ORIGINAL RESEARCH ARTICLE

Estimating the Influence of Maternal Height on Under-Five Mortality in Nigeria

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Abstract

This study uses a nationally representative data sample to assess the effect of maternal height as an intergenerational influence on under-five mortality. Data from the 2003 and 2008 Nigerian Demographic Health Survey (NDHS) (n=41,005) selecting women aged 15 to 49yrs whose most recent births were within 5 years (n=23,568), were analyzed. The outcome measure was under-five mortality. Independent variables included maternal height categorized as ≥63inch, 61-62.9inch, 59.1-60.9inch, <59.1inch. Confounding factors were controlled for. A multivariable logistic regression was used to obtain odds ratio estimates along with their respective confidence interval. After adjusting for confounding factors, we found that each 1inch increase in maternal height, was associated with a decreased odds of mortality OR 0.98(95%CI 0.97-0.99). The OR of under-five mortality when comparing women ≥63inch versus women <59.1inch was 1.13(95%CI 0.98-1.31). The population attributable fraction of child death due to maternal short stature was 0.36. *(Afr J Reprod Health 2014; 18[1]: 54-60).*

Keywords: Under-Five Mortality, Maternal height, Intergenerational Influences.

Résumé

utilise un échantillon représentatif échantillon de données pour évaluer l'effet de hauteur maternelle comme une influence intergénérationnelle de mortalité des enfants de moins de cinq ans. Les données de l'année 2003 et 2008 nigérian Enquête démographique et de santé (NDHS) (n=41 005) la sélection de femmes âgées de 15 à 49 ans dont les plus récentes naissances étaient en 5 ans (n=23 568), ont été analysés. La mesure des résultats était mortalité des moins de cinq ans. Variables indépendantes comprises hauteur maternelle classés comme ≥63pouces, 61 -62.9pouces, 59,1 pouces -60.9, < 59.1pouces. Facteurs de confusion ont été contrôlées. Plusieurs variables de régression logistique a été utilisée pour obtenir odds ratio estimations avec leur intervalle de confiance. Après le réglage des facteurs de confusion, nous avons constaté que chaque 1pouce augmentation de hauteur maternelle, a été associée à une diminution des chances mortalité ou 0,98 (95 %CI 0.97 -0.99). Les ou de mortalité des moins de cinq ans lorsque l'on compare les femmes ≥63pouces versus les femmes < 59.1pouces était 1.13 (95 %CI 0.98 -1.31). La population fraction attribuable de décès d'enfants dus à maternelle petite stature était de 0,36. *(Afr J Reprod Health 2014; 18[1]: 54-60).*

Mots-clés: mortalité des enfants maternelle, hauteur, influences intergénérationnelles.

Introduction

As Africa moves towards achieving the millennium development goals, attempts have been made to describe the factors responsible for the high child mortality rates in the region. In Nigeria, despite the rising GDP and lower inflation rates, the 2013 Nigerian Economic Report by the World Bank notes that *"poverty reduction and job creation have not kept pace with population growth, implying social distress for an increasing number of Nigerians.* The current under five mortality estimates are 124 per 1000 live births[1] while the literacy rate of females (% of females aged 15 years and above) is 66. Traditionally, Nigerian women have been described as hardworking. Amaucheazi describes Nigerian women in the following words: "…they engage themselves in income generating activities of various types such as processing of palm oil and garri, soap making, weaving, sewing and pottery"[2]. It is also noted that they efficiently combine these responsibilities with their role as mothers and homemakers.

Previous research on the determinants of child mortality focused on socioeconomic determinants of health, with variables like place of birth, birth order, maternal income and maternal education showing a significant association with infant mortality[3.] Intergenerational factors are thought to be potentially responsible for perpetuating a cycle of growth failure and poor child survival. This hypothesis states that girls whose growth was stunted and later give birth, have smaller infants with poorer survival outcomes[4]. The mechanism may be either physiological factors from stunting which retard intra-uterine growth, or enduring socioeconomic and environmental factors that affect both the mother's growth and later the intra-uterine growth of their fetuses. This concept was postulated as potentially significant for developing countries[5]. There is some evidence that maternal health history matters when resources are scarce during pregnancy and in the first few years of a child's life[6]. Studies using maternal height as a proxy for the accumulated maternal health history have attempted to demonstrate a relationship to infant health, with varying results.

Subramamanian et al demonstrated a decreased risk of infant mortality with increase in maternal height amongst Indian children[5]. Ozaltin et al also demonstrated similar results using a cross-national study of low and middle-income countries[6]. In contrast, a study by Kirchengast et al conducted amongst Namibian women demonstrated that smaller and lighter women had significantly more surviving children postulating a theory of maternal depletion in which a woman depletes her health stock as she nurses her children[7].

Other studies have shown no association between maternal height and under five mortality[8]. We examined the association of maternal height and under-five mortality using the most recent data from Nigeria.

Method

Data Source

Data for the present study were obtained from the 2003 and 2008 Nigerian Demographic Health Survey (DHS). The DHS measures household characteristics, socioeconomic characteristics, maternal and child health. The target groups were women aged 15-49 years in randomly selected households across Nigeria. Respondents were selected through a stratified two stage sample design collected from all the 36 states of Nigeria. The Nigerian DHS uses population and housing census data provided by the National Population commission, for stratification. Each local government within each state of Nigeria, is divided into areas called census enumeration areas (EAs). The primary sampling units (PSUs), were derived from the EAs. Each PSU was selected by a stratified two- stage cluster design consisting of 888 clusters (286 in the urban and 602 in the rural areas). In the second stage, 41 households were randomly selected in each cluster based on an equal probability systematic sampling[9]. The respondents were all women aged 15-45yrs and men aged 15-59years who were residents or visitors of the households.

Study population and sample size

The response rate of women in the dataset was 96.5% with no difference between women in rural or urban areas. The study population consisted of women aged 15 to 49years (n=41,005). The final analytical sample for mortality analysis was 23,568 children born 5 years prior to the survey period, to mothers aged 15-49years.

Outcomes exposures and covariates

Child mortality was a binary variable, indicating whether a child born 5 or more years prior to the time of survey, was dead (1) or alive (0) at the time of the interview. Maternal height which was slightly left skewed, was modelled first as a continuous and later as a categorical exposure with cut points of <59.1, 59.1 -60.9, 61 -62.9 and >63 inches or more. Marital status, sex of child, wealth status, multiple births, twin status, location (urban or rural), tribe, maternal age group, maternal education level and religion were all included as covariates (Table 1). Marital status was coded as 1 if married or living with a partner and 0 if single, divorced, widowed or never married. Location was classified as rural or urban. Wealth status was classified as upper, middle or lower class. Upper class was generated by merging the two highest wealth quintiles (4,5) the 3rd highest wealth quintile were assigned middle class, while the two lowest wealth quintiles were classified as lower class. Tribe was classified as Igbo, Yoruba, Hausa and other tribes apart from these three were classified as "others". Educational status was based on the highest level of schooling reported by the respondent at the time of the survey. It was categorized as no schooling, primary, secondary and higher, according to Nigerian educational system. Religion was coded as Islam, Christianity or other.

Analysis

A multivariable logistic regression model was used for the binary outcome of mortality. The estimated models used the "svy" procedures in Stata MP 12.1 to take into account the "two-staged cluster" survey sampling design and the sample weights of the 2003 and 2008 Nigerian Demographic Health Survey. Variables were assessed for collinearity and then the unadjusted association between maternal height and child mortality was estimated. The model then included variables that were considered confounders of the association between maternal height and under-five mortality at p<0.05. We then re-estimated this association, to obtain adjusted ORs, and 95% confidence intervals. Because our data had many unique patterns, a Hosmer-Lemeshow goodness-of-fit test was used to assess model fit to the data. Odds ratios were converted to Relative Risks using the following formula:

$$RR = \frac{OR}{1 - Rc + (Rc \times OR)}$$

Where R_C is the absolute U5MR in children of un-stunted mothers.

To compute the population attributable fraction we used the following formula.

$$\frac{\{(RRvery\ stunted * Pvery\ stunted) + (RRmoderately\ stuted * Pmoderately\ stunted) - (RRunstunted * Punstunted)\}}{\{(RRvery\ stunted * Pvery\ stunted) + (RRmoderately\ stunted * Pmoderately\ stunted)\}}$$

Results

The mean height of women in our sample was 61.8 inches. Table 1 shows the weighted frequency and percent distribution of the baseline characteristics of the children's mothers. Taller women with heights ≥62.9cm constituted 39% of the sample and were more likely to be married, of higher wealth status, of higher education and were more frequently residing in urban areas . The overall mortality rate for under- five children was 9.5%, with the rates higher for males 10% and 8.8% for females (P <0.001). Under-five mortality was different across localities (p<0.01) and highest in rural areas. It also differed among tribes (p<0.01) with the Hausa having the highest mortality 11.3% and the Igbo having the lowest mortality rate 5.1%.

Table 1. Frequency and percent distribution of baseline characteristics of women across marital status, wealth, age, tribe, location and other covariates. (* P values were based on a Chi-squared test for the null hypothesis of no association across all 4 maternal height categories.)

Characteristics	**No (%) Maternal Height (inch)**				
Mortality	**>=63inch (n = 11,697)**	61-62.9inch (n=8675)	59-60.9inch (n=5, 656)	<59.1 (n=2,834)	*Pvalue
Died	1,047 (8.95)	834 (9.61)	547(9.67)	304(10.73)	0.03
Marital Status					
Married	11,648 (72.63)	8,726(71.82)	5,763 (69.74)	2,974(65.28)	<0.01
Location					<0.01
Urban	6,132(38.24)	3,944(32.46)	2,274(27.52)	1,196(26.25)	
Rural	9,905 (61.76)	8,205(67.5)	5,989(72.48)	3,360(73.75)	
Wealth Status					<0.01
Lower	5,803(36.19)	4,993(41.10)	3,850(46.59)	2,333(51.21)	
Middle	2,942(18.35)	2,505(20.62)	1,715(20.76)	930(20.41)	

Upper	7,292(45.47)	4,651 (38.28)	2,698 (32.65)	1,293(28.38)	
Twin					0.01
Not Twin	11,392(97.39)	8,479(97.74)	5,554(98.20)	2,788(98.38)	
Twin	305(2.61)	196(2.26)	102(1.80)	46(1.62)	
Birth Order					<0.01
First	1,674 (14.31)	1,370 (15.79)	960(16.97)	505(17.82)	
Second	1,687 (14.42)	1,234(14.22)	839(14.83)	495(17.47)	
Third	1,675 (14.32)	1,180(13.60)	801(14.16)	402(14.18)	
Fourth	1,538 (13.15)	1,117 (12.88)	698(12.34)	364(12.84)	
Fifth or higher	5,123(43.80)	3,774(43.50)	2,358(41.69)	1,068(37.69)	
Tribe					<0.01
Igbo	2,163(13.49)	1,434(11.80)	843(10.20)	421(9.24)	
Yoruba	2,119(13.21)	1,279(10.53)	783(9.48)	402(8.82)	
Hausa	2,345(14.62)	1,999 (16.45	1,622 (19.63)	1,120(24.58)	
Others	9,410(58.68)	7,437(61.21)	5,015(60.69)	2,613(57.35)	
Education					<0.01
None	5,745(35.82)	4,803(39.53)	3,534(42.77)	2,165(47.52)	
Primary	2,975(18.55)	2,470 (20.33)	1,816(21.98)	996(21.86)	
Secondary	5,548 (34.59)	4,010(33.01)	2,551(30.87)	1,258(27.61)	
Higher	1,769(11.03)	866 (7.13)	362(4.38)	137(3.01)	
Religion					<0.01
Islam	6,084 (38.04)	4,999(41.29)	3,578 (43.44)	2,211(48.69)	
Christian	8,271(51.71)	5,831(48.16)	3,687(44.77)	1,843(40.59)	
Others	1,639(10.25)	1,277(10.55)	971(11.79)	487(10.72)	

After adjusting for confounding factors, each 1inch increase in maternal height was associated with a decrease odds of mortality OR 0.98(95%CI, 0.97-0.99). When comparing women ≥63inch versus women 61-62.9inch the OR of under-five mortality was 1.05(95%CI, 0.91-1.12), when comparing women ≥63inch versus women 59-60.9inch the OR of under-five mortality was 1.04(95%CI,0.93-1.16); when comparing women ≥63inch versus women <59.1inch the OR of under-five mortality was 1.13(95%CI, 0.98-1.31). (Table 2) These ORs from the models of height as a categorical variable were not statistically significant

Table 2: Primary Outcome: Adjusted under-five mortality and maternal height, and other maternal and child factors (weighted) (Adjusted models were adjusted for mother's education, wealth status, religion, tribe, urban/rural effect, child's sex, birth- order, twin status; **Abbreviations: OR, Odds ratio; CI, confidence Interval; ***Single, divorced, widowed, ever married; ****Married or living with a spouse)

	Maternal Height as continuous		**Maternal Height as categorical**	
	OR(95% CI)**	P value	OR(95% CI)	Pvalue
Maternal Height per 1inch increase	0.98(0.97-0.99)	0.02		
Maternal Height(inch)	--------			
≥63	--------		1(reference)	
61-62.9	--------		1.05(0.91-1.12)	0.32
59-60.9	------		1.04(0.93-1.16)	0.47
<59.1	-------		1.13(0.98-1.31)	0.10
Marital Status				
Single***	1 (Reference)			
Married****	0.41(0.35-0.50)	<0.01	0.63(0.55-0.72)	<0.01
Location				
Urban	1(Reference)			
Rural	1.07(0.92-1.23)	0.37	1.07(0.94-1.21)	0.30
Wealth Status				0.03
Upper	1(Reference)			
Middle	1.08(0.92-1.29)	0.35	1.10(0.97-1.26)	0.15

Lower	1.05(0.90-1.24)	0.82	1.16(0.84-1.13)	0.03
Twin				
Not Twin	1(Reference)			
Twin	4.77(3.77-6.03)	<0.01	3.98(3.34-4.74)	<0.01
Birth Order of child				<0.01
First	1 (Reference)			<0.01
Second	0.73(0.60-0.88)	<0.01	0.81(0.69 -0.95)	0.01
Third	0.64(0.52-0.80)	<0.01	0.87(0.88- 1.25)	0.60
Fourth	0.59(0.47-0.75)	<0.01	1.06(0.74-1.03)	0.11
Fifth or higher	0.40(0.32-0.50)	<0.01	1.26(1.11-1.43)	<0.01
Sex of child				
Male	1(Reference)			
Female	0.87(0.79-0.96)	<0.01	0.86(0.79-0.93)	<0.01
Tribe				<0.01
Igbo	1(Reference)			
Yoruba	1.53(1.19-1.98)	<0.01	1.68(1.35-2.10)	0.01
Hausa	1.67(1.34-2.08)	<0.01	1.74 (1.43-2.11)	<0.01
Others	1.54(1.26-1.88)	<0.01	1.45(1.22-1.73)	<0.01
Maternal Education				<0.01
Higher	1(Reference)			
Secondary	1.40(1.06-1.86)	0.02	1.17(0.92 1.49)	0.19
Primary	1.43(1.07-1.91)	0.02	1.32(1.03- 1.68)	0.03
None	1.72(1.26-2.34)	<0.01	1.76(1.37- 2.27)	<0.01
Religion				<0.01
Islam	1(Reference)			
Christian	1.03(0.90-1.18)	0.68	1.11(0.98-1.26)	<0.10
Others	1.27(1.07-1.52)	<0.01	1.26(1.09-1.46)	<0.01

Children born to married mothers or mothers living with a spouse had reduced odds of mortality when compared to children born to currently single, divorced, never married or widowed OR 0.63(95%CI,0.55-0.72). Under-five mortality was not significantly different when comparing rural versus urban regions after adjusting for confounding factors OR 1.07(95%CI, 0.94-1.21). Children born to mothers who had received no prior education had increased odds of mortality OR 1.76(95%CI 1.37- 2.27). Of our covariates, twin status of child was associated with the highest odds of mortality OR 3.98(95%CI, 3.34-4.74). Female children had lower child mortality OR 0.86(95%CI, 0.79-0.93). "Ethnicity/region" was significantly associated with child mortality, with the Hausa northern tribe having increased odds of mortality, when compared to the Igbo eastern tribe 1.74 (95%CI 1.43-2.11).

We calculated the population attributable fraction of child death due to maternal short stature as:

$$\frac{\{(1.128 * 2834) + (1.017 * 5656) + 1.046 * 8675) - (1 * 11697)\}}{\{(1.128 * 2834 + 1.017 * 5656) + (1.046 * 8675)\}} = 0.36$$

Discussion

Our study showed that in a nationally representative sample of under-five children in Nigeria, maternal height was associated with under-five mortality. Our findings are similar to that of Ozaltin et al[6] (RR, 0.9880; 95%CI, 0.987-0.988) and Subramanian et al[5]. (RR, 0.978; 95% CI, 0.970-0.987) Martin et al demonstrated this finding in a study using long term follow up of children from families that participated in a Pre-War British survey between 1937-1939[10]. The authors postulated that maternal childhood growth was an important determinant of the weight of her future off springs. Certain mechanisms can speculatively explain the relationship of maternal height and child health. Mechanical factors like cephalo-pelvic disproportion and obstructed labor are more associated with shorter women, who have narrower pelves[11]. Biological explanations postulate inadequate nutrient supply to the fetus, leading to intrauterine growth restriction and low birth weight[12]. Low birth weight has also been associated with anemia and increased odds of child hood mortality[13,14]. Animal models have demonstrated the sustainability of intergenerational influences on child health over several generations. The transfer of health stock was particularly important for mothers and female children. Evidence suggests that this intergenerational cycle of growth failure can be broken through improved economic and health conditions[20]. This is consistent with the linear trends seen in Europe and North America[15]. However; it is also possible that socioeconomic confounders other that the ones controlled for in the model may still be at work creating both the low growth of the mother and later high mortality for the children.

Our study demonstrates that intergenerational factors still account for a substantial portion of the under-five mortality rates evident in Nigeria. Findings from our study did not show a significant difference in infant mortality when comparing children born in rural versus urban area, demonstrating equitable child health outcomes. A less sanguine interpretation might be that some of the health advantages associated with urban life such as better access to health facilities are being offset by other social disadvantages associated with cities. Continued efforts nationally and globally are needed because further improvements are possible. Additionally, wealth status was not a significant contributor to infant mortality highlighting the action of those health determinants that are not related to income such as public health campaigns for vaccinations, and sanitation.

Using the DHS data allowed us to generate a large sample size with significant power to detect a difference. Also, the quality of the DHS data and its comparability across countries, particularly in Nigeria, where the DHS data remains the only nationwide source of maternal and child health indices, made it the obvious choice for our study[16]. The DHS data also allow us control for important confounders such as age of marriage, especially among tribes with early marriage.

A major limitation of this study is recall bias, as it may be difficult for mother's to recollect a child's birth and death history. Additionally, since our data is of a cross-sectional nature we are unable to dram causal inferences from our findings. Also, current maternal height was used as a proxy for a woman's height at the time of the child's delivery, this may be important especially with the inclusion of a population of women between the ages of 15 and 19 years who may have been teenagers at the time of the delivery of the infant and hence still able to grow further.

Our results indicate the need to focus on improved nutritional access and socio-economic development to overcome stunting and its high attributable mortality in later generations. In Guatemala, a nutritional intervention improved linear growth in two generations; most especially amongst female offspring[17]. Adoption studies also explain how intergenerational effects can be overcome[18] . Studies of children born in countries with limited resources and adopted into wealthy nations also show that early adverse conditions can be overcome to some degree by improved socio-economic conditions[20].

In Brazil, narrowing inequalities and improvements in social determinants of health and the national health system led to a steady decline in stunting[19]. A study by Bhutta et al has shown that stunting can be reduced by a third, and under five mortality by approximately a quarter, by intensifying existing interventions for nutrition and disease prevention[20].

Social and economic reforms in developing countries are still needed to counter the inter-generational cycle of poverty and thus significantly improve child health.

Contribution of Authors

All authors contributed to the study conception and design. Dr Enwerem and Dr Bishai contributed to the acquisition of data. Dr Enwerem completed analysis and interpretation of data. Dr Enwerem, Dr Obirieze, and Dr Bishai drafted the manuscript. All authors undertook critical Review of the manuscript.

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