

SCHOOL PUPILS AND UNIVERSITY STUDENTS SURVEYED FOR DRINKING BEVERAGES CONTAINING CAFFEINE

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ABSTRACT

Background. Caffeine is a commonly found ingredient in many beverages. Its main dietary source is coffee, cola drinks and in recent years, energy drinks.

Objectives. To compare the consumption of drinks containing caffeine (coffee, colas and energy drinks) and the reasons and circumstances under which they were drunk by middle school (junior high school) pupils and university students.

Material and methods. Surveyed subjects were 90 middle school pupils from Warsaw and Kutno together with 100 students attending the Warsaw University of Life Sciences (SGGW). A questionnaire, designed by the authors, was used to determine the amounts, frequency and the reasons or circumstances in which coffee, colas and energy drinks were consumed. Statistics used, consisted of the *Mann-Whitney U* and *Chi-square* (χ^2) tests, with significance taken as $\alpha \leq 0.05$.

Results. Cola drinks were found to be the most popularly consumed beverages containing caffeine; 97% pupils and 93% students. Coffee was however drunk twice less by pupils compared to students, whilst similar amounts of energy drinks were consumed by both groups; respectively 48% and 53%. Gender differences were observed for the energy drinks with young men drinking the most. Coffee and energy drink consumption also rose with age by respectively 39% and 57%. The mean caffeine intake in pupils and students were respectively estimated to be 141 and 163 mg/day(d). The reasons why these beverages were drunk varied, from drinking coffee to keeping awake and drinking cola because of its good taste. Pupils also drank energy drinks due to its taste but students because of improved mental performance and in staying awake.

Conclusions. Drinking caffeine containing drinks by adolescents can be very variable and comes from many different sources. Thus, its intakes may be very high and so require monitoring, particularly for the youngest. Further observational studies are needed to assess the consumption of energy drinks in relation to physical activity.

Key words: *caffeine, intake, school pupils/children, students*

STRESZCZENIE

Wprowadzenie. Kofeina jest składnikiem wielu spożywanych napojów. Jej głównym źródłem w diecie jest kawa, napoje typu cola, a w ostatnich latach dodatkowo napoje energetyzujące.

Cel badań. Celem badania było porównanie ilości i uwarunkowań spożywania napojów zawierających kofeinę (kawy, napojów typu cola i napojów energetyzujących) przez młodzież gimnazjalną i akademicką.

Material i metody. Badaniami objęto 90 uczniów gimnazjum (Warszawa i Kutno) i 100 studentów ze Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie. Badania zostały przeprowadzone na podstawie autorskiego kwestionariusza, zawierającego pytania dotyczące ilości, częstotliwości i uwarunkowań spożywania kawy, napojów energetyzujących i typu cola. Uzyskane dane poddano analizie statystycznej za pomocą testu *U Manna-Whitney'a* oraz testu *Chi²*, przyjmując poziom istotności $\alpha \leq 0,05$.

Wyniki. Powszechnie spożywanym napojem zawierającym kofeinę wśród badanej grupy były napoje typu cola, które spożywało 97% gimnazjalistów i 93% studentów. Spożywanie kawy deklarowało prawie dwukrotnie mniej gimnazjalistów w porównaniu ze studentami, natomiast napoje energetyzujące spożywał podobny odsetek badanych w obydwu grupach (48% gimnazjalistów i 53% studentów). Spożywanie napojów energetyzujących zależało od płci, młodzież męska deklarowała częstsze ich spożywanie. Z wiekiem wzrastało spożycie kawy (o 39%) i napojów energetyzujących (o 57%). Średnie spożycie kofeiny oszacowano w grupie gimnazjalnej na poziomie 141 mg/d, a w grupie studentów na poziomie 163 mg/d. Uwarunkowania spożywania napojów zawierających kofeinę różniły się dla poszczególnych ich rodzajów: kawę spożywano

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głównie dla zwalczenia senności, napoje typu cola ze względu na smak. Gimnazjaliści spożywali napoje energetyzujące ze względu na smak, a studenci celem poprawy sprawności umysłowej i zwalczenia senności.

Wnioski. Spożywanie napojów zawierających kofeinę wśród młodzieży, z uwagi na fakt, iż zawartość w nich kofeiny może być znacznie zróżnicowana, a łączne dostarczanie jej z różnymi produktami, może powodować znacznie wyższe jej pobranie, wymaga monitorowania, zwłaszcza w młodszych grupach wiekowych. Dalszych badań wymaga zaobserwowana zależność spożywania napojów energetyzujących w związku z wysiłkiem fizycznym.

Słowa kluczowe: kofeina, spożycie, gimnazjaliści, studenci

INTRODUCTION

Caffeine is an alkaloid, naturally occurring in coffee beans, tea leaves, cola nuts, Yerba-mate leaves, cocoa beans and guarana seeds. Its main source of intake is through drinking infusions of coffee, tea or cocoa. An extract from cola nuts is used in the many cola drinks, however synthetic caffeine is added to energy drinks [19]. Caffeine is also added to some foodstuffs and medicines. Modest intakes of caffeine (i.e. 200 – 300 mg) are beneficial to health through being a stimulant of the central nervous system (CNS), muscle activity, heart and kidneys. It also increases mental processes/performance and decreases fatigue and tension in smooth muscles of the vasculature [4]. A safe level of daily caffeine intake is regarded as one not exceeding 400 mg [23]. Excessive daily intakes above 400 mg may however cause agitation, sleep disturbances, anxiety, irritability, nervousness [8, 21], as well as insulin resistance [6]. A regular, long-term and excessive caffeine intake may lead to an addiction and adverse health consequences [10]. A toxic dose of caffeine is difficult to precisely define as the literature reports wide variation between 0.5 to 1.5 g for a healthy individual [23].

Children and adolescents widely consume many caffeine containing foodstuff products. Because the effects of caffeine on their development and health are relatively unknown, surveillance of caffeine intake levels becomes necessary. Due to the child's nervous system being in growth and developmental stages, it is supposed that the effects of caffeine are different when compared to adults. In addition, as children are building up their bone mass, drinking caffeine containing beverages when coupled to any calcium deficiencies will decrease bone mass density [19, 23].

Only in Canada, have maximum daily intakes of caffeine been established for children aged below 12 years at < 2.5 mg/kg body mass/d [23]. Other recommendations for children aged 4 – 12 years state safe doses of 45 – 85 mg/d [20] and for adolescents up to 18 years at < 100 mg/d [16]. Children and adolescents most often consume caffeine with sugar as from colas and energy drinks. This is detrimental as it very likely leads to having a predilection for sweet tasting foodstuffs. Furthermore, another effect of caffeine is to increase

blood glucose through stimulating adrenal hormones that may lead to type II diabetes [5]. Sweetened fizzy drinks, such as colas or energy drinks, contribute towards the development of overweight and obesity due to their high sugars' content [2].

A study by Temple [18] has stressed that caffeine, like sugar, may activate the dopaminergic-reward system and thence lead to addiction. Their joint consumption in foodstuffs and beverages synergistically increases dopamine release and as a result their effects become potentiated, which, in the long term, during a critical stages of individual's development are not clearly understood. During childhood and adolescence, the brain undergoes intensive development, especially those centres responsible for performance, planning and emotional control, where frequent caffeine consumption by these groups may have adverse health impacts.

Additionally, energy drinks can contain ingredients such as guarana, taurine, inositol, group B vitamins, glucuronolactone and others which enhance the action of caffeine [5]. Because of their composition, energy drinks should not be given to children nor adolescents below 16 years, however in many countries, including Poland, they are readily available [5, 8]. Nevertheless, drinks are generally popular in these age groups. In the USA it is estimated that children aged 2 – 5 years consume 16 mg/d caffeine, those aged 6 – 11 years 26 mg/d and 59 – 80 mg/d for ages above 11 years. As pointed out by Wierzejska [23], these surveys were undertaken in the 1990s of the previous century, based on food interviews, when foodstuff products had much less caffeine. For Polish children, there is a dearth of data on this topic. For this reason, the presented study is therefore focused on comparing the amounts and reasons/circumstances for consuming drinks containing caffeine (coffee, colas and energy drinks) in middle school pupils and university students.

MATERIAL AND METHODS

The study was conducted on 90 pupils attending middle school at Warsaw and Kutno and 100 students of the Warsaw University of Life Sciences in 2011-12, which had been preceded by a pilot study. A proprietary

questionnaire was used to assess the consumption of coffee, colas and energy drinks together with questions on age, gender, height, body mass and the amounts, circumstances/reasons why these drinks had been consumed – Table 3. The relevant features of the subject groups are shown in Table 1.

The mean intakes of caffeine for both groups were estimated from taking the average contents of caffeine in coffee, colas and sweet drinks as respectively being; 60 mg/100 ml, 11 mg/100 ml and 32 mg/100 ml. To determine what effect age and gender has, the quantitative data were analysed by the *Mann-Whitney U*-test whilst the χ^2 test was used to analyse the qualitative data using the SPSS statistical software package. Significance was taken as $\alpha=0.05$.

RESULTS

Both groups had similar gender proportions. The mean ages of middle school pupils was 15 years and 23 years for university students. The BMI was at normal levels in both groups and did not differ significantly (Table 1).

Table 1. Characteristics of the study groups

Group	Gender		Age (years)	Body mass (kg)	Height (cm)	BMI (kg/m ²)
	F	M				
pupils n=90	46	44	15 ± 1	62 ± 9	173 ± 15	21 ± 3
students n=100	50	50	23 ± 2	68 ± 11	173 ± 13	23 ± 2

F – females, M – males

The consumption of cola was found to be particularly popular in pupils and students, however drinking coffee was significantly ($p=0.02$) more popular with students than pupils (88% vs 51%). There were no age differences in consuming colas and energy drinks. Differences between genders were observed, in that males more frequently ($p=0.01$) drank energy drinks than females; this being true in both groups (respectively $p=0.03$ and $p=0.001$). Females from middle school however, drank more coffee ($p=0.02$); Table 2.

The highest numbers of drinks consumed containing caffeine were colas (average of 3 litres per week), where pupils drank 33% more than students; Table 3. The older student subjects significantly drank more energy drinks than pupils (by 57%; $p=0.04$). Female students drank more colas compared to males ($p=0.01$), whilst male pupils drank more energy drinks than females ($p=0.02$).

The mean caffeine intakes were 141 mg/person/d (pupils) and 163 mg/person/d (students). Significantly higher mean caffeine intakes were observed in males; $p=0.04$, Table 3. The main source of caffeine were coffee and colas, however energy drinks only contributed 10 – 20% of the caffeine consumption. The reasons for consuming caffeine containing beverages varied according to category; Table 4. Coffee was mostly drunk to prevent sleepiness and in students to improve mental alertness (92%) and well-being (83%). Meantime, colas were drunk because they tasted good and quenched thirst. Pupils drank energy drinks mainly due to them being tasty (65%) and 51% did so to increase physical efficiency. Students however drank energy drinks to improve their mental process function ie. performance (68%) and for keeping awake (65%); Table 4. Most sub-

Table 2. Consumption of caffeine-containing beverages (%) in studied groups

Beverages	Subjects						Pupils			Students		
	pupils n=90	students n=100	p ¹	F		p ¹	F n=46	M n=44	p ¹	F n=50	M n=50	p ¹
				n = 96	n= 94							
Coffee	51	88	0.02	74	67	NS	63	38	0.02	84	92	NS
Colas	97	93	NS	94	96	NS	98	96	NS	90	95	NS
Energy drinks	48	53	NS	34	67	0.01	36	59	0.03	32	74	0.001

¹ *Chi*² test results, F– females, M – males, NS – statistically insignificant differences

Table 3. Average intake of caffeine-containing beverages (ml/week) and estimated average caffeine intake (mg/d) in groups

Beverage	Subjects						Pupils			Students		
	Pupils	Students	p ¹	F	M	p ¹	F	M	p ¹	F	M	p ¹
Coffee	N = 46 752±323	N = 88 1044±415	NS	N= 74 912±405	N= 63 884±336	NS	N=29 844±350	N=17 660±399	NS	N=42 980±360	N=46 1108±470	NS
Colas	N = 87 3666±1184	N = 93 2750±1024	NS	N=90 2494±990	N=90 3922±1108	NS	N=45 3394±1074	N=42 3938±1054	NS	N=45 1594±894	N=48 3906±1157	0.01
Energy drinks	N = 43 419±192	N = 53 656±103	0.04	N=33 384±202	N=63 692±252	NS	N=17 255±199	N=26 584±171	0.02	N=16 512±125	N=37 800±158	NS
Caffeine	141±57	163±61	NS	134±48	170±59	0.04	137±58	146±62	NS	132±49	193±67	0.03

¹ *Mann-Whitney U* test results, F – Females, M – Males, NS – Statistically insignificant differences

Table 4. Determinants of caffeine-containing drinks intake (% responses) for middle school pupils and university student subjects

Reasons and circumstances for drinks' intake*	Coffee		Colas		Energy drinks	
	Pupils n=46	Students n=88	Pupils n=87	Students n=93	Pupils n=43	Students n=53
<i>Reasons</i>						
Keeping awake	74	85	7	2	10	65
Taste	60	78	85	90	65	24
Thirst quenching	11	2	53	65	23	19
Improved mood	28	82	39	20	33	26
Improved mental alertness	5	92	10	20	33	68
Increased physical efficiency	5	15	4	20	51	25
<i>Circumstances</i>						
During studying	55	89	31	30	23	50
On social occasions	40	75	65	78	30	18
During/after physical exertion	11	7	14	59	60	17

*Several replies could be given (values do not add up to 100)

jects also declared that the circumstances for drinking coffee (i.e. caffeine containing beverage) was during studying and social occasions (58%). Colas were drunk most often socially but in students also after physical exertion (59%). Pupils drank energy drinks mostly to do with physical exercise (60%), whilst 50% students did so during study.

DISCUSSION

Caffeine containing products are consumed at all ages, resulting from their availability, popularity and stimulating effect, and are widely enjoyed even by younger population groups. Children and adolescents are however most vulnerable to the adverse effects of caffeine because of their still developing metabolism and nervous system [19]. The risk of untoward effects on a developing individual increases when coupled to raised caffeine intakes from various sources [18, 20, 23].

The current study demonstrates that drinking caffeine containing beverages is widespread irrespective of age and does not differ between the two age groups studied. Studies by *Wierzbička* et al. [22] on women, *Bartosiuk* et al. [3] on female students and *Semeniuk* [17] on students indicated that energy drinks are becoming increasingly popular. According to *Kopacz* et al. [12], over half of the student subjects consumed energy drinks, with consumption significantly rising during examination periods. The presented study however showed that cola was the most popular.

Significant gender differences were observed in especially energy drink consumption. These findings agree with studies by *Attele* and *Cakir* [1] and *Wanat* and *Woźniak-Holecka* [19] which reported that males drank more energy drinks than females. Caffeine intakes rose with age, particularly from coffee and energy drinks, consistent with the aforementioned *Wanat* and

Woźniak-Holecka [19] study on high school pupils and university students that found that the latter drank more coffee than the former.

In children and adolescents, caffeine intake should not exceed 100 mg/d [16], but in the middle school pupils this value was 141 mg which did not differ with the students (i.e. adults). These estimations were somewhat lower than results reported by *Wanat* and *Woźniak-Holecka* [19] or *Wierzbička* et al. [22]; at respectively 196–241 mg/d and 251 mg/d, but the caffeine sources were not accounted for. Furthermore, these estimations were given as mean caffeine intakes, where the ranges may have shown wide variations. The amount of caffeine in coffee depend on the coffee type and method of preparing the drink. For energy drinks there are no legal regulations and established limits, which results in wildly fluctuating caffeine levels in many varieties of products where added caffeine is ever increasing [23].

The main grounds for consuming caffeine in drinks was to improve well-being so that sleepiness could be prevented and that intellectual or physical performance be enhanced. These were likewise found in other studies [1, 11, 14, 17]. Energy drinks were drunk more due to physical exercise in pupils which concurs with studies by *Łagowska* et al. [13] and *Malinauskas* et al. [14], which showed that they are mostly drunk for increasing physical and mental efficiency. Similarly, *Bajerska* et al. [2] found that adolescents engaged in sport are twice more likely to drink energy drinks compared to their peers undertaking lower levels of physical activity. This requires further studies. Energy drinks can cause much harm and even lead to caffeine poisoning. They are perceived by young consumers as being drinks that have a cool image and intensive advertising campaigns are launched to popularise these products as increasing physical-mental endurance and efficiency without having any ill effects on health [5]. The problem is that there are no restrictions on the sale of these products to

children and adolescents who have lower tolerances to caffeine [15]. An 2013 EFSA (European Food Standards Agency), report indicated that 68% teenagers (aged 10 – 18 years) consume energy drinks, of whom 12% do so at rates of 7 litres per month.

In conclusion, the study has demonstrated that the popular consumption of such beverages may lead to an excess caffeine intake in middle school pupils which does not differ from their older student counterparts i.e. in effect adults.

CONCLUSIONS

1. For adolescents, the consumption of beverages containing caffeine may lead to excessive intakes because of the wide variations in product content. This requires monitoring, particularly for the more vulnerable, younger age groups.
2. Further studies are needed to assess the observed relation between energy drinks and undertaken physical activity.

Conflict of interest

The authors declare no conflict of interest.

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