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Consumption of caffeinated beverages and the awareness of their caffeine content among Dutch students

Marlou Mackus [a], Aurora J.A.E. van de Loo [a], Sarah Benson [b], Andrew Scholey [b], Joris C. Verster [a, b, *]

[a] Utrecht University, Division of Pharmacology, Utrecht, The Netherlands
[b] Centre for Human Psychopharmacology, Swinburne University of Technology, Melbourne, 3122 VIC, Australia

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ABSTRACT

The purpose of the current study was to examine the knowledge of caffeine content of a variety of caffeinated beverages among Dutch university students. A pencil-and-paper survey was conducted among N = 800 Dutch students. Most participants (87.8%) reported consuming caffeinated beverages during the past 24 h. Their mean ± SD past 24-h caffeine intake from beverages was 144.2 ± 169.5 mg (2.2 ± 3.0 mg/kg bw). Most prevalent sources of caffeine were coffee beverages (50.8%) and tea (34.8%), followed by energy drink (9.2%), cola (4.7%), and chocolate milk (0.5%). Participants had poor knowledge on the relative caffeine content of caffeinated beverages. That is, they overestimated the caffeine content of energy drinks and cola, and underestimated the caffeine content of coffee beverages. If caffeine consumption is a concern, it is important to inform consumers about the caffeine content of all caffeine containing beverages, including coffee and tea. The current findings support previous research that the most effective way to reduce caffeine intake is to limit the consumption of coffee beverages and tea.

1. Introduction

Recently, the European Food Safety Authority (EFSA) published the "Scientific Opinion on the safety of caffeine" (EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies), 2015). In the EFSA opinion, data from 39 national representative European surveys conducted in adults, adolescents and children were summarized. Based on the outcome of these surveys, and an extensive search of the available other scientific literature, the EFSA panel concluded that, for healthy adults, daily caffeine consumption up to 400 mg (3 mg/kg body weight) does not give rise to safety concerns. This recommendation is in line with other guidelines such as those formulated by Health Canada (Health Canada, 2010).

As a guidance for consumers, EFSA lists the caffeine content of various caffeinated beverages on their website (EFSA Fact Sheet on Caffeine). In addition, individual Member States of the European Union also present these listings. The latter is important as typical beverage serving sizes may differ between European countries. For example, the Dutch standard serving sizes (which can be found at www.voedingscentrum.nl) are slightly different from the ones presented by EFSA.

Although the information on serving sizes and the corresponding caffeine content of caffeinated beverages is readily available for the Dutch general public, it is not known whether consumers actually visit corresponding websites. It is thus unclear if consumers are aware of the actual caffeine content of caffeinated beverages. A literature search revealed that, to date, this topic has received very little research attention.

The 2013 Australian Galaxy Poll revealed that only 4% of Australians correctly state that coffee from a café contains the highest amount of caffeine (Galaxy Poll 2013). Instead, Australians in this survey reported that energy drinks contain the most caffeine. Another study showed that US adolescents were poor in addressing whether common beverages contain caffeine or not (Thrake, Deoras, Griffin, Vemana, & Podmore, 2015). Almost one third of seventh and eighth graders (29%) were unaware that their favorite drinks contain caffeine.

Given the limited scientific information on this topic, the current study was conducted to examine the knowledge of caffeine content of a variety of caffeinated beverages among Dutch university students.

* Corresponding author. Utrecht University, Division of Pharmacology, Universiteitsweg 99, 3584CG, Utrecht, The Netherlands.
E-mail address: j.c.verster@uu.nl (J.C. Verster).

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2. Methods

A pencil-and-paper survey was conducted among N = 800 Dutch students. Participants were recruited at various locations at Utrecht University, Utrecht, The Netherlands. Both male and female students were approached. To be included, participants had to be students and aged 18–30 years old. In accordance with local guidelines, no ethics approval was required for this anonymous survey. Consent to take part in the study was implied by completion of the questionnaire.

This one-page survey comprised questions on demographics, including age, gender, height, weight, study type, past 24-h caffeine consumption and questions about their knowledge of the caffeine content of various beverages.

Past 24-h caffeinated beverage consumption was computed by asking how many of these beverages were consumed by participants. These beverages included standard Dutch serving sizes of tea (125 ml), energy drink (250 ml), filter coffee (125 ml), instant coffee (125 ml), espresso (50 ml), cola (180 ml), chocolate milk (180 ml), alcohol + energy drink (250 ml) and alcohol + cola (180 ml). Pictures of standard serving sizes were shown, including the corresponding amount of the beverage in ml, and participants were instructed to adjust their counting if they consumed other serving sizes than shown. Standard serving sizes and corresponding caffeine content were taken from the caffeine information of the Dutch Food Center (www.voedingscentrum.nl), a public source on food for Dutch consumers. Cappuccino was not listed, but participants were instructed to count a cup of cappuccino as a cup of filter coffee. Past 24-h caffeine consumption was calculated, both in mg/day as well as mg/kg body weight/day. Total caffeine consumption was computed for past 24-h caffeine consumers only. The relative contribution of the different caffeinated beverages to total caffeine intake was also computed. Other sources of caffeine than beverages (e.g., food) were not considered in this survey, as previous nationally representative surveys pointed out that the contribution of these sources to total daily caffeine intake is usually less than 5%–10% (EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies), 2015).

In a subsequent question, participants were asked to rank the caffeine content of these beverages from lowest (1) to highest (7). The beverages included tea (30 mg), energy drink (80 mg), filter coffee (85 mg), instant coffee (60 mg), espresso (65 mg), Starbucks coffee (≥160 mg), cola (18 mg) and chocolate milk (4 mg). The average caffeine rankings were calculated and compared with the actual rankings.

In the next question it was explained that EFSA concludes that for healthy adults 400 mg of caffeine per day does not raise any safety concerns. Participants were asked to indicate how many standard servings of filter coffee, energy drink or cola equals 400 mg caffeine. This question allowed calculation of the perceived amount of caffeine of a standard serving of coffee, energy drink, and cola, and to compare these with the actual caffeine content of these beverages.

Finally, participants were informed about the fact that only few caffeinated beverage products currently disclose their caffeine content on the package. It was asked whether participants felt it was necessary that every caffeine containing product should label its caffeine content. Participants could answer either ‘yes’ or ‘no’, and space was provided to add any comments.

3. Results

N = 800 participants were invited to complete the survey. Data from N = 43 participants were excluded, because they were either incomplete, unreliable, or outside the predefined age range of 18–30 years old. Data from N = 757 participants were included in the statistical analyses. The sample included N = 253 (33.4%) men and N = 504 (66.6%) women, reflecting the current Utrecht student population. Their mean (SD) age was 20.5 (2.1) years.

Surveys were completed on Tuesdays and Wednesdays. Hence past 24-h caffeine intake concerned week days (i.e. Monday and Tuesday). The majority of participants (87.8%) had consumed caffeinated beverages during the past 24 h. Mean ± SD past 24-h caffeine intake was 144.2 ± 169.5 mg (2.2 ± 3.0 mg/kg bw). No significant differences were found between men and women. Most prevalent sources of caffeine were coffee beverages (73.3 mg) and tea (50.2 mg), followed by energy drink (13.3 mg), cola (6.8 mg) and chocolate milk (0.7 mg). The relative contribution to total caffeine intake of these beverages is depicted in Fig. 1.

Participants ranked the relative caffeine content of standard servings of tea, energy drink, filter coffee, cola, chocolate milk, espresso, Starbucks coffee and instant coffee. The results are shown in Fig. 2.

Fig. 2 demonstrates that participants wrongly assume that energy drinks have the highest caffeine content, whereas the drink with the actually highest caffeine content (Starbucks coffee) received only a middle-ranking among the beverages. Although the caffeine content of Starbucks Coffee (160 mg caffeine for Short, 236 ml, up to 400 mg of caffeine for Venti, 591 ml) is two to five times higher when compared to energy drink (250 ml, 80 mg caffeine), 81.6% of participants stated that the caffeine content of energy drink was higher.

The discrepancy between perceived and actual caffeine content was also clear from the participants’ answer to the question of how many standard servings of filter coffee, energy drinks or cola equals 400 mg of caffeine. Participants reported that according to them 400 mg caffeine equates to a mean (SD) of 4.8 (3.3) cups of filter coffee, 2.8 (2.9) cans of energy drink, and 7.4 (7.0) glasses of cola. However, the actual amount of servings to equate 400 mg caffeine are 4.7 cups of filter coffee, 5.0 cans of energy drink, and 22.2 glasses of cola. Fig. 3 illustrates the discrepancy in actual and perceived caffeine content of energy drink and cola, when expressed in mg caffeine per serving.

Fig. 3 illustrates that participants overestimate the caffeine content of energy drinks and cola. Whereas filter coffee and energy drinks contain approximately the same amount of caffeine per serving, participants perceive that the caffeine content of energy drinks is approximately 1.7 times higher than that of a cup of coffee. The caffeine content of a typical 250 ml can of energy drink is rated about 1.7 times higher than its actual caffeine content (142.9 mg versus 80 mg, respectively), and the caffeine content of a glass of cola is perceived three times higher than its actual content (54.1 mg versus 18.0 mg, respectively). Only 13.6% of participants correctly identified that a cup of coffee contains more caffeine than a can of energy drink. All differences between perceived and actual caffeine content were statistically significant ($p < 0.001$). Perceived caffeine content was significantly ($p < 0.05$) higher when rated by women when compared to men for filter coffee (90.9 mg versus 72.7 mg, respectively), cola (61.5 mg versus 43.0 mg, respectively), and energy drink (160.0 mg versus 125.0 mg, respectively).

Finally, the vast majority of participants (85.5%) agreed with the statement that caffeine content should be labeled on any type of caffeine containing product.

4. Discussion

The main finding of our study is that participants have little knowledge of the relative caffeine content of caffeinated beverages. For example, 86.4% of participants stated that a typical energy drink (250 ml, 80 mg caffeine) contains more caffeine than a cup of filter

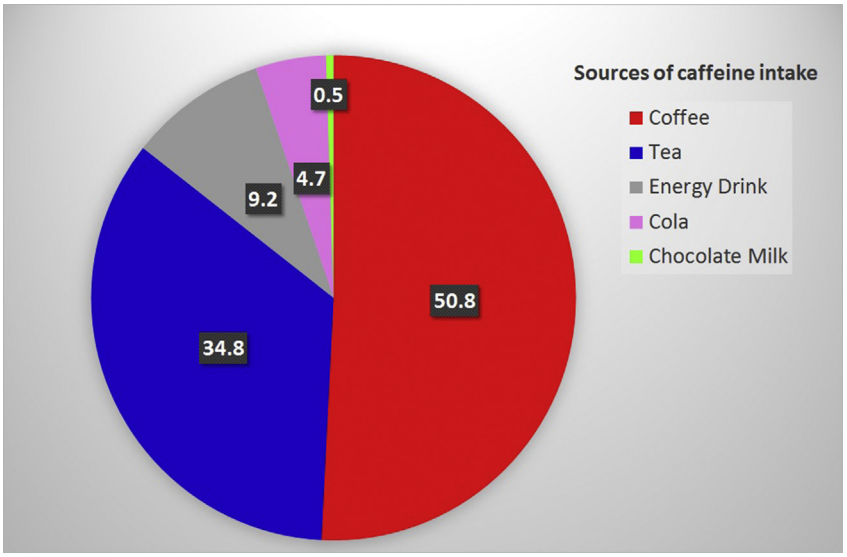

Fig. 1. Sources of caffeine intake. Relative contribution (%) to total past 24-h caffeine intake from beverages is shown.

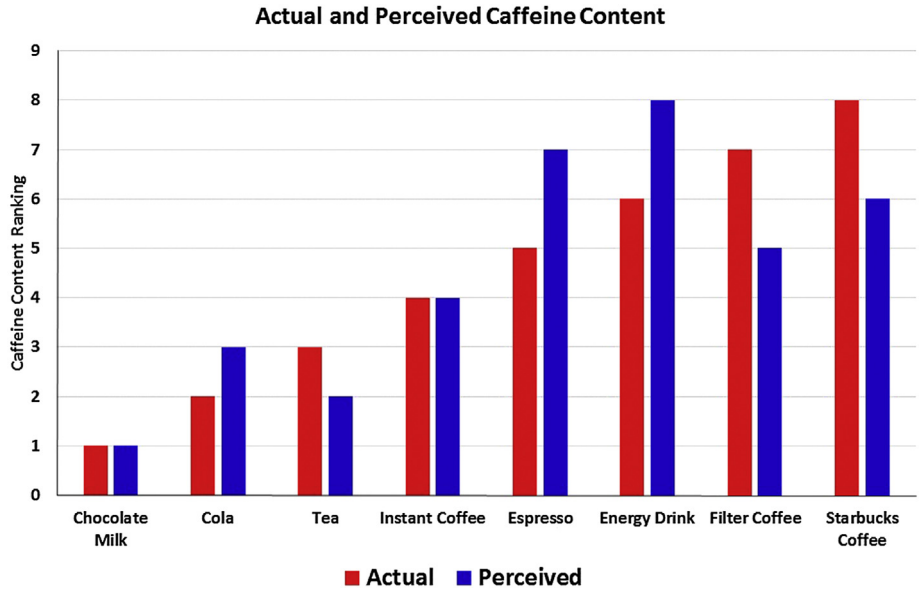

Fig. 2. Actual and perceived caffeine content. Participants rated 8 beverages from lowest (1) to highest (8) caffeine content per standard serving.

coffee (125 ml, 85 mg caffeine). Given that coffee is the most common source of daily caffeine intake, this lack of knowledge is an interesting finding.

In our student sample, the average past 24-h caffeine intake of the current sample was below the recommendations of EFSA and Health Canada (400 mg per day for adults). The observed mean past 24-h caffeine intake of 144.2 mg corresponds to that seen on average in nationally representative European surveys who examined this age group (EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies), 2015). In line with previous research (e.g., EFSA NDA Panel (EFSA Panel on Dietetic Products, Nutrition and Allergies), 2015; Verster, 2014), most caffeine comes from coffee beverages and tea: taken together these two beverages contribute to 85.6% of past 24-h caffeine intake. It should be taken into account however that our data concerns a convenience sample of students whereas the studies covered in the EFSA report are nationally representative surveys. Therefore, an in depth comparison with these surveys is not warranted. Although on average our findings match with observations for this age group in the general European population, it is also important to note that there are considerable differences in caffeine intake and its sources between European countries.

There are several limitations of this study that need to be addressed. First of all, this was a convenience sample of Dutch students. Therefore, it is not known whether these results are representative for the general Dutch population. On the other hand, it can be argued that students receive a relatively high level of education compared to the population average. From that perspective, it is feasible that, if already highly educated individuals are unaware of caffeine content of caffeinated beverages, it is likely that the outcome among the general population can be expected to be even more explicit. Second, as in all survey research there may be the issue of recall bias, i.e. under- or over reporting of beverage consumption. In this survey, the influence of recall bias seems

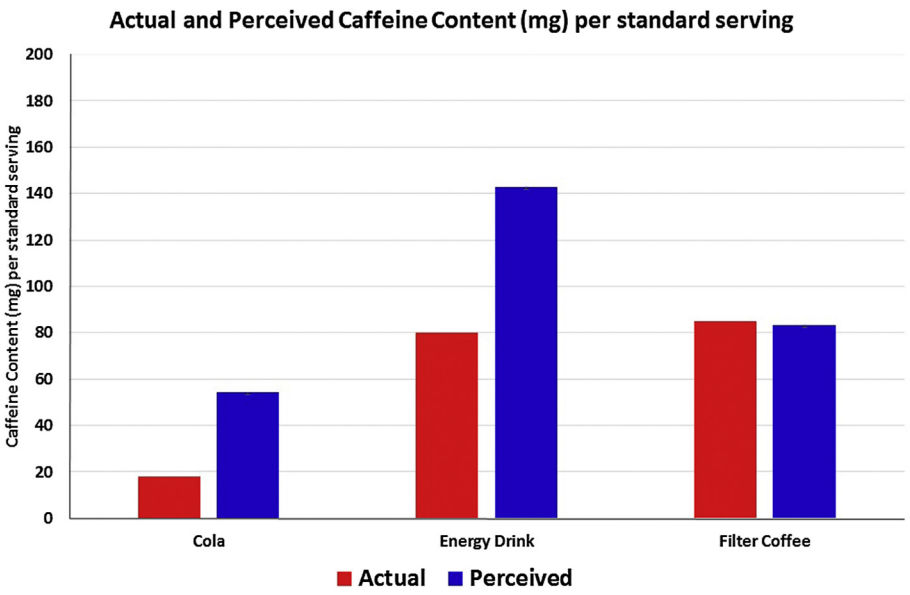

Fig. 3. Actual and perceived caffeine content (mg) per standard serving. Actual caffeine content per serving size for cola (18 mg), filter coffee (85 mg) and energy drink (80 mg) were taken from www.voedingscentrum.nl.

limited as recall was limited to the past 24 h. Previous assessments of caffeine consumption of national representative surveys also successfully used a 24-h recall period, which seems less prone to recall bias than using longer periods of time. However, it can be questioned whether the past 24 h is a true reflection of an "average" day. In this survey, all data referred to week day caffeine consumption. It may be that some caffeinated drinks may be more or less often consumed on weekend days when compared to week days. Therefore, the daily amount caffeine consumed in the current sample, although in line with recent findings reported by EFSA, should be interpreted with caution as (a) this is not a national representative sample, and (b) caffeine consumption on weekend days was not assessed.

It is also important to note that the caffeine content of beverages we used for the calculations are averages, and may differ between brand types of the same product. For the calculation of the amount of caffeine contributed by alcohol mixed with energy drink a conservative approach was used, assuming that consumers drank the full depicted 250 ml can of energy drink (equating to 80 mg caffeine). In practice, however, consumers may have used less than the full can to mix with alcohol. In that case, the amount of consumed caffeine via alcohol mixed with energy drink is less.

Notwithstanding these limitations, the data clearly suggest that Dutch students do not have good knowledge of the caffeine content of various caffeinated beverages. This lack of awareness may be caused by the fact that not all caffeine containing beverages have to label their caffeine content. When participants were asked to rank the relative caffeine content of beverages, they overestimated the relative caffeine content of cola and energy drinks, and underestimated the caffeine content of filter coffee, Starbucks coffee and espresso. Labels of products naturally containing caffeine such as coffee and tea often do not state the caffeine content of the product, while beverages with added caffeine such as energy drinks have to. Although many coffee products contain higher amounts of caffeine when compared with energy drinks, the current study actually suggests that participants generally think the opposite is true.

Popular coffee beverages may contain multiple amounts of caffeine (e.g., Starbucks coffee ranges from 160 mg (Short, 236 ml) to 400 mg of caffeine (Venti, 591 ml) per serving) versus 80 mg caffeine for a typical can of energy drink (250 ml). The current study also revealed a lack of awareness among Dutch students of the relative caffeine content of filter coffee versus energy drinks, as on average they reported a standard serving of energy drink to contain 1.7 times more caffeine than a cup of filter coffee.

On the other hand, participates were accurate when asked directly about estimating the caffeine content of filter coffee. This observation does not provide support that participants lack awareness of caffeine content because it is not labeled. Moreover, research has shown that simply labeling nutrients on products may not be sufficient to change consumption patterns (Sacks, Rayner, & Swinburn, 2009, Sacks, Tikellis, Millar, & Swinburn, 2011). However, creating more awareness by education consumers (for example via the label or advertisement) showed to be effective in producing behavioral change. For example, using a label that also indicates the quality of food via a shelf-label 3-tiered star icon led to shifts in US supermarket sales towards healthier products (Sutherland, Kaley, & Fischer, 2010). These findings suggest that labeling caffeine content on all caffeinated beverages is a first and essential step to create awareness among consumers and may help them to adhere to the guidelines postulated by EFSA or Health Canada.

Overall, it is important to inform consumers about the caffeine content of all caffeine containing beverages, including coffee and tea. In the current survey, more than 85% of participants support this idea.

Declaration of interest

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Unilever, and Wrigley. The other authors have no potential conflicts of interest to disclose.

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