Inequalities in Under-five Mortality in Nigeria: A Population-based Analysis of Individual- and Community-level Determinants

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Abstract

Background
Regions with geographically diverse ecology and socio-economic circumstances may have different disease exposure and child health outcomes. This study assessed variations in the risks of under-five deaths across regions of Nigeria and determined the individual- and community-level factors that explain possible variations between regions.

Methods
Multilevel multivariable logistic regression analysis was performed using a nationally-representative sample of 6029 children from 2735 mothers aged 15-49 years and nested within 365 communities from the 2003 Nigeria Demographic and Health Survey. Odds ratios with 95% confidence intervals were used to express measures of association between the characteristics. Variance partition coefficients and Wald statistic were used to express measures of variation.

Results
Patterns of under-five mortality cluster within families and communities. The risks of under-five deaths were significantly higher for children of mothers resident in the South South (Niger Delta) region. Individual-level (birth order and birth interval, mother’s age, mother’s education, and household wealth index) and community-level factors (percentage of mothers who had prenatal care by doctor and hospital delivery) were significantly associated with the risks of under-five deaths.

Conclusion
Findings suggest the need to differentially focus on community-level interventions aimed at increasing maternal and child health care utilization, changing birth spacing behaviour, and improving maternal socio-economic position especially in disadvantaged regions, such as the
South South (Niger Delta) region. Findings call for further studies on community-levels determinants of under-five mortality.

Introduction

The reduction of regional and socio-economic inequalities in mortality within countries is a major objective of national governments and international organisations [1-3]. To achieve this goal, determinants of high mortality among disadvantaged people, communities and regions need to be identified. The physical and ecological structure, political and impoverished socio-economic milieu in several countries in sub-Saharan Africa accounts for geographic variations in childhood mortality [4-6]. One such environment is the regional environment. Poor or polluted environments tend to expose children to disease-causing agents, predisposing them to high mortality risks [7]. In Nigeria, marked regional disparities in under-five mortality have been reported, with higher rates observed in the Northern regions than in the Southern regions [8-10]. Regional disparities in health-seeking behaviour have been reported regarding child immunization [11], maternal and child healthcare utilization [12], differences in the socio-economic composition [13], communicable diseases [13], childhood nutrition and malnutrition [14]. Other studies report higher proportions of home delivery and complications during childbirth [15], younger age of first marriage, younger age at birth of first child, ideal family size, lower knowledge and use of contraception in the Northern regions compared to the Southern regions [16].

Regional disparities in these parameters in Nigeria are associated with factors that distinguish these regions from each other. Some of these factors include differences in regional development, population density, prevalence of poverty and migration patterns. These are often interrelated aspects of the regional environment that are important for child health and well-being, and may also be relevant in exacerbating or mitigating inequities in resources and population health outcomes across regions [7]. Regions may either exert fair
independence and autonomy within nations (in which case they become even more salient for child health), or may exhibit greater centralization (in which case regional factors may not be as significant) [7]. A classic example of attempts to attain the former is the South South (Niger Delta) region in Nigeria [17]. Understanding the links between child survival and geographic location is crucial for exhibiting that, within nations, socio-political conditions (and associated factors) may not be homogeneous, and often lead to regional child health inequities. The aims of this study are two-fold: *i*) to determine whether there is significant variation in the risks of under-five deaths across regions of Nigeria; and *ii*) to determine the individual- and community-level factors that explain disparities in the risks of under-five deaths between regions.

**Data and Methods**

This study used data from the 2003 Nigeria Demographic and Health Survey (DHS), which is a nationally-representative sample, collected with a stratified two-stage cluster sampling procedure and performed according to the list of enumeration areas developed from the 1991 Population Census sampling frame. The first sampling stage involved selecting 365 clusters (primary sampling units) with a probability proportional to the size, the size being the number of households in the cluster. The second sampling stage involved systematically selecting households from the already selected clusters. This resulted in a nationally-representative probability sample of 7864 households, from which data were collected by face-to-face interviews from 3725 women aged 15 to 49 years who contributed a total of 6029 live born children born. An extensive report of the survey could be found elsewhere [18].

**Measures**
**Outcome**

The outcome variable is the risk of under-five death (0-59 months), defined as the probability of dying between birth and the fifth birthday.

**Exposures**

**Region of residence**

Region of residence of the mother was the main exposure variable, categorized according to the six geo-political zones in Nigeria, as: North Central, North East, North West, South East, South South and South West.

**Individual-level explanatory factors**

Nine additional individual-level factors of interest were examined: i) birth order and interval between births, a composite child-level variable created by merging “birth order” and “preceding birth interval” into one variable. The variable ‘preceding birth interval’ is the interval before the birth of the child in question; as such, the effect of the preceding birth interval is considered in relation to the younger of the two children. Frequently, first births are left out of the analysis of preceding birth interval and survival of the preceding child because they are not preceded by another birth. In order to enable the inclusion of first births in the analysis, birth order was merged with birth interval. The resulting variable was classified into seven categories as: first births, birth order 2-4 with short birth interval (<24 months), birth order 2-4 with medium birth interval (24-47 months), birth order 2-4 with long birth interval (48+ months), birth order 5+ with short birth interval (<24 months), birth order 5+ with medium birth interval (24-47 months), and birth order 5+ with long birth interval (48 months or longer); ii) sex of the child, grouped as: male and female; iii) mother’s age, grouped as: 15-18, 19-23, 24-28, 29-33, 34 years and older; iv) mother’s age at birth of first child, categorized on the basis of differentiating mothers into those with “early” and “late” marriages, as: 18
years or less and 19 years or older; v) marital status, categorized as: single, married and formerly married; vi) ethnicity, categorized as a) Hausa/Fulani/Kanuri, which were grouped on the basis of these ethnic groups either speaking a common language or dialect, share a common sense of identity, cohesion and history; or having a single set of customs and behavioural rules as in marriage, clothing, diet and taboos; b) Igbo; c) Yoruba; and d) Others (a merger of other minority ethnic groups); vii) mothers’ education, categorized as: no education, primary and secondary or higher education; viii) mother’s occupation, grouped as: professional/technical/managerial; clerical/sales/services/skilled manual; agricultural self employed/agricultural employee/household & domestic/ unskilled manual occupations; and not working; and finally ix) wealth index, applied in the analysis as a composite index and an indicator of the socio-economic status of households since the DHS does not generally collect information on household income or wealth. It is consistent with expenditure and income measures in low- and middle-income countries. It assigns weights or factor scores generated by principal component analysis to information on household assets collected from censuses and surveys. These indicators include those relating to household ownership of durable assets and household environmental conditions. Principal components analysis allows each asset owned to be given a score, and the factor loading scores used to create linear composites of each household socio-economic status variable. The scores were then summed up and divided into quintiles (poorest, poorer, middle, richer and richest) to represent different levels of wealth.

Community-level explanatory factors

Three community-level factors were used: i) community mother’s education, defined as the percentage of mothers with secondary or higher education in the primary sampling unit (PSU), and categorized as: low and high. This variable was selected because higher levels of
maternal education are associated with better child health outcomes like childhood mortality and child immunization rates [19, 20], thus the proportion of mothers with secondary of higher education is a predictor of child survival; 

ii) community hospital delivery, defined as the percentage of mothers who delivered their child in the hospital, and categorized as: low, middle and high (cut-off at the median value); and 

iii) community prenatal care by doctor, defined as the percentage of mothers who had prenatal care provided by a doctor, and categorized as: low, middle and high (cut-off at the median value). Prenatal care directly increases the chances that mothers would access subsequent health care services for their child, such as delivery in a health institution as well as mother and child immunization [21, 22].

Hospital delivery is also one of the most important preventive measures against maternal and child health outcomes and an important determinant of full immunization [23, 24]. Hence the proportion of mothers that received prenatal care and that delivered in a hospital setting are both salient predictors of child survival, hence their inclusion in the analysis. The contextual variables were at the level of the PSU (n = 365). Primary sampling units are small administratively-defined areas designed to be fairly homogenous units in relation to population socio-demographic characteristics, economic status and living conditions. They are used as proxies for “neighbourhoods” or “communities” [25, 26] and contain one or more enumeration areas (EAs), which are the smallest geographic units for which census data are available in Nigeria. Each cluster consisted of a minimum of 50 households, with a contiguous EA being added when a cluster had less than 50 households [18].

Statistical analysis

Characteristics of the study population by region of residence
The distribution of the children and mothers in the sample were assessed by region of residence using normalized sample weights provided in the DHS data. This allows adjustment for non-response and generalization of findings to the general population. Stata 10 was used for this analysis [27].

**Multilevel logistic regression modelling**

A three-level multilevel logistic regression model was used [28], to assess the association between the risk of under-five deaths and region of residence. Children (level 1) were clustered within mothers (level 2), who were in turn clustered within communities (level 3). Five models were fitted. **Model 0** (empty model) contained no explanatory variable since its role was to decompose the total variance into its individual- and community-level components and to identify a possible contextual phenomenon that can be quantified by clustering of under-five mortality within neighbourhoods [29]. **Model 1** contained region of residence as the only explanatory variable, and **Model 2** added sex of the child and birth order/birth interval. **Model 3** included the mother-level variables (mother’s age, mother’s age at birth of first child; marital status, ethnicity, mother’s education, mother’s occupation, and household wealth index). Finally, **Model 4** added community-level variables (community mother’s education, community hospital delivery, and community prenatal care by doctor). The simultaneous inclusion of both individual- and neighbourhood-level predictors in the multilevel logistic regression model permits: *i*) the examination of neighbourhood or area effects after individual-level confounders have been controlled for; *ii*) the examination of individual-level characteristics as modifiers of the area effect (and vice versa); and *iii*) the simultaneous examination of within- and between neighbourhood variability in outcomes, and of the extent to which between-neighbourhood variation is “explained” by individual- and neighbourhood-level characteristics [30, 31].
**Measures of association (fixed effects)**

The association between the risk of under-five deaths and individual- and community-level characteristics were expressed as odds ratio (OR) and 95% confidence intervals (95% CIs).

**Measures of variation (random effects)**

Measures of variation (random effects) were expressed as variance partition coefficient (VPC) and proportional change in variance (PCV). The variance partition coefficient measures the clustering of death of individuals with a specific covariate pattern i.e. the extent to which members of a family resemble each other more than they resemble individuals from other families in relation to the risk of under-five deaths. The variance partition coefficient is the percentage of the total variance ($V_F + V_I$) in the risk of under-five deaths that is attributed to the family level ($V_F$) and is, thus, a measure of clustering within neighbourhoods. It can therefore be used to operationalize the concept of contextual phenomena [29, 32]. The equation for the variance partition coefficient is:

$$VPC = \frac{V_F}{V_F + V_I} \times 100$$

A large VPC value (close to 1) indicates maximally segregated clusters, while a low VPC value (close to zero) suggests homogeneous risk of under-five deaths among clusters.

Statistical testing of the population variance was performed using the Wald statistic i.e. the ratio of the estimate to its standard error [33]. The analysis was performed using MLwiN 2.0.2 [34], with Binomial, Penalized Quasi-Likelihood (PQL) procedures [35]. By Proportional change in variance (PCV) enables us take into account some part of the compositional differences and explain some of the neighbourhood variance detected in the empty model (model 0) after adjusting for individual characteristics in models 1 - 3, and community-level characteristics in model 4 since neighbourhood differences in the risk of under-five deaths may be attributable to either contextual influences or to differences in the
individual composition of neighbourhoods by child, maternal characteristics and other individual characteristics not considered in the study model. The equation for the proportional change in variance is:

\[ PCV = \frac{(V_A - V_B)}{V_A} \times 100 \]

Where \( V_A \) = variance of the initial model, and \( V_B \) = variance of the succeeding model.

The precision of the estimates was appraised by their standard error (SE). Parameters were tested using Wald statistics i.e. the ratio of an estimated variance to its standard error [33] and exact \( p \)-values.

**Model fit statistics**

Bayesian Deviance Information Criterion (DIC) was used to assess the goodness-of-fit of consecutive models. The DIC decreases as significant effects (both random and fixed) are added to the model; lower DIC values indicate a better fit of the model [36, 37].

**Ethical considerations**

This study is based on analysis of secondary DHS data with all respondent identifiers removed. The survey was approved by the National Ethics Committee in the Federal Ministry of Health, Nigeria and the Ethics Committee of the Opinion Research Corporation Macro International, Incorporated (ORC Macro Inc.), Calverton, USA.

**Results**

**Characteristics of children and women by region of residence (Table 1)**

Children in the Northern regions were most likely to be of high birth order, born to mothers who were 18 years or less at birth of first child, married, with primary or no education, not working and...
clerical/sales/services/skilled manual employees. Mothers who had secondary of higher education were most likely to be from the Southern regions. Mothers from the South West and South South region were mostly in the richest quintile while mothers from the South South region were mostly single.

**Multilevel logistic regression analysis**

Exposure variables included in the multilevel analysis are presented in Table 2. In **Model 0** (empty model), the variance in the odds of under-five mortality was significant across mothers ($\tau = 0.316, p = 0.021$) and communities ($\tau = 0.253, p = 0.001$). This justifies the use of multilevel analysis. The variance partition coefficient indicated that 8.2% and 6.6% of the variance were explained by mother- and community-level characteristics, respectively.

Region of residence was included as the only explanatory variable in **Model 1** to assess the independent influence of region of residence on the risks of under-five deaths. Region of residence was significantly associated with the risks of under-five deaths, with children of mothers resident in the North East and North West having 47% (OR = 1.47, 95% CI = 1.13–1.93) and 42% (OR = 1.42, 95% CI = 1.09–1.84) higher risks of dying, respectively, compared to children of mothers resident in the North Central region. On the contrary, children of mothers resident in the South West had 35% lower risks of dying (OR = 0.65, 95% CI = 0.44 – 0.94) than children of mothers resident in the North Central region. The variation in under-five mortality remained significant across mothers ($\tau = 0.271, p = 0.039$) and communities ($\tau = 0.200, p = 0.003$). As indicated by the variance partition coefficient, the intra-mother- and intra-community correlations were 7.2% and 05.3% respectively. In comparison to model 0, the proportional change in variance in model 1 indicates that 14.2% of the variance in the odds of under-five mortality across mothers and 21% across communities were attributable to the effect of region of residence.
The risks of under-five deaths remained significant after controlling for child-level characteristics (birth order/birth interval and sex of the child) in Model 2. The risks of dying were 38% higher for children of mothers resident in the North East (OR = 1.38, 95% CI = 1.05–1.80) and 37% higher for children of mothers resident in the North West (OR = 1.37, 95% CI = 1.06–1.78) regions. The risks of under-five deaths were 32% lower for children of mothers resident in the South West region (OR = 0.68, 95% CI = 0.47–0.99). Furthermore, first births had 37% higher risks of under-five deaths (OR = 1.37, 95% CI 1.09 – 1.72) while children of 5+ birth order after short birth interval < 24 months had more than two and one-half times higher risks of under-five deaths (OR = 2.52, 95% CI 1.93 - 3.29) compared to children of 2nd–4th birth order with medium birth interval 24 - 47 months. The variation in under-five mortality in Model 2 remained significant only across communities (τ = 0.196, p = 0.003). Judging by the variance partition coefficient, the intra-mother correlation was 3.5% and the intra-community correlation was 5.4%. The proportional change in variance in the odds of under-five mortality of 60% across mothers and 22.5% across communities was attributable to child-level (individual) compositional factors, meaning that part of the clustering of under-five mortality within areas is due to the composition of the communities by birth order/birth interval and sex of the child.

Adjusting for mother-level characteristics in Models 3 resulted in 50% higher risks of under-five deaths (OR = 1.50, 95% CI = 1.06–2.12) for children of mothers resident in the South South region compared to children of mothers resident in the North Central region. In addition, the risks of under-five deaths were 59% higher (OR = 1.59, 95% CI = 1.23 – 2.06) for first births and almost two-fold higher (OR = 1.99, 95% CI = 1.46 – 2.71) for 5+ birth order after short birth interval < 24 months, but were 43% lower (OR = 0.57, 95% CI = 0.37 – 0.87) for children of 5+ birth order after long birth interval 48+ months compared to
children in the reference group. Children of mothers who were 34 years and older had 36% higher risks of under-five deaths (OR = 1.36, 95% CI = 1.04 – 1.78) compared to children whose mothers were 24 – 48 years of age. Mothers with no education and primary education had 61% (OR = 1.61, 95% CI = 1.21 – 2.16) and 54% (OR = 1.54, 95% CI = 1.17 – 2.03) higher risks of under-five deaths respectively compared to children of mothers with secondary or higher education. The risks of under-five deaths were more than two-times higher for children of mothers in the poorest (OR = 2.06, 95% CI = 1.44 – 2.94) and poorer (OR = 2.23, 95% CI = 1.58 – 3.14) wealth quintiles compared to children of mothers in the richest wealth quintile, while children of mothers in the middle wealth quintile had 34% higher risks of under-five deaths (OR = 0.66, 95% CI = 1.17 – 2.35). The variation in under-five mortality in Model 3 remained significant only across communities (τ = 0.118, p = 0.042), and the variance partition coefficient indicated intra-mother and intra-community correlations of 3.2% and 3.3% respectively. As indicated by the proportional change in variance, 15.5% and 40.4% of the odds of under-five mortality across mothers and communities respectively were explained by mother-level (individual) characteristics, indicating that part of the clustering of under-five mortality within areas is due to the composition of the communities by mother-level characteristics.

Finally, Model 4 introduced community-level variables (community mother’s education; community hospital delivery and community prenatal care by doctor). Region of residence remained significantly associated with the risks of under-five deaths, with children of mothers resident in the South South region having 68% higher risks of under-five deaths (OR = 1.68, 95% CI = 1.17 – 2.42) compared to children of mothers in the North Central region. The risks for first births, 5+ birth order after short birth interval < 24 months, 5+ birth order after long birth interval 48+ months and for children of mothers 34 years and older, with primary
education or less, and in the middle-, poorer- and poorest wealth quintiles remained basically unchanged. Children of mothers living in communities with low percentage of hospital delivery had 26% higher risks of under-five deaths (OR = 1.26, 95% CI = 1.01 – 1.57) compared with those in communities with hospital delivery at the median level. In contrast, children of mothers residing in communities with high percentage of mothers attending prenatal care by doctor had 40% lower risks of under-five deaths (OR = 0.60, 95% CI = 0.44 – 0.80) compared with children of mothers living in communities with prenatal care by doctor at the median level. The variance in under-five mortality was also only significant across communities (τ = 0.109, p = 0.047). As indicated by the variance partition coefficient, the intra-mother correlation was 3.5% and the intra-community correlation was 3.1%. The proportional change in variance in the odds of under-five mortality across mothers (-7.9%) and across communities (7.6%) was explained by contextual factors, indicating that part of the clustering of under-five mortality within areas is attributable to contextual factors. Furthermore, lower values of the deviance information criterion (DIC) in successive models were indicative of the fit of the multilevel model in explaining the variation in the risks of under-five deaths across regions.

**Discussion**

**Main findings**

This study showed that under-five mortality was significantly associated with region of residence, with the risks of under-five deaths being higher for children of mothers resident in the South South region. This could be attributed to individual-level demographic (birth order/birth interval and mothers’ age) and socio-economic (mothers’ education and mothers’ household wealth index) factors, as well as to community-level factors (the percentage of mothers that received prenatal care by doctor and hospital delivery). Regional disparities in child survival are common in low- and middle-income countries such as Nigeria, and may be
associated with population density, differential levels of regional development, political and ethno-religious situations, as well as varying economic resources [38]. The above-mentioned factors are true of the South South region of Nigeria, which is reported to suffer from deficient social infrastructure and services (schools, roads, electricity and health services), high unemployment, social deprivation and endemic conflict, in spite of the region accounting for over 90% of Nigeria’s proven gas and oil reserves and the nation’s wealth [39, 40].

Geographically, the region is characterized by extensive mangrove forests, extensive networks of lagoons and swamps affected by environmental degradation from crude oil spillage and pollution. These conditions may be associated with the increased risks of under-five deaths for children in this region.

The risks of under-five deaths were higher for first births as well as for children of high birth order and short birth interval (Order 5+ & <24 months), but were lower for children of high birth order with long birth interval (Order 5+ & 48+ months). These are expected findings supporting those from previous studies, which show that shorter birth intervals increase the risks of having low birth weight babies [41, 42] and of infection transmission among closely spaced siblings [43] – factors that are associated with increased risks of child deaths.

Children of older mothers (34 years and older) had higher risks of under-five deaths, which can be explained by the U-shaped curve indicating the relationship between maternal age and under-five mortality and is in agreement with previous findings [44, 45]. This study also found that lower socio-economic position (no education, primary education, middle-, poorer- and poorest wealth quintiles) was associated with increased risks of under-five deaths, and is in agreement with findings from previous studies indicating that higher socio-economic position of individuals and populations strongly influences health-seeking behaviour, and is associated with better health [46, 47]. In addition, this study showed that living in a
community with high percentage of mothers that received prenatal care by doctor was associated with lower risks of under-five deaths, while living in a community with low percentage of mothers with hospital delivery was associated with higher risks of under-five deaths. These are expected findings, given that increased access to prenatal care directly increases the chances that mothers in the community would utilize health care services, such as institutional delivery and immunization for their child [48, 49]. Timely access to maternal healthcare (hospital delivery) is one of the most important preventive measures against maternal and child health outcomes [50, 51]. Community hospital delivery is also an indication of the quality of care received by the mother and infant during child birth. These associations at the community level are also a reflection of socio-economic position at the individual level, since individual socio-economic position strongly influences health-seeking behaviour by enhancing mothers’ perception of disease aetiology and treatment patterns, which result in improved health and welfare of their child. Higher socio-economic position empowers mothers and enhances their decision-making power. Community-level variation remained significant after controlling for individual- and community-level variables, further justifying the use of multilevel logistic regression, and indicates a need for further exploration of community-levels determinants of under-five mortality.

Policy implications

The geo-political regions of low- and middle-income countries like Nigeria are an important sphere of influence on child survival. As such, interventions aimed at promoting child health and wellbeing need to be increased in disadvantaged and inaccessible communities within the disadvantaged regions. In addition to National and State policies, regional policies need to be adopted, given that regions are usually made up of peoples and communities sharing similar
geographical, political, socio-economic and cultural characteristics that either promote or inhibit health-seeking behaviour and access to healthcare facilities.

Findings in this study suggest that regional inequalities are associated with increased risks of under-five deaths, and this has important policy implications. In order for the country to meet the Millennium Development Goal 4 target of reducing under-five mortality by two-thirds between 1990 and 2015, determinants of regional disparities in under-five mortality need to be identified and appropriately addressed. There is a need for policy makers to tailor community-level interventions differentially within regions aimed at:

i. improving community-level utilization of health care services, such as prenatal care by doctor and hospital delivery;

ii. changing maternal health behaviour and norms associated with, for example, birth spacing and having children at an older age;

iii. increasing maternal education may improve the general socio-economic position of mothers;

iv. The South South region is characterized by disproportionately high unemployment [52], high level of poverty and illiteracy, lack capital resources or skills and deficient social amenities such as water, sanitation, and housing [53].

Limitations and strengths

Several limitations need to be considered when interpreting findings in this study. First, administratively defined boundaries were used as a proxy for neighbourhoods or communities in this study. There is an inherent risk of non-differentially misclassifying individuals into inappropriate administrative boundaries, which may generate information biases and reduce the validity of the analysis. Second, data on household income or expenditure, which are the indicators commonly used to measure wealth are not routinely collected in DHS surveys. The
assets-based wealth index used in this study is only a proxy indicator for individual/household economic status and may not always produce results similar to those obtained from direct assessments of income and expenditure where such data are available or can be reliably collected [54, 55]. The strengths of this study are also worth mentioning and include: i) DHS surveys are nationally-representative and enable the generalization of the results across the country; ii) the DHS variables are defined similarly across countries and results are therefore comparable across countries [56, 57]; and iii) using administrative boundaries permits the comparability of any set of DHS data on the same geographical frame, or of presenting complex data in a simple way, provided there is a good conceptual framework of the studied territory.

Conclusion

This study showed that there are regional inequalities in under-five mortality in Nigeria and that individual- and community-level demographic and socio-economic factors were significantly associated with increased risks of under-five deaths for children in the South South (Niger Delta) region of Nigeria. Findings suggest that regions are an important sphere of influence on child health and wellbeing. As such, there is a need to differentially focus on community-level interventions that increase maternal and child health care utilization (prenatal care by doctor and hospital delivery), maternal socio-economic position, and changing birth spacing behaviour. While further studies on community-levels determinants of under-five mortality are warranted, emphasis needs to be given to communities in disadvantaged regions such as the South South (Niger Delta) region if the targets of the millennium development goals are to be met.

Conflict of interests

None to declare
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Authors’ contributions The conception, data analyses and interpretation of results in this manuscript were done by DA.

References


27. StataCorporation: *Stata Statistical Software*. College Station, TX; 2001.


Additional files provided with this submission:

Additional file 1: Table 1.doc, 119K
http://www.pophealthmetrics.com/imedia/6215400533331855/supp1.doc
Additional file 2: Table 2.doc, 125K
http://www.pophealthmetrics.com/imedia/7571776763331856/supp2.doc