

## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form (<http://bmjopen.bmj.com/site/about/resources/checklist.pdf>) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below. Some articles will have been accepted based in part or entirely on reviews undertaken for other BMJ Group journals. These will be reproduced where possible.

### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	Fast Food consumption and Body Mass Index in children and adolescents: an international cross-sectional study
<b>AUTHORS</b>	Braithwaite, Irene; Stewart, Alistair; Hancox, Bob; Beasley, Richard; Murphy, Rinki; Mitchell, Edwin

### VERSION 1 - REVIEW

<b>REVIEWER</b>	Jennifer Poti University of North Carolina at Chapel Hill, US
<b>REVIEW RETURNED</b>	03-Oct-2014

<b>GENERAL COMMENTS</b>	<p>Thank you for this interesting analysis examining the association between the frequency of fast food consumption and BMI among children and adolescents participating in a large international study. This topic is valuable for providing insight into dietary behaviors that might potentially contribute to increases in the prevalence of obesity worldwide. However, there are major limitations of the data analyzed in this study, such as possible reverse causality, great potential for misreporting of both exposure and outcome, unclear definition of fast food, and inability to control for important confounders such as physical activity, at-home dietary intake, or socioeconomic status. While the manuscript clearly acknowledges these issues and emphasizes that these results should be interpreted with caution, it is not clear whether this study can make a meaningful contribution to the literature.</p> <p>Introduction: Lines 76-79: The introduction needs to be greatly expanded to clearly identify the gaps in the research literature and explain how this study addresses the limitations of previous work. The cited review by Rosenheck et al. presents many potential explanations for inconsistent findings about the association between fast food consumption and BMI that should be noted here. Considering these limitations include single question assessment of fast food frequency without consideration of quantity or quality, cross-sectional data, and confounding by other lifestyle factors (physical activity, access to healthy foods, overall eating patterns), it is not clear how the current study improves upon the existing literature.</p> <p>Lines 79-80: The characterization that many of the previous studies were "single centre studies and involved small populations" does not seem to accurately reflect these references. Many of the studies included large sample sizes (Niemeier et al., Taveras et al.), and some were nationally representative US samples or included participants from all US states.</p> <p>Lines 81-88: This information about the ISAAC study might be better placed in the Methods section.</p>
-------------------------	--

Methods:

Figure 1, Lines 132-134: Please address the potential selection bias that results from all these exclusions. Considering that only about 1/3 of the children and 1/2 of the adolescents participating in the ISAAC study were included in this analysis, please provide a comparison of how the excluded participants differed from those included in the analysis. Do the excluded participants differ in ways that might suggest that the association between fast food and BMI is different in the excluded vs included participants? How is generalizability of your results affected by these exclusions?

Lines 139-142: Considering that this is a cross-sectional observational study, these models do not seem to be sufficiently adjusted for potential confounders such as individual socioeconomic status (household/family income or education), race/ethnicity, physical activity, sedentary behavior, access to more healthful food sources, food preferences, or the remainder of dietary intake. Were any other factors assessed in this study that could be included in the models?

Results:

Figure 3: Please provide more details in the figure legend. Why do some countries have more than one estimate? Why are some estimates circled? Are estimates for frequent fast food consumption, very frequent fast food consumption, or some combination? What do the percentages in parentheses next to the country name indicate?

Table 1: Should the headings for "Frequent fast food consumption" and "Very frequent fast food consumption" be labeled as beta coefficients (rather than means) since these are the "Difference in BMI compared with infrequent fast food consumption"?

Table 1: The footnote about the p value is not quite clear. Why would this test whether the mean BMI is zero (as stated)? Is this a test of whether the beta coefficient equals zero (i.e., a test of whether the difference between frequent fast food consumers and infrequent consumers equals zero)? Is this a joint test of the coefficients for frequent and very frequent fast food consumption?

Discussion:

Lines 232-241: Please also note that most of these studies were prospective analyses, not cross-sectional, and included more complete control of confounding factors. Researchers usually also acknowledge that fast food consumers might differ from non-consumers in unobserved or unmeasured characteristics that might also be associated with obesity. Many studies use first-difference models or fixed effects longitudinal models to account for this potential endogeneity; inability to use these methods might be mentioned as another limitation. Again, it is not totally clear how the current study adds to the literature, considering that it is in "stark contrast" to other studies.

Lines 241-249: Please provide some discussion about previous studies that have examined misreporting of weight and height among adolescents.

Lines 249-251: Please also discuss prior work that studied dietary underreporting among adolescents and the association between underreporting and weight status. Perhaps consider rewording this

	<p>sentence; the literature might support a stronger statement than just a “possibility” of underreporting.</p> <p>Lines 256-262: The high proportion of fast food consumers observed across many countries worldwide is an important finding and perhaps should be emphasized as a primary conclusion from this study.</p> <p>Lines 249-254, 265-267, 276-281, 282-289, 290-291, 292-293, 298-300: It seems like all discussion of the results for adolescents emphasize that these results have many limitations – misreporting of weight and height, underreporting of fast food among overweight adolescents, unclear definition of fast food, lack of information about the amount of fast food consumed, lack of standardized measurement of weight and height, inability to control for SES, inability to control for physical activity or inactivity - and cannot be readily interpreted. The thorough discussion of these concerns is greatly appreciated. However, please justify why these acknowledged limitations do not undermine the ability of this data to answer the research question.</p> <p>Lines 282-289: Does this questionnaire capture frequency of eating food from fast food restaurants or frequency of eating fast food-like items (e.g., burgers)? Is that comparable to previous studies?</p> <p>Minor Comments:  Abstract:  Methods, Line 43: Consider rewording that the model was adjusted for “reported or measured height and weight.” This phrase implies that models were adjusted for height and weight, rather than that the models adjusted for whether height and weight were self-reported or measured.  Conclusion, Lines 52-53: Please qualify these statements - “In this cross-sectional international study, frequent and very frequent consumption are associated.” The phrase “this is associated” is vague.  Introduction:  Line 75: “Low nutritional nature” – awkward wording  Discussion:  Lines 208-210: Awkward wording “children whose parents reported frequent consumption of fast food” – this phrase could imply that the parents themselves frequently consumed fast food, rather than the children.  Line 238: References 15 and 23 appear to be the same paper (Taveras et al.).  Line 259: Is a word omitted in this sentence? “This study has highlighted is the unexpectedly high...”  Lines 295-296: Please qualify this statement – this cross-sectional study observed these associations; the conclusion “there is an association...” cannot be made from a single study.</p>
--	--

<b>REVIEWER</b>	Michelle Estrade University of Edinburgh, UK
<b>REVIEW RETURNED</b>	10-Oct-2014

<b>GENERAL COMMENTS</b>	Surely ethical approval was obtained for the main study, however even for secondary data analysis it is good reaffirm that, as well as clarify how permission was obtained to gain access to the data used
-------------------------	--

	<p>for this analysis.</p> <p>This is a timely piece of work that will be of broad international interest, and the authors have done an excellent job presenting and discussing the data in this article.</p> <p>Recommended minor revision:  There is a discrepancy in the description of Figure 3 in the text versus the figure's subheading. The text states that "Figure 3 shows the DIFFERENCE in BMI..." while the figure subheading says "Figure 3: ASSOCIATION between BMI..."  Please amend appropriately to reduce confusion.</p> <p>Overall evaluation:  While there are clearly serious caveats to interpreting data from a vague question about fast food consumption, the authors have addressed the limitations and satisfactorily explored possible explanations for the unexpected results.</p>
--	---

### VERSION 1 – AUTHOR RESPONSE

**Reviewer One:**

Thank you for this interesting analysis examining the association between the frequency of fast food consumption and BMI among children and adolescents participating in a large international study. This topic is valuable for providing insight into dietary behaviors that might potentially contribute to increases in the prevalence of obesity worldwide. However, there are major limitations of the data analyzed in this study, such as possible reverse causality, great potential for misreporting of both exposure and outcome, unclear definition of fast food, and inability to control for important confounders such as physical activity, at-home dietary intake, or socioeconomic status. While the manuscript clearly acknowledges these issues and emphasizes that these results should be interpreted with caution, it is not clear whether this study can make a meaningful contribution to the literature.

This study adds to the literature by providing a ‘snapshot’ of Fast food consumption in children and adolescents internationally, including a number of countries in which such data has not previously been published. It also uses the power of large numbers to test for an association between different levels of reported fast food consumption and BMI in children and adolescents. We make no pretence that the study has weaknesses which we have gone to some lengths to highlight and discuss. However, this study has some robust components, particularly the number of participants included in the analysis and the use of a single simple question over the discrete time period in which the study was conducted. We have addressed each of Reviewer One’s specific comments below.

**Introduction:**

Lines 76-79: The introduction needs to be greatly expanded to clearly identify the gaps in the research literature and explain how this study addresses the limitations of previous work. The cited review by Rosenheck et al. presents many potential explanations for inconsistent findings about the association between fast food consumption and BMI that should be noted here. Considering these limitations include single question assessment of fast food frequency without consideration of quantity or quality, cross-sectional data, and confounding by other lifestyle factors (physical activity, access to healthy foods, overall eating patterns), it is not clear how the current study improves upon the existing literature.

- We have referenced the Rosenheck et al. manuscript more extensively in the introduction as suggested, comprising lines 79 to 92. We have added a further sentence outlining what our study adds to the literature in lines 93 to 98 as follows: ‘A secondary analysis of the data from the International Study of Asthma and Allergies in Childhood (ISAAC) Phase Three programme allows an

international 'snapshot' of fast food consumption and an assessment of the association between fast food consumption and BMI in 72,900 children from 17 countries and 199,135 adolescents from 36 countries at a single point in time, using a simple universal question. While few confounding variables are taken into account, the large numbers involved give power to this analysis.

Lines 79-80: The characterization that many of the previous studies were "single centre studies and involved small populations" does not seem to accurately reflect these references. Many of the studies included large sample sizes (Niemeier et al., Taveras et al.), and some were nationally representative US samples or included participants from all US states.

- This sentence has been removed

Lines 81-88: This information about the ISAAC study might be better placed in the Methods section. All ISAAC specific information is now in the Methods section.

Methods:

Figure 1, Lines 132-134: Please address the potential selection bias that results from all these exclusions. Considering that only about 1/3 of the children and 1/2 of the adolescents participating in the ISAAC study were included in this analysis, please provide a comparison of how the excluded participants differed from those included in the analysis. Do the excluded participants differ in ways that might suggest that the association between fast food and BMI is different in the excluded vs included participants? How is generalizability of your results affected by these exclusions?

- ISAAC comprised a self-selected group of centres without intent to represent any population, (this is different from each Centre itself, which DID try to represent their local population). The subset of ISAAC Centres that then decided to utilise the Environmental Questionnaire is also a self-selected group. This paper outlines the findings in study participants.

Lines 139-142: Considering that this is a cross-sectional observational study, these models do not seem to be sufficiently adjusted for potential confounders such as individual socioeconomic status (household/family income or education), race/ethnicity, physical activity, sedentary behavior, access to more healthful food sources, food preferences, or the remainder of dietary intake. Were any other factors assessed in this study that could be included in the models?

- Unfortunately there are few factors that could be reliably included in the models, besides the ones we have already adjusted for. With respect to the specific factors you have mentioned:

o Individual ethnicity is likely to be very closely confounded with country, and so is unlikely to be useful in this model.

o Individual information on socioeconomic status (such as household income), was not collected. The closest pseudo-measure available in the dataset is maternal education. We doubt that this is helpful in inferring household income or individual socioeconomic circumstances. As a result we settled for GNI by country, but understand that this is a general measure, not participant specific

o Physical activity was included in the original Environmental Questionnaire but did not specify the same time frame as that covered in the food questions (exercise over the prior week rather than on a weekly basis over the previous year). Additionally, participants that responded to the fast food question did not necessarily answer the exercise question; this would have curtailed the number of participants available for analysis.

o Data on sedentary behaviour was not collected, nor was data on food preferences

o The questions about particular dietary components were oriented to possible detrimental or protective effects on symptoms of asthma and rhinoconjunctivitis, and were not designed to be a comprehensive dietary survey. Unfortunately the dietary data in its' entirety is too limited yet complex for comprehensive analysis to be undertaken in a meaningful way.

Results:

Figure 3: Please provide more details in the figure legend. Why do some countries have more than one estimate? Why are some estimates circled? Are estimates for frequent fast food consumption,

very frequent fast food consumption, or some combination? What do the percentages in parentheses next to the country name indicate?

- Thank you for pointing this out. We have added further clarification to the figure legend as follows: 'Figure 3: The difference in BMI of study participants that consumed fast food consumption frequently and very frequently compared to infrequent fast food consumption. Children are represented in panel (a) and adolescents in panel (b). For each country the proportion of participants who consume fast food frequently or very frequently is shown in parentheses. Those centres with reported height and weights are shown with filled in circles, and those centres that measured heights and weights are shown with hollowed circles.'

Table 1: Should the headings for "Frequent fast food consumption" and "Very frequent fast food consumption" be labeled as beta coefficients (rather than means) since these are the "Difference in BMI compared with infrequent fast food consumption"?

- We have clarified the overarching comment for these two groups to read 'Difference in mean BMI compared with infrequent fast food consumption'. This should provide more clarity to the table.

Table 1: The footnote about the p value is not quite clear. Why would this test whether the mean BMI is zero (as stated)? Is this a test of whether the beta coefficient equals zero (i.e., a test of whether the difference between frequent fast food consumers and infrequent consumers equals zero)? Is this a joint test of the coefficients for frequent and very frequent fast food consumption?

- This has been revised to read 'P value is a joint test of whether the differences in BMIs for frequent and very frequent fast food consumption relative to infrequent fast food consumption are zero.'

Discussion:

Lines 232-241: Please also note that most of these studies were prospective analyses, not cross-sectional, and included more complete control of confounding factors. Researchers usually also acknowledge that fast food consumers might differ from non-consumers in unobserved or unmeasured characteristics that might also be associated with obesity. Many studies use first-difference models or fixed effects longitudinal models to account for this potential endogeneity; inability to use these methods might be mentioned as another limitation. Again, it is not totally clear how the current study adds to the literature, considering that it is in "stark contrast" to other studies.

- Please refer to our response to Reviewer One's opening paragraph and to our response to Reviewer One's comments on Introduction: lines 76-79

Lines 241-249: Please provide some discussion about previous studies that have examined misreporting of weight and height among adolescents.

- Thank you for raising this issue. We have added discussion in lines 279-297 as follows: 'In a study evaluating the correlation of measured versus self-reported heights and weights in adolescents, Brener et al found that their study subjects tended to over-report their height by 2.7 inches (6.9cm) on average, and to under-report their weight by 3.5 pounds (1.6kg) on average, resulting in a BMI understated by 2.6kg/m<sup>2</sup> when compared to measured values. White adolescents were most likely to over-report their height and female adolescents were more likely to under-report their weight(25). Similarly Danubio et al found that height was over-estimated in males and females (2.1 and 2.8cm respectively), and that weight was understated (1.5kg in males and 1.9kg in females)(26). Rasmussen et al reported that in the COMPASS study, boys and girls who wished to be leaner under-reported their weight and BMI more than subjects who were satisfied with their body size(27). When we restricted our analysis to measured height and weight data only, the association between higher fast food intake and lower BMI was no longer observed in male adolescents, but the association between higher rates of fast food consumption and lower BMI persisted in female adolescents.'

Lines 249-251: Please also discuss prior work that studied dietary underreporting among adolescents

and the association between underreporting and weight status. Perhaps consider rewording this sentence; the literature might support a stronger statement than just a “possibility” of underreporting.

- Thank you for the opportunity to comment on this issue in this paper. We have amended this sentence and added a reference in lines 296-303 as follows: ‘We need to consider the likelihood that because of the perception of the negative effects of fast food consumption, adolescents who are overweight or obese are likely to have under-reported their actual fast food consumption. In a review of validation studies on energy-intake reporting in children and adolescents, Livingstone and Robson describe an increasing in under-reporting of energy intake reporting as age and BMI increases in childhood and adolescence, with 14%, 25% and 40% of energy intake under-reported in obese 6 year olds, 10 year olds and adolescents respectively (28).’

Lines 256-262: The high proportion of fast food consumers observed across many countries worldwide is an important finding and perhaps should be emphasized as a primary conclusion from this study.

- While we agree this is an important finding, it was not the primary outcome variable in our pre-specified analysis plan. Rather we elected to focus on the hypothesis that there would be an association between frequent fast food consumption and BMI in both age groups. We have endeavoured to emphasise this finding more by

o adding a new sentence to the end of the first paragraph in the discussion (Lines 246 and 247) as follows: ‘We have also found that up to 25% of children worldwide consume fast food frequently or very frequently, and this increases to over 50% in the adolescent age group.’

o And we have added a comment into the first line of the conclusion (line 347) as follows: ‘This cross-sectional study has found that one quarter of children and half of adolescents consume fast food frequently or very frequently. Additionally there was an association....’

Lines 249-254, 265-267, 276-281, 282-289, 290-291, 292-293, 298-300: It seems like all discussion of the results for adolescents emphasize that these results have many limitations – misreporting of weight and height, underreporting of fast food among overweight adolescents, unclear definition of fast food, lack of information about the amount of fast food consumed, lack of standardized measurement of weight and height, inability to control for SES, inability to control for physical activity or inactivity - and cannot be readily interpreted. The thorough discussion of these concerns is greatly appreciated. However, please justify why these acknowledged limitations do not undermine the ability of this data to answer the research question.

- Please refer to our response to Reviewer One’s opening paragraph and to our response to Reviewer One’s comments on Introduction: lines 76-79

Lines 282-289: Does this questionnaire capture frequency of eating food from fast food restaurants or frequency of eating fast food-like items (e.g., burgers)? Is that comparable to previous studies?

- The ISAAC EQ question asked the frequency with which Fast food / burgers were consumed over the previous 12 months. How this compares to previous studies is discussed in lines 256 to 264 of our original submission, now lines 310-318

Minor Comments:

Abstract:

Methods, Line 43: Consider rewording that the model was adjusted for “reported or measured height and weight.” This phrase implies that models were adjusted for height and weight, rather than that the models adjusted for whether height and weight were self-reported or measured.

- This has been clarified as follows: ‘....adjusting for Gross National Income per capita by country, measurement type (whether height and weight were reported or measured), age, and sex.’

Conclusion, Lines 52-53: Please qualify these statements - “In this cross-sectional international study, frequent and very frequent consumption are associated.” The phrase “this is associated” is vague.

- This has been re-worded as follows: ‘Compared with infrequent fast food consumption, frequent and

very frequent consumption is associated with a higher BMI in children and a lower BMI in adolescents.'

Introduction:

Line 75: "Low nutritional nature" – awkward wording

- This sentence has been re-worded as follows: 'While potential contributors to the problem of childhood obesity are considered to be multiple and complex, in many countries fast food has been implicated due to its increasing availability, energy density, and large portion sizes.'

Discussion:

Lines 208-210: Awkward wording "children whose parents reported frequent consumption of fast food" – this phrase could imply that the parents themselves frequently consumed fast food, rather than the children.

- This sentence has been re-worded as follows: 'This international study has identified that 6-7 year old children who consumed fast food frequently had higher BMIs than those who consumed fast food infrequently.'

Line 238: References 15 and 23 appear to be the same paper (Taveras et al.).

- Reference 23 has now been removed.

Line 259: Is a word omitted in this sentence? "This study has highlighted is the unexpectedly high..."

- Thank you, this sentence has been changed as follows: 'This study has also highlighted the unexpectedly high proportion...'

Lines 295-296: Please qualify this statement – this cross-sectional study observed these associations; the conclusion "there is an association..." cannot be made from a single study.

- This has been re-worded as follows: 'This cross-sectional study found an association between a high frequency of fast food consumption and higher BMIs in 6-7 year old children, but this association was reversed in adolescents. As this is an observational study, causality cannot be proven....'

Reviewer: 2

Surely ethical approval was obtained for the main study, however even for secondary data analysis it is good reaffirm that, as well as clarify how permission was obtained to gain access to the data used for this analysis.

- We have added a paragraph to cover this point in Subjects and Methods: Lines 131 to 133 as follows: 'Ethical approval was obtained for the original ISAAC Phase Three study, and permission was gained to use the data from ISAAC Phase Three through agreement with the ISAAC Phase Three Steering Committee.'

This is a timely piece of work that will be of broad international interest, and the authors have done an excellent job presenting and discussing the data in this article.

Recommended minor revision:

There is a discrepancy in the description of Figure 3 in the text versus the figure's subheading. The text states that "Figure 3 shows the DIFFERENCE in BMI..." while the figure subheading says "Figure 3: ASSOCIATION between BMI..."

Please amend appropriately to reduce confusion.

- The Figure 3 heading has been re-written as follows 'Figure 3: The difference in BMI of study participants that consumed fast food consumption frequently and very frequently compared to infrequent fast food consumption. Children are represented in panel (a) and adolescents in panel (b). For each country the proportion of participants who consume fast food frequently or very frequently is



shown in parentheses. Those centres with reported height and weights are shown with filled in circles, and those centres that measured heights and weights are shown with hollowed circles.

Overall evaluation:

While there are clearly serious caveats to interpreting data from a vague question about fast food consumption, the authors have addressed the limitations and satisfactorily explored possible explanations for the unexpected results.

### VERSION 2 – REVIEW

<b>REVIEWER</b>	Jennifer Poti, PhD University of North Carolina at Chapel Hill US
<b>REVIEW RETURNED</b>	18-Nov-2014

<b>GENERAL COMMENTS</b>	<p>Thank you for your responsiveness to the feedback on your original manuscript. The revised version provides a much stronger introduction and discussion, and the tables and figures are presented with more detail and clarity.</p> <p>As noted in the revised manuscript, the ISAAC study was designed to study asthma and allergies, not the association between fast food intake and BMI. Consequently, it seems that insufficient data was collected about important confounding factors, yet this information is essential for addressing the research question about fast food and BMI. The introduction notes that associations between fast food consumption and BMI are often inconsistent because many studies are cross-sectional and have inadequate adjustment for confounding factors such as physical activity or food preferences. If these are the major gaps in the research literature, it is not clear how the current study addresses them, as insufficient data was collected to account for dietary misreporting, physical activity, individual SES, dietary preferences, and many other confounders. It is not clear how it is advantageous to have ample power to detect an association that likely remains biased. It is unfortunate that these confounders were not measured, given the impressive scope of the overall study.</p> <p>However, this manuscript does add to the research literature by determining the prevalence of frequent and very frequent fast food intake in a large international sample of children and adolescents, including many low and middle income countries in which data on fast food intake had not been previously reported. The authors are careful to interpret their findings with caution and include a thorough discussion of potential sources of bias in their estimated associations.</p> <p>Suggested revision: Abstract, Conclusion - Because of residual confounding, reverse causation, and likely misreporting, please make a more cautious conclusion about the association observed among adolescents. A sentence similar to Lines 62-64 would be a more appropriate conclusion.</p>
-------------------------	--