Author’s response to reviews

Title: Low consumption of Fruits and Vegetables among Adults in Uganda: Findings from a countrywide cross-sectional survey

Authors:
Steven Ndugwa Kabwama (skabwama@musph.ac.ug)
Silver K Bahendeka (silverbahendeka@gmail.com)
Ronald Wesonga (wesonga@wesonga.com)
Gerald Mutungi (gnmutungi@yahoo.com)
David Guwatudde (dguwatudde@gmail.com)

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Author’s response to reviews:

Dear Dr. Olivier Bruyère,

We would like to thank the reviewers for expeditiously reviewing our paper and giving us valuable comments to help us improve the quality of the paper. Below this message are point by point responses to all the comments that were raised by each of the reviewers. We thank you for considering our paper in your esteemed journal. I have submitted the revised version of the paper on behalf of my co-authors. All changes to the original version of the paper have been left in track-changes so that the reviewers can easily see them.

Regards,

Steven Ndugwa Kabwama MSc Public Health

Comment

Reviewer #1
I suggest to add more sentences on the setting
Response: We agree with the reviewer and have added more detail on the sampling and methods used
Reviewer #2
Your manuscript was well written and good readable. I was not familiar with eating habits in Africa/Uganda, but one point especially strikes me and seems to me a very important element in public health strategies in your country: the geographical significance in fruit/vegetable consumption.
Response: We thank the reviewer for this positive comment.
In your discussion it is linked to cultural diversity and its influence on food choices: is there any possibility that it also can be linked to macro-socioeconomic and geographical differences (and as such be important in public health prioritisation on a higher policy level)? Optional, it would be an extra asset in this perspective to do a multilevel analysis e.g. based on regions (or other relevant geographical grouping, e.g. Including some aggregated variables like socioeconomic status of the region,…) and/or map/visualise the consumption by e.g. regions.
Response: The reviewer is wondering whether there could be deeper explanations of the observed geographical differences in fruit and vegetable intake aside from the cultural diversity as is explained in the paper currently. This is a valid concern considering that one has to have the economic resources to afford the fruits and vegetables. The conduct of the survey was designed taking into account estimates for urban and rural residence (Page 5, Lines 97-98). The fact that this variable was not statistically significantly associated with fruit and vegetable intake in the adjusted model implies that social economic status might not be a strongly associated with fruit and vegetable intake. Also, in developing countries like Uganda, level of completed education is another proxy indicator for social economic status. Both level of education and urban/rural residence were included in the adjusted model and were found to not be significantly associated with fruit and vegetable intake.
On whether another geographical grouping could be used, this cannot be done with the data available that were used in the current paper.
Page 4 study design: Although there is reference to other publication on the topic sample size and sampling procedures, I would prefer somewhat more text so that it easier to know to which extend your sample is representative for your country.
Response: We agree with the reviewer and have added more detail on the sampling and methods used to obtain a sample that was representative of the national population. Page 5, Lines 95-102, Page 6, Lines 118-121
Page 6, backward stepwise elimination: the removing of the variables: what was the level of statistical significance to remove variables?
Response: We thank the reviewers for this comment and have clarified that the cut-off for statistical significance was a p-value of <0.05. Therefore, variables with a p-value ≥0.05 were removed from the model. Page 6 Lines 139-141
The goal is adjustment for confounding, but how did you assure that you did not have colliding variables (that might cause bias) in your model?
Response: We agree with the reviewer and have included in the methods section how we investigated for multicollinearity in the variables that were included in the regression model. (Page 6 Lines 141-152)
"When building a multiple regression model, including variables that are highly correlated affects the integrity of the model leading to wrong estimates of the standard errors.
We thus investigated multicollinearity in the regression model using the variance inflation factor where by a mean variance inflation factor less than 10 showed that there was no multicollinearity. The pairs of variables investigated include level of education and urban/rural residence, employment status and level of education and urban/rural residence and employment status.

In the results section, we have also included the results of the multicollinearity where none of the pairs of variables investigated revealed multicollinearity. Page 8, Lines 175-176. "The three pairs of variables investigated for multicollinearity yielded mean variance inflation factors less than 10 meaning that there was no multicollinearity in the regression model."

It is noted that marital status is strongly associated with fruit/vegetable consumption. Has it the same importance for men and women, or not? (or: did you examined the Interaction term Sex*marital status?) Response: This is a very insightful suggestion by the reviewer – to assess whether fruit and vegetable consumption differs by sex among those who are married. We thus went ahead to investigate this by including sex##marital status as an interaction term and found that this was not statistically significant and have thus chosen to present these data independently as they are.

It is an interesting choice to use Possion regression and PRR and I understand the scope of your article is to examine the adherence to the guidelines. Did you test your Poisson also on a non-binary outcome, but e.g. on the whole range of mean fruit/vegetable servings per day? Response: We thank the reviewer for rightly noting that the intent was to examine adherence to a standard/ guideline and that is why we used a binary outcome i.e. those that met the standard/ guideline compared to those that did not. In otherwords, the objective was not looking at quantities (or numbers) per se but whether the recommended quantity was met or not.

With Poisson you can find out more than only the event (yes/no) and have more details on the number of events as such. It would be interesting to know if your conclusions on the relevance of your covariates remains the same (because the path to 5 consumption per day is influenced by the gradual increase in the number of consumptions). We agree with the reviewer that the number of fruits and vegetables could reveal some useful information. However, we believe that this would be beyond the scope of the current paper. The WHO and the Dietary guidelines from the nutrition committee of the American Heart Association recommend a minimum of 5 servings of fruits and/or vegetables per day in a typical week and that is why we opted to use this as a cut off to obtain a binary variable of those who did meet the recommendation and those who did not meet the recommendation. These references have been indicated in the methods section.

Reviewer #3:
Overall comments: This is a concise and well-written manuscript with important new information for the fields of nutrition, public health and preventative medicine. It offers a strong estimate of poor fruit and vegetable intake, and provides a clear and interesting evaluation of potential risk factors. Response: We thank the reviewer for this positive comment.

It lacks some important measurement details and would benefit with discussion on the possibility of selection bias, as evidenced by the disproportionately high number of female participants.
Response: This is a pertinent observation by the reviewer considering that 40.2% were males and 59.8% were females. The survey utilized a three stage sampling design to obtain a sample that is representative of the national population so apart from random error, it is difficult to point to how the selection bias could have been introduced. However, considering that the survey was conducted during
the day during working hours where males are more likely to be away at work compared to females might explain the higher number of female participants. The possibility of this bias has been acknowledged in the limitations section of the paper. We also acknowledge the possibility of a selection bias that could have been introduced because the data collection was carried out during the day at times when men are more likely to be away from home which could explain the disproportionately higher number of female participants compared with males. Limitations section, Page 12 Lines 260-266

Abstract

Summary: This is a community-based survey, utilizing the STEPwise approach, was used to assess the prevalence of adequate fruit and/or vegetable intake in Uganda. Of 3962 participants, only 12.2% reported adequate intake. Interestingly, analysis of commonly collected demographic data identified potential risk factors of being single or living in the Western region.

Response: We thank the reviewer for this positive comment.

Comments: Well written. The first sentence in the conclusion is redundant. Response: We agree with the reviewer and have deleted the redundant sentence

Introduction
Summary: Fruit and vegetable consumption have a quantifiable impact on mortality, of which nearly 1/3 is ischemic heart disease. Given this potential area for intervention and the limited population-based dietary intake data in Uganda Comments: Every line is relevant and provides an excellent introduction to the topic. Response: We thank the reviewer for this positive comment.

Study design
Summary: WHO STEPwise approach was to collect data for baseline, cross-sectional study between March and July 2014.

Comments: Although the authors make clear that the study design has been described in detail in previous papers, it would be helpful for the reader to have a few of the design components included here. I see in previous papers by the authors that a random sample of 350 enumeration areas was selected out of 78,950. From each of these enumeration areas, 14 households out of approximately 150-200 households were randomly selected from a list. Trained research assistants then visited each household and used a personal digital assistant (PDA) to randomly select one individual from the household to complete the survey on site. Eligible subjects were household members aged 18 to 69 years, who had resided in the sampled households for at least six months preceding the date of interview. I suggest that authors include a brief statement, similar to the above, that allows the reader to understand that the goal was to interview approximately 14 individuals from each enumeration site, resulting in 4,900 surveys. Response: We agree with the reviewer and have added more detail on the sampling and methods used to obtain a sample that was representative of the national population and the conduct of the survey. Page 5, Lines 95-102, Page 6, Lines 118-121

Measurements
Summary: Participants answered interview questions on the frequency of fruits and vegetables per week, and number of servings eaten on one of those days. Height, weight and blood pressure, and blood glucose were also measured.
Comments:

1. How was the "typical day" during the interview decided? Was it the most recent day when fruits and/or vegetables were consumed? If there was not a systemized method for determining the "typical day," please include this in the discussion on limitations.  
Response: We agree with the reviewer. The interpretation of a ‘typical’ day was left to the interviewee which could have introduced bias. This limitation has been acknowledged in the limitation section of the paper. Limitations section Page 12, Lines 266-270

2. What qualified as "fruits and/or vegetables"? Were these described to the participants? Please include a statement either defining "fruits and/vegetables" or defining exclusionary products (i.e. anything in a package, ketchup, potato flakes, etc.) and whether this was explained as part of the protocol.  
Response: We thank the reviewer for this comment. In the methods section, we describe that ”A show card was used to show participants pictures of examples of commonly available fruits and vegetables in Uganda, with each picture representing the size of one serving.” Page 5 Lines 111-112. Thus, anything in a package, ketchup, or other processed items were not included among the examples of fruits and vegetables.

3. Were all Steps completed on the same day and/or onsite at the location of the participant's household? Please include these details in the methods.  
Response: The 3 steps of data collection were conducted over 2 days and this has been clarified in the methods section Page 6 Lines 118-121: "Data collection was conducted over 2 days whereby the interview (STEP 1) and physical measurements (STEP 2) were done on the first day while the biochemical measurements (STEP 3) were conducted the next day among participants reporting compliance with an overnight 8-hr fast, no exercise or smoking."

Statistical Analysis
Summary: Fruit and/or vegetable consumption were dichotomized by achievement of 5 servings on a given day. PRRs were used in the evaluation of potential risk factors. Weighted modified Poisson regression was used instead of logistic regression in model development.  
Comments: Since there is no consensus on which risk estimate to report and how to analyze it, the authors present an adequate justification for the use of PRRs and modified Poisson regression method. This is demonstrated to be useful in high prevalence clustered exposures. Specifically, lines 117 and 118 argue that a weighted modified Poisson regression is preferred over logistic regression analysis because it improves the estimation of the standard errors of the estimated risk ratios. The references cited referred to analyses using prospective data that compare risk estimates. Although common in clustered analyses, are there additional studies to demonstrate the use of modified weight Poisson risk estimate in cross-sectional studies rather than prospective studies? Please report here.  
Response: We agree with the reviewer and have included a reference to show the robustness of Prevalence Risk Ratios (PRRs) obtained using modified poisson regression compared with logistic regression in cross sectional studies. (Reference 15: Barros AJ, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med Res Methodol. 2003;3(1):21.)
Results

Summary:

Comments:
1. The percentage of female participants is disproportionately high. Please report this and include in discussion. Response: We agree with the reviewer and have included this in the limitation section. The possibility of this bias has been acknowledged in the limitations section of the paper Page 12 Lines 260-266. "We also acknowledge the possibility of a selection bias that could have been introduced because the data collection was carried out during the day at times when men are more likely to be away from home which could explain the disproportionately higher number of female participants compared with males."

2. Were the demographic risk factors assessed by region? Did BMI differ by region? If these were analyzed but not reported in the tables due to space, briefly mention any significant findings and include in the discussion on regional differences and possible effect modification. Response: We thank the reviewer for this suggestion. Effect modification occurs when the association between a predictor and an outcome differs by a third separate categorical variable. Since the adjusted model showed that region of residence and marital status were significantly associated with fruit and vegetable consumption, we investigated which other independent categorical variables could modify the association between region of residence and fruit and vegetable intake, and marital status and fruit and vegetable intake. We investigated these by including them one at a time into the regression model and then removing them if they were not significant.

Using intuition and scientific and logical plausibility, the variables that could modify the association between marital status and fruit and vegetable intake were sex (sex#marital status), age (agegroup#marital status), employment status (employment status#marital status), education (education level#marital status), urban/ rural residence (urban/rural residence#marital status).

Using intuition and scientific and logical plausibility, the variables that could modify the association between region of residence and fruit and vegetable intake were sex (sex#region), age (age group#region), employment status (employment status#region), urban/ rural residence (urban/rural residence#region).

None of the interaction terms were statistically significant indicating that there was no effect modification.

Discussion
Summary: The majority of Ugandan adults do not report meeting fruit and vegetable recommendations, and this is not dissimilar to reports from other Sub-Saharan African countries. Reasons for the low prevalence include regional variations in fruit and vegetable access, agricultural focus on cash crops. Risk factors identified in this survey in marital status and region. Mechanisms for this relationship include spousal interest and control over his or her partner's diet, and cultural identities attached to food staples. Interestingly, age, gender, level of education, and knowledge about fruit/vegetable consumption were not found to be significantly related to reported fruit and vegetable consumption.
Comments: Overall, the discussion is clear and useful, but is missing some key points:

1. As mentioned in the measurements section, please discuss what constituted a typical day in the limitations. Response: We agree with the reviewer. The interpretation of a ‘typical’ day was left to the interviewee which could have introduced bias. This limitation has been acknowledged in the limitation section of the paper. Page 12 Lines 266-270.

2. Please discuss the high proportion of female participants in this study its implication towards food recall. What sort of bias and in what direction might it influence the point estimate if mostly females are reporting fruit and/or vegetable intake? We thank the reviewer for this observation. It is possible that the high number of female participants has a potential to bias the results of the recall of an individual’s servings of fruits and vegetables. Indeed, the prevalence of consumption of adequate servings of fruits and vegetables was higher among males compared to females i.e. 13% for men compared with 11.7% among women because of the larger denominator. This could have led to an over estimation of the number of people that consume the adequate servings of fruits and vegetables meaning that in reality this number could be lower. This could have biased our results away from the null. All this has been included in the limitations section : Page 12 Lines 260-266.

In Table 2, I see that there was no detected difference between male and female participants. Who are the men that are not included in this sample? Please discuss this possible selection bias in limitations.

We agree with the reviewer and have acknowledged the fact that women might have been over sampled in this survey. We have also indicated the direction of the possible bias. Page 12 Lines 260-266. "We also acknowledge the possibility of a selection bias that could have been introduced because the data collection was carried out during the day at times when men are more likely to be away from home which could explain the disproportionately higher number of female participants compared with males. Indeed, the prevalence of consumption of adequate servings of fruits and vegetables was higher among males (13.0%) compared with females (11.7%) because of the larger denominator which could have biased the results away from the null."

In addition, please compare with other studies published from this survey to determine if distribution of sex amongst food responders was similar to other item responders.

We thank the reviewer for this comment. We have found that the distribution of sex i.e. 1591 (40.2%) males and 2371 (59.8%) is similar to what has been published in earlier studies as shown in the table below.

<table>
<thead>
<tr>
<th>Assessment</th>
<th>Males (%)</th>
<th>Females (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tobacco (Kabweama et al 2016)</td>
<td>1601 (40.2)</td>
<td>2382 (59.8)</td>
<td>3983 (100)</td>
</tr>
<tr>
<td>Hypertension (Guwatudde et al 2015)</td>
<td>1570 (40.2)</td>
<td>2336 (59.8)</td>
<td>3906 (100)</td>
</tr>
<tr>
<td>Alcohol (Kabweama et al 2016)</td>
<td>1585 (40.2)</td>
<td>2371 (59.8)</td>
<td>3956 (100)</td>
</tr>
</tbody>
</table>

3. If significant associations between demographic risk factors and regions, such as BMI mentioned above, please discuss the role of possible effect modification. Effect modification occurs when the association between a predictor and an outcome differs by a third separate categorical variable. Since the adjusted model showed that region of residence and marital status were significantly associated with fruit and vegetable consumption, we investigated which independent categorical variables could modify the association between region of residence and fruit and vegetable intake, and marital status and fruit and vegetable intake. We investigated these by including them one at a time into the
regression model and then removing them if they were not significant.

Using intuition and scientific and logical plausibility, the variables that could modify the association between marital status and fruit and vegetable intake were sex (sex#marital status), age (agegroup#marital status), employment status (employment status#marital status), education (education level#marital status), urban/ rural residence (urban/rural residence#marital status).

Using intuition and scientific and logical plausibility, the variables that could modify the association between region of residence and fruit and vegetable intake were sex (sex#region), age (age group#region ), employment status (employment status#region), urban/ rural residence (urban/rural residence#marital status).

None of the interaction terms were statistically significant indicating that there was no effect modification.

4. Lines 177-180: The authors discuss the estimated 105.5 kg of available fruit and vegetables per person per year in the Africa region. Is there such an estimate for Uganda? Even more so, is there an estimate for each region in Uganda? If so, please include here. We agree that the ideal comparison here should have been the quantities of fruits and vegetables per person per year by region. However, these data are not available regionally. However, we have included the quantities for Uganda which is 64.2kg per person per year, which is 43% of the recommended 146kg per person per year. We thank the reviewer for this recommendation. Page 9 Lines 200-202

In addition, is this low availability of fruits and vegetables different from the past? Please include prior WHO and FAO data to establish whether there has been an overall change in the availability.

Although this is a pertinent question, there are no updated data and statistics on fruit and vegetable intake at national level by the WHO and FAO. The reference used in this manuscript was a background paper for the joint FAO/WHO workshop on Fruits and vegetables for health in 2004 and no other data have ever been published before or after that one.

5. Lines 234-236: There are two problems with the statement presented in these lines. First, the authors state that there is substantial evidence to suggest that nutrient intakes are similar between weighed records and recall questionnaires; however, the topic of this paper is fruit and vegetable consumption so it would be relevant if the statement could reflect that. We agree with the reviewer’s suggestion and have revised the sentence to reflect the comparison to fruit and vegetable consumption.

"However, there is also a substantial body of evidence to show that there are no significant differences between estimates of nutrient intake using weighed records and recall questionnaires as is the case with the recall of the number of servings of fruits and vegetables that was used in the current paper." Second, the authors reference a study (Bingham, 1994) that compares seven different dietary assessment methods that, contrary to the authors' implication, actually reports significant vegetable intake differences between the 16-day weighed food record (the gold standard) and the Oxford food frequency questionnaire, the Cambridge food frequency questionnaire, the 7d season checklist and the 7d season checklist with portions (Table 6). I suggest redirecting this reference to highlight that even though the validity of the individual survey question on fruit and vegetable consumptions remains to be validated in the study population, the validity of other forms recall measures of fruit consumption is
supported in a European population by the Bingham study. Vegetable intake, however, remains uncertain. We agree with the reviewer and have reworded this limitation as recommended Page 12 Lines 257-267. "However, there is also a substantial body of evidence to show that there are no significant differences between estimates of nutrient intake using weighed records and recall questionnaires as is the case with the recall of the number of servings of fruits and vegetables that was used in the current paper. Furthermore, even though the validity of the individual survey question on fruit and vegetable consumption remains to be validated in the study population, the validity of other forms of recall measures of fruit consumption is supported in European population by the Bingham study. Vegetable intake however remains uncertain. Thus the presence of this bias could have affected the validity of the results."

Conclusions
Summary: There is low fruit and vegetable consumption, overall, and this may be associated with marital status and regional variation. Public health initiatives should consider impediments to healthy fruit and vegetable consumption. Agricultural policy-makers should also consider the consequences to the public's diet.

Comments:
Lines 240-241: The statement "There is a need to promote nutritional education for people to appreciate the value of fruits and vegetables in their diet in terms of its quantity and quality" is not supported by the data in this study (Table 3). However, there is a need to better understand the level of people's understanding of fruits and vegetables, and whether nutritional education may be an appropriate focus on the improvement of the Ugandan dietary behaviors. I suggest changing the original statement to qualify as such. We thank the reviewer for this comment and have reworded the conclusion as the reviewer has suggested. Page 13 Lines 280-283

References:
Comments: Line 332. An extra period before the word "Prevalence." The extra period has been removed.

Tables and figures:
Comments: No concerns Noted.