

## PEER REVIEW HISTORY

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### ARTICLE DETAILS

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| <b>TITLE (PROVISIONAL)</b> | The silent epidemic of obesity in The Gambia: Evidence from a nationwide population-based cross sectional health examination survey |
| <b>AUTHORS</b>             | Cham, Bai; Scholes, Shaun; Ng Fat, Linda; Badjie, Omar; Groce, Nora Ellen; Mindell, Jennifer S.                                     |

### VERSION 1 – REVIEW

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| <b>REVIEWER</b>        | Carlos H Orces<br>Laredo Medical Center<br>Laredo, TX, USA |
| <b>REVIEW RETURNED</b> | 20-Sep-2019  |

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| <b>GENERAL COMMENTS</b> | The authors have conducted a secondary data analysis of a national survey to examine the prevalence of generalized and abdominal obesity among adults aged 25 to 64 years in the Gambia. The results clearly demonstrated that obesity has become a major public health problem in this country, which was mostly associated to gender urbanization, ethnicity, income, and low physical activity. I believe the prevalence of abdominal obesity among men is most likely underestimated using the IDF waist circumference cutoff points of 80 cm. Indeed, the mean abdominal circumference in the study population was 74 cm. Therefore, the authors should describe this study limitation. |
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| <b>REVIEWER</b>        | Benn Sartorius<br>London School of Hygiene and Tropical Medicine<br><br>I am employed at the same institution as some of the co-authors but I don't not know them nor do I work with them in any capacity. |
| <b>REVIEW RETURNED</b> | 12-Dec-2019  |

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| <b>GENERAL COMMENTS</b> | Major<br>General: The study presents findings from a national cross sectional STEPS survey among the adult population of The Gambia. Most estimates from The Gambia are now out of data (more than 20 years ago) and one prominent contribution of the work is new data and estimates for overweight/obesity prevalence and associated predictors. However, the novelty/contribution of this work needs to be substantially improved and expanded. From a policy perspective, it would be important to visualisation map prevalence of obesity and overweight by gender across The Gambia to highlight high vs lower prevalence areas as well as rural vs urban differences. Secondly many key confounders do not appear to have been accounted for in the methods/analysis e.g. household income or socio-economic status and unhealthy food |
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consumption which may very well confound the relationship with higher education documented in this paper. If these were not measured then this would be a significant limitation and if they were than I would suggest inclusion in the analyses. Thirdly, I think it would be useful to triangulate the prevalence vs predictors to identify how these predictors vary across The Gambia geographically and how this might explain in the part the spatial distribution alluded to in my first point above. I have some further comments below which I hope will be of use. Lastly, as the primary study employed sampling weights as per the multistage random sampling design, it would be worth considering extrapolating the prevalence to estimate absolute population counts (with 95% CIs) to further increase the policy relevance (this would provide a useful additional panel to the prevalence map whereby population counts of overweight/obese are mapped across The Gambiae).

The article is missing a STROBE checklist. Please include in the supplementary material.

Study design, Independent covariates/predictor variables: was household income or socio-economic status not measured? This is not listed in the methods or presented in the results and this would be a major predictor and/or confounder. Especially given the finding of higher education as a risk factor for obesity.

Study design, Independent covariates/predictor variables: in addition to fruit/vegetable consumption were there no questions regarding unhealthy or fast food consumption?

Visualisations: I would suggest that a map of obesity prevalence by gender be included. This will highlight heterogeneity within the country and be useful from a policy guidance perspective. This can be a map down to the lowest administrative health unit or using household coordinates to produce a smoothed risk surface i.e. Gaussian kernel based smoothing approach.

Methods, "The analytical sample was restricted to non-pregnant participants with valid weight and height data (n=3533)." Unclear what number were excluded i.e. how many did not have a valid weight/height measurement or did not have a measurement taken? How many participants were sampled? Please see comment below – what was the target sample size? I think a flow diagram showing the target sample size and breakdown to the final sample used and exclusions will be useful.

Abstract – important to mention that income/socio-economic status not determinant otherwise reader will wonder if this was measured and/or what confounding effect it would have on the finding of higher education being a risk factor for obesity.

Abstract, conclusions: "While obesity rates in rural areas was lower than urban areas, a rising rate of obesity in rural areas is also of concern." The design of the study does not support this i.e. this is a cross sectional study not longitudinal.

Introduction, general: I think the structure and flow can be improved as well as the justification for this study. More specific comments for this section are below.

Introduction - Reference 2 – "2. WHO. Noncommunicable diseases Factsheet 2017 [updated 06/07/2017; cited 2017 12/07/2017].

Available from:

<http://www.who.int/mediacentre/factsheets/fs355/en/>." I would suggest rather giving more direct source(s) i.e. references for the

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|  | <p>estimates referred to in the introduction, namely “NCDs account for 70% of global deaths; 80% occur in low- and middle-income countries.2.”</p> <p>Introduction – “A great concern is the rapid increase of obesity in SSA.” Please include relevant reference(s) to support this statement. This statement may also more logically be placed at start of paragraph 2 in the introduction which further delves in this theme.</p> <p>Introduction – “Countries in SSA face the challenge of the double burden of communicable and noncommunicable diseases, namely that of underweight/malnutrition and obesity.” This statement does not make sense as not all underweight/malnutrition is due to communicable disease.</p> <p>Introduction, paragraph 3 – I think you can strengthen the rationale for why this study given that most data/previously estimates are pre 2000?</p> <p>Introduction, paragraph 4 – I would also suggest to re-iterate the linkage to the halt of obesity 2025 target as obesity is a precursor metabolic risk statement which increases risk of NCD mortality i.e. “reduction in premature mortality due to NCDs by one-third by 2030.”</p> <p>Methods, sampling strategy and size: I think a brief indication of the target sample size, power or precision calculation and sampling strategy (multistage random I presume) are required. Most readers will not refer to the previously described reference.</p> <p>Methods, multivariate model: no mention of the strategy used for model building i.e. from univariate to multivariate. Also there is not mention of assessment of model fit/adequacy.</p> <p>Results, Characteristics of participants: “Average levels of BMI and waist circumference were higher among women.” This needs summary statistics and p-values.</p> <p>Results, Prevalence of underweight, overweight and obesity: “Among both men and women, the prevalence of overweight and of obesity were substantially higher among urban residents, those with a higher level of education, those physically inactive, and those with a high waist circumference.” Linking overweight/obesity prevalence with high waist circumferences does not make sense.</p> <p>Discussion, page 20, “A potential positive finding from this study is that higher rates of obesity are found among those with higher incomes,..” Not sure how this conclusion can be arrived at as no analysis of income is presented in the main results.</p> <p>Minor</p> <p>Abstract – I suggest including the target sample size in addition to the attained and response rate which is presented.</p> <p>Abstract – generalised obesity – need to include cut-off used for BMI. Similarly, for waist circumference (by sex) as different cut-offs have been proposed for specific ethnic groups.</p> <p>Abstract, results – “and urban residents. 10% of men and 8% of women were underweight.” Problem with sentence structure and comparative % among rural not provided.</p> <p>Methods, “We did not include smoking (in women) and alcohol consumption (both sexes) in the regression models due to their low prevalence.” This is out of sequence in this section.</p> |
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VERSION 1 – AUTHOR RESPONSE

Response to reviewers' comments

| No                | Reviewers comments  | Response to the editor   |
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| <b>Reviewer 1</b> |   |  |
|                   | <p>The authors have conducted a secondary data analysis of a national survey to examine the prevalence of generalized and abdominal obesity among adults aged 25 to 64 years in the Gambia. The results clearly demonstrated that obesity has become a major public health problem in this country, which was mostly associated to gender urbanization, ethnicity, income, and low physical activity. I believe the prevalence of abdominal obesity among men is most likely underestimated using the IDF waist circumference cut off points of 80 cm. Indeed, the mean abdominal circumference in the study population was 74 cm. Therefore, the authors should describe this study limitation.</p>  | <p>Thank you for this valuable comment. There is insufficient evidence on the recommended cut off point for waist circumference for sub-Saharan African populations. However, the WHO recommends using the IDF thresholds for Europeans among people of African descent (<math>\geq 80</math> cm and <math>\geq 94</math> cm for women and men respectively) but we used the threshold for Asians (<math>\geq 80</math> cm in women; <math>\geq 90</math> cm in men), as explained in lines 423-431 of the revised manuscript. We have now acknowledged the lack of evidence on the recommended cut off points for people in sub-Saharan Africa as a limitation.</p> |
| <b>Reviewer 2</b> |   |  |
| <p>1.</p>         | <p>The study presents findings from a national cross-sectional STEPS survey among the adult population of The Gambia. Most estimates from The Gambia are now out of data (more than 20 years ago) and one prominent contribution of the work is new data and estimates for overweight/obesity prevalence and associated predictors.</p> <p>However, the novelty/contribution of this work needs to be substantially improved and expanded. From a policy perspective, it would be important to visualisation map prevalence of obesity and overweight by gender across The Gambia to highlight high vs lower prevalence areas as well as rural vs urban differences.</p> <p>Secondly many key confounders do not appear to have been accounted for in the methods/analysis e.g. household income or socio-economic status and unhealthy food consumption which may very well confound the relationship with higher education documented in this paper. If these were not measured</p> | <p>Thank you for the opportunity to revise our manuscript and hope you feel we have done so adequately.</p> <p>You raised an important point by suggesting we include a map and triangulate the prevalence vs predictors to identify how predictors vary across the country. However, we submitted a table with the prevalence of obesity by region and feel that including a map of obesity prevalence would not add any value apart from a visual figure. It would also be a repetition of what we are already presenting.</p> <p>Information on household income was collected in the survey but the response rate was very low. We therefore used level of</p>   |

| No | Reviewers comments   | Response to the editor   |
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|    | <p>then this would be a significant limitation and if they were than I would suggest inclusion in the analyses.</p> <p>Thirdly, I think it would be useful to triangulate the prevalence vs predictors to identify how these predictors vary across The Gambia geographically and how this might explain in the part the spatial distribution alluded to in my first point above. I have some further comments below which I hope will be of use.</p> <p>Lastly, as the primary study employed sampling weights as per the multistage random sampling design, it would be worth considering extrapolating the prevalence to estimate absolute population counts (with 95% CIs) to further increase the policy relevance (this would provide a useful additional panel to the prevalence map whereby population counts of overweight/obese are mapped across The Gambia).</p> | <p>education as a measure of socioeconomic position, as is very common in many studies of socio-economic inequalities. This is now outlined as one of our study limitations. The WHO STEPwise survey approach which was used in this survey as outlined in the methodology collects information on fruit and vegetable intake and this was included in our model.</p> <p>Biochemical analysis of the level of cholesterol in the blood of survey participants was not collected in the survey. We have now mentioned the problem of unmeasured confounders in the limitations.</p> |
| 2. | The article is missing a STROBE checklist. Please include in the supplementary material.   | We included a STROBE checklist as part of the supplementary documents. It is now resubmitted indicating the sections where the relevant information can be found in the revised manuscript.  |
| 3. | Study design, Independent covariates/predictor variables: was household income or socio-economic status not measured? This is not listed in the methods or presented in the results and this would be a major predictor and/or confounder. Especially given the finding of higher education as a risk factor for obesity   | As explained in our response to comment 1 above, household income was collected but the response rate was very low and hence we used <u>education</u> as a measure of socio-economic status. We have now mentioned this in the study limitations. Therefore, we were unable to estimate the associations between education and the outcome variables after adjustment for income.  |
| 4. | Study design, Independent covariates/predictor variables: in addition to fruit/vegetable consumption were there no questions regarding unhealthy or fast food consumption?   | As outlined in our response to comment 1 above, the WHO STEP collects information on fruit and vegetable intake but does not collect information on fast food consumption. We have now mentioned the problem of unmeasured confounders in the  |

| No | Reviewers comments   | Response to the editor  |
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|    |  | limitations. Low level of fruit and vegetable intake was included in our analysis.  |
| 5. | <p>Visualisations: I would suggest that a map of obesity prevalence by gender be included. This will highlight heterogeneity within the country and be useful from a policy guidance perspective.</p> <p>This can be a map down to the lowest administrative health unit or using household coordinates to produce a smoothed risk surface i.e. Gaussian kernel based smoothing approach.</p>  | <p>Please refer to our response to comment 1 above regarding mapping the data.</p> <p>Using household coordinates to produce a smoothed risk surface using the Gaussian kernel based smoothing approach is beyond the scope of this research. The WHO STEP survey approach was used to collect data and there is no information on household coordinates in the data.</p> |
| 6. | <p>Methods, “The analytical sample was restricted to non-pregnant participants with valid weight and height data (n=3533).” Unclear what number were excluded i.e. how many did not have a valid weight/height measurement or did not have a measurement taken? How many participants were sampled? Please see comment below – what was the target sample size? I think a flow diagram showing the target sample size and breakdown to the final sample used and exclusions will be useful</p> | <p>Thank you for bringing this to our attention. We have now included a flow chart with these details as Figure 1.</p>  |
| 7. | <p>Abstract – important to mention that income/socio-economic status not determinant otherwise reader will wonder if this was measured and/or what confounding effect it would have on the finding of higher education being a risk factor for obesity.</p>  | <p>We now explain that income was not included in our analysis, in the main document. Therefore, we were unable to estimate the associations between education and the outcome variables after adjustment for income.</p>   |
| 8. | <p>Abstract, conclusions: “While obesity rates in rural areas was lower than urban areas, a rising rate of obesity in rural areas is also of concern.” The design of the study does not support this i.e. this is a cross sectional study not longitudinal.</p>  | <p>Thank you for bringing this to our attention. We came to this conclusion by comparing our findings with previous findings. We now have reframed the sentence to make this clearer to the readers.</p>  |
| 9. | <p>Introduction, general: I think the structure and flow can be improved as well as the justification for this study. More specific comments for this section are below.</p>   | <p>Thank you for this suggestion. We have now revised the introduction and justification of the study.</p>  |

| No  | Reviewers comments  | Response to the editor   |
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| 10. | Introduction - Reference 2 – “2. WHO. Noncommunicable diseases Factsheet 2017 [updated 06/07/2017; cited 2017 12/07/2017]. Available from: <a href="http://www.who.int/mediacentre/factsheets/fs355/en/">http://www.who.int/mediacentre/factsheets/fs355/en/</a> .” I would suggest rather giving more direct source(s) i.e. references for the estimates referred to in the introduction, namely “NCDs account for 70% of global deaths; 80% occur in low- and middle-income countries.2.” | Thank you for this comment. The information is from the WHO 2017 factsheet on non-communicable diseases. We have now updated this with more recent information.  |
| 11. | Introduction – “A great concern is the rapid increase of obesity in SSA.” Please include relevant reference(s) to support this statement. This statement may also more logically be placed at start of paragraph 2 in the introduction which further delves in this theme.  | Thank you for this suggestion. We have now moved this statement to the second paragraph and provided references to support the statement.  |
| 12. | Introduction – “Countries in SSA face the challenge of the double burden of communicable and noncommunicable diseases, namely that of underweight/malnutrition and obesity.” This statement does not make sense as not all underweight/malnutrition is due to communicable disease.   | <p>We have rephrased the text to make this clearer, and have also cited a recent publication on the issue: ‘Countries in SSA face the challenge of the double burden of communicable and non-communicable diseases, and also the double burden of underweight/malnutrition and obesity.’ (Pokin, Barry M et al. The Lancet, 395;10217, 65-74<br/> <a href="https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(19)32497-3/fulltext">https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(19)32497-3/fulltext</a>)</p> <p>We have also clarified a similar statement about Banjul in line 92 replacing ‘and’ with ‘exacerbated by’:</p> <p>‘A study using data from 1942 to 1997 on the causes of death in The Gambian capital Banjul documented the double burden of non-communicable diseases with communicable diseases <b>exacerbated by</b> malnutrition.<sup>15</sup>’</p> |
| 13. | Introduction, paragraph 3 – I think you can strengthen the rationale for why this study given that most data/previously estimates are pre 2000?<br>Introduction, paragraph 4 – I would also suggest to re-iterate the linkage to the halt of obesity 2025 target as obesity is a precursor metabolic risk   | Thank you for this suggestion, we have now strengthened the rationale of the study and linked it with the Global 2025 targets.   |

| No  | Reviewers comments   | Response to the editor  |
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|     | statement which increases risk of NCD mortality i.e. “reduction in premature mortality due to NCDs by one-third by 2030.”  |   |
| 14. | Methods, sampling strategy and size: I think a brief indication of the target sample size, power or precision calculation and sampling strategy (multistage random I presume) are required. Most readers will not refer to the previously described reference.   | Thank you for this comment. This paper was based on secondary analysis of WHO STEP survey data. We have now outlined the sampling strategy in the methods section.  |
| 15. | Methods, multivariate model: no mention of the strategy used for model building i.e. from univariate to multivariate. Also there is not mention of assessment of model fit/adequacy.   | Thank you for bringing this to our attention, the strategy used for model building is now explained in the methods section. We did not conduct model fit assessment, and this is now explained in the methods.  |
| 16. | Results, Characteristics of participants: “Average levels of BMI and waist circumference were higher among women.” This needs summary statistics and p-values.   | The summary statistics and confidence intervals were presented in Table S1. We have now included this in the main text to guide the readers.  |
| 17. | Results, Prevalence of underweight, overweight and obesity: “Among both men and women, the prevalence of overweight and of obesity were substantially higher among urban residents, those with a higher level of education, those physically inactive, and those with a high waist circumference.” Linking overweight/obesity prevalence with high waist circumferences does not make sense. | Thank you for this comment. We were just trying to show the groups with the highest level of underweight, overweight and obesity but waist circumference was not included in the model for generalised obesity and vice versa as explained in the methodology. The phrase is now deleted in the revised manuscript. |
| 18. | Discussion, page 20, “A potential positive finding from this study is that higher rates of obesity are found among those with higher incomes,..” Not sure how this conclusion can be arrived at as no analysis of income is presented in the main results.   | Thank you for bringing this typo to our attention. Education was used as the measure of socio-economic position. We have now rephrased the sentence and checked the rest of the manuscript for consistency and accuracy.  |
| 19. | Abstract – I suggest including the target sample size in addition to the attained and response rate which is presented.  | We have revised as suggested.   |

| <b>No</b> | <b>Reviewers comments</b>   | <b>Response to the editor</b>  |
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| 20.       | Abstract – generalised obesity – need to include cut-off used for BMI. Similarly, for waist circumference (by sex) as different cut-offs have been proposed for specific ethnic groups. | We have revised as suggested.  |
| 21.       | Abstract, results – “and urban residents. 10% of men and 8% of women were underweight.” Problem with sentence structure and comparative % among rural not provided.                     | The word limit for the abstract is 300 words. Therefore for the purposes of clarity we have removed the part of the sentence outlining the higher prevalence in urban areas. |
| 22.       | Methods, “We did not include smoking (in women) and alcohol consumption (both sexes) in the regression models due to their low prevalence.” This is out of sequence in this section.    | Thank you for bringing this to our attention. We have now moved this sentence to the modelling section.  |