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Knowledge and consumption of caffeinated products by university students in Beirut, Lebanon

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SUMMARY

Background & aims: Caffeine consumption is well studied among children and adults on a national level. Literature about university student comprehensive consumption, in particular, is scarce. This study aims to measure university student caffeine consumption during weekdays, weekends and exam days.
Methods: A cross-sectional study using the online Lime Survey tool was sent to a random sample of 2154 students at the American University of Beirut. The survey included a self-report questionnaire that asked participants to quantify servings of various products consumed on a typical day using the visual presentation of available serving sizes of common brand names present in the market.
Results: A total of 146 students replied to the survey, yielding a response rate of 6.8%. The mean total consumption of caffeine was 373.1 ± 286.6 mg during weekdays, 326.7 ± 305.3 mg on weekends and 473.6 ± 444.0 mg during exams. Consumption beyond the approved level of 400 mg/day was found among 34.9%, 28.8% and 46.6% of participants during weekdays, weekends and exams, respectively. Products other than coffee and energy drinks contributed to at least 61% of daily caffeine consumption. Total caffeine consumption was associated with smoking, alcohol drinking, and general stress level.
Conclusion: University students consume high levels of caffeine from products other than coffee and energy drinks. During exams, the total daily consumption of caffeine is alarmingly above the Food and Drug Administration (FDA)-approved daily intake. Targeted programs and awareness campaigns are needed on campus.

1. Introduction

Caffeine is the most widely consumed substance in the world and is present in many products such as coffee, tea, energy drinks, soft drinks, food and over-the-counter (OTC) drugs [1]. The most commonly consumed caffeinated products among adults in national representative studies are coffee, tea, and soft drinks [2,3]. The amount of caffeine consumed per day should be less than 400 mg [2,4] in order to avoid side effects which include: anxiety, poor sleep, daytime drowsiness, lower academic performance, and other more serious cardiovascular and central nervous problems. Side effects usually emerge when caffeine intake exceeds 3 mg/kg/day. Acute clinical toxicity occurs when daily doses reach 1 g. Doses of 5 g and 10 g can be fatal [5].

Most caffeine intake among university students is through coffee (79%) and caffeinated alcoholic beverages (65%) [6,7], with daily intake ranging from 60 to 70 mg up to 800 mg, two times the recommended amount [8]. University students consume caffeine for a number of reasons which include: studying, partying, driving, energy-boosting, completing a major course or simply for the taste [2,5,8]. One study found that 50% of students drank energy drinks while studying, 45% while driving and 17% to treat a hangover [5].

Differences in consumption may exist between regular weekdays when students have to wake up early for classes, and weekends when they stay up late for parties and hangouts, and during exams, when they are stressed and require more energy to concentrate. Most studies among university students measure the consumption of one type of caffeinated beverage [1,6–8] and not the simultaneous consumption of various caffeinated products. The aim of this study is to measure university student caffeine

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consumption from coffee, energy drinks and other commonly consumed products such as tea, soda, chocolate and OTC medication during weekdays, weekends and exam periods.

2. Materials and methods

2.1. Survey setting and participants

This cross-sectional study was conducted among university students at the American University of Beirut (AUB) in Lebanon, during the academic year of 2015–2016. Being a KAP (knowledge, attitude and practice) study and estimating a 15% proportion of students who will exceed the daily caffeine allowance with a margin of error of 5% and 95% confidence level, a sample size of 200 is considered adequate. Expecting a 10% response rate, we expected to target 2154 students. The sample is a convenience sample of the entire university students-graduate, undergraduates, and all faculties. None of the students will be excluded. Targeting a sample size of 200 and a 10% response rate, 2154 randomly selected students were emailed an invitation to fill out an anonymous online questionnaire using Lime Survey. The sample was randomly selected by the Office of Registrar as follows: 1754 students (20% of undergraduate students from each of the seven faculties present at the university) and 400 graduate students (20% of all graduate students irrespective of faculty). The students received three email reminders four weeks apart across the entire three-month semester.

2.2. Measurement of caffeine consumption

The most used tool to measure caffeine consumption to date is the self-report questionnaire that asks participants to quantify servings of various products consumed in a specified period of time. The first questionnaire, *Caffeine Consumption Questionnaire (CCQ)*, was developed in 1992 and lacks many newer caffeinated items [9]. *The Sandford Caffeine Questionnaire*, developed and validated against the salivary content of caffeine, asks participants to fill out a three-day diary [10]. Recently modified by Irons et al., *CCQ-revised* now includes a visual presentation of available serving sizes, new caffeinated items and asks participants to record the average amount of product consumed per week [11].

The *CCQ-revised* questionnaire was not published when we conducted our study, though we used many of the modifications suggested, such as a visual presentation of the serving sizes (Supplement 1). An extensive list of products containing caffeine, including brand names available in the Lebanese market, was provided and included estimate caffeine content taken from product labels (Supplement 2). To avoid recall bias, knowing that consumption of caffeine products may differ from one day to the next, we asked participants to record the number of products they consumed on a typical day.

2.3. The questionnaire

The questionnaire included the following segments [1]: servings of caffeinated products (in addition to some that do not contain caffeine) consumed during weekdays, weekends and exams [2]; measurement of knowledge of caffeine amount contained in various products using a four-category Likert Scale (none, minimal, moderate, and high) [3]; a list of reasons for consuming products adapted from previous studies [4]; demographics including stress level, academic year and whether students were full or part-time. Students were also provided with a table of caffeine content (milligrams per serving) in common caffeinated products so that they could calculate daily consumption. See supplement 1 for the detailed questionnaire.

2.4. Ethical statement

This study was approved by the American University of Beirut (AUB) Institutional Review Board (IRB).

2.5. Statistical analysis

Descriptive statistics were reported as absolute or relative frequencies for categorical variables, and means (standard deviation) for continuous variables. Caffeine intake scores were calculated for the consumption of all products containing caffeine, including coffee-related products, tea products, chocolate products, energy drinks, and OTC drugs. The data was not normally distributed using the Shapiro_Wilk test. Means of caffeine consumption by the various demographics were compared using the Kruskal Wallis test. Statistical significance was set at $p < 0.05$. All analyses were performed with SPSS 19.0 software (SPSS, Chicago, IL).

3. Results

An email was sent to 2154 randomly selected students; a total of 146 students completed the questionnaire, with a response rate of 6.8%. Students were mostly females (64.7%) and single (93.3%). There was an almost equal distribution between undergraduate and graduate students. Nearly three quarters reported moderate to extremely high levels of stress (Table 1).

The mean consumption of caffeine was 373.1 ± 286.6 mg during weekdays, 326.7 ± 305.3 mg on weekends and 473.6 ± 444.0 mg during exams. Consumption beyond the approved level of 400 mg/day was consumed among 34.9%, 28.8% and 46.6% of the participants during weekdays, weekends and exams, respectively. The

Table 1
Demographics of university students who completed the survey.

	Total Number = 146
Gender	
Male	35.3%
Female	64.7%
Marital status	
Single	93.3%
Married	6.7%
University level	
Undergraduate	52.6%
Graduate	47.4%
University year	
First year among undergraduates (N = 77)	24%
Graduating year among graduates (N = 69)	32.5%
Social habits	
Smoker	17.8%
Regular alcohol intake (at least three times weekly)	5.9%
Alcohol on weekend	31.1%
Alcohol at a party	48.5%
Regular exercise	23.7%
Part time job	32.3%
BMI	
Underweight	4.4%
Normal	64%
Overweight	25.7%
Obese	5.9%
Stress during last week	
Not at all stressed	3.7%
Somewhat stressed	20%
Moderately stressed	34.1%
Very stressed	27.4%
Extremely stressed	14.8%

mean consumption of caffeine for participants that surpassed the advisable amount was 670.1 ± 275.3 mg during weekdays, 626.8 ± 411.1 mg on weekends and 780.3 ± 479.6 mg during exams. A difference in the consumption of caffeine for all participants during the different periods was observed for total caffeine, OTC drugs, and coffee consumption (Fig. 1). The average percentage of caffeine consumed over total daily consumption was from coffee (55%), chocolate (36%), tea (15%), soft drinks (10%), OTC drugs (6%) and energy drinks (4%). The consumption of coffee and OTC drugs increased during exam periods, resulting in higher daily consumption. More tea and soft drinks were consumed on the weekend.

Using Kruskal–Wallis Test, the bivariate analysis showed that total caffeine consumption was positively associated with smoking whether on weekdays, weekends or exam days. Regular alcohol drinkers consumed more caffeine during weekends and exam days than participants who are not regular drinkers. Total caffeine consumption was positively associated with the general stress level of the students (Table 2).

Student knowledge regarding caffeine content in various products revealed some misconceptions. One-third of the students (33.6%) believed that chocolate had small amounts of caffeine, whereas chocolate is a good source of caffeine. One-third of students (33.6%) considered that soft drinks contained high amounts of caffeine though the amount is moderate. Also, 38.7% of students underestimated the amount of caffeine in OTC drugs, believing it to be minimal. The majority knew that both coffee and energy drinks contain high amounts of caffeine.

The reasons for consuming caffeinated products were various (Table 3). Most students consumed chocolate (67.1%) and tea (38.4%) for taste. Soft drinks were mostly consumed with a meal. OTC drugs were used to soothe headaches. Coffee was consumed for a number of reasons, mostly to stay awake, to help focus, for taste, as a social pastime, to deal with daily stress, to combat headaches and to satiate caffeine cravings. Energy drinks were mostly consumed to help focus.

4. Discussion

This is the first study to measure the simultaneous consumption of caffeine in various products by university students during specified time periods. Almost one-third of participants exceeded the safe level of caffeine per day (400 mg/day). Almost half exceeded the level during exams (reaching 780 mg/day). A good proportion of daily caffeine intake (61%) came from non-coffee/energy drink products, which students seemed to have various misconceptions about. They underestimated the amount of caffeine in OTC drugs and chocolate and they overestimated the amount in soft drinks.

A recent review of nationally representative studies in the United States, Europe, Canada, Australia, New Zealand, and Korea have shown that caffeine consumption among adults is below the Food and Drug Administration (FDA)-approved amount of 400 mg/day [3]. NHANES 24-h dietary recall showed the mean consumption of caffeine among adults to be 173 mg/day [12]. Based on a daily weekly diary, mean caffeine intake was 212 mg/day for 18- to 24-

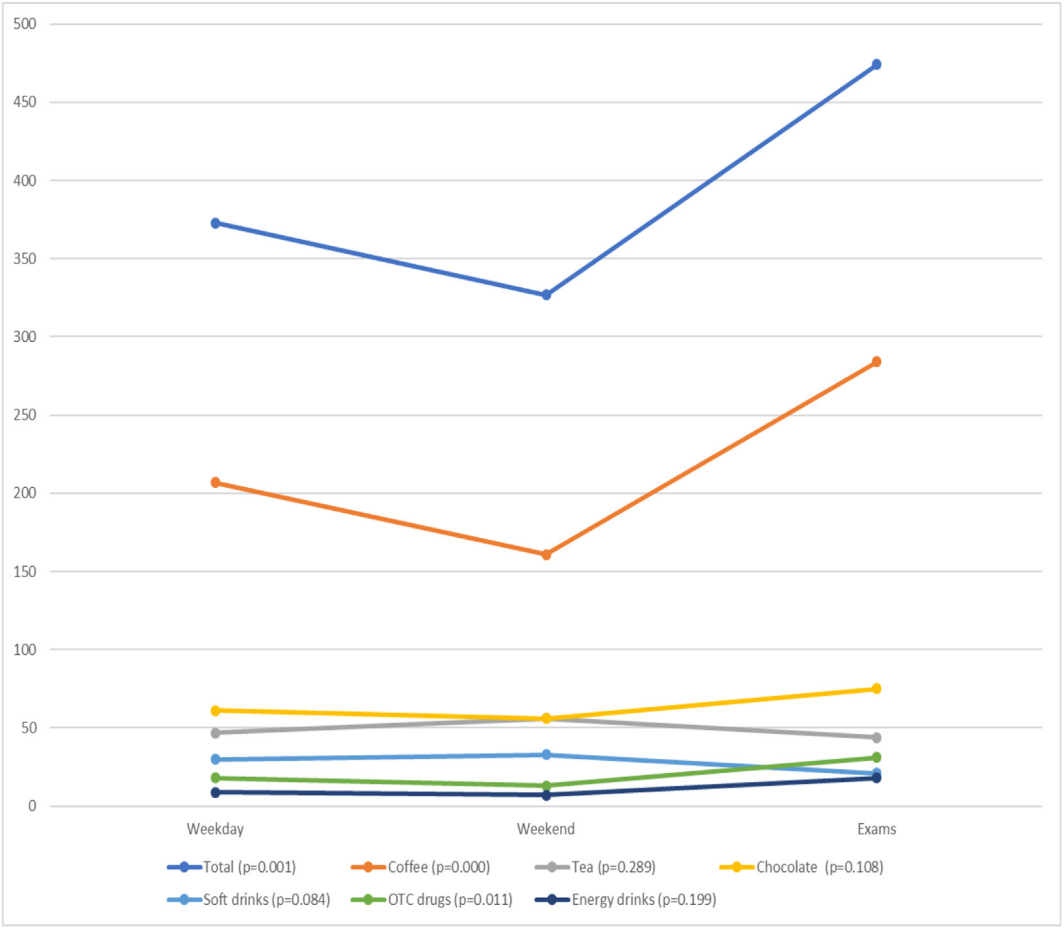

Fig. 1. Daily consumption of caffeine from various products during typical weekdays, weekends and exam days.

Table 2
Association of caffeine intake with smoking, alcohol consumption and stress level.

	Total consumption of caffeine (Mean ± SD)		
	Weekdays	Weekends	Exam days
Smokers (N = 24)	493.5 ± 315.7	664.2 ± 647.1	458.3 ± 587.6
Non-Smokers (N = 111)	346.5 ± 275.2	411.6 ± 332.6	298.1 ± 204.0
P value	0.022	0.022	0.006
Regular Alcohol intake (N = 8)	401.8 ± 267.2	637.6. ± 983.6	748.5 ± 927.2
Irregular Alcohol intake (N = 127)	369.9 ± 289.1	304.6 ± 206.9	436.8 ± 359.7
P value	0.761	0.003	0.039
Not at all stressed (N = 5)	339.8 ± 298.3	186.0 ± 43.2	262.7 ± 129.0
Somewhat stressed (N = 27)	347.0 ± 250.6	282.2 ± 199.3	318.4 ± 262.1
Moderately stressed (N = 46)	310.7 ± 193.2	290.2 ± 196.0	416.3 ± 278.6
Very stressed (N = 37)	465.1 ± 390.2	418.1 ± 485.3	635.1 ± 608.3
Extremely stressed (N = 20)	389.7 ± 269.2	328.4 ± 258.1	469.6 ± 347.8
P value	0.275	0.346	0.033

Kruskal Wallis statistic was used to calculate p values.

year-olds and 137 mg/day for 25- to 34-year-olds [2]. Similarly, our study revealed values below the FDA-approved amount during weekdays and weekends, albeit the values were much higher, close to 400 mg/day. Our results were similar to caffeine intake among a representative sample of the Austrian population, which was found to be 357 mg/day with 90th percentile intake reaching 957 mg [13]. Moreover, at least one-third of the students consumed more than 400 mg/day, in contrast to just 4% of UK consumers who exceed 300 mg/day [14]. The *Korean National Health and Nutrition Examination* survey revealed a very low mean of daily caffeine intake at 67 mg/day. Caffeine consumption clearly varies by country. This study, according to the knowledge of its authors, is the first to measure caffeine consumption in a developing country.

Few studies, in fact, address the caffeine consumption of college students and, those that do, show varied results. A general study of monthly caffeine consumption showed that college students consumed 455 mg of caffeine daily [15]. A pencil-and-paper 24-h recall among Dutch university students found caffeine intake from beverages to be 144 mg/day [16]. A study among US college students showed a mean consumption of 173 mg/d among caffeine users [17]. The difference in results could be attributed to different data collection methods and recall of consumption (24 h as opposed to 30 days). Our results were similar to those obtained by longer recall duration, as we asked participants to record their daily consumption of caffeine. Asking for a longer duration of days or a typical day is a better way to assess variation in caffeine consumption through various products.

College students use caffeine to stay focused and increase concentration during exams. However, caffeine was found to boost the explicit memory of young college students only in the morning and not in the afternoon [18] and the use of energy drinks is associated with a lower Grade Point Average (GPA) [19]. In fact, there is an association between caffeine intake and lower academic performance; the association is exaggerated when the caffeine intake exceeds 500–600 mg per day [20]. Furthermore, the use of alcohol and smoking have a negative impact on academic performance [21]. In our sample, caffeine intake was highly associated with smoking and alcohol drinking. Similarly, two large cohorts in the Netherlands and the United Kingdom showed a positive association between smoking and caffeine consumption [22]. In a prospective study over 12 months, caffeine was found to promote the use of cigarette smoking and alcohol use [23]. There is a controversy about the genetic-based causality of the epidemiologic finding of an association between alcohol, smoking and caffeine use [24–26]. Nevertheless, there is no doubt that daytime sleepiness and caffeine intake mediate the negative effects of alcohol and smoking on academic performance [21]. Although college students consume coffee for better concentration, it will be counterproductive in the long run on their academic performance especially if it was associated with alcohol and smoking.

In this study, caffeine intake was associated with stress levels. Based on a cross-sectional design, causality cannot be tested and it is not clear whether caffeine intake leads to stress or vice versa. College students who consumed high amounts of caffeine were more likely to show symptoms of anxiety and depression [27]. However, studies using animal models, caffeine prevented the maladaptive changes caused by chronic stress and prevented depression [28,29]. Furthermore, a meta-analysis of observational studies suggested a non-linear J-shaped relation between coffee intake and depression with a peak of protective effect for 400 mL/day [30]. A balanced intake of caffeine may be helpful to college students who may have general stress over their career and academic performance. College students should be informed of other stress-reduction techniques that could replace their current strategies to increase caffeine consumption during exams.

4.1. Strengths and limitations

This study is the first to address the caffeine intake of college students during different segments of the week and during different academic periods. In order to overcome the recall bias, we asked the participants to report consumption of caffeinated products in a typical day. One limitation we encountered is the small sample size. Due to a low response rate, we were not able to reach the needed 200 participants and this could affect generalizability. Both the sample size and the non-parametric analysis may affect the precision of the results. Another challenge was securing an

Table 3
Reasons why university students consume caffeinated products.

N = 146	Tea (N/%)	Chocolate (N/%)	Soft drinks (N/%)	OTC drugs (N/%)	Coffee (N/%)	Energy drinks (N/%)
Drink with meal	38 (26)	2 (1.4)	87 (59.6)	0	5 (3.4)	1 (0.7)
Combat a headache	21 (14.4)	7 (4.8)	3 (2.1)	71 (48.6)	50 (34.2)	2 (1.4)
I like its taste	56 (38.4)	98 (67.1)	44 (30.1)	1 (0.7)	72 (49.3)	13 (8.9)
Deal with stress in daily life	26 (17.8)	35 (24)	3 (2.1)	8 (5.5)	50 (34.2)	3 (2.1)
Helps me focus my attention	17 (11.6)	14 (19.6)	5 (3.4)	5 (3.4)	76 (52.1)	13 (48.9)
I like the jolt of energy rush I feel	1 (0.7)	11 (7.5)	5 (3.4)	3 (2.1)	33 (22.6)	9 (6.2)
Stay awake	18 (12.3)	10 (6.8)	5 (3.4)	1 (0.7)	95 (65.1)	18 (12.3)
Social pastime	34 (23.3)	15 (10.3)	10 (6.8)	1 (0.7)	55 (37.7)	2 (1.4)
Crave caffeine	4 (2.7)	5 (3.4)	2 (1.4)	0	48 (32.9)	2 (1.4)
Like to mix it with alcohol	2 (1.4)	0	13 (8.9)	1 (0.7)	1 (0.7)	14 (9.6)

accurate and complete list of all caffeinated products available in the market.

In conclusion, this study has shown that caffeine consumption among university students almost exceeded the FDA-approved daily amount. Caffeine consumption reached alarming levels during exams. In parallel, students underestimated the caffeine content in common non-coffee/non-energy drink products. It is important to educate students on the various sources of caffeine such as tea, chocolate, soft drinks, and OTC drugs. Further studies are needed to determine whether awareness campaigns and stress management sessions may help reduce caffeine intake.

Statement of authorship

Both authors were involved in the research design, statistical analysis, interpretation of results and final manuscript writing.

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Declaration of Competing Interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clnesp.2020.02.014.

References

[1] Tseng HC, Wang CJ, Cheng SH, Sun ZJ, Chen PS, Lee CT, et al. Tea-drinking habit among new university students: associated factors. Kaohsiung J Med Sci 2014;30(2):98–103.
[2] Mitchell DC, Knight CA, Hockenberry J, Teplansky R, Hartman TJ. Beverage caffeine intakes in the U.S. Food Chem Toxicol 2014;63:136–42.
[3] Verster JC, K J. Caffeine intake and its sources: a review of national representative studies. Crit Rev Food Sci Nutr 2018 May 24;58(8):1250–9.
[4] Orbeta RL, Overpeck MD, Ramcharran D, Kogan MD, Ledsky R. High caffeine intake in adolescents: associations with difficulty sleeping and feeling tired in the morning. J Adolesc Health 2006;38(4):451–3.
[5] Malinauskas BM, Aeby VG, Overton RF, Carpenter-Aeby T, Barber-Heidal K. A survey of energy drink consumption patterns among college students. Nutr J 2007;6:35. https://doi.org/10.1186/1475-2891-6-35.
[6] Hughes JR, Oliveto AH. A systematic survey of caffeine intake in Vermont. Exp Clin Psychopharmacol 1997;5(4):393–8.
[7] Amlung M, Few LR, Howland J, Rohsenow DJ, Metrik J, MacKillop J. Impulsivity and alcohol demand in relation to combined alcohol and caffeine use. Exp Clin Psychopharmacol 2013;21(6):467–74.
[8] Seifert SM, Schaechter JL, Hershorin ER, Lipshultz SE. Health effects of energy drinks on children, adolescents, and young adults. Pediatrics 2011;127(3):511–28.
[9] Shohet KL, Landrum RE. Caffeine consumption questionnaire: a standardized measure for caffeine consumption in undergraduate students. Psychol Rep 2001;89(3):521–6.
[10] Rudolph E, Farbinger A, Konig J. Determination of the caffeine contents of various food items within the Austrian market and validation of a caffeine assessment tool (CAT). Food Addit Contam 2012;29(12):1849–60.
[11] Irons JG, Bassett DT, Prendergast CO, Landrum RE, Heinz AJ z. Development and initial validation of the caffeine consumption questionnaire-revised. J Caffeine Res 2016;6(1):20–5.
[12] Drewnowski A, Rehm CD. Sources of caffeine in diets of US children and adults: trends by beverage type and purchase location. Nutrients 2016;8(3):154. https://doi.org/10.3390/nu8030154.
[13] Rudolph E, Faerbinger A, Koenig J. Caffeine intake from all sources in adolescents and young adults in Austria. Eur J Clin Nutr 2014;68(7):793–8.
[14] Fitt E, Pell D, Cole D. Assessing caffeine intake in the United Kingdom diet. Food Chem 2013;140(3):421–6.
[15] Verster JC. Caffeine consumption in children, adolescents, and adults. Curr Drug Abuse Rev 2014;7(3):133–4.
[16] Mackus M, van de Loo AJ, Benson S, Scholey A, Verster JC. Consumption of caffeinated beverages and the awareness of their caffeine content among Dutch students. Appetite 2016;103:353–7.
[17] Mahoney CR, Giles GE, Marriott BP, Judelson DA, Glickman EL, Geiselman PJ, et al. Intake of caffeine from all sources and reasons for use by college students. Clin Nutr 2019;38(2):668–75.
[18] Sherman SM, Buckley TP, Baena E, Ryan L. Caffeine enhances memory performance in young adults during their non-optimal time of day. Front Psychol 2016;7(NOV):1764. https://doi.org/10.3389/fpsyg.2016.01764.
[19] Champlin SE, Pasch KE, Perry CL. Is the consumption of energy drinks associated with academic achievement among college students? J Prim Prev 2016;37(4):345–59.
[20] Pattison S, Rusin R, Bai Y. Caffeine consumption among college students: its effect on sleep hours and academic achievement. J Acad Nutr Diet 2016;116(9):A13. https://doi.org/10.1016/j.jand.2016.06.028.
[21] James JE, Kristjánsson ÁL, Sigfúsdóttir ID. Adolescent substance use, sleep, and academic achievement: evidence of harm due to caffeine. J Adolesc 2011;34(4):665–73.
[22] Treur JL, Taylor AE, Ware JJ, McMahon G, Hottenga JJ, Baselmans BM, et al. Associations between smoking and caffeine consumption in two European cohorts. Addiction 2016;111(6):1059–68.
[23] Kristjansson AL, Kogan SM, Mann MJ, Smith ML, Juliano LM, Lilly CL, et al. Does early exposure to caffeine promote smoking and alcohol use behavior? A prospective analysis of middle school students. Addiction 2018;113(9):1706–13.
[24] Cornelis MC, Munafo MR. Mendelian randomization studies of coffee and caffeine consumption. Nutrients 2018;10(10):1343. https://doi.org/10.3390/nu10101343.
[25] Verweij KJ, Treur JL, Vink JM. Investigating causal associations between use of nicotine, alcohol, caffeine, and cannabis: a two-sample bidirectional Mendelian randomization study. Addiction 2018;113(7):1333–8.
[26] Treur JL, Taylor AE, Ware JJ, Nivard MG, Neale MC, McMahon G, et al. Smoking and caffeine consumption: a genetic analysis of their association. Addiction Biol 2017;22(4):1090–102.
[27] Gilliland K, Andress D. Ad lib caffeine consumption, symptoms of caffeinism, and academic performance. Am J Psychiatr 1981;138(4):512–4.
[28] Kaster MP, Machado NJ, Silva HB, Nunes A, Ardais AP, Santana M, et al. Caffeine acts through neuronal adenosine A2A receptors to prevent mood and memory dysfunction triggered by chronic stress. Proc Natl Acad Sci Unit States Am 2015;112(25):7833–8.
[29] Cakir OK, Ellek N, Salehin N, Hamamcı R, Keleş H, Kayalı DG, et al. Protective effect of low dose caffeine on psychological stress and cognitive function. Physiol Behav 2017;168:1–10.
[30] Grosso G, Micek A, Castellano S, Pajak A, Galvano F. Coffee, tea, caffeine and risk of depression: a systematic review and dose-response meta-analysis of observational studies. Mol Nutr Food Res 2016;60(1):223–34.