [90, 91]. During normal days and exam days, smokers' caffeine intake was greater than non-smokers. This may be because smoking accelerates metabolism and shortens caffeine half-lives [92]. Moreover, it was mentioned that caffeine consumers are more likely to be smokers [91]. But, in this study there were fewer smokers as compared to caffeine consumers.

Regarding energy drinks, a greater percentage of males than females were found to consume energy drinks which is similar to the report by Australian Convenience Store News [51] and the study by Miller [55]. In both these studies men were more frequent users than women. In addition, the consumption of energy drinks was found to be statistically significantly associated with the students' faculty of study which is similar to the findings of Attila et al [48]. In both the studies students studying health related subjects were less likely than those from other faculties to consume energy drinks. Health literacy might be the reason for the lower consumption of energy drinks as health science students have better knowledge regarding the effects of the consumption of caffeine. Similarly, there was significant association between the smoking status and energy drinks consumption.

### 8.2 Total dose of caffeine

It has been stated that caffeine intake of 50-300mg/day produces positive effect on performance and higher doses of 300-800mg/day can lead to adverse effects. Nawrot et al., defined 6mg/Kg/day as moderate daily caffeine intake for all the healthy adult population which was not found to cause any adverse effects [93]. A dose of 4mg/Kg of caffeine has been reported not to affect the magnitude or accuracy of memory predictions [94]. Similarly, low doses (1mg/Kg) and moderate doses (2.5mg/Kg) of caffeine have been shown to activate mood and sleep whilst high doses of (10mg/Kg) caffeine induce addiction and reward [43]. Accordingly in this study, $\leq$ 5mg/kg is regarded as low dose, >5mg/Kg and <10mg/Kg as moderate dose and $\geq$ 10mg/kg as high dose. Using this classification, there were 430 students taking low dose caffeine, 82 students taking moderate dose and 14 students taking high dose during normal days. However, the number of students taking high dose increased by three fold on exam days with 346 students, 132 students and 48 students consuming low dose, moderate dose and high dose respectively.

### 8.3 Side effects following caffeine consumption

Almost all the adverse symptoms associated with caffeine consumption were reported in the study. The participants reported the most frequent symptom experienced as insomnia followed by jolt and crash, and headache. This result was to some extent aligned with the report in which the energy drink Redline® produces symptoms of nausea/vomiting, tachycardia, hypertension, jittery/agitated/tremors , dizziness, chest pain and bilateral numbness [13]. But more so with the results of Brenda et al study, in which the common side effects were “jolt and crash episodes”, headaches and heart palpitations[12].

In this study more students experienced side effects following high dose caffeine as compared to moderate and low dose. A previous study has reported that only jolt and crash had significant dose effect with no effect on heart palpitations or headaches [12]. In this study, however, a normal day’s dose was not found to be associated with all the side effects except aggressive behaviour and depression. Whereas the higher exam days’ doses were found to be significantly associated with all the side effects with the exception of aggressive behaviour and headache.

It is important to note that the amount of caffeine required to produce an effect varies from person to person depending their weight and sensitivity to caffeine. Therefore, for a caffeine sensitive person, it is suggested that they consume no more than 400mg/day to avoid headaches, drowsiness, anxiety, and nausea [95]. For adults the toxic level has been estimated to be approximately 10g/day [93]. However, dependence can develop over a wide range of caffeine consumption from 129mg to 2548mg per day [43].

### 8.4 Reasons for consumption of caffeine

The findings from the study support the results from previous studies that caffeine containing beverages are popular among students for a variety of reasons: to boost their energy and while studying for exams or completing major projects and to counteract lack of sleep [12]. Authors of one study have suggested that students consumed these beverages to improve the taste of alcoholic drinks, to extend their evening leisure period, to improve their sport performance, for the caffeine stimulating effect, to enjoy the taste and some consumed to clear their curiosity, whilst a small percentage of students take caffeine to study [61]. Similarly, another study has also reported that students consumed energy drinks due to curiosity of their taste/effect, and to boost energy and performance [48].

### 8.5 Relationship of caffeine to prescription stimulants

It should be noted that here, as in a previous study [13], caffeine use was found to be associated with the use of other forms of prescription stimulants. In a study by Gromov et al it was reported that nearly one-quarter of young people abused non-prescription drugs who also abused caffeine [46]. With regard to energy drinks in particular, there are studies which have found that the frequency of energy drink consumption is significantly associated with subsequent nonmedical prescription stimulant use [63, 64, 70]. In this study, there were a lesser number of students who were taking caffeine and other prescription stimulants together. Approximately 3% used stimulants together with caffeine on both normal and exam days. Also, in line with studies mentioned above, this research also revealed that there was significant difference in terms of prescription stimulant use and the level of caffeine consumption. The prevalence of taking prescription stimulants was higher in students consuming higher doses of caffeine.

### 8.6 Reasons for Prescription Stimulant use and Side effects following its use

This study replicated the likely reasons for using these prescription stimulants as discussed by McCabe et al [4]. The students reported that they used these prescription stimulants to improve concentration, to get high, to improve alertness and to help in exams. However, the reason for the enhancement of academic achievement (in exam) was not found to be as commonly cited as a reason for using stimulants as in another study [46].

Some of the common side effects following use of prescription stimulants (e.g. Ritalin) reported are anxiety, insomnia, decreased appetite, headache, stomach ache, dizziness and heart palpitation and less commonly depression [96]. In this study, most of the students stated that they experienced insomnia. They also reported to experience jolt and crash. In contrast, depression and aggressive behaviour were not reported as frequently as in other studies [7, 8], with around one third participants reporting these symptoms.

## 9 LIMITATIONS

There are number of limitations to this study that need to be mentioned. The first limitation involves demographic profile. There were more undergraduate students than postgraduate students. In addition, there was significantly higher numbers of first year students with only a few students from fourth year and a slightly greater percentage of female participants. Moreover, there were more full time students in the study than part time students. Regardless, the present study complements the results of previous findings; it's generalizability to other universities is limited by the fact that it was conducted in only one university. Therefore, similar studies should be conducted in other universities.

The second limitation of the study was the use of self-reporting. This may result in underestimates or overestimates of prevalence, depending on circumstances and processes such as respondent recall and willingness to report use [97]. But, such surveys have been widely used and considered generally valid in examining substance use when certain conditions of confidentiality are met [6]. In particular, reasons for using cognitive enhancing substances, each student could enter multiple reasons. As a result, assessment of reasons for consumption of these cognitive enhancing substances may have been overestimated or repeated for each person. However, using these substances for a number of reasons is common and the study provides an overall estimation of usage of these substances by university students. In terms of measurement of quantity of caffeine consumption, the students might not have reported the amount accurately; although they were assured that their responses would be anonymous.

The third limitation is the use of a cross-sectional study design which has some inherent limitations. There is potential susceptibility for measurement bias due to measurement error and also as exposure is measured retrospectively. All the data related to the use of cognitive enhancing substances were examined retrospectively. For instance, we cannot confirm whether the side effects that respondents reported were associated with dose of caffeine consumed because of recall bias; for example failure to remember symptoms or failure to associate symptoms correctly with caffeine or other prescription stimulants use. However, this is the best method to determine the prevalence of any phenomenon or condition in a population as it can measure several factors and outcomes at one time relatively quickly and at low cost.

The fourth limitation is the estimation of daily dose of caffeine consumption. The daily dose of caffeine consumed by the students was calculated on the basis of total caffeine content in standard quantities of different beverages. Due to a significant variation in caffeine concentration within a beverage category, as in the case of coffee and tea, the exact estimation of the caffeine consumption by the respondents was not possible. Therefore, an average of caffeine content was calculated based on different ranges available in reference texts and websites. Accordingly, the volume of a cup of coffee and tea was estimated to be 180mL. This could lead to some measurement bias. For example, the side effects associated with the dose of caffeine might be estimated either more or less.

Although the students did mention that they took prescription stimulants, it is not possible to determine what proportion of respondents used stimulants for medical and non-medical use. Therefore, the results cannot explore whether individuals who used prescription stimulants used these drugs under doctor's supervision or prescription. However, they have mentioned the intake of these prescription stimulants separately on exam days and non-exam days.

# 10 CONCLUSION

As expected, caffeine was popular among university students. Over 90% students surveyed reported taking some form of caffeine containing products. Whilst only a small proportion of students (4%) reported prescription stimulants (other than caffeine). Coffee and tea were the common source of caffeine intake. The level of consumption of caffeine was found to be influenced by whether or not students were sitting for exams or completing another forms of assessment. General caffeine consumption levels were below the therapeutic dosage range of caffeine, i.e. 10mg/Kg/day. On average students consumed 3.0mg/kg/day but this increased to 3.8mg/kg/day. During exam periods, the number of students taking therapeutic doses increased from 14 to 48, an over three fold increase. In accordance with the previous literature side effects appeared to be more common at higher doses. Smokers were more likely to take high dose of caffeine than non-smokers. Health literacy affected the consumption as health science students were less likely than those from other faculties to consume energy drinks. Caffeine containing products were particularly popular for boosting energy, when studying for an exam or major projects, and when the users needed to counteract a lack of sleep. The use of other stimulants was linked to higher levels of consumption of caffeine potentially putting users at greater risk of adverse effects.

# 11 IMPLICATIONS

The current study determined the prevalence of use of prescription stimulants and intake of caffeine containing products amongst university students. In addition, it estimated the level of consumption of cognitive enhancers and the side effects associates with their use. These data should raise the awareness regarding the use of cognitive enhancing substances amongst university students and highlight the potential risk of high intake.

Similar research should be undertaken in other universities to enhance the generalizability of these results. Also, studies should be undertaken to identify if students recognize how much caffeine is present in the beverages or products they consume, how much they consume (cognitive enhancers) in different situations and the potential side effects associated with their consumption. It is important that students are educated about risk of high intake of caffeine and other stimulants.

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# 13 APPENDIX 1: INFORMATION SHEET FOR STUDENTS

## USE OF COGNITIVE ENHANCING DRUGS BY UNIVERSITY STUDENTS: A CROSS-SECTIONAL STUDY

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Email: paliza.joshi@postgrad.curtin.edu.au

**Summary of the study:**

Studies undertaken in colleges of USA have revealed a high prevalence of non-medical prescription stimulants use and excessive intake of caffeine in the form of energy drinks. The purpose of this study is to determine the prevalence, patterns of use of cognitive enhancing substances such as stimulants, soft drinks and energy drinks and other caffeine containing beverages amongst university students at Curtin University. Further, to determine the potential for adverse effects from their use.

**Participant's responsibility:**

After you understand the study information and give verbal consent, you will be required to complete the survey which includes questions related to your age, gender, weight, area of study and any medical conditions you suffer from; together with questions particularly related to the use of cognitive enhancing substances (e.g. energy drinks, soft drinks, tea, coffee, and stimulants). Once you complete the questionnaire, you will be required to return it in the blank envelope provided.

You do not have to enter this study if you do not want to. You can ask any question regarding the study. But it would not be possible to withdraw from the study after you complete the questionnaire.

**Risks:**

The risk is minimal as the survey is completely anonymous and no direct risks are expected to the participants.

**Record keeping of personal information:**

You will not be asked to provide information that can identify you. All the data will be grouped for the purpose of analysis and publication with no reference made to any individual. The data will be kept in secure place. All the data collected will be confidential with only access to investigator and their supervisor.

**Cost of participation in the study:**

There will be no cost related to your participation in the research.

**Further enquiry:**

If you have any queries regarding the study, please feel free to discuss them with the investigators. After going through this information sheet, if you are willing to participate in this study please complete the attached questionnaire.

# 14 APPENDIX 2: QUESTIONNAIRE

**Questionnaire No.__________**

**A. Demographic Data Questionnaire:**

| | |
|---|---|
| **AGE : _____ years** | **SEX : O Male O Female** |
| **WEIGHT : ______ Kg** | |
| **STUDENT TYPE: O International Student O Local Student** | |
| **FACULTY OF STUDY:**<br>☐ Center For Aboriginal Studies<br>☐ Curtin Business School<br>☐ Health sciences<br>☐ Humanities<br>☐ Science And Engineering | |
| **ARE YOU –**<br>☐ FULL TIME STUDENT<br>☐ PART TIME STUDENT | **DEGREE TYPE:**<br>☐ UNDERGRADUATE<br>☐ POSTGRADUATE<br>☐ Course work (PG)<br>☐ Research work (PG) |
| **YEAR OF STUDY-**<br>☐ First year<br>☐ Second year<br>☐ Third year<br>☐ Fourth year | |
| **Do you smoke cigarettes?**<br>☐ Yes, If YES, Numbers per day _________________<br>☐ No | |

**Do you suffer from any of the following medical conditions?**

| | YES | NO |
|---|---|---|
| **1. Abnormal heart rhythm (e.g. palpitations)** | ☐ | ☐ |
| **2. Seizures (Epilepsy)** | ☐ | ☐ |
| **3. Raised Blood Pressure** | ☐ | ☐ |
| **4. Acid Reflux Disease (e.g. indigestion, acid in mouth)** | ☐ | ☐ |
| **5. Other heart problems_________(please specify)** | ☐ | ☐ |

**B. Cognitive Enhancing Substance Use Data:**

**1.**

**a) Six situations are given below for consuming caffeine containing products. Please indicate on a scale of 1 to 5 (where 1=Never and 5=Always) how likely you are to consume caffeine.**

| SITUATIONS | SCALE | | | | |
|---|---|---|---|---|---|
| | NEVER | RARELY | SOMETIMES | OFTEN | ALWAYS |
| To counteract lack of sleep | 1 | 2 | 3 | 4 | 5 |
| To boost energy (generally) | 1 | 2 | 3 | 4 | 5 |
| To study for an exam or to complete a major project | 1 | 2 | 3 | 4 | 5 |
| To reduce fatigue | 1 | 2 | 3 | 4 | 5 |
| To increase concentration | 1 | 2 | 3 | 4 | 5 |
| To help me relax during study | 1 | 2 | 3 | 4 | 5 |

**b) Six situations are given below for stimulant (e.g. dexamphetamine, Methylphenidate etc) consumption.**
**Please indicate on a scale of 1 to 5 (where 1= Never and 5= Always) how likely you are to consume a stimulant other than caffeine under that situation.**

| SITUATIONS | SCALE | | | | |
|---|---|---|---|---|---|
| | Never | Rarely | Sometimes | Often | Always |
| To improve alertness | 1 | 2 | 3 | 4 | 5 |
| To improve concentration | 1 | 2 | 3 | 4 | 5 |
| To improve exam performance | 1 | 2 | 3 | 4 | 5 |
| To improve memory | 1 | 2 | 3 | 4 | 5 |
| To get high | 1 | 2 | 3 | 4 | 5 |
| To relax | 1 | 2 | 3 | 4 | 5 |

2. **If you use the caffeine containing beverages, please provide how many quantity per day you consume *NORMALLY* and *DURING THE EXAM PERIOD* (e.g. if you consume 375ml can of Coca-Cola per day then write 1 under "Quantity per day" box for Coca-Cola)**

| **ITEMS** | | **QUANTITY PER DAY** | | ***FOR OFFICE USE ONLY*** | |
|---|---|---|---|---|---|
| | | **Normal Days** | **During The Exam Period** | ***Volume*** | ***Caffeine Dose*** |
| **Do you drink coffee?** ☐ **YES** ☐ **NO** | | | | | |
| **If YES, how much per day** | | | | | |
| ***COFFEE (6oz or 180ml cup)**** | Regular Brewed | | | | |
| | Decaffeinated | | | | |
| **Do you drink tea?** ☐ **YES** ☐ **NO** | | | | | |
| **If YES, how much per day** | | | | | |
| ***TEA (6oz or 180ml cup)**** | Caffeinated | | | | |
| | Decaffeinated | | | | |
| **Do you drink energy drink?** ☐ **YES** ☐ **NO** | | | | | |
| **If YES, how much per day** | | | | | |
| ***Energy drinks [8oz or 250ml can]**** | Red Bull | | | | |
| | V | | | | |
| | Monster | | | | |
| | Mother | | | | |
| | Rockstar | | | | |
| | Full Throttle | | | | |
| | Others ___________ | | | | |

| ITEMS | NAME OF THE PRODUCT | QUANTITY PER DAY | ***<u>FOR OFFICE USE ONLY</u>*** | |
|---|---|---|---|---|
| | | | ***Volume*** | ***Caffeine Dose*** |
| **Do you drink soft drink?**<br>☐ **YES** ☐ **NO** | | | | |
| **If YES, how much per day** | | | | |

* **represents standard quantity**

**If you use other cognitive enhancing substance, please provide how many doses per day you consume *__NORMALLY__* and *__DURING THE EXAM PERIOD__*.**

| **ITEMS** | | **TABLETS PER DAY** | | ***__FOR OFFICE USE ONLY__*** |
|---|---|---|---|---|
| | | **Normal Days** | **During The Exam Period** | ***Daily Dose*** |
| **Do you take OTC and other preparations containing caffeine?** □ **YES** □ **NO** | | | | |
| **If YES, how much per day** | | | | |
| ***OTC and other drugs containing caffeine (Tablets per day)*** | NoDoz Tablets | | | |
| | NoDoz Plus Tablets | | | |
| | Cafergot Tablets | | | |
| | Others____________ | | | |
| **Do you take other stimulants?** □ **YES** □ **NO** | | | | |
| **If YES, how much per day** | | | | |
| ***Stimulants (Tablets per day, milligrams per day)*** | Methylphenidate (Ritalin, Concerta) | | | |
| | Modafinil (Modavigil) | | | |
| | Amphetamines | | | |
| | Methamphetamine | | | |
| | Others ____________ | | | |

**3. a) After you take caffeine containing product, do you suffer from any of the symptoms listed below? Please indicate the frequency of your symptoms on a scale of 1 to 5 (when 1 = Never and 5 = Always)**

| FEATURES | NEVER | RARELY | SOMETIMES | OFTEN | ALWAYS |
|---|---|---|---|---|---|
| Anxiety | 1 | 2 | 3 | 4 | 5 |
| Insomnia | 1 | 2 | 3 | 4 | 5 |
| Gastrointestinal upset | 1 | 2 | 3 | 4 | 5 |
| Headache | 1 | 2 | 3 | 4 | 5 |
| Heart palpitation | 1 | 2 | 3 | 4 | 5 |
| Jolt and crash (increase energy followed by sudden drop in energy) | 1 | 2 | 3 | 4 | 5 |
| Raised blood pressure | 1 | 2 | 3 | 4 | 5 |
| Aggressive behaviour | 1 | 2 | 3 | 4 | 5 |
| Depression | 1 | 2 | 3 | 4 | 5 |

**3. b) After you take a stimulant other than caffeine containing products do you suffer from any of the symptoms listed below? Please indicate the frequency of your symptoms on a scale of 1 to 5 (when 1 = Never and 5 = Always)**

| FEATURES | NEVER | RARELY | SOMETIMES | OFTEN | ALWAYS |
|---|---|---|---|---|---|
| Anxiety | 1 | 2 | 3 | 4 | 5 |
| Insomnia | 1 | 2 | 3 | 4 | 5 |
| Gastrointestinal upset | 1 | 2 | 3 | 4 | 5 |
| Headache | 1 | 2 | 3 | 4 | 5 |
| Heart palpitation | 1 | 2 | 3 | 4 | 5 |
| Jolt and crash (increase energy followed by sudden drop in energy) | 1 | 2 | 3 | 4 | 5 |
| Raised blood pressure | 1 | 2 | 3 | 4 | 5 |
| Aggressive behaviour | 1 | 2 | 3 | 4 | 5 |
| Depression | 1 | 2 | 3 | 4 | 5 |

4. **If you take cognitive enhancing substances during the exam period, please indicate how effective they are on a scale of 1 to 5 (where 1 is Very Ineffective and 5 = Very Effective) in improving the following:**

| **Situations** | **Scale** | | | | |
|---|---|---|---|---|---|
| | **Very ineffective** | **Ineffective** | **Neither effective or ineffective** | **Effective** | **Very effective** |
| Concentration | 1 | 2 | 3 | 4 | 5 |
| Memory | 1 | 2 | 3 | 4 | 5 |
| Alertness | 1 | 2 | 3 | 4 | 5 |
| Energy level | 1 | 2 | 3 | 4 | 5 |
| Stamina | 1 | 2 | 3 | 4 | 5 |
| Academic performance | 1 | 2 | 3 | 4 | 5 |

# 15. APPENDIX 3: ETHICS APPROVAL

**Memorandum**

**Curtin University**

| | |
|---|---|
| **To** | Paliza Joshi |
| **From** | Miss Danii Harry<br>Acting Ethics Committee Secretary |
| **Subject** | Protocol Approval **PH- 16-2010** |
| **Date** | 21st September 2010 |
| **Copy** | Prof Jeff hughes |

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Thank you for your "Form C Application for Approval of Research with Minimal Risk (Ethical Requirements)" for the project titled **"USE OF COGNITIVE ENHANCING SUBSTANCES BY UNIVERSITY STUDENTS: A CROSS-SECTIONAL STUDY. ."** On behalf of the Human Research Ethics Committee I am authorised to inform you that the project is approved.

Approval of this project is for a period of twelve months from **20th September 2010** to **20th September 2011**.

If at any time during the twelve months changes amendments occur, or if a serious or unexpected adverse event occurs, please advise me immediately. The approval number for your project is **PH- 16-2010.**
*Please quote this number in any future correspondence.*

Miss Danii Harry
Acting Committee Secretary
Human Research Ethics Committee

Please Note: The following standard statement must be included in the information sheet to participants:
*This study has been approved by the Curtin University Human Research Ethics Committee. If needed, verification of approval can be obtained either by writing to the Curtin University Human Research Ethics Committee, c/- Office of Research and Development, Curtin University of Technology, GPO Box U1987, Perth, 6845 or by telephoning 9266 2784.*