Author’s response to reviews

Title: Evaluation of sex differences in dietary behaviours and their relationship with cardiovascular risk factors: A cross-sectional study of nationally representative surveys in seven low- and middle-income countries

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Author’s response to reviews:

Dear reviewers,

Thank you kindly for your reviews, and comments. You have both raised important points and we
believe addressing these has strengthened the manuscript.
We have addressed your comments as set out below, and as shown by tracked changes in our revised manuscript.

Kind regards,

Briar McKenzie

Reviewer One:
Line 76. This sentence needs a reference ("The weight of the current evidence demonstrating the burden of ill health due to diets high in salt, low…").
Changes made:
Added the following references:
“The weight of the current evidence demonstrating the burden of ill health due to diets high in salt [9, 10], low in fruits and vegetables [11-14], and high in trans- and saturated fats [12, 13, 15-17]”
References:
Response: Thank you for pointing this out, references to support this comment have been added.

Fruit and vegetable intake
Line 153. It is not clear when authors describe "participants were asked to report the number of days per week they consume fruits..." and "if this question was answered affirmatively". It seems that the first question was something like "do you consume fruits and vegetables? Yes/no. Please revise it.
Changes made:
Added, lines 164-170: “In the surveys, participants were asked to report the number of days per week they consume fruits and vegetables. If participants reported that they consumed fruits or vegetables on one or more days a week, they were then asked to state on any given day how many portions of fruits or vegetables they consume. To aid their response, they were shown pictures of local fruits and vegetables to refer to as a portion, corresponding to approximately 80 g.”
Response: Thank you for this comment. We have revised as shown to clarify how this question was asked.

Line 205. Please correct "reference" and not "referent"
Response: Thank you, changed from “referent” to “reference”

Considering that the three dietary aspects (salt consumption, low F&V and animal fat intake) were not associated with the outcomes investigated, it seems appropriate to discuss the necessity to investigate the consumption of ultraprocessed food consumption instead of isolate ingredients/food items. Some population studies have shown a reduction of salt, sugar and fat consumption as ingredients, but these are largely used by food industry. A short discuss on that must be considered in this manuscript.

Changes made:
Added lines 493-502: "Overall, it is important to reflect on the dietary behaviours measured in the STEPS survey given that for many LMICs, the STEPS surveys are the only source of national dietary intake data. In particular, ultra-processed foods and drinks are important overlooked dietary risk factors [54, 55] and countries should consider including questions on theses in future iterations of the STEPS survey. These products are high in salt, fat and/or sugar, and people who frequently consume ultra-processed products in their diets often have low intakes of fresh fruits and vegetables [55]. Sales of ultra-processed products have been shown to be increasing globally, including in LMICs, with corresponding increases in body mass index [56]. While we have investigated components of diet quality, we were not able to investigate the level of consumption of ultra-processed products, which may be a reason for the overall minimal associations observed between the diet behaviours and cardiovascular risk factors."

Added, lines 504-507: "As discussed, policies need to focus on improving the accessibility and affordability of fruit and vegetables, and decreasing the use of salt during cooking, while monitoring the consumption of ultra-processed products which are becoming more accessible in LMICs.”
Response: This is an excellent comment, and we fully agree with the reviewer. We have added a section discussing the need to monitor and evaluate the effect of ultra-processed foods, as detailed.

Table 1.
a) Use symbols instead of '*' to describe footnotes; * is more appropriate to indicate p-values and significant results.
Comment: Amended so that “*” is used in regards to p-values and lowercase superscript letters such as “a” and “b” are used to describe footnotes.
b) Indicate the statistical test applied
Comment: Added to footnote “Differences between sexes tested using Pearson's chi-squared test for categorical variables and linear regression analysis for continuous variables”
Table 2.
Indicate the statistical test applied
Comment: Added to footnote “Differences between sexes tested using Pearson's chi-squared test”
Tables 3 and 4.
Title: Please, indicate in title where the data come from; e.g. "in seven low- and middle-income countries".
Changed to: “Table 3. Cross-sectional associations of salt behaviour with exceeding waist circumference recommendations, having undiagnosed or diagnosed hypertension or diabetes, in seven low-and middle-income countries”

And

“Table 4. Cross-sectional associations of meeting fruit and vegetable recommendations with exceeding waist circumference recommendations, having undiagnosed or diagnosed hypertension or diabetes, in seven low-and middle-income countries”

Comment: Great point. Titles have been amended to reflect data source as shown.

Indicate how diabetes and hypertension were diagnosed; the cutoff of waist circumference; statistical test applied.

Footnotes added: "b Definition of high waist circumference, waist ≥ 102cm for males and waist ≥ 88cm for females

c Hypertension was defined as an average systolic blood pressure (SBP) measurement >140 mmHg, or their average diastolic blood pressure (DBP) measurement > 90mmHg, or they reported taking medication for hypertension. Self-reported diagnosed hypertension were those who met the criteria for hypertension and also reported a diagnosis of hypertension. Undiagnosed individuals were those who had a high SBP (>140mmHg) or a high DBP (>90mmHg), did not report taking hypertension medication, and did not report a hypertension diagnosis. d Diabetes was defined as having an average fasting blood glucose (FBG) level ≥7 mmol/L, or having a random blood glucose (RBG) level of ≥11.1 mmol/L or on medication for diabetes. Individuals with self-reported diagnosed diabetes met the criteria for diabetes and also reported a diagnosis of diabetes. Undiagnosed individuals were those who had a high FBG (≥7 mmol/L) or a high RBG (≥11.1 mmol/L), did not report taking diabetes medication, and did not report a diabetes diagnosis."

Table 4: Indicate F&V abbreviation in footnote

Comment: Added footnote “f “F&V” – Fruit and vegetable intake, categorised into meeting or not meeting fruit and vegetable recommendations of 400g/day”

Reviewer Two:

In general, I suggest a review of the language in the article, sometimes is not very clear what the authors want to express.

Response: Thank you for your comment, we have edited the manuscript to clarify aspects. Please see tracked changes in the revised document.

Comments related to the title, when I read the title, I thought that I would observe differences in dietary intake of salt, fruits and vegetables and oil and fat by sexe, however the authors did not observe strong differences. In your abstract you conclude that dietary behaviours were not notably different between sexes. Further, in table 4 the p-interaction was not significative with sexe. You can state your title as a question (Is there differences in dietary intake by sex?) or that there was not differences by sexe.

Change made: Title changed to “Evaluation of sex differences in dietary behaviours and their relationship with cardiovascular risk factors: A cross-sectional study of nationally representative surveys in seven low- and middle-income countries”

Response: Excellent point. The title has been changed, as shown.

The methods of the article were not very clear and I have some doubts. In the section "data source or data collection": How many surveys did you have available? Why the country survey data were included if the survey was conducted during or after 2005? What is the temporality of the surveys?
Why did you include participants 15 and older if hypertension and diabetes risks increase with age? In this section the temporality of the outcome, exposure and covariates is not clear, these variables came from the same survey in terms of time? (for example, all the previous variables came from the survey of 2005?).

Changes made: Added to the methods, lines 113-129, "In brief World Health Organization (WHO) Stepwise Approach to Surveillance (STEPS) surveys [33] conducted in low, low-middle, or upper-middle income countries since 2005 were searched for. The search was limited to surveys conducted since 2005, as these studies were considered contemporary enough to be included in the same analysis. WHO STEPS surveys use a standardised questionnaire and protocol to monitor non-communicable disease risk at a population level, with the questionnaire comprising three steps: step one “behavioural measurements”, step two “physical measurements” and step three “biochemical measurements” [21, 33, 34]. Survey contacts were approached for the de-identified individual level data to be pooled for analyses. Data was pooled if signed agreement was made and they had a response rate ≥50%; participants were aged 15 years or older; included data on waist circumference, and/or a biomarker for diabetes (either a glucose measurement or HbA1c), and/or a measurement of blood pressure. For the current analyses surveys were included if questions on salt behaviour, fruit and vegetable intake, and the use of fats and oils for cooking were asked, seven out of 46 surveys. The surveys used a two-stage cluster random sampling design, with one person from each household (within the defined age range) randomly selected to complete the survey. All surveys were carried out by a trained data collection team member in the household setting, or at a conveniently-located health center and data on the three questionnaire steps were collected during the same visit.”

Response: We are sorry that the methods were not clear to you. We have added a brief description of the data sources, as shown, and specified reasons for limiting the survey data included based on year of data collection. Participants 15 and older were included because this was the age range targeted by these nationally representative samples and we sought to present findings that accurately reflected this sampling approach. This is consistent with previous publications using these data, for example: Geldsetzer et al. The state of hypertension care in 44 low-income and middle-income countries: a cross-sectional study of nationally representative individual-level data from 1·1 million adults. Lancet. 2019 Aug 24;394(10199):652-662 and Manne-Goehler et al. Health system performance for people with diabetes in 28 low- and middle-income countries: A cross-sectional study of nationally representative surveys. PLoS Med. 2019 Mar 1;16(3):e1002751

In the section terminology sex and gender: "A person's sex is recorded in the WHO STEPs surveys by the interviewer documenting the observed sex of the participant (binary, male or female)". According to the survey the answers were female and male, can you explain please.

Changes made: Amended, lines 134-136:
“A person’s sex is recorded in the WHO STEPs surveys by the interviewer documenting the observed sex of the participant (binary, male or female) [21]. While acknowledging that the self-report of dietary behaviours is likely to be influenced by a person’s identity and social constructs, and therefore also related to a person’s gender, to be in line with the data collected, the term “sex”, and corresponding terms “male” and “female”, are used throughout this paper [35].” Amended to use the terms female (instead of woman) and male (instead of man) when talking about data from the surveys throughout the manuscript.

Response: Thank you for your comment. We have amended this section, and the terminology used in the manuscript.

Terms of sex/gender, male/man and female/women, are often used interchangeably, however they do have different meanings. As such we have included this paragraph on terminology to be transparent on our reasons for choosing the terms used in our paper.
In the classification of dietary behaviours: I disagree with the use of the term "behaviours". Usually when we refer to diet, we use dietary intake, consumption, use or pattern when principal component was conducted. However, behaviour is a more complex variable. Which was the source of this definition?

Changes made: Added to methods, under “classification of dietary behaviours” lines 139-141:
“Diet behaviours [36] of salt use, fruit and vegetable consumption and type of oil and fat used in cooking are included within “Step 1 – Behavioural Measurements” of the questionnaire, and are the only dietary factors included in STEPS [21]”

Response: Thank you for your comment. The questions on diet in the WHO STEPs survey focus on the three dietary factors included in our study, and sit under “Step 1 – Behavioural Measurements”. Our use of the term “behaviour” is further supported by the WHO technical report on Diet, Nutrition and the Prevention of Chronic Diseases where factors such as fruit and vegetable consumption, salt use and oil/fat use are contextualised as behaviours which can be targeted to improve health. We have referenced this in our description (ref 36).

When I reviewed the article, I had to look for WHO STEPS, I suggest to include a paragraph describing these, because is part of your methods and it was not easy to understand what you did.

Changes made: Added to methods, lines 113-129:
“In brief World Health Organization (WHO) Stepwise Approach to Surveillance (STEPS) surveys [33] conducted in low, low- middle, or upper-middle income countries since 2005 were searched for. The search was limited to surveys conducted since 2005, as these studies were considered contemporary enough to be included in the same analysis. WHO STEPS surveys use a standardised questionnaire and protocol to monitor non-communicable disease risk at a population level, with the questionnaire comprising three steps: step one “behavioural measurements”, step two “physical measurements” and step three “biochemical measurements” [21, 33, 34]. Survey contacts were approached for the de-identified individual level data to be pooled for analyses. Data was pooled if signed agreement was made and they had a response rate ≥50%; participants were aged 15 years or older; included data on waist circumference, and/or a biomarker for diabetes (either a glucose measurement or HbA1c), and/or a measurement of blood pressure. For the current analyses surveys were included if questions on salt behaviour, fruit and vegetable intake, and the use of fats and oils for cooking were asked, seven out of 46 surveys. The surveys used a two-stage cluster random sampling design, with one person from each household (within the defined age range) randomly selected to complete the survey. All surveys were carried out by a trained data collection team member in the household setting, or at a conveniently-located health center and data on the three questionnaire steps were collected during the same visit.”

Response: Thank you for your comments. We have added a brief description within the “data sources” section of the methods and included references to the WHO STEPS website, protocol and methods paper (refs 21, 33 and 34).

What kind of instrument was used to assess diet? Food frequency questionnaire (FFQ), 24 h recall? The alcohol consumption was evaluated using a FFQ? why you did not use percentiles? Is better to rank the participants according to their consumption in the survey.

Changes made: Methods, under “Classification of dietary behaviours” (lines 139-141) we have added:
“Diet behaviours [36] of salt use, fruit and vegetable consumption and type of oil and fat used in cooking are included within “Step 1 – Behavioural Measurements” of the questionnaire, and are the only dietary factors included in STEPS [21]”

Discussion, in the limitations section (lines 529-534) we have added:
“Finally, the dietary behaviour questions analysed do not provide a comprehensive picture of an individual’s diet, and do not allow the quantification of dietary intake. Additionally, the self-report of dietary behaviours is subject to multiple biases…”
Response:
Thank you for your comment. The WHO STEPS survey only includes a few dietary behaviour questions focused on salt use, fruit and vegetable consumption and the type of oil and fat used in cooking. It is not a 24-hr diet recall or an extensive FFQ. Limitations of this have been discussed. In terms of your comment on use of percentiles, we wished to compare the dietary behaviours in a similar way. While we could have looked at percentiles for fruit and vegetable consumption we could not do this for salt use behaviours or the type of fat and oil used in cooking. As such we classified dietary behaviours into “positive” or “poor” behaviours. Alcohol was treated as a potential confounder, and we treated it like we treated physical activity and tobacco smoking, classifying as the presence or not of that behaviour. This is consistent with the WHO, who classified alcohol as a distinct risk factor from dietary intake.

Regarding the way you defined and classified salt intake. You state that is a salt use behavior, it is better to use salt intake or salt use. Also, when you state that is positive behaviour is confusing, first I understood that was a higher intake of salt, maybe high-low or adequate-inadequate. Is there a particular reason to you this definition?

Changes made: Reference on the use of the term “behaviour” in regards to salt use added under “Classification of dietary behaviours” (lines 139-141). “Diet behaviours [36] of salt use, fruit and vegetable consumption and type of oil and fat used in cooking are included within “Step 1 – Behavioural Measurements” of the questionnaire, and are the only dietary factors included in STEPS [21]”

Response: Thank you for your comment. The questions regarding salt use in WHO STEPs are behavioural questions, as they focus on behaviours that individuals undertake to limit their salt intake, as described in the methods under “Salt use behaviours”.

We have termed one group “positive” behaviour as these people have reported behaviours to reduce salt use in 50% or more of the questions. As stated in our methods “Another method of scoring salt use behaviour and categorising into positive vs. poor behaviour was not identified in the literature, and therefore other options of quantification were tested”.

Which is the reference for the way you score the consumption of salt (These answers were assigned a value of 0, 0.25, 0.5, 0.75 or 1, respectively)? WHO STEPs? Which is the reference for this: "Another method of scoring salt use behaviour and categorizing into positive vs. poor behaviour was not identified in the literature, and therefore other options of quantification were tested".

Response: Thank you for your comment. As stated in our methods under “Salt use behaviours”, to our knowledge categorising salt use behaviour from the WHO STEPs surveys into “positive” or “poor” groups has not been done before. As such we looked at different groupings and cut-off points for salt use behaviour in the analyses (as shown in the supplementary files, with the results from the sensitivity analysis). Therefore there is no reference for our approach.

Fruit and vegetable intake (per day) was then calculated using the methods of Frank S et al, you can add a brief paragraph to describe the method.

Changes made: Methods, under “fruit and vegetable intake” we have added (lines 164-170): “Briefly, individuals were categorised as meeting, or not meeting, the fruit and vegetable recommendations, based on the WHO- recommendation of five 80-g portions of fruit and vegetables, or more, on a given day, equivalent to 400 g or more a day”

Response: Thank you for your comment, we have added a brief section on how fruit and vegetable intake was quantified.
The authors have to be careful in the use of the terminology in the article. When you cited the STEPS include the reference (line 183), further in the line 191 referent=reference. In the analyses section the authors mentioned that they adjusted for potential confounding factors. The correct term is for potential confounders, I suggest you to verify the terminology used in the article.
Changes made:
- STEPs manual referenced
- Corrected “referent” to “reference”
- Corrected “potential confounding factors” to “potential confounders” in the analysis section
- Authors have checked terminology throughout the manuscript
Response: Thank you for your comment, the issues raised have been amended as described.

The final population for your analyses was 24,332, what were the inclusion and exclusion criteria for the study?
Response: Thank you for your comment. Under the analyses section it is stated: “Analyses for the population and dietary behaviour characteristics were performed on the sample of individuals with data on all three dietary behaviours from the seven countries.” Final numbers for this are then set out in the first paragraph of the results.

The authors used Generalized linear models, if there are model assumptions, did you verify them? In addition, you conducted a complete case analysis. Did you compared participants with missing data with those included in the analyses to evaluate a potential selection bias?
Changes made: Added to methods, lines 260-263:
“Generalized linear models with country-level fixed effects were used to investigate cross-sectional associations between the dietary behaviours and waist circumference. Given that our outcome variables were discrete (i.e. dichotomous), we’ve fitted our generalized linear models using the binomial family distribution”
Added to results, lines 338-345:
“Individuals with missing data for the diabetes outcome were compared to individuals with data in an unweighted analysis. Those with data were older (39 vs. 36 years), had a higher mean waist circumference (88.28 vs. 85.11 cm), had a higher average systolic (129.78 vs. 125.19 mmHg) and diastolic blood pressure (81.68 vs. 79.21 mmHg), a higher proportion were hypertensive (17.6 vs. 12.6%), and had higher average blood glucose levels (5.73 vs. 4.27 mmol/L). However, no differences were evident in the reported dietary behaviours. The proportion of people with missing data from the hypertension and waist circumference outcome groups were minimal, 321 (1.4%) and 1,059 (4.4%), respectively (supplementary table 3).”
Response: Thank you for your comments. We have clarified our use of generalised linear models and the assumptions made, as shown. In terms of your comment on participants with missing data, we have added a paragraph in our results comparing those with/without data for the diabetes outcome group. The proportion of individuals with missing data for the hypertension or the waist circumference outcome was small and hence we only looked at comparisons for the diabetes group, as described.

In the results section, in table 1, I observed the population characteristics according to the sex in seven countries, however the tittle described something completely different. The variables were regrouped in socioeconomic including age and sex which are not socioeconomic variables and then the other variables of the table were risk factors for hypertension or diabetes and the outcomes. This table has to be improved in order to be clearer.
Changes made: Table one title: “Table 1. Characteristics of individuals with data on dietary behaviours, in seven low- and middle- income countries (n=24,332)”
Sub heading changed from “socioeconomic” to “socio-demographic” characteristics.
Response: Thank you for your comment. We have amended the subheading in this table as stated.

As well as the description and the presentation of the results in the text, for me was very difficult to understand. For example: "Just under a third of the sample were affected by hypertension (26.7%, 25.8-27.6%, 27.4%, 26.1-28.8% of men". In this result you showed two prevalence for men?
In the "Sample characteristics and dietary behaviours" section I suggest you to review the wording is very difficult to understand as well as the way you present the results. In this section first finish to present the results and then add table 2, the last paragraph of this section seems incomplete.
Response: Thank you for your comment. We have made edits to clarify throughout the results section.

Table 2 also has to be improved in the columns of male and female you write down the confidence interval of a prevalence? You did not specify this information in the columns. Further, the p-value are in the middle of the variable is better when they are in the same level of the variable of interest.
Changes made: Percentage (95% CI)” added to the column headings. P-values moved to be in line with variable of interest.
Response: We have made amendments to this table as described.

In table 3 as in other tables, presentation needs to be improved for example: "Percentage (CI) with undiagnosed” instead you can use this format: % (95% CI) undiagnosed. In addition, if you found no association the p-value can be presented with two decimals.
Changes made: Changed subheadings on tables 3 and 4 to “Percentage (95% CI)…” The number of decimal points have been amended in each table.
Response: We have made amendments as described.

In the discussion the authors mentioned that seven STEPs were included in the analyses nonetheless in the methods no information about this was explained. Moreover, in the study seems that the exposure was measured after the assessment of the outcomes. Thus, health condition could influence the diet.
Changes made: Added to methods, lines 113-129:
“In brief World Health Organization (WHO) Stepwise Approach to Surveillance (STEPS) surveys [33] conducted in low, low-middle, or upper-middle income countries since 2005 were searched for. The search was limited to surveys conducted since 2005, as these studies were considered contemporary enough to be included in the same analysis. WHO STEPS surveys use a standardised questionnaire and protocol to monitor non-communicable disease risk at a population level, with the questionnaire comprising three steps: step one “behavioural measurements”, step two “physical measurements” and step three “biochemical measurements” [21, 33, 34]. Survey contacts were approached for the de-identified individual level data to be pooled for analyses. Data was pooled if signed agreement was made and they had a response rate ≥50%; participants were aged 15 years or older; included data on waist circumference, and/or a biomarker for diabetes (either a glucose measurement or HbA1c), and/or a measurement of blood pressure. For the current analyses surveys were included if questions on salt behaviour, fruit and vegetable intake, and the use of fats and oils for cooking were asked, seven out of 46 surveys. The surveys used a two-stage cluster random sampling design, with one person from each household (within the defined age range) randomly selected to complete the survey. All surveys were carried out by a trained data collection team member in the household setting, or at a conveniently-located health center and data on the three questionnaire steps were collected during the same visit.”
Response: Thank you for your comment. We have addressed this comment through adding information to the “data source” section of the methods, as stated above.

In terms of health conditions influencing the diet, we have tried to address this by splitting disease into “diagnosed” and “undiagnosed” sub-groups where possible (as shown for hypertension and diabetes, but not possible for waist circumference). This is stated in our introduction “Given the hypothesis that
disease diagnosis may change behaviour, and therefore those with diagnosed disease may be more likely to report more positive dietary behaviours, investigation of associations with both undiagnosed and diagnosed hypertension and diabetes were conducted” Additionally, we have acknowledged the limitations of looking at cross-sectional associations in our discussion.

No energy adjustment is a very important issue in nutritional epidemiology, any nutrient is associated with daily calorie intake, including sodium. Thus, the results observed may be invalid.

Changes made: Added to the discussion, lines: 529-534

“Finally, the dietary behaviour questions analysed do not provide a comprehensive picture of an individual’s diet, and do not allow for the quantification of dietary intake. Additionally, the self-report of dietary behaviours is subject to multiple biases [59]. While overall dietary intake is not assessed by STEPS surveys, the survey has been used widely throughout low-and middle-income countries to assess risk of non-communicable disease based on the key dietary behaviours. This provides useful insight on the need for dietary interventions at a population level in resource poor settings [34].”

Response: Thank you for your comment. It was not possible to adjust for energy intake given the type of data collected through WHO STEPs. We have clarified the type of dietary questions collected in STEPs (see response to comments above), and added to our study strengths and limitations section, as described.

We would like to highlight that currently, researchers do not have consistent or complete dietary data across countries. The best global information we have are estimates of dietary intake that are modelled. Our study is an attempt to present available dietary data from the seminal WHO STEPS (which is a national survey tool analogous to the Demographic and Health Surveys, except focused on NCDs instead of reproductive health), highlight to the global nutrition community that diets indeed are unhealthy in LMICs, and also emphasize the need to collect more national dietary data – as the reviewer also desires to see. This is a first attempt to compile STEPS surveys and present dietary data across multiple countries that is not modeled. We therefore feel it is an important study despite these limitations – which are limitations of the WHO STEPS that we hope upon publication of this study, will be addressed and improved upon in future rounds of the STEPS surveys.