

PEER REVIEW HISTORY

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ARTICLE DETAILS

TITLE (PROVISIONAL)	Use Pattern and Predictors of Use of Highly Caffeinated Energy Drinks among South Korean Adolescents: a study using the Health Belief Model
AUTHORS	Ha, Dongmun; Song, Inmyung; Jang, Gyeongil; Lee, Eui-Kyung; Shin, Ju-Young

VERSION 1 – REVIEW

REVIEWER	Andreas G. Franke University of Neubrandenburg, Germany There are no competing interests.
REVIEW RETURNED	15-Apr-2017

GENERAL COMMENTS	<p>Content of the study: The study informs the readers of the important and international open access journal about the use of caffeinated substances among Korean subjects.</p> <p>Objectives: According to the authors, there is growing concern about the (ab)use of “highly” caffeinated energy drinks among Korean adolescents and compared adolescents’ perceptions regarding the use of these caffeinated drinks to their pattern of use behaviours and try to identify factors associated with the respective use. To answer these questions, the authors developed a questionnaire with respective questions and used the Health Belief Model. They asked nearly 1,000 adolescents of the Bucheon in South Korea. Using adequate statistic models, the authors present results of 830 adolescents having a response rate of nearly 100% respectively (!). Nearly 2/3 reported the use of energy drinks (ED). Furthermore, they present odds ratios of divergent factors (see results section). The authors conclude, that presenting and explaining, presenting risks of ED use should influence the use of such drinks. The authors begin their study with presenting strengths and limitations of their study admitting. The most important limiting factor may be the missing representative character of the data. Furthermore, they did not identify data about cola drinks and other caffeinated drinks. However, they state to assess only highly caffeinated drinks and define therefore the use of cola drinks etc. not be studied.</p> <p>In general, the data are presented in an intelligible fashion. Sections are subdivided very well allowing a constructive data presentation. Descriptive statistics are appropriate. Furthermore, some tables and one illustration are used to illustrate the presented results.</p>
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	<p>There are only some aspects which should be addressed for the reader:</p> <ul style="list-style-type: none"> • The introduction section presents interesting facts about ED use. However, the authors should refer to the international situation of caffeinated drink use in the US as well as in Europe. Therefore, they should orientate the study of the literature regarding international studies e.g. Franke et al. among surgeons (Ann Surg), Dietz et al. among “managers” (Front Psych), etc. Lots of studies are missing to be cited. The authors should introduce the reader to more important studies about ED use for example by using the above mentioned studies (and beyond). • Introduction: Please try to define “overuse”. What is meant to be “much”, “too much”, “overuse”, etc. Please specify. • The effects and side effects of ED use should be compared to information of caffeinated prescription drugs. Even in the discussion section this comparison should be made. • A comparison between caffeinated drinks in general (e.g. cola drinks) and caffeinated tablets could be an interesting aspect which should be introduced/ discussed in the discussion section. • The results are presented adequately; standard values are given in an appropriate way. Tables are added to show and to underline/ explain results. • Discussion section: The reviewer wants to encourage the authors to find more comparable international studies. Especially studies of Franke, Lieb, Dietz (Germany) and other authors of Switzerland and other countries should be used for comparison, esp. regarding prevalence rates and motives of ED use. • Discussion section: It would be great to find something about the risk of addiction in the discussion section. Is caffeine addictive (see older studies in the Am J Psych, etc.). Maybe, this point could be strengthened in the discussion section.
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REVIEWER	Emma Childs University of Illinois at Chicago, USA
REVIEW RETURNED	30-May-2017

GENERAL COMMENTS	<p>The study aimed to assess predictors of energy drink consumption among adolescents in South Korea. Study participants completed a survey that obtained information on demographics, use of energy drinks, and health beliefs. The authors report that beliefs regarding harm and benefits of energy drink use were the strongest predictors of use and increased the likelihood of use by a factor of approximately 2-4.5.</p> <p>Overall the study is interesting and reports novel data regarding predictors of energy drink use. In general the paper would benefit from clarification on the methods and stating the results more clearly. I have some comments to strengthen the paper’s impact.</p> <p>1) The authors should introduce the Health Belief Model theory earlier in the paper, and use this to formulate their hypotheses which should be stated at the end of the Introduction.</p> <p>2) In general there is a lack of methodological detail.</p> <p>a. Was the survey completed online? How were individuals identified?</p> <p>b. Was the structured questionnaire on HBM a standardized questionnaire? How many questions comprised each factor of the HBM? Were the scores added together or averaged for each factor?</p>
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	<p>c. The authors state that respondents were grouped by grade, stress regarding grades, socioeconomic status and health of parents (page 6, Demographic Factors) but no clear rationale is given for this or the cut-offs (average, below average, above average) for each group.</p> <p>d. It is not clear what statistics were used to test the relationship between the independent variables and current use of highly caffeinated drinks (page 8, Beliefs and Behaviors). Please provide more details and whether these analyses were corrected for multiple comparisons.</p> <p>3) More detail is required for the regression model including the beta values and ANOVA results for each step and the overall model. Maybe the authors could add these to table 5. Also, I think the description of 'cues to act' (page 9, line10) is incorrect. Do the authors mean that, together all of the factors explained 20.2% of the variance?</p> <p>4) The authors should clarify the results for each step of the model. One page 8, the authors simply state that demographic factors explained a significant amount of the variance in use, but they should elaborate on these findings. For example, which demographic factors explained the most variance and what were their influence?</p> <p>5) Relatedly, all of the findings should be stated in the Results section. The authors introduce new results in the Discussion e.g. more males than females used energy drinks use.</p> <p>6) It is interesting that perceptions regarding health benefits and harms were the strongest predictor of use. It is not surprising that benefits were associated with greater use than harms, however knowledge of the harms was associated with higher use than not knowing about the harms (1.86. This suggests that individuals do not perceive the harms as that worrying or not applicable to themselves. The authors should discuss this interesting finding further and its implications.</p> <p>Minor comments: Page 4, line 18 – Please define OECD. Page 4, line 41 – Please add a citation after the statement regarding energy drink use and depression. Page 7, line 55 – What proportion of respondents reported that their parents had a high school degree? The authors simply state 'most' without providing the proportion.</p>
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VERSION 1 – AUTHOR RESPONSE

Reviewer 1

Comment 1. Please state any competing interests or state 'None declared': There are no competing interests.

Response:

We stated 'No conflicts of interest' in the manuscript. Thanks.

Comment 2. The introduction section presents interesting facts about ED use. However, the authors should refer to the international situation of caffeinated drink use in the US as well as in Europe. Therefore, they should orientate the study of the literature regarding international studies e.g. Franke et al. among surgeons (Ann Surg), Dietz et al. among "managers" (Front Psych), etc. Lots of studies

are missing to be cited. The authors should introduce the reader to more important studies about ED use for example by using the above mentioned studies (and beyond).

Response:

Thank you for your thoughtful suggestion. We modified our introduction by referring to the articles of Franke and Dietz.

(page 4, line 2,3 and 5)

Comment 3. Introduction: Please try to define "overuse". What is meant to be "much", "too much", "overuse", etc. Please specify.

Response:

The American Academy of Pediatrics recommends adolescents aged 12 to 18 years old should not consume more than 100 mg of caffeine a day. Most energy drinks contain more than 80 mg of caffeine per can. Some contain as much as 300 mg of caffeine per can. Dariusz et al. (2015) studied the consumption patterns of energy drinks in Poland by defining overuse as daily consumption of energy drinks, too much use as consuming these drinks a few times a week, and much use as consuming these drinks once a week.

(page 5, line 1)

Comment 4. The effects and side effects of ED use should be compared to information of caffeinated prescription drugs. Even in the discussion section this comparison should be made.

Response:

The mechanism of action and effects of caffeine were stated before the description of the side effects of caffeine in the introduction section.

(page 4, line 13)

Comment 5. A comparison between caffeinated drinks in general (e.g. cola drinks) and caffeinated tablets could be an interesting aspect which should be introduced/ discussed in the discussion section.

Response:

The finding of relatively higher consumption of caffeinated drinks than caffeine tablets among German adolescents was discussed in the discussion section.

(page 10, line 15)

Comment 6. The results are presented adequately; standard values are given in an appropriate way. Tables are added to show and to underline/ explain results.

Response:

We appreciate your positive comments. Thanks.

Comment 7. Discussion section: The reviewer wants to encourage the authors to find more comparable international studies. Especially studies of Franke, Lieb, Dietz (Germany) and other authors of Switzerland and other countries should be used for comparison, esp. regarding prevalence rates and motives of ED use.

Response:

As suggested by the reviewer, the prevalence rates of and motives for the use of caffeinated drink use studied in Germany, Switzerland, Poland, and the United States were included in the Discussion.

(page 10, line 15)

Comment 8. Discussion section: It would be great to find something about the risk of addiction in the discussion section. Is caffeine addictive (see older studies in the Am J Psych, etc.). Maybe, this point could be strengthened in the discussion section.

Response:
The c line 18)

Reviewer 2

Please state any competing interests or state 'None declared': None declared.

We stated 'No conflicts of interest' in the manuscript. Thanks.

Comment 1. The authors should introduce the Health Belief Model theory earlier in the paper, and use this to formulate their hypotheses which should be stated at the end of the Introduction.

Response:
Descriptions of the HBM stated in the Method (Conceptual model and measurement) were moved to the end of the Introduction.
(page 5, line 7)

Comment 2. In general there is a lack of methodological detail. A. Was the survey completed online? How were individuals identified?

Response:
The survey was conducted offline. A paper questionnaire were administered to all freshmen and sophomores at three high schools in Bucheon, South Korea. The students were asked to complete the questionnaire themselves and return the completed questionnaires to the survey administrator.
(page 5, line 14)

B. Was the structured questionnaire on HBM a standardized questionnaire? How many questions comprised each factor of the HBM? Were the scores added together or averaged for each factor?

Response:
We developed a questionnaire based on the conceptual framework of the HBM. Each factor of the HBM consists of 2 questions and responses to each question were scored on a 5 point scale.
(page 5, line 23)

C. The authors state that respondents were grouped by grade, stress regarding grades, socioeconomic status and health of parents (page 6, Demographic Factors) but no clear rationale is given for this or the cut-offs (average, below average, above average) for each group.

Response:
For each variable, the average was set based on the respondent's subjective evaluation. The respondent was then asked to select one out of three choices (average, below average, above average).
(page 7, line 1)

D. It is not clear what statistics were used to test the relationship between the independent variables and current use of highly caffeinated drinks (page 8, Beliefs and Behaviors). Please provide more details and whether these analyses were corrected for multiple comparisons.

Response:

Chi-square tests were used to test the relationship between the three variables (perceived health threat, likelihood of action, and cues to act) and current use of highly caffeinated drinks.
(page 7, line 20)

Comment 3. More detail is required for the regression model including the beta values and ANOVA results for each step and the overall model. Maybe the authors could add these to table 5. Also, I think the description of 'cues to act' (page 9, line10) is incorrect. Do the authors mean that, together all of the factors explained 20.2% of the variance?

Response:

We appreciate your thoughtful comments. We conducted logistic regression and thus, the estimated odds ratios were the same as the value of exp (Beta). The beta values, standard error, and wald statistics of chi-square could be added to table 5; however, we think odds ratio with 95% confidence interval would be the most clear indicator to explain our results and achieve our study purpose.

Yes, your comment is correct. We revised the sentence so as to be clearer.
(page 9, line 20)

Comment 4. The authors should clarify the results for each step of the model. One page 8, the authors simply state that demographic factors explained a significant amount of the variance in use, but they should elaborate on these findings. For example, which demographic factors explained the most variance and what were their influence?

Response:

Demographic factors explained 1.5% of the variance in energy drink use ($p < 0.05$); however, all subsequent variables of the demographic factors were not significant.
(page 9, line 12)

Comment 5. Relatedly, all of the findings should be stated in the Results section. The authors introduce new results in the Discussion e.g. more males than females used energy drinks use.

Response:

The statement regarding distribution of highly caffeinated energy drinks between sexes were clarified in the Results section.
(page 8, line 14)

Comment 6. It is interesting that perceptions regarding health benefits and harms were the strongest predictor of use. It is not surprising that benefits were associated with greater use than harms, however knowledge of the harms was associated with higher use than not knowing about the harms (1.86. This suggests that individuals do not perceive the harms as that worrying or not applicable to themselves. The authors should discuss this interesting finding further and its implications.

Response:

As the reviewer advised, adolescents' inadequate perception of the harms of highly caffeinated energy drinks was further discussed.
(page 10, line 5)

Minor comments:

Comment 1. Page 4, line 18 – Please define OECD.

Response:

We provided the full name of OECD as recommended.
(page 4, line 10)

Comment 2. Page 4, line 41 – Please add a citation after the statement regarding energy drink use and depression.

Response:

We added a citation to the statement.
(page 4, line 23)

Comment 3. Page 7, line 55 – What proportion of respondents reported that their parents had a high school degree? The authors simply state ‘most’ without providing the proportion.

Details are noted in the parenthesis. Most of the respondents’ parents had no more than high school degrees (fathers = 36.9%, mothers = 54.0%) or college degrees (fathers = 54.5%, mothers = 40.9%).
(page 8, line 15)

VERSION 2 – REVIEW

REVIEWER	Emma Childs University of Illinois at Chicago USA.
REVIEW RETURNED	10-Jul-2017

GENERAL COMMENTS	<p>The authors have been responsive to my comments. I have a couple of notes regarding the changes and some additional notes on the revised manuscript.</p> <p>1: The authors should introduce the Health Belief Model theory earlier in the paper, and use this to formulate their hypotheses which should be stated at the end of the Introduction.</p> <p>The authors responded that they have moved the descriptions of the HBM to the end of the Introduction. However, the authors need to add more information regarding the model including the factors that it measures and briefly what each of those measures represents. The authors also need to state their hypotheses at the end of the Introduction.</p> <p>2D: It is not clear what statistics were used to test the relationship between the independent variables and current use of highly caffeinated drinks (page 8, Beliefs and Behaviors). Please provide more details and whether these analyses were corrected for multiple comparisons.</p> <p>The authors have added details regarding the analyses but did not clarify whether the analyses were corrected for multiple comparisons. If the analyses were not corrected, the authors should acknowledge this in the Discussion and adjust their conclusions appropriately. It would be useful to include a table of the relationships between all variables and include the appropriate statistics where these relationships are discussed (Results – Beliefs and Behaviors).</p>
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	<p>6: It is interesting that perceptions regarding health benefits and harms were the strongest predictor of use. It is not surprising that benefits were associated with greater use than harms, however knowledge of the harms was associated with higher use than not knowing about the harms (1.86). This suggests that individuals do not perceive the harms as that worrying or not applicable to themselves. The authors should discuss this interesting finding further and its implications.</p> <p>The authors stated that they had further discussed adolescents' inadequate perception of the harms of highly caffeinated energy drinks, however I do not think that the added sentence ("These findings imply that respondents do not perceive the harms as that worrying or that they are not susceptible to the harms..") is adequate. I think the authors need to discuss their findings in much greater detail. Why does knowledge about the harms increase the probability of use i.e., OR = 1.86?</p> <p>Minor Comment 3. Page 7, line 55 – What proportion of respondents reported that their parents had a high school degree? The authors simply state 'most' without providing the proportion.</p> <p>The authors stated that the details are noted in the parenthesis on page 8, line 15. "Most of the respondents' parents had no more than high school degrees (fathers = 36.9%, mothers = 54.0%) or college degrees (fathers = 54.5%, mothers = 40.9%)." However, overall this sentence is confusing and should be rewritten. As I interpret the values in the parentheses, most mothers had high school degrees (54%) and most fathers had college degrees. Thus, most parents had a degree (whether high school or college), and it is confusing to write that most parents had no more than a degree at high school or college level.</p> <p>Additional notes:</p> <ol style="list-style-type: none"> 1) Please change 'abuse' to 'use' in the first sentence of the Abstract. It is not certain that energy drinks are being used inappropriately (defining abuse). 2) Please define 'Likelihood of action' and 'Benefits and Harms' in the Abstract. 3) Strengths and limitations: It is unclear what is meant by "power of the factors". Please clarify. 4) The emphasis on suicide rates in the Introduction is irrelevant unless the authors plan to make a connection between caffeine use and suicide. If the intended point is that adolescents in South Korea are under enormous pressure which might motivate their use of energy drinks, I suggest dropping the final sentence of paragraph 1 and instead stating that point distinctly. 5) Please define the study population in the study by Dariusz et al. Are these definitions for adolescents? 6) Results page 8. Please add the numbers or proportion of males and females that used energy drinks after stating that more males than females used energy drinks. 7)
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VERSION 2 – AUTHOR RESPONSE

Reviewer

Comment:

The authors should introduce the Health Belief Model theory earlier in the paper, and use this to formulate their hypotheses which should be stated at the end of the Introduction.

The authors responded that they have moved the descriptions of the HBM to the end of the Introduction. However, the authors need to add more information regarding the model including the factors that it measures and briefly what each of those measures represents. The authors also need to state their hypotheses at the end of the Introduction.

Response:

Thank you for useful comment. We revised the manuscript to reflect your suggestion that the authors should add more information regarding the model; furthermore, we have now included the factors that it measures and briefly described what each of those measures represents. Specifically, the following text has been added:

The health belief model (HBM) is a commonly employed theoretical model used to explain the relationship between individuals' beliefs and their behaviours in individual areas of health. In order to assist decisions concerning the correct actions to adopt to address certain issues, the model advocates considering 'perceived health threat', 'likelihood of action', and 'cue to action'. Specifically, 'perceived health threat' relates to perceived susceptibility to a particular health problem and the perceived severity of that health problem; 'likelihood of action' is defined as when an individual considers the perceived benefits and barriers associated with certain actions; and 'cue to action' is defined as exposure to commercial advertisements and recommendations from acquaintances that encourage the user to make a behavioural change.

(page 5, line 9)

In regard to your second point, we added a reference at the end of introduction section to the hypothesis set in this study:

Specifically, we hypothesise that adolescents' patterns of use of highly caffeinated energy drinks may be determined using the HBM models' aspects of 'perceived health threat', 'likelihood of action', and 'cues to action'.

(page 5, line 18)

Comment: It is not clear what statistics were used to test the relationship between the independent variables and current use of highly caffeinated drinks (page 8, Beliefs and Behaviors). Please provide more details and whether these analyses were corrected for multiple comparisons.

Response:

The authors have added details regarding the analyses but did not clarify whether the analyses were corrected for multiple comparisons. If the analyses were not corrected, the authors should acknowledge this in the Discussion and adjust their conclusions appropriately. It would be useful to include a table of the relationships between all variables and include the appropriate statistics where these relationships are discussed (Results – Beliefs and Behaviors).

Thank you for your detailed response. All of our analyses were based on a 2 × 2 table relating to users and non-users of highly caffeinated drinks and the positive and negative responses given to each category. Therefore, a multiple comparison method is not applicable to our analyses. We modified the text to clarify this point.

Then, applying a 2 × 2 table, chi-square tests were used to examine the relationship between adolescents' beliefs concerning (positive and negative responses) and current use (whether they were a user or non-user) of highly caffeinated drinks.

(page 8, line 12)

Comment :

It is interesting that perceptions regarding health benefits and harms were the strongest predictor of use. It is not surprising that benefits were associated with greater use than harms, however knowledge of the harms was associated with higher use than not knowing about the harms (1.86). This suggests that individuals do not perceive the harms as that worrying or not applicable to themselves. The authors should discuss this interesting finding further and its implications.

The authors stated that they had further discussed adolescents' inadequate perception of the harms of highly caffeinated energy drinks, however I do not think that the added sentence ("These findings imply that respondents do not perceive the harms as that worrying or that they are not susceptible to the harms..") is adequate. I think the authors need to discuss their findings in much greater detail. Why does knowledge about the harms increase the probability of use i.e., OR = 1.86?

Response:

We appreciate your thoughtful comment. As you indicated, it is natural that the more cognizant an individual is of the benefits of caffeinated drinks, the more likely they are to consume the drinks. Therefore, we agree that the result that a person with knowledge of the harms of such drinks is also more likely to consume them is questionable, although the association between the cognition of harm and consumption of drinks is much smaller than the association between cognition and benefits. We conducted a cross-sectional study based on a survey method to simultaneously investigate the cause (recognition of harms and benefits) and the effect (consumption of caffeinated drinks). As a result of the characteristics of the cross-sectional study, a linear temporal relationship between the cause and the effect remained unclear and, therefore, the odds ratio of 1.86 shown in our study cannot be interpreted as a result of a causal relationship. Thus, the results may represent a case of reverse causality: higher consumers of such drinks are aware of the associated harms. That is, one consumes drinks despite knowledge of the harm, not because of it. We have inserted the following text into the section:

These findings imply that the more cognizant an individual is of the benefits and harms of energy drinks, the more likely they are to consume these drinks. It is natural that knowledge of benefits is associated with a greater use of highly caffeinated energy drinks; however, it is probable that the positive association between the recognition of harms and the use of these drinks represents a case of a reverse causal relationship: in other words, high consumers of these drinks have greater knowledge of their harms.
(page 10, line 25)

Minor comments:

Comment :

Page 7, line 55 – What proportion of respondents reported that their parents had a high school degree? The authors simply state 'most' without providing the proportion.

The authors stated that the details are noted in the parenthesis on page 8, line 15. "Most of the respondents' parents had no more than high school degrees (fathers = 36.9%, mothers = 54.0%) or college degrees (fathers = 54.5%, mothers = 40.9%)." However, overall this sentence is confusing and should be rewritten. As I interpret the values in the parentheses, most mothers had high school degrees (54%) and most fathers had college degrees. Thus, most parents had a degree (whether high school or college), and it is confusing to write that most parents had no more than a degree at high school or college level.

Response:

Considering the reviewer's advice, we rewrote the passage as follows:

Additionally, most of the respondents' parents had college degrees or lower (fathers = 91.4%, mothers = 94.9%).
(page 9, line 9)

Additional notes:

Comment:

Please change 'abuse' to 'use' in the first sentence of the Abstract. It is not certain that energy drinks are being used inappropriately (defining abuse).

Response:

As the reviewer advised, we change 'abuse' to 'use' in the first sentence of the Abstract.

Concerns exist in regard to Korean adolescents' use of highly caffeinated energy drinks.

Comment: Please define 'Likelihood of action' and 'Benefits and Harms' in the Abstract.

Response:

We added definitions of 'likelihood of action' and 'benefits and harms' in the Abstract, and also defined 'likelihood of action' in the Methods section.

Specifically, we defined benefits as the beneficial effects obtained from the use of highly caffeinated energy drinks (e.g., increased alertness), and harms as the adverse effects of such drinks (e.g., cardiac palpitation). Further, we classed likelihood of action as the likelihood that a user, after comparing the benefits and harms of caffeine use, chooses to continue drinking caffeinated drinks because the consequences are perceived to be more beneficial than harmful.
(page 6, line 25)

Comment: Strengths and limitations: It is unclear what is meant by "power of the factors". Please clarify.

Response:

We rewrote the statement to clarify it:

This study measured the explanatory power of each factor influencing the consumption of highly caffeinated energy drinks, and compared these power levels between factors.
(page 3, line 2)

Comment 4: The emphasis on suicide rates in the Introduction is irrelevant unless the authors plan to make a connection between caffeine use and suicide. If the intended point is that adolescents in South Korea are under enormous pressure which might motivate their use of energy drinks, I suggest dropping the final sentence of paragraph 1 and instead stating that point distinctly.

Response:

As the reviewer advised, we deleted the sentence concerning suicide and emphasized the academic stress adolescents feel.

...students in Korea are under extraordinarily high pressure to academically achieve, and this is evidenced by the fact that in 2013 the academic stress index in Korea was found to be 50.5% higher than the average (33.3%) of the 30 countries surveyed.

(page 4, line 10)

Comment 5: Please define the study population in the study by Dariusz et al. Are these definitions for adolescents?

Response:

We have included the study population and school year.

...for example, Dariusz et al. studied the consumption patterns of energy drinks in Poland (analysing 2,629 students from junior and senior high schools), and defined overuse as daily consumption of energy drinks, too much use as consuming these drinks several times a week, and regular use as consuming these drinks once a week.

(page 2, line 5)

Comment 6: Results page 8. Please add the numbers or proportion of males and females that used energy drinks after stating that more males than females used energy drinks.

Response:

We have included the proportion of males and females that used energy drinks.

In regard to gender, we found that more males (42.6%) than females (25.1) used highly caffeinated energy drinks.

(page 9, line 8)

VERSION 3 – REVIEW

REVIEWER	Emma Childs University of Illinois at Chicago, USA
REVIEW RETURNED	30-Aug-2017
GENERAL COMMENTS	The authors have provided clear, thoughtful responses to my comments and the manuscript is much improved. I have no further comments.