Author's response to reviews

Title: Australian children's consumption of caffeinated, formulated beverages: a cross-sectional analysis

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Author's response to reviews: see over
To whom it may concern,
Thank you for reviewing our manuscript and providing your feedback and providing us with the opportunity to improve the quality of our paper.
Comments and proposed revisions are detailed below, and changes have been made within the manuscript.
With thanks,
Kelsey Beckford

Reviewer 1: Rosanna Watowicz

Major Compulsory Revisions

1. **After reading the introduction, I’m not sure I’m convinced of the dangers of caffeine intake in children based on the information presented. There was one study that showed increased anxiety and one that shows potential for increased blood pressure in adolescent males. I’m not familiar with the negative consequences of caffeine intake in children, but I expected them to be more severe, especially if consumed in excess. The reader needs to be able to see very clearly why caffeine intake is important to study.**

   The background and discussion sections have been refocused to clarify the goal of this research. This work was primarily interested in the consumption of caffeine as an additive in beverages because of its potential role in increasing the consumption of energy-rich nutrient poor formulated drinks. Aside from the caffeine content, these formulated beverages have been linked with various adverse health outcomes, including overweight and obesity. Therefore, by identifying current consumption patterns we can provide both baseline data for monitoring changes in consumption of caffeinated formulated beverages and increase our understanding of the intake of caffeine as a food additive.

2. **For 24-hr recall data (lines 134-142), I would like to see a citation that shows the validity of the 3-pass approach.**

   The use of a 3-pass dietary recall methodology is a standardised procedure used in Australian and New Zealand national nutrition surveys. The following has been added
to this section:

LINES 126-128: “The three-pass dietary recall method is a standardised procedure used in Australian and New Zealand national nutrition surveys, including a national survey of New Zealand schoolchildren 5-14 years of age[1].”

Also, a citation for the AUSNUT2007 database would be helpful so that the reader can see how that was developed.

The following has been added to the manuscript (Line 131), reference 33: Food Standards Australia New Zealand (2008): AUSNUT 2007—Australian Food, Supplement and Nutrient Database for Estimation of Population Nutrient Intakes. Canberra: Food Standards Australia New Zealand.


3. The second paragraph in the beverage classification section needs some additional clarity (lines 165-186. Why were soft drinks singled out? Are they the only type of drink that was considered to possibly contain added caffeine? Why not classify beverages by caffeinated versus uncaffeinated? Line 172: excluded from the definition of what? CFBs?

In Australia and New Zealand, cola-type beverages and energy drinks (encompassed within the CFB definition) are the only beverages permitted to have caffeine added to them within the Food Standards Code, this is specified in the introduction lines XX. The focus of this work was specifically on beverages where caffeine has been included as an additive, not beverages which contain naturally present caffeine. Therefore, beverages in which caffeine occurs naturally were not included within the definition of caffeinated, formulated beverages (CFBs). To clarify this the methods section has been modified:

LINES 155-159: “CFBs were defined as formulated beverages to which caffeine has been added as an ingredient in accordance with the FSANZ Food Standards Code, which restricts caffeine’s use as an additive to cola based beverages and energy drinks[2, 3]. Beverages in which caffeine occurs naturally (e.g. tea, coffee, chocolate beverages) were excluded from the CFB definition.”
**Description of using the 8 digit code in lines 172-176 is unclear to me.**

The 8-digit food coding system was developed specifically for the Australian National Nutrition Survey[4], by Food Standards Australia New Zealand. For clarity and acknowledgment that international readers may not be familiar with the details of Australian food composition database we have removed reference to food group numbering system and instead focused on food group names. This section has been simplified using plain language to describe this process.

**LINES 146-153:** “The CNPAS food group coding system[31] was used to classify beverage items consumed during the survey. All food items consumed on the day of the survey were assigned an eight-digit food code, which linked each food item to nutrient information within the AUSNUT2007 nutrient composition database[36]. More details on the development of these codes can be found in the AUSNUT 2007 explanatory notes[37].

Soft drinks were defined as all beverages, including caffeinated and non-caffeinated, falling within the “soft drinks and flavoured mineral waters” and “electrolyte, energy and fortified drinks food code categories.”

**Was the same process used for calculating caffeine from food?**

Total caffeine from all beverages was determined, and deducted from total caffeine intake.

The following has been added to:

**LINES 164-167:** “Daily caffeine contribution from all beverage sources was determined by aggregating the amount of caffeine consumed from beverages within the “non-alcoholic beverages” food group. This amount was then deducted from total daily caffeine intake from all sources, to determine caffeine intake from food sources.”

And the following to:

**LINES 216-219** “The majority of caffeine was consumed through beverages (81%) and the remainder (19%) from food sources (Figure. 1). A brief examination of the AUSNUT2007 database revealed that food sources of caffeine included items such as baked products containing chocolate or cocoa powder.”
4. **In line 185: is “intense sweetened” a standard term meaning artificially sweetened? American readers may need clarification.**

“Intense sweetened” is the term used within the AUSNUT2007 database, to define artificially sweetened beverages. The term artificially sweetened is not fully representative of the current ranges of intense sweeteners used. To make this clearer a reference to the database and examples from the database have been added.

LINES 170-175 “The AUSNUT2007 database was used to define beverages as artificially-sweetened (AS) if labelled ‘intense sweetened’, for example “soft drink, cola flavour, intense sweetened”, which includes beverages marketed as ‘sugar-free’ such as coca-cola zero or pepsi max. If this was not specifically defined within the database, for instance “soft drink, cola flavour”, the beverages were assumed to be sugar sweetened (SS), and labelled as such[34].”

5. **Table 1, all of the percentages (which you state are weighted percentages) seem to exactly match the unweighted percentages. Is this just a coincidence? Please double check that percentages are weighted.**

All descriptive statistics have been re-run with the correct weightings and shown to be correct, any matches are purely coincidental.

6. **Please explain how the age categories in Table 1 were chosen**

These age categories correspond to the age groups used in the sample design and selection for the Australian Children’s National Nutrition and Physical Activity Survey(CNPAS), from which the data for this study was taken, and correspond to the age categories referred to in our Nutrient Reference Values[5].

7. **Data are presented as consumers of CFB and non-consumers of CFB. But if caffeine is dangerous, why do we care where it comes from (i.e. naturally occurring versus formulated). Does naturally occurring caffeine not have the same affect as formulated caffeine.**

Beverages to which caffeine is commonly added (CFBs) are often energy rich and nutrient poor and the addictive nature of caffeine may further promote the consumption of CFBs. Through restructuring the background and discussion sections we
have clarified the goals of this research.

8. **Lines 223-226: Stated that 81% of caffeine was consumed through beverages, but only 34% was from CFBs. So is the rest from caffeine that is naturally occurring in beverages?**

   The breakdown of sources of caffeine in all participants is highlighted in the new Figure 1: Dietary sources of caffeine in Australian children aged 2-16 years: Total population (n=4,487) (LINE 217).

9. **Tables 4 and 5, lines 246-247: is g/day of CFBs the best way to measure this? It seems like there is an assumption that mg caffeine per g CFB is stable across beverages. Isn’t it possible that children could drink similar grams of CFB, but the caffeine content could vary? If we are interested in caffeine intake, then why not compare mg caffeine intake across SES and day of the week (and age groups) instead of comparing grams of CFB?**

   The caffeine content of each CFB was calculated based on analytical data within the AUSNUT database specific for that beverage, no assumptions of caffeine content were made. Thus if the children did consume CFB of differing caffeine contents this would be
measured in the AUSNUT database and captured within this calculation. The use of g/day also corresponds with our main outcome of the paper, to provide baseline data for tracking CFB consumption over time. These units may also provide the opportunity for data from this study to be compared with data from future studies, in order to effectively track consumption over time.

The change in the focus of the paper to the potential for caffeine to increase the consumption of unhealthy beverages such as SSBs, as opposed to the adverse health effects of caffeine itself, helps clarify the purpose of looking at CFB consumption in grams per day across various demographic factors.

10. **Lines 304-306: These recommendations seem important, and should probably be included in the introduction.**

These recommendations have been included in the restructured background section, along with a brief comment that there are currently no health-based guidelines for recommended daily intake of caffeine.

*LINES 70-78: “Currently there are no recognised health-based guidance values on recommended daily intake values for caffeine in Australia and New Zealand, however a recent review by the FSANZ caffeine expert working group found that doses of caffeine at approximately 3mg per kilogram of bodyweight led to increased anxiety levels in children[6]. This is similar to recommendations made by Health Canada that children under twelve years of age should not consume more than 2.5mg per kilogram of bodyweight[7]. Using the current Australian National Health and Medical Research Council’s reference ranges for bodyweight[5], this would equate to approximately 39-171 mg of caffeine for 2-16 year olds.”*

*Since the mean mg caffeine intake falls well within this recommended range, I would be interested in seeing what proportion of children were above the recommendation. I expect that this can be done since you have body weight for each child and therefore should be able to calculate the recommended intake for each child. Interpretation of these data may be different if most children within a particular category (i.e. SES, age, weight) are within the recommendation.*

This data has been calculated and added to the last row of Table 1:
| Total Caffeine intake (mg/kg)<sup>d</sup> | Mean (95% CI) |  
|---|---|---|
| 0.43 (0.39–0.46) | 1.33 (1.20-1.45) | 0.27 (0.25-0.30) |

<sup>d</sup><sup>mg/kg bodyweight of participant</sup>

These intakes have also been included in the discussion:

LINES 291-300: “Although the total caffeine intakes observed within the current study are below recommended intake levels per kilogram of bodyweight[2], these data represent intakes from 2007. Changes in formulated beverage production and marketing have occurred since this time, with a wider variety of CFBs available within the Australian market and an increase in portion sizes also evident[9]. Therefore, it is important that the consumption of CFBs continue to be monitored to ensure that the practice of adding caffeine to commonly consumed beverages available to children and adolescents does not put them at risk of exceeding these recommendations. The results from this study provide important baseline data for tracking changes in consumption over time. By monitoring consumption patterns over time, potential areas for intervention can also be identified.”

The main focus of this study was to examine CFB intake within this population, not overall caffeine intake. As such an examination of total caffeine intakes across various demographic factors was not conducted.

**If most children were within the recommended range, then why would we need to intervene?**

The following section of the restructured background describes why we are interested in caffeine consumption of Australian children, specifically from formulated beverages LINES 79-84: “Studies from the UK, US and Canada in children and adolescents have shown that formulated beverages are the most commonly consumed form of caffeine amongst children and adolescents [14-16]. This is concerning as these beverage are often high in sugar, energy-rich, and nutrient poor[17], have been linked with adverse health outcomes in children and adolescents including dental caries[18], bone health[19], and in the case of SSBs, overweight and obesity[20-23].”
11. **Lines 307-311: this is a tough argument to swallow. If you are arguing that current intakes may be very different from intakes in 2007, then why this study is important? I think you can address the fact that consumption patterns may have changed since 2007, but the way it is presented here makes it sound like we should ignore all of the results in this paper.**

As mentioned above, the discussion has been modified to make it clearer that these data provide baseline information, which can be used to track consumption over time.

12. **Line 316: earlier in the paper you seem to argue that there are known negative consequences of caffeine consumption. Here it seems like we don’t really know what the consequences are.**

This has been removed to correspond with the restructuring of the background and discussion.

13. **Lines 345-347: wouldn’t the weighted data account for this sampling bias?**

The sample weights incorporated into the database were based on “age, gender, and region”, SES was not defined during the survey, rather within the current analysis participants were grouped based on the primary parent/caregivers’ highest level of education. Therefore, the sample weighting applied during statistical analysis may not properly account for the higher level of SES, as defined by the primary parent/caregivers’ highest level of education, observed within the CNPAS population.

The following is an excerpt from the CNPAS user guide, describing the sample weights:

“Family size and structure were unlikely to be major influences on nutritional variables and so it was decided to weight only on age, gender and region. This leaves potential biases due to family size and structure. Data from the ABS, based on the 2006 Census, on household size by Postal Area by State by Capital/Rest-of-State were used to estimate the population numbers. Data from the survey were used to estimate the sample numbers and hence the weights for each individual child. The ABS data obtained for determining the weights consisted of a table of number of households by number of children of each sex.”[8]
14. **Lines 356-358: what does age have to do with misclassification of meal times?**

As the meal times were not participant defined, the beverages could have been incorrectly classified into the wrong meal time. For example, children under 5 years may have meal times earlier than the traditional times used in the current study, and older adolescents may have consumed CFBs after dinner as a snack. However, the broad ‘meal times’ used in this current study would consider the beverage to be consumed with dinner, resulting in a misclassification of the beverage. To make it clearer the following has been added:

LINES 333-335: “Due to the wide age range of participants within the survey and the lack of participant defined meal times, some misclassification of meal times may have occurred and consumption patterns reported across meal time may have been incorrectly estimated.”

15. **Not convinced that seasonality is addressed, what about the other 6 months?**

The description of seasonality as a limitation has been adjusted to read:

LINES 328-332: “Data for this study was collected over a six-month period from February to August, encompassing three different seasons. In Australia this covers summer, autumn and winter. Although this minimises the possible effect of seasonality on results, it should be noted that seasonal variation may influence fluid consumption and this may limit the results of this study.”

**Minor Essential Revisions**

1. **Line 63: I believe this should be 145mg/L instead of 145mg/kg**

   According to the Australia New Zealand Food Standards Code: “In cola-type drinks, the total caffeine content must not exceed 145mg/kg in the drink as consumed. The maximum permitted levels of caffeine in energy drinks is 320mg/L”[6]

2. **Line 80, I think the term “negative impact” here is intended to mean “undesirable”, however it could be interpreted as meaning “decreased”. For clarity, suggest changing lines 79-80 to say something like “…caffeine consumption was related to increased cognitive and physical performance as well as increased anxiety levels”**.
This study has been removed in the restructuring of the background.

3. **Line 113- data were**  
   This has been corrected

4. **Lines 139-140, what about children who were 9 years old?**  
   This has been corrected:  
   LINES 125-126: “The 24-hour dietary recall was conducted with the primary caregiver of participants aged <9 years and with the study child in participants aged 9 years and over[28]”

5. **Line 240: better to avoid the word “increased” when presenting cross-sectional data since we cannot assess longitudinal change over time**  
   This sentence has been revised:  
   LINES 233-235: “older children were found to have significantly higher intakes of CFB, compared to younger children (P<0.001).”

6. **Table 2: unclear what “Proportion of soft drink caffeinated” refers to. Is this the proportion of caffeine from soft drinks? The proportion of CFBs that are soft drinks? Something else?**  
   The description in the tables has been modified to:  
   “Proportion of total soft drink as CFB”

7. **Line 310: reference missing**  
   This has been removed in the restructuring of the discussion.

8. **Lines 311-315: sentence repeated**  
   Duplicate sentence deleted

9. **Figure 1: two labels are shown on the Y axis**  
   This has been corrected
Discretionary Revisions

1. **Unsure about the term caffeinated-formulated. I think the grammatically correct phrase would be ‘caffeinated, formulated beverages’. Or maybe ‘formulated beverage with added caffeine’**.

   Thank you for this suggestion. We have changed the term to “Caffeinated, formulated beverages”.

2. **Line 55-56: suggest changing to “caffeine is sometimes added to formulated beverages”**.

   Text has been modified.

3. **Lines 55-57: is caffeine only used as a flavoring agent, not as a stimulant? Again in lines 89-90, somewhat unclear here. Do manufacturers claim that caffeine is added only as a flavoring agent?**

   This has been addressed in the restructuring of the focus of the background.

   The following adjustment has been made:

   LINES 84-87: “Manufacturers claim that caffeine is added to formulated beverages, including ASBs and SSBs, as a flavouring agent[24]. This has been questioned by researchers, who have determined that most consumers are unable to detect caffeine in beverages on the basis of taste[17, 25].”

4. **Instead of the term “place of residence”, consider “home”, may improve readability**

   The term “place of residence” has been used to encompass all places of residences, not only the child’s home. During the survey, two of the options for location of consumption were “home” and “any other residence”, which could include the residence of a friend or family members not residing with the child. For ease of use during statistical analysis these were collapsed into one variable “place of residence”.

   The description has been adjusted in the methods section, to make it clearer what this encompasses.

   LINES: 140-142: “Location of consumption was defined by the participant during the 24 hour recall as either: i) place of residence: incorporating “home” and “other residence”, for example a family member or friend’s home.”
Major Compulsory Revisions

1. **Results section: p. 10, lines 211-218:** The proportion of children/adolescents reporting caffeine consumption seems low at only 15%. A recent US study reported approximately 75% of children and adolescents reported caffeine consumption on any given day (Branum et al, 2014). Although the results are from two different countries, the discrepancy seems greater than what might be expected. Can the Authors give any reasons why overall caffeine consumption may be relatively low among Australian youth?

   These data refer to fifteen percent of participants who were classified as **CFB consumers**, and as such only reflect the consumption of beverages containing caffeine as an additive, not all caffeinated beverages. When looking at consumption from all sources, 78% of the population consumed caffeine on the day of the survey, these data have been added to the participant characteristics section of the results.

   **LINES 202-203:** “Overall, 78% of consumers reported consuming caffeine on the day of the survey (data not shown), with 15% of participants classified as CFB consumers.”

   In addition we have clarified in the background that the focus of this work was beverages that contain added caffeine, not naturally present caffeine.

2. **Results regarding mean caffeine consumption:** I believe that the Authors have an error in their mean caffeine intake calculations which needs to be addressed. In Table 1, a mean intake of 61 mg/day among consumers is presented which is in keeping with previous studies. However, a similar mean intake is presented, now in g/day, among all children (64 “g/day”). Aside from the mg to g issue, this mean intake is not consistent with the information presented in Table 1 where a mean intake of 11 mg/day for the entire sample is presented. Furthermore, the means presented in Tables 3-5, even if presented in mg/day instead of g/day, are not consistent with Table 1 and seem excessively high. A 12 ounce can of soda contains 130 mg of caffeine so a mean intake of 555 mg per day is the equivalent of drinking over 4 cans of soda per day. This type of value seems like an outlier, rather than a mean, even if the distribution of intake is heavily skewed. The Authors need to double check these results and make sure the units of measurement are consistent/plausible.
The value of 61mg/day in table one refers to total caffeine intake, from all food and beverage sources, whereas in table 2, 64g/day refers to the amount of CFBs consumed, not caffeine. In table 1, 11mg/day refers to the mean caffeine intakes of children who did not report consuming a CFB on the day of the survey (CFB non-consumer) and represents the amount of caffeine consumed naturally, not from beverages containing caffeine as an additive. Data in tables 2-5 refer to CFB (beverage) intake in g/day, not caffeine intake. The variable “proportion of caffeine from CFB” values, describe the contribution of CFBs to overall caffeine intakes, as a proportion (%). Therefore, the 555g value in Table 3 describes the mean intake of CFB consumed by 14-16 year olds on the day of the survey, in g/day.

3. **Figure 2: Is it possible for the Authors to break down CFB by type in this figure? Since non-energy drinks account for the overwhelming majority of CFB consumed, it may be more helpful to see the individual types of CFB (e.g., soda, tea, etc.) in this figure.**

Figure 1: Dietary sources of caffeine in Australian children aged 2-16 years: Total population (n=4,487) has been added to the results section. This figure breaks down the main sources of caffeine by food sources in all participants, and is discussed in lines 216-217:

“The majority of caffeine was consumed through beverages (81%) and the remainder (19%) from food sources (Figure. 1).”

References:
