Urban area disadvantage and under-five mortality in Nigeria: The effect of rapid urbanization

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ABBREVIATIONS:

DHS: Demographic and Health Survey

CI: Confidence interval

OR: Odds ratio

PSU: Primary sampling unit

VPC: Variance Partition Coefficient

PCV: Percentage Change in Variance

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Abstract

Background

Living in socio-economically disadvantaged areas is associated with increased childhood mortality risks. As city-living becomes the predominant social context in low- and middle-income countries, the resulting rapid urbanization together with the poor economic circumstances of these countries greatly increase the risks of under-five mortality.

Objective

This study examined the trends in urban population growth and urban under-five mortality between 1983 and 2003 in Nigeria. We assessed whether urban area socio-economic disadvantage has an impact on under-five mortality.

Methods

Urban under-five mortality rates were directly estimated from the 1990, 1999 and 2003 Nigeria Demographic and Health Surveys. Multilevel logistic regression analysis was performed on data containing 2118 children nested within 1350 mother, who were in turn nested within 165 communities.

Results

Urban under-five mortality increased as urban population steadily increased between 1983 and 2003. Urban area disadvantage was significantly associated with under-five mortality after adjusting for individual child- and mother-level demographic and socio-economic characteristics.

Conclusions

Significant risks of under-five deaths both at the individual and community levels underscore the need for interventions tailored towards community- and individual-level interventions. We stress the need for further studies on community-level determinants of under-five mortality in disadvantaged urban areas.

Introduction

Although it has long been known that there is a correlation between individual-level socio-economic position (SEP) and childhood mortality (Lawlor et al. 2006; Galobardes et al. 2006; Power et al. 2005), researchers have turned their attention to the role of socio-economic characteristics of areas in child survival (Kawachi and Berkman 2003; Macintyre et al. 2002). The evidence suggests that living in socio-economically disadvantaged areas is associated with increased mortality risks, even after adjusting for individual demographic and socio-economic characteristics (Marinacci et al. 2004; Martikainen et al. 2003; Pickett and Pearl 2001; Bosma et al. 2001; Sundquist et al. 1999). The world's urban population is growing at a fast pace, necessitating greater emphasis on the association between area-based measures of socio-economic position within urban areas and the health of populations living in those areas (Galea and Vlahov 2005; Eames et al. 1993). These area-based measures are seen largely as aggregate correlates of the individual measures and generally show strong graded associations to most health outcomes. This not only mimics the associations seen at the individual level (Kaplan 1996), but also reflects the health affects of physical and social infrastructure above and beyond individual compositional effects (Kaplan 1996, MacIntyre et al. 1993).

Half of the world's population (3 billion people) now lives in urban areas, and it is expected that by 2030, about two-thirds (5 billion people) of the world's population will live in urban areas (United Nations 2004). Urbanization, the process of becoming urban, reflects aggregate population growth in cities through either natural population increase or migration (Galea and Vlahov 2005) and is inextricably linked with development. As a result, urban- or city-living has become the ideal for many people in low- and middle-income countries (Kasarda and Crenshaw 1991). Urban-living has important health benefits, such as better access to health care, education and social amenities (McMichael 2002; Vlahov and Galea 2002). However, with the present pace of urbanization in low- and middle-income countries like Nigeria and within the context of poor economic performance, poor governance, failure of national and urban housing policies, institutional and legal failure, the capacity of most urban economies in developing countries is overstretched. Hence only a fraction of the growing social needs of urban areas are met (UN-Habitat 2003), resulting in an increasing proportion of urban dwellers living under disadvantaged conditions that are characterized by overcrowded or deteriorating housing, inadequate social amenities, poor environmental and sanitary conditions, as well as poor economic opportunities. This in turn increases the susceptibility of residents in these areas to a variety of health problems and increases childhood mortality risks (Hembree et al. 2005; Galea and Vlahov 2005; Northridge and Sclar 2003; Zulu et al. 2002; Krieger and Higgins 2002; Gracey 2002; McMichael 2002; Vorster 2002; Popkin 2001; Satterthwaite 2000; Alexander and Ehrlich 2000). Under such disadvantaged conditions, the health risks arising from living in disadvantaged urban areas rival or exceed those of rural areas, despite the generally easier access of urban residents to modern health services (African Population and Health Research Center 2002; Timæus and Lush 1995), thereby outweighing the advantages of living in urban areas (Rakodi 1997).

Why focus on urban area disadvantage?

The importance of access to safe drinking water and housing structure quality, particularly in urban areas, is well documented. Diarrhoea and other infectious diseases remain the major causes of death among children below five years of age (Fotso et al. 2007; Bryce et al. 2005; Woldemicael 2000). Availability of these resources is highly correlated with household socio-economic position, which is in turn influenced by poverty and overall economic development in the community. Poor and disadvantaged urban populations are characterized by overcrowding, shortage of safe water, lack of adequate waste and sanitary services, and higher levels of air pollution and other hazardous substances, which result in increased risks of infectious diseases and mortality (Van de Poel et al.

2007; Mintz et al. 2001). The socio-economic position of people living in poor and disadvantaged urban communities is generally low and characterized by unemployment and underemployment (Ahmad et al. 2000). In addition, ownership of fewer assets and lack of access to economic resources among people living in poor and disadvantaged urban communities make them less capable of coping with ill-health (Wichmann and Voyi 2006; Kandala et al. 2006; Adepoju 2004). This is the urban neighbourhood context in which a large number of residents of densely populated areas live in Nigeria. Furthermore, although the spatial concentration of poverty is essential to the definition of disadvantaged neighbourhoods, current efforts at systematizing this definition use indicators such as access to safe drinking water, adequate sanitation, electricity, overcrowding and security of housing tenure. The focus is often on households rather than directly taking into account the concentrations of poverty or affluence in the neighbourhoods that surround these households. Neighborhood effects are a leading example of the forces operating outside households that can exert influence on household-level behaviour and health outcomes (Montgomery and Hewett 2004). Thus, there is ample reason, on both substantive and methodological grounds, to explore neighbourhood effects of the urban areas of low-and middle-income countries.

The Nigerian Context

Nigeria possibly had the fastest urbanization growth rate in the world in the 1970s (Oni 2002). Between 1970 and 1980, the proportion of Nigerians living in urban areas was estimated to have grown from 16% to more than 20%, and by 2010, urban population is expected to be more than 40% of the nation's total (Oni 2002). In 1995, Lagos (the former administrative capital of Nigeria) was the world's 29th largest urban agglomeration with 6.5 million inhabitants and in 2000, it became the 23rd largest with 8.8 million people. In 2002, Lagos became one of sub-Saharan Africa's first mega-urban regions with its metropolitan population reaching 10 million inhabitants. The city continues to grow and by 2015 it is expected to become the world's 11th largest urban system with 16 million inhabitants (UN Habitat 2003).

As city-living becomes the predominant social context for most of the world's population, the urban environment is bound to shape population health in cities (Galea and Vlahov 2005). Thus, explaining the association between urban area disadvantage and under-five mortality in low- and middle-income countries undergoing rapid urbanization is of importance in developing appropriate health interventions and preventive measures for the rising number of urban inhabitants.

Rationale for focusing on under-five mortality

Under-five mortality rate is a leading indicator of the level of child health and overall development in countries (McGuire 2006). As such, it is an indicator of the Millennium Development Goals (MDG 4), which seeks to reduce the under-5 mortality rate by two-thirds between 1990 and 2015. Under-five mortality measures child survival and reflects the impact of social, economic and environmental circumstances as well as other causes of death on infants, toddlers and young children, including their health care (UNICEF 2007; UNFPA 2003). Thus, under-five mortality rate captures more than 90 percent of the global mortality among children below 18 years (UNICEF 2008) and shows large variation across socio-economic groups, geographical areas and between rural and urban areas. Moreover, data on under-five mortality are relatively reliable compared with other measures of population health (UNFPA 2003).

We used a multilevel approach to account for the hierarchical structure of the demographic and health survey (DHS) data i.e. children (level 1) were clustered within mothers (level 2) who were in turn clustered within communities (level 3), and because of its suitability for investigating the relationship between area level socio-economic disadvantage and mortality using census data or survey data (Subramanian 2004; Diez-Roux 2004; Diez-Roux 2001; Bosma et al. 2001). This is based on the notion that area-level characteristics are potential determinants of health outcomes and that area-level inequalities may be relevant in the context of increasing geographic clustering of poverty with other forms of disadvantage (Gephart 1997). Though several studies have assessed child survival in urban areas of sub-Saharan Africa, this study is unique in its assessment of the effect of urban area/neighbourhood socio-economic disadvantage on under-five mortality.

The aims of this study were to: *i)* assess the trend of urban under-five mortality in relation to urban population growth in Nigeria; and *ii)* assess whether area level socio-economic disadvantage has an impact on under-five mortality risks after individual demographic and socio-economic characteristics are taken into account.

Methods

Cross-sectional data from the 2003 Nigeria Demographic and Health Survey (NDHS) was used in this study. This sample was collected using a stratified two-stage cluster sampling procedure. A full report and detailed description of the data collection procedures are presented elsewhere (NPC 2004). Birth history data, such as sex, month and year of birth, survivorship status and current age or age at death if the child had died were all collected for each of these births. This study was restricted to children born to the sub-sample of 2118 mothers living in urban areas at the time of the survey and to births in the last five years prior to the survey to ensure that the household variables investigated provided a close enough or accurate picture of the current living conditions of the children within the period they were exposed to increased risks of mortality.

Ethical considerations

This study is based on analysis of secondary data with all participant 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. Permission to use the DHS data in this study was obtained from ORC Macro Inc.

Measures

Outcome variable

The outcome variable was the risk of under-five death, defined as a child dying between birth and the fifth birthday.

Exposure variables

Urban area disadvantage index

Urban area disadvantage was measured using the urban area disadvantage index (UADI) score. The UADI scores reflect the overall level of urban area disadvantage measured based on eight indicators of socio-economic disadvantage at the neighbourhood level including the percentage of children: *i*) living in a household without piped water; *ii)* living in a household without flush toilet; *iii)* living in a household without electricity; *iv)* living in a household without non-polluting cooking fuel; *v)* whose mothers were unemployed; *vi)* whose mothers were uneducated; *vii)* living in crowded households; and *viii*) living in households within the lowest two wealth quintiles (poorest 40%).

The UADI scores were generated through principal component analysis at the level of primary sampling units (PSUs). 165 urban PSUs were included in the study from the total number of 365. Primary sampling units or clusters are administratively-defined areas used as proxies for "neighbourhoods" or "communities" (Diez-Roux 2001). These are small fairly homogenous units made up of 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 contiguous enumeration areas being added when a cluster had less than 50 households (NPC 2004). Similar index has been used in other studies (Noble et al. 2006; Barnes et al. 2007) in the following situations: *i)* when the main focus of analysis lies in the effects of characteristics of place of residence on health (Whitely et al. 1999; MacIntyre et al. 2002); *ii)* to allow for the control of possible socio-economic confounding when examining the effects of the local environment on health (MacIntyre et al. 2002); and *iii)* when data describing an individual's socio-economic circumstances have not been, or cannot be collected directly (Danesh et al. 1999). The clusters were ranked on the basis of the continuous UADI scores and categorised into quintiles divided at the 20th, 50th and the 80th percentiles, such that Class I was assigned to the 20% least disadvantaged urban areas and Class V the 20% most disadvantaged urban areas. The ranks indicate how a neighbourhood compares to all the other neighbourhoods and are easily interpretable. Normalized sample weights provided in the DHS data were used for this analysis using the Stata 10 (StataCorporation 2001) to adjust for non-response and enable extrapolation of findings to the general population.

Individual-level explanatory factors

Potential confounders were grouped into child- and mother-level demographic and socio-economic characteristics and included: *i)* sex of the child categorized as: male and female; *ii)* birth order and interval between births, created by merging "birth order" and "preceding birth interval" classified 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); *iii)* mother's age, grouped as: 15-18, 19-23, 24-28, 29-33, 34 years and older; *iv)* marital status, categorized as: single, married and divorced; *v)* mothers' education, categorized as: no education, primary and secondary or higher education; *vi)* mother's occupation, grouped as: professional/technical/managerial; clerical/sales/services/skilled manual occupations; and not working; and *vii)* wealth index, categorized into quintiles as: poorest, poorer, middle, richer and richest.

Statistical analyses

Trend in urban under-five mortality rates between 1986 and 2003

The probability of child deaths below five years of age was directly estimated from the 1990, 1999 and 2003 Nigeria DHS birth history data. Urban population pattern for the period between 1983 and 2003 was derived from the United Nations Department of Economics and Social Affairs of the Secretariat (UN DESA 2004).

Multilevel logistic regression modelling

The data were analysed using MLwiN version 2.10 (Rashbash et al. 2008). We fitted a multilevel model with binomial, penalized quasi-likelihood procedures and second-order linearisation (Goldstein 2003). We used a three-level multilevel logistic regression analysis with 2118 children (level 1), nested within 1350 mothers (level 2), who were in turn nested within 165 communities (level 3). Four sequential models were fitted to:

i) examine the effect of no predictor variables in the fixed part, but only the intercepts in the random part so as to present a baseline for comparing the magnitude of contextual variations in under-five mortality risks in subsequent models (Model 0);

ii) examine the association between under-five mortality and urban area disadvantage (Model 1);

iii) adjust for child-level characteristics (Model 2); and *iv)* simultaneously adjust for urban area disadvantage and both child- and mother-level characteristics (Model 3).

The measures of association (fixed effects) for each of these models were expressed as odds ratios (ORs) and their 95% confidence intervals (95% CIs). Measures of variation (random effects) were expressed as variance partition coefficient (VPC) and proportional change in variance (PCV). VPC expresses the proportion of the individual differences in the risk of under-five deaths (i.e. individual variance) that is at the community level. A variance partition coefficient different from zero is indicative of significant differences in under-five mortality risks between mothers and communities. The proportional change in variance was estimated to evaluate how much of the variance in the first model is attributable to differences in individual characteristics (Merlo et al. 2007). The significance of the random variation at each level was tested with the Wald test and p values were based on a χ^2 distribution. The deviance information criterion (DIC) was used as a measure of how well the different models fitted the data. Lower values indicate a good model fit relative to the number of parameters in the model (Spiegelhalter et al. 2002).

Results

Trend in urban under-five mortality rates between 1986 and 2003 (Figure 1)

Urban under-five mortality rate in Nigeria declined from 74 per 1000 in the period 1979-1983 to 52 per 1000 in 1984-1988. It then increased successively to 142 per 1000 in the period 1999-2003. Urban population in Nigeria showed a steady increase from about 27,000 in 1986 to about 61,000 in 2003 (urban population here refers to the de facto population living in areas classified as urban according to the criteria used by each area or country) (Figure 1).

Figure 1 (about here)

Table 1 presents the distribution of the independent variables by urban area disadvantage index. Children in the most disadvantaged urban area disadvantage index (UADI) quintile (Class V) were most frequently male, of high birth order and medium birth interval (order 5+ & 24-47 months) and had mothers who were younger (24 – 28 years), married, uneducated, who worked as clerical/sales/services/ skilled manual employees and in the poorest household wealth quintile. On the other hand, a higher proportion of children in the least disadvantaged UADI quintile (Class I) were male, of low birth order and medium birth interval (order 2-4 & 24-47 months), whose mothers were older (34 years and older), married, educated at the secondary or higher level, working as clerical/sales/services/skilled manual employees, and in the richest household wealth quintile.

Table 1 (about here)

Figure 2 illustrates the association between under-five mortality and urban area disadvantage index and showed that under-five mortality varied according to urban area disadvantage, with moderate increase in under-five mortality risk associated with increasing urban area disadvantage. This meant that the risks of dying were higher for children of mothers residing in increasingly disadvantaged urban areas.

Figure 2 (about here)

Table 2 presents the results of the multilevel analysis for the association between urban area disadvantage and under-five mortality. Model 0 gives an indication of the amount of spatial clustering of under-five mortality and indicated that the community-level variance was significant ($\tau = 0.273$, $p = 0.014$) while the mother-level variance remained non-significant, suggesting some clustering of mothers of children with similar risks of under-five deaths within disadvantaged communities. There was between 30 and 50 percent increased risks of under-five deaths among the least disadvantaged compared to the most disadvantaged UADI quintiles. The risks were however statistically significant only for class II and class III (Class II OR 1.32, 95% CI 1.19 – 1.54 and Class III OR 1.39, 95% CI 1.26 – 1.56). The community-level variation decreased, but remained significant ($\tau = 0.129$, $p = 0.063$), indicating some clustering of mothers of children with similar risks of death within disadvantaged communities - a compositional effect i.e. the increased risks are explained by the increased risks of the residents who "make up" that neighbourhood. The proportional change in variance indicated that 52.7% and 44.9% of the variance in the odds of under-five mortality across communities and mothers, respectively, were explained by urban area disadvantage index. Inclusion of child-level characteristics in Model 2 did not affect the risks of under-five deaths among children in the more disadvantaged UADI quintiles but resulted in a two-fold increase in the risks for children of high birth order after short birth interval (Order 5+ & < 24 months). The community-level variance decreased further while remaining significant ($\tau = 0.103$, $p = 0.035$), this indicates clustering of mothers of children with similar risk factors within disadvantaged communities, a similar compositional effect. The proportional change in variance of the odds of under-five mortality in this model was 20.1% across communities and 24.6% across mothers.

After further adjustment for mother-level characteristics in Model 3 the risks of under-five deaths increased as the level of disadvantaged UADI quintiles increased. The risks of under-five deaths among children of mothers in the most disadvantaged UADI quintiles (class V) was more than twice the risk among children of mothers in the least disadvantaged UADI quintiles (class I)(OR 2.14, 95% CI 1.11 – 4.12). Furthermore the risks were significantly increased for children who were first births (OR 1.66, 95% CI 1.04 – 2.66), high birth order after short birth interval (Order 5+ & < 24 months) (OR 1.55, 95% CI 1.01 - 2.36), as well as for children of mothers with no education (OR 2.34, 95%

CI 1.31 - 3.16), primary education (OR 2.00, 95% CI 1.27 - 3.13), not working (OR 2.56, 95% CI 1.03 - 6.34) and in the poorest wealth quintile (OR 1.64, 95% CI 1.08 – 2.57). The community-level variance remained unchanged and significant ($\tau = 0.103$, $p = 0.043$); indicating clustering of mothers of children with similar risk factors within disadvantaged communities and also implies a contextual effect, having taken into relevant differences between disadvantaged neighbourhoods in the characteristics of individual residents. The proportional change in variance of the odds of under-five mortality was 6.8% and 34.7% across communities and mothers respectively. However, there was still a fairly large amount of "unexplained" variation between communities, which is probably due to other unmeasured individual- and community-level factors. Lower deviance information criterion (DIC) values with successive models indicated that our analytic model was a good fit.

Table 2 (about here)

Discussion

Trend in urban under-five mortality

We found that under-five mortality rate increased with increasing urban population growth in Nigeria (urbanization) between the periods 1979-1983 and 1999-2003. On examination of the association between under-five mortality and UADI, our findings indicated that under-five mortality rate increased with increasing levels of urban area disadvantage. Thus, the results of our study, in line with the results of other studies (Eloundou-Enyegue et al. 2000), suggest that with the increasing urban population, the resulting rapid urbanization within the context of poor economic circumstances in Nigeria, an increasing proportion of urban dwellers live in disadvantaged urban neighbourhoods with associated increased risks of under-five deaths.

Multilevel logistic regression modelling

This study provides evidence that the characteristics of urban areas have a significant association with the risks of under-five deaths, above and beyond the mothers' socio-economic position. Living in urban neighbourhoods that are more socio-economically disadvantaged thus represents an independent mortality risk factor for children below five years of age, and confirms the findings from recent studies (Guidotti & Gitterman 2007; Pongou et al 2006). The increased risks of under-five deaths in these disadvantaged areas may be explained either directly as a result of living in a deprived neighbourhood also reported in other studies (Dibben et al. 2006; Pickett and Pearl 2001; Krieger et al. 1993) or indirectly as a sum of the socio-economic characteristics of people living these disadvantaged areas. Among such characteristics, we found that first births had higher risks of under-five deaths. Residing in a disadvantaged urban area may in itself be an important predictor of the survival status of the first child. We found that mothers resident in highly disadvantaged areas were most likely to be younger, of low socio-economic position (uneducated and in the poorest household wealth quintile). Lack of maternal experience in childcare and lack of knowledge of health information may predispose first-born children of younger disadvantaged mothers to increased risks of morbidity and mortality (El-Zanaty and Way 2009). The survival of first births may also be associated with birth spacing and age of the mother at the time of the second birth (Rahman et al. 1996). Moreover, we found that high birth order after short birth interval was associated with increased risks of under-five deaths, an expected finding shown by other studies (Makepeace and Pal 2006). Preceding birth intervals of 36–59 months have been shown to be optimal for reducing the risk of neonatal mortality (Conde-Agudelo et al. 2006; Rutstein 2005). In addition, birth-to-pregnancy intervals of less than 18 months have been associated with the highest risk of neonatal mortality (which reflects a birth-to-birth interval of <27 months) with the lowest risks was among birth-to-birth intervals of less than 27 months (or birth intervals of >35 months) (Marston 2006).

Our results indicated that low socio-economic position (primary education or less, unemployment and being in the poorest wealth quintile) was associated with increased risks of under-five deaths. This finding is corroborated by those in other urban studies (Giashuddin et al. 2009; Schulz et al. 2008; Singh and Kogan 2007; Raphael et al. 2003; Songsore 2000). Ultimately, it is the multiplicity of socio-economic factors at both the individual and community levels that shape the survival chances of children in urban environments.

A number of limitations need to be considered in relation to this study. First, defining neighbourhoods administratively defined boundaries may not always reflect meaningful neighbourhood boundaries, especially for area-based measures that characterize the availability of neighbourhood socio-economic characteristics. Such measures may be particularly sensitive to whether people live near neighbourhood boundaries (Macintyre et al. 1993). The effect of this non-differential misclassification of individuals into an inappropriate administrative boundary can generate information biases and reduce the validity of analyses. Second, indices in general are difficult to construct and validate and tend to mask variation in the characteristics that contribute to a score when two or more areas have the same score (Pickett and Pearl 2001).

The strengths of this study are also worth mentioning. First, neighbourhood-level socio-economic characteristics are much more highly correlated than individual-level socio-economic factors; hence the risk of mis-specifying the neighbourhood-level effect is minimal (Pickett and Pearl 2001). Second, the development of composite indices enable easy handling of several highly correlated neighbourhood-level variables and improves statistical efficiency and simplifies the presentation of results. Using several single neighbourhood-level measures separately to reflect a single underlying concept such as urban socio-economic position introduces the risk of collinearity and cumbersome results, a point emphasized by previous studies (Pickett and Pearl 2001). Third, the DHS surveys are nationally-representative and allow for generalization of the results across the country (Fotso 2006). Fourth, variables in the DHS surveys are defined similarly across countries and results are therefore comparable across countries (de Walque 2008). Fourth, the advantages of using administrative boundaries are the possibility of comparing any set of data on the same geographical frame, or of presenting complex data in a simple way. Lastly, further inclusion of individual-level characteristics to the model may have resulted in reduced strength of the association with area disadvantage.

Policy implications

Several policy implications are therefore inherent from our findings. First, there is a need for accessible and relevant data to better describe and quantify relationships between health outcomes and the urban environment. Second, because most disadvantaged urban neighbourhoods are characterized by significant levels of inequality, we do not necessarily support a policy that concentrates only on the most deprived areas of low- and middle-income countries like Nigeria, because interventions resulting from policies that focus solely on priority areas risk excluding a major proportion of mothers and children babies who might otherwise have benefited from resulting interventions and widening such inequalities. Hence there is a need to focus on inequality-reduction measures. Third, there is a need for policies to promote the optimal birth interval of 36–59 months, which has been repeatedly observed to reduce risk of neonatal or child mortality (Setty-Venugopal 2002) or a birth-to-pregnancy interval of 24 months (Marston 2006).

Conclusion

We found that urban area disadvantage was independently associated with the risks of under-five deaths even after controlling for individual child- and mother-level demographic and socio-economic characteristics. The existence of significant risks of under-five deaths both at the individual and community levels underscore the need to tailor interventions not only aiming at the community level (the disadvantaged neighbourhoods) but also to focus strategies implemented at the individual level. Community or neighbourhood-level strategies could aim to counter adverse environmental conditions of deprived areas, such as the sustainable development of urban household amenities and community infrastructure, improved water supply, as well as improving maternal literacy, education, employment and other neighbourhood socio-economic upliftment strategies in deprived these communities. Increased risks associated with first births and high order births after short preceding birth interval emphasizes the need for strategies that promote optimal birth-to-birth intervals and enhanced health-seeking behaviour of mothers in these disadvantaged areas, especially young uneducated mothers. Significant variation between communities found in this study stresses the need for further studies on possible unmeasured community-level determinants of under-five mortality in disadvantaged urban areas.

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Table 1 Socio-demographic characteristics of the urban population according to area level disadvantage index

Characteristics	Class I (Least disadvantaged) n=338	Class II n=856	Class III n=490	Class IV n=43	Class V (Most disadvantaged) n=391	Total N=2118
	n (%)	n (%)	n (%)	n (%)	n (%)	
Sex of child						
Male	172 (51)	424 (49)	238 (49)	24 (56)	218 (56)	1076
Female	166 (49)	432 (51)	252 (51)	19 (44)	173 (44)	1042
Birth order and birth interval						
First birth (order 1)	71 (21)	247 (29)	83 (17)	11 (26)	52 (13)	464 (22)
Order 2-4 & <24 months	46 (13)	89 (10)	36 (7)	2 (5)	41 (10)	214 (10)
Order 2-4 & 24 – 47 months	104 (31)	241 (28)	96 (20)	17 (39)	83 (21)	541 (26)
Order 2 -4 & 48+ months	41 (12)	74 (9)	46 (9)	1 (2)	27 (7)	189 (9)
Order 5+ & < 24 months	13 (4)	24 (3)	40 (8)	2 (5)	49 (13)	128 (6)
Order 5+ & 24-47 months	47 (14)	129 (15)	148 (30)	6 (14)	101 (26)	431 (20)
Order 5+ & 48+ months	16 (5)	52 (6)	41 (8)	4 (9)	38 (10)	151 (7)
Mother's age						
15 – 18	1 (0)	27 (3)	22 (4)	3 (7)	23 (6)	76 (4)
19 – 23	29 (9)	171 (20)	88 (18)	9 (22)	45 (11)	342 (16)
24 – 28	100 (29)	283 (33)	126 (26)	11 (25)	123 (32)	643 (30)
29 – 33	97 (29)	188 (22)	97 (20)	11 (25)	87 (22)	480 (23)
34+	111 (33)	187 (22)	157 (32)	9 (21)	113 (29)	577 (27)
Marital status						
Single	6 (2)	26 (3)	2 (0)	12 (28)	5 (1)	51 (3)
Married	327 (97)	783 (91)	464 (95)	30 (70)	356 (91)	1960 (92)
Divorced	5 (1)	47 (6)	24 (5)	1 (2)	30 (8)	107 (5)
Mother's education						
No education	1 (0)	37 (4)	400 (82)	13 (30)	292 (75)	743 (35)
Primary	71 (21)	327 (38)	55 (11)	12 (28)	68 (17)	533 (25)
Secondary or higher	266 (79)	492 (58)	35 (7)	18 (42)	31 (8)	842 (40)
Mother's occupation						
Not working	45 (14)	313 (37)	187 (38)	19 (44)	136 (35)	700 (33)

Clerical/sales/services/skilled manual	231 (68)	479 (56)	293 (60)	14 (33)	249 (64)	1266 (60)
Professional/Technician/Management	62 (18)	64 (7)	10 (2)	10 (23)	6 (1)	152 (7)
Wealth index						
Poorest	0 (0)	0 (0)	3 (1)	10 (23)	107 (27)	120 (6)
Poorer	0 (0)	0 (0)	7 (1)	3 (7)	203 (52)	213 (10)
Middle	1 (0)	97 (11)	162 (33)	21 (49)	70 (18)	351 (16)
Richer	24 (7)	356 (42)	272 (56)	9 (21)	11 (3)	672 (32)
Richest	313 (93)	403 (47)	46 (9)	0 (0)	0 (0)	762 (36)

Note: N = number

Table 2 Multilevel logistic regression models of urban area disadvantage and under-five mortality

Characteristics	Model 0 (Empty)	Model 1 (UADI)	Model 2 (Child-level)	Model 3 (Mother-level)
	OR (95% CI)	**OR (95% CI)**	**OR (95% CI)**	**OR (95% CI)**
Fixed effects				
Urban area disadvantage index				
Class I (Least disadvantaged)		1	1	1
Class II		1.32 (1.19-1.54)	1.32 (0.19-1.55)	1.72 (0.91-3.29)
Class III		1.39 (1.26-1.56)	1.38 (0.26-1.56)	1.78 (1.17-2.70)
Class IV		1.76 (0.52-1.81)	1.76 (0.52-2.11)	2.03 (1.04-3.97)
Class V(Most disadvantaged)		1.51 (0.65-1.72)	1.49 (0.14-1.65)	2.14 (1.11-4.12)
Sex of child				
Male			1	1
Female			1.04 (0.78-1.39)	1.02 (0.76-1.36)
Birth order/birth interval				
First birth (order 1)			1.40 (0.91-2.13)	1.66 (1.04-2.66)
Order 2-4 & <24 months			1.05 (0.60-1.84)	1.07 (0.61-1.89)
Order 2-4 & 24-47 months			1	1
Order 2 -4 & 48+ months			0.76 (0.40-1.44)	0.65 (0.34-1.27)
Order 5+ & < 24 months			2.17 (1.21-3.88)	1.55 (1.01-2.36)
Order 5+ & 24- 47 months			1.16 (0.75-1.79)	0.81 (0.49-1.35)
Order 5+ & 48+ months			0.76 (0.39-1.49)	0.51 (0.24-1.07)
Marital status				
Single				0.67 (0.20-2.30)
Married				1
Divorced				1.57 (0.73-3.37)
Mothers age				
15-18 years				0.84 (0.39-1.80)
19-23 years				0.81 (0.50-1.31)
24-28 years				1
29-33 years				1.08 (0.69-1.69)
34 years and older				1.53 (0.94-2.47)
Mother's education				
No education				2.34 (1.31-3.16)
Primary				2.00 (1.27-3.13)
Secondary or higher				1
Mother's occupation				
Not working				2.56 (1.03-6.34)
Clerical/sales/services/skilled manual				1.53 (0.63-3.69)
Professional/Technical/ Management				
Wealth index				
Poorest				1.64 (1.08-2.57)
Poorer				1.60 (0.68-3.76)
Middle				1.50 (0.85-2.64)
Richer				1.01 (0.62-1.62)

Richest				1
Community-level	**Empty**	**UADI**	**Child-level**	**Mother-level**
Variance (SE)	0.273 (0.111)*	0.129 (0.063)*	0.103 (0.049)*	0.097 (0.051)*
VPC	7.4	3.7	3.0	2.8
Explained variation (PCV) (%)	Reference	52.7	20.1	6.8
Mother-level				
Variance (SE)	0.118 (0.334)	0.065 (0.107)	0.049 (0.091)	0.032 (0.020)
VPC	3.2	1.9	1.4	0.9
Explained variation (PCV) (%)	Reference	44.9	24.6	34.7
DIC	1398	1375	1365	1287

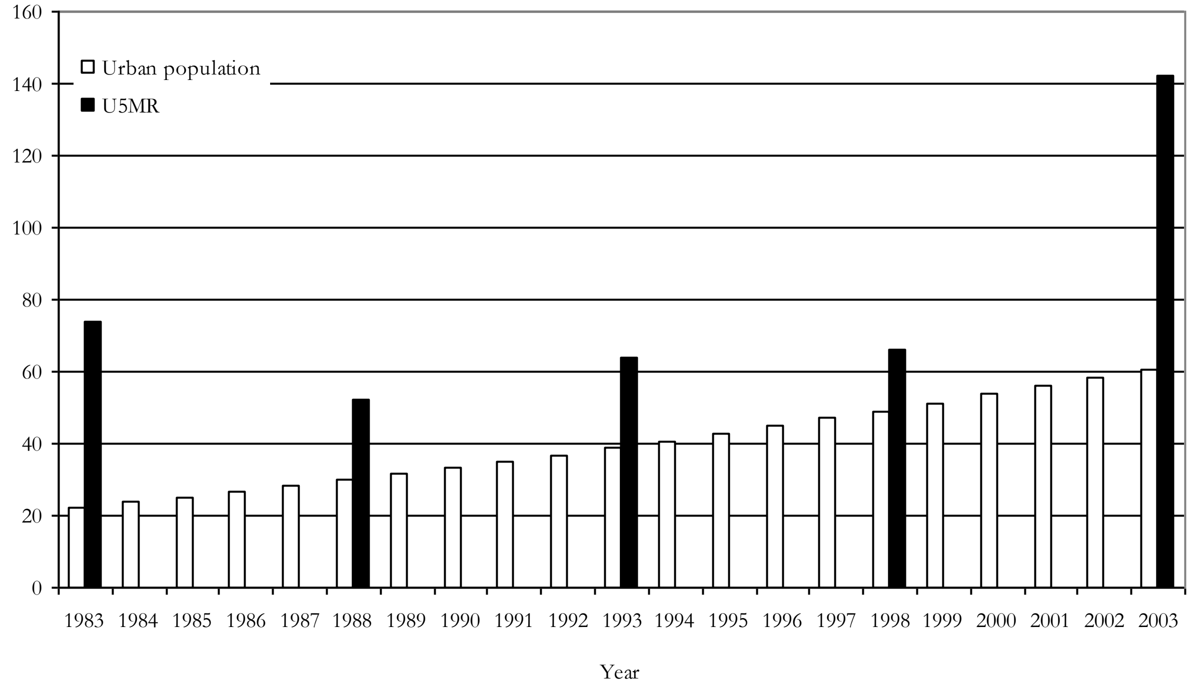
Note: Model 0 empty; Model 1 Urban area disadvantage index (UADI); Model 2 adjusted for child-level characteristics; and Model 3 additionally adjusted for mother-level characteristics.

P-value: **p*< .05; ***p*< .01; ****p*< .001

Abbreviations: OR = Odds ratio; CI = Confidence Interval; VPC = Variance partition coefficient; PCV = Percentage change in variance; SE = Standard error.

Data source: 2003 Nigeria Demographic and Health Survey.

Figure 1 Trends in urban under-five mortality rates (U5MR) and urban population in Nigeria, 1986-2003



Source: Urban under-five mortality rates were directly estimated from the 1990, 1999, and 2003 Nigeria DHS birth history data. Urban population was from the population division of the Department of Economics and Social Affairs of the United Nations Secretariat, World population Prospects: The 2004 Revision and World Urbanization Prospects. http://esa.un.org/undp

Figure 2 Association between under-five mortality and urban area disadvantage index, 2003 Nigeria Demographic and Health Survey.