Author’s response to reviews

Title: Association of the client-provider ratio with the risk of maternal mortality in referral hospitals: A multi-site study in Nigeria

Authors:

Friday Okonofua (feokonofua@yahoo.co.uk)
Lorretta Ntoimo (lorretta ntoimo@fuoye.edu.ng)
Rosemary Ogu (rosemary.ogu@ uniport.edu.ng)
Hadiza Galadanci (hgaladanci@yahoo.com)
Rukiyat Abdus-salam (deolaabdussalam@gmail.com)
Mohammed Gana (mohammedalhaji2003@yahoo.com)
Ola Okike (onmokike@yahoo.com)
Kingsley Agholor (knagholor@yahoo.com)
Abe Eghe (ognosa@yahoo.com)
Adetoye Durodola (adetoye.durodola@gmail.com)
Abdullahi Randawa (ajrandawa@gmail.com)

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Reviewer reports:

Reviewer #1: General Comments -

This study investigates the association between clients-provider ratios providing antenatal and delivery care in eight Nigerian referral hospitals and the risk of maternal mortality in the hospitals. The study attempts to explore the relationship between the number of maternal deaths and the total number of healthcare providers within the referral hospitals by adopting a cross-sectional study design and conducted across four out of the six geo-political zones of Nigeria. The paper was well-written, however comments below which are provided as feedback to the authors are classified as 'Minor essential revisions' which should be addressed before the manuscript is considered for publication and 'Discretionary revision' which are suggestions which the authors can choose to adopt or reject.
Minor Essential Revisions -

1. There is need for more descriptive information about the selected referral hospitals, for e.g. what is the estimated catchment population for each hospital? what are the referral systems and networks for the selected hospitals? on average what is the monthly number of complicated deliveries or emergency obstetric cases referred to these hospitals? More descriptive information about the selected hospitals will give much needed context and provide the reader with a greater appreciation of the selected hospitals.

Response: Thank you for your review. This information and details have now been added to the manuscript.

2. It will be helpful for the authors to provide more information around the selection criteria for the selected hospitals for this study or the formative research which the study is based on. It is noted that the authors mentioned that the selected hospitals covered four out of the six geo-political zones of Nigeria and that there were two tertiary and six secondary level referral hospitals. Also on Page 8/9, the authors indicate that "only the hospitals that agreed to participate....were enlisted into the study", but the selection criteria used by the authors is not clear! So for instance, why was Karishi General Hospital and General Hospital Minna selected and not other referral hospitals within North-Central Nigeria? This also applies to other referral hospitals selected within other geo-political zones of the country. Hopefully, the selection criteria will also explain why the 2 tertiary hospitals selected for the study were in the northern part of Nigeria while no tertiary hospital was selected from the southern part of the country.

Response: This has now been described in detail in the manuscript.

Discretionary revision -

1. Within the paper, it maybe good to substitute 'quantum' with another word e.g. number, density etc. as 'quantum' is not a term typically associated with health workers!

Response: The word quantum has been replaced by density and numbers as appropriate in various parts of the text.

2. What further insights can be drawn from the entirety of the study's dataset as well as the statistical association between births-provider ration, ANC attendee-provider ratio and maternal mortality beyond the current inferences mentioned in the paper including the inference that there is negative association between number of maternal deaths and number of healthcare providers? Despite the fact that the stated null hypothesis of the study has been investigated, more inferential analysis may provide even more insights from the dataset of the study. The decision to undertake further inferential analysis is left to the discretion of the authors and the decision of the journal's editors and editor-in-chief.
Response: We will do this when we undertake a secondary analysis of the dataset.

Reviewer #2: This appears to be a good study paper that tackles a critical health issue in Nigeria. However, there are some areas that may need further clarifications from my perspective. These are:

MAJOR REVIEW

In the Discussion, there is a sentence in Page14 that reads, "It was not surprising therefore that the Central Hospital, Benin had the highest numbers and ratio of maternal deaths, since it is evident that they mainly deal with women who had not received antenatal care, but who turned up at the time of delivery or when they experience complication". This tends to suggest that the data on births and maternal deaths in the hospital have been disaggregated into "booked' and 'unbooked" categories, can you provide this evidence perhaps in a table? If not please clarify. More so, if birth data is not disaggregated, one would want to believe that if Central hospital Benin conducts more emergency deliveries than others, then it is more likely to have higher percentage of deliveries than others, and not just more maternal deaths and less percentage births as is being presented.

Response: Information on the booked and unbooked categories was not collected in this dataset. That does not mean the hospitals do not have records of booked and unbooked patients. The discussion in this aspect has been modified.

MINOR REVIEWS

A. The results of the study clearly notes that less than 10% of ANC women deliver in the hospital (page 11 line 4), and, in the Discussion, there is a strong argument that increasing health workers in the facilities will improve maternal mortality. While partly agreeing with this view, the question becomes, can the birth outcome for the more than 90% that deliver outside the hospital alter this outlook? If yes, shouldn't a more impact-focused strategy be to investigate the other >90%.

Response: Yes, we agree with the need to study the more than 90% of women who failed to deliver in the hospitals after they registered for antenatal care. This will be a subject for a future study. We have included this remark in the relevant part of the manuscript.

B. If data on maternal deaths could not be accessed in a referral hospital (Karshi hospital in Page 10) over a three year period, can we trust other data like, live births, ANC and others from the same hospital? Are there reasons why they may be unwilling to make data on deaths that public?

Response: We inquired about this at the time we reviewed the data for this study. The Karshi Hospital (a General hospital) reported that they have a practice to refer all severely ill patients to the Abuja Teaching hospital for further treatment to prevent maternal deaths. So, they had no recorded maternal deaths during the period. For this reason, Karshi General hospital was not included in the Poisson regression and correlation analyses that are related to maternal mortality.
We have no reason to doubt the records for births, antenatal attendees and the number of providers for this hospital.

C. It is clear that the study period was for three years (Page8) from 2011-2013. It may be necessary to provide the specific months: Are we saying January 1st 2011 to December 31st 2013?
Response: Yes; thank you. Study period January 1st, 2011 to December 31st, 2013; Data collection period January 1, 2014 to June 30, 2014). This has been clarified in the manuscript.

D. The paper points out that Nigeria has six Geopolitical Zones and then understandably notes that the insurgency in the North East Zone made it impossible to conduct study in that area. However, the following statements, "We failed to sample women from the south-east zone in order to balance the representation and ensure that equal hospitals and women from the northern and southern parts of the country are represented in the sample. Thus, the results of the study are generalizable to the entire country and can be interpreted for policy making at national and subnational levels", tend to suggest that the need to balance southern and northern representation clearly overrides geopolitical representation. Is this true? Do the geopolitical zones in southern Nigeria have similar social, educational and economic configuration such that one can be substituted for the other? Is it possible to have allocated one of the four southern Nigeria slots to a hospital in the South-east zone?

Does the decision made above really strengthen the generalizability of the findings?

Response: Based on our knowledge, we believe that the four hospitals in the South and four in the north adequately represent the southern and northern zones and adequately represent the social and cultural differences between the two regions to make for adequate comparisons. In particular, selecting four hospitals from the south-west and south-south will be sufficient to represent the health systems realities in southern Nigeria. The same applies to the selection of hospitals in the north-central and north-west regions for northern realities. We believe that the data can be generalized to the wider Nigerian health systems context.

We thank you for the review and look forward to publishing with Reproductive Health.