Increasing Levels of Urban Malnutrition with Rapid Urbanization in Informal Settlements of Katutura, Windhoek: Neighbourhood Differentials and the Effect of Socio-Economic Disadvantage

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Abstract
Rapid urbanization and increasing urban poverty characterize much of Southern Africa, resulting in poor urban health. This study investigates inter-urban differences and determinants of undernutrition among marginalized communities. Using the 1992, 2000 and 2006/2007 Namibia Demographic and Health Survey data, we fitted hierarchical random intercept logit models, applied at 52 enumeration areas

in the capital city (Windhoek), to estimate trends in undernutrition, and investigate risk factors associated with stunting and underweight. Findings demonstrate that undernutrition among children has risen (7.4% to 25.1%, $p<0.001$ for stunting; and 9.7% to 17.6%, $p<0.001$ for underweight, between 1992 and 2006/2007). The risk was pronounced for children from socioeconomically disadvantaged households (OR=1.53, 95% CI:[1.01, 2.31] for stunting and OR=2.16, 95% CI:[1.03, 4.89] for underweight). Evidence emerged of intra-urban variation in undernutrition. We argue that with increasing urbanization, comes the challenge of food insecurity and, consequently, malnutrition. For improved child health, urban planners should have targeted interventions for poor urban households and deprived neighbourhoods.

Introduction

Until recently, rural areas were considered the epicentre of poverty and malnutrition. Even the proposed solution to food insecurity is entrenched in "increasing productivity of small-scale farmers" (Sanchez et al. 2009). Moreover, most measures of poverty, whether based on income, consumption or expenditure, show that rural poverty is deeper and more widespread than in the cities (World Bank 2013). However, there is now evidence that although urban centres on the whole offer better access to health, education, basic infrastructure, information, knowledge and opportunity, poverty is now increasing more rapidly in urban areas than in rural areas, especially in Africa, and most assessments underestimate the scale and depth of urban poverty (Haddad et al. 1999; Kessides 2005; Mitlin and Satterthwaite 2011; Satterthwaite et al. 2010).

Particularly, in many countries in Southern Africa, urban populations have increased, with some having reached proportions above 50%. Since 2010, 59% of Southern Africa Development Community's (SADC) population lived in urban areas, and this figure is projected to reach over 75% by mid-century (UN-Habitat 2010), and poverty and associated health problems are likely to increase. Recent studies show that Southern Africa is urbanizing rapidly (Crush 2012), urban poverty and malnutrition is growing (Haddad et al. 1999; Potts 2006) and the poor are migrating faster than the non-poor (Ravallion et al. 2007), increasing the proportion of urban poor. Namibia is no exception to these changes. Although urbanization and modernization are associated with increased income and improved nutrition, what is not clear is whether the urban poor, particularly those in the informal settlements, are reaping the benefits of the urban advantage and the increase in per capita income[1] or they are bypassed by this growth, especially given the rising income inequalities, which manifests in food insecurity and child undernutrition (Antai and Moradi 2010).

Food insecurity, which is defined as "access by all people at all times to sufficient food for an active healthy life" (FAO 1996), implies that food has to be available and accessible. In urban areas, the most source of food insecurity is accessibility (Crush and Frayne 2011), which is determined by lack of income rather than availability. Hunger and starvation represent the most severe forms of food insecurity. Food and Agriculture Organisation (FAO) estimated that nearly one billion people worldwide (14% of the world's population) are undernourished owing to insufficient access to energy- and protein-rich foods (FAO 2009). Undernutrition is defined as the outcome of insufficient food intake and repeated infections (UNSCN 2012). Undernutrition in adults is measured by the body mass index (BMI), with individuals with BMI of 18.5 or less being considered as underweight.[1] Urbanization is associated with changes in diets (especially in the developing world, which is now producing a second "silent emergency" – overnutrition or obesity). Whereas obesity was once associated with rising incomes and industrialized countries, this is no longer the case. In Brazil, Monteiro et al. (2004) discovered that obesity was increasing among low-income women and decreasing among high-income women.

Similarly, for the poor areas in urban centres, there is a likelihood that the malnutrition might be on the rise owing to problems of inability to afford diverse diet. While there exist growing literature on the investigation between family/household income and the health status of children (Crush 2013), that greater resources at household level will increase the ability of household to acquire more calories and that parents and, in particular, women invest more in nutrition and child health (Levin et al. 1999), it remains unclear whether increased income improves nutritional status among urban poor, in particular the children. Lack of disaggregated data within the urban areas tends to mask these differences. Smith et al. (2005) illustrate these intra-urban differentials that urban children in the lowest socioeconomic quintile in some countries of Latin America had up to 10 times the risk of stunting than children in the highest quintile.

Urbanization and informal settlements in Windhoek, Namibia

During the apartheid colonial rule of Namibia by South Africa and in particular after 1948, the South African National Party began to implement its urban apartheid policy in Windhoek. Whereas white immigration was encouraged, especially between 1946 and 1960, leading to the significant proportion of the white population (6,985 to 19,378), at the same time, pass laws were implemented to control the influx of the black population to Windhoek, and the population stood at 13,935 in 1960. In 1959, the black residents of Windhoek were forcibly moved to a new place, Katutura, north-west of the city, to make way for the white population, as the blacks occupied the area of Hochland Park, which was considered suitable for whites (Pendleton 1996). They were moved to Katutura, which literally mean "a place where we will not stay." By 1981, the population of Katutura had escalated to 44,000 primarily through rural–urban migration. From then on, the black population in Windhoek continued to grow rapidly, and it almost doubled between 1981 and 1991 from 44,003 to 86,640. This unprecedented urban growth also meant that Windhoek's population grew as a proportion of the national population from 10.4% in 1991 to 12.4% in 2001 and to 16% in 2011. The 2011 census estimated Windhoek's population at 322,500, up from 230,000 in 2001 or an annual growth rate of 4%, making it one of the fastest-growing cities in Southern Africa. Today, the city is home to 36% of the total urban population.

Katutura today is divided into six constituencies and those at the peripheral areas, i.e., Tobias Hainyeko, Samora Machel and Moses Garoeb, are dominated by black population with lack of or low income, and most of these residents are recent migrants. During the period 1991–1994, the City of Windhoek established three reception areas to temporarily accommodate the new influx of poor migrants. However, within and outside these established areas, the number of informal housing continued to grow rapidly. The city found it difficult to keep people out of the designated reception areas, and major land invasions occurred prior to site layout and rudimentary construction (Mitlin and Muller 2004). The uncontrolled, unauthorized and unplanned occupation of land by unemployed rural–urban migrants continues even today. It is estimated that by 2011, about 114,000 people were living in shacks, an increase from 48,000 in 2001 (City of Windhoek 2005; NPC 2001). This translates to informal settlements growth of 9% per annum, a rate more than double that of the city (City of Windhoek 2012).

Unemployment is estimated at 40%. Given these living conditions, the increasing level of unemployment, the increased urbanization and the growth of the informal settlements have serious implications on the nutritional status of children.

Food production in Namibia is influenced by natural rainfall, and national cereal production fluctuates according to rainfall patterns. The cultivation of rain-fed crops is regionally concentrated and is primarily confined to the north-central and north-eastern communal areas, though a small but significant area of commercial maize production is found in the so-called maize triangle, i.e., Otavi, Tsumeb and Grootfontein areas (Sweet 1998). Considering Namibia as a whole, food availability is not a problem, as the country depends on food imports to ensure food security for its inhabitants. However, food security is a concern in a number of households.

A study in the non-formal areas of Windhoek found that the prevalence rate of wasting was 19.7% higher than that reported by the 2000 Namibia Demographic and Health Survey (NDHS) of 9% (Ochurus 2007). Similarly, stunting was reported to be 28.8%. The same study reported that wasting in one of the informal settlements stood at a high of 52.2%. Causes of malnutrition in the informal settlements were discovered to be unemployment and low income levels. Unemployment rate in the Khomas region, where Windhoek is located, stood at 22.3%, translating to 46,849 peorsons (NSA 2015); however, official unemployment in the informal settlements is high (at around 40%). Windhoek's population has increased from 235,500 in 2001 to 340,900 in 2011, with an annual growth rate of 5% and a total urban population of 36% (NSA 2013). Windhoek is about the same size as the cumulative population of the next 10 largest urban centres in the country, making it the focal point of Namibia's urban transition. This has implications on nutritional status of especially poor urban residents.

The 2006/2007 NDHS found that one of three Namibian children under the age of five were malnourished, one in three Namibian children under the age of five were stunted (too short for their age), one in five (underweight) were too thin for their age and one in 20 Namibian children weigh too much for their age (MoHSS and Macro 2008). The impact of malnutrition on Namibia's human and economic development is huge. While regional differences exist, undernourishment and undernutrition are growing rapidly under conditions of rapid urbanization. It is therefore useful to examine the level and trends of undernutrition in the rapidly growing areas of Windhoek and simultaneously identify determinants of undernutrition in the growing urban poor areas of this city.

Materials and Methods

Study area

The study site is Katutura Township, situated north-west of Windhoek. This study is based on the informal settlements of Katutura Township, in Windhoek, Namibia. The township has six constituencies (Tobias Hainyeko, Katutura Central, Katutura East, Soweto, Samora Machel and Moses Garoeb), of which three (Tobias Hainyeko, Samora Machael and Moses Garoeb) have informal settlements. According to the 2011 Namibian Population and Housing Census, the total population in the township was 199,100 within 52,100 households, and an average household size, per constituency, ranging between 3.3 and 4.9 persons. Therefore, over 60% of Windhoek's population lives in the low-income areas characterized by informal settlements. This study isolated all sampled enumeration areas (EAs) drawn from Katutura Township for the analysis of levels, trends and determinants of undernutrition in children under the age of five years.

It should be noted here, that the problem of informal settlements occurs in other towns in Namibia, such as Walvis Bay, Oshakati and Swakopmund. These areas were not considered because the urban population of Windhoek is equal to that of three towns combined; thus, any pattern observed in Windhoek, and Katutura in particular, can be modelled to the smaller townships elsewhere in the country.

Data

Three sets of NDHS data, drawing independent population-based household samples conducted with similar sampling design and data collection methodologies, were used. The study draws from the 1992, 2000 and 2006/2007 NDHS. All samples were drawn using a two-stage cluster probability sampling. Details about the survey are provided elsewhere (MoHSS and Macro, 2008). In brief, the NDHS sampled, at the first stage, EAs, which are the primary sampling units, proportional to the size of the region – so as to obtain reliable estimates at regional and national level, while stratifying by rural and urban status of EA. The EAs were designed from the master sampling frame of the previous censuses. For example, the 1992 and 2000 EAs were sampled from the 1991 Namibia census, while the 2006/2007 EAs were sampled from the 2001 census. Having selected an EA, all households in that EA were listed, and a random sample of fixed households was drawn using systematic sampling. From the chosen household, all women of age 15–49 years were eligible for interview. Those who agreed to participate were asked questions pertaining to birth history and health, mostly for children under the age of five or of those children who were born within three years preceding the survey date. This study only considered the index child in the age range of 0 to 5 years.

Ethical considerations

The study was based on secondary data. At the time data were collected, ethical clearance was obtained from institutional review boards of the Ministry of Health and Social Services in Namibia and ORC Macro Inc., Washington DC. Participation in the survey was voluntary, and informed consent was obtained from all participants. The data were provided in an anonymized format.

Outcome variables

The outcome variables were nutritional statuses, which were measured by a binary indicator of chronic malnutrition: stunting (height-for-age) and underweight (weight-for-age). A child was considered stunted if his or her height-for-age z-score was two standard deviations below the median height of children of the same age and sex in a “healthy” reference population. The same definition applied for underweight based on the child’s weight-for-age z-scores (WHO 2006). The z-score is defined as z=00; where AI_i is the individual anthropometric indicator, $MA1$ is the median of the reference population and sigma is the standard deviation of the reference population.

Primary covariates

Two binary variables to capture exposure associated with urban disadvantage were constructed. The first was an indicator of material deprivation (categorized as 1 for most deprived or 0 for least deprived), defined by adapting an approach by Barnes et al. (2007) and Antai and Moradi (2010). The material deprivation was based on the following: (i) a child living in a household without piped water; (ii) child living in a house without flush toilet; (iii) child living in a house without finished floor; (iv) child living in a house with cooking using wood/charcoal or coal; (v) a child in a home without electricity; (vi) a child in a crowded house (with five or more household members based on average household size, which is 4.2 household members); and (vii) a child with a mother who is not working. Using these seven binaries, we created a quintile index through principal component analysis; then, the two highest quintiles were classified as most deprived, and the other three as least deprived.

The second exposure indicator was based on assets to create a wealth index. The wealth index was again computed using principal component analysis based on questions asked on available household assets (e.g., radio, TV, car, oxcart, bicycle and refrigerator) and housing characteristics (electricity; type of roof, wall and floor; water source and time to water point). Details of how the wealth index is generated can be found in Rutstein and Kiersten (2004). Using the two lowest quintiles from this indicator, we generated a binary classifying the child as belonging to a poor-resource (coded as 1) or rich-resource (coded as 0) household. Collinearity between the two exposure variables was assessed.

Other control variables

The following explanatory variables, guided by literature, were identified for inclusion in the analysis: low birth weight, maternal education, maternal age, sex of the head of household, age of head of household, BMI of the mother, age of child, birth order of child, number of birth in the past five years, child is twin, immunization and feeding patterns of child and years lived at the present place.

Statistical analysis

We first ran the descriptive statistics and chi-square to assess variables related to stunting and underweight. The following variables did not vary and were dropped from further analysis: low birth weight, age of household head, child is twin (98% of births were single births), BMI (not available for all survey periods), immunization status (also left out in the analysis, as there was not much variation; about 99% of children were immunized), as well as feeding pattern and currently pregnant (which provided little variability).

We examined trends in stunting and underweight for the three periods: 1992, 2000 and 2006/2007. Furthermore, separate cross-tabulations for each outcome and all remaining variables, and by year, were carried out. We then pooled all the data and carried out a chi-square test of each outcome across all covariates. Those covariates that were associated with the two outcomes, at $p<0.2$, were then used for model fitting. The independent variables relate to the household, the mother and the child. Variables at *household level* included: material deprivation (proxy for urban disadvantage), wealth index (proxy of socioeconomic status), years lived in the current place and sex of the head of household; *mother level*: level of education and number births in the past five years; and *child level*: age of child and birth order.

The following multivariate logistic regression models were estimated. Model M1 fitted a trend, while model M2 adjusted for the exposure variables and cluster heterogeneity. In model M3, we added the remaining variables as fixed effects. The last model, M4, assumed smooth functions for the continuous variables such as age of child and length of residence at present place. All models were fitted using Bayesian inference and implemented in BayesX (Brezger et al. 2005). The choice of the Bayesian analysis is guided by the complexity of M3 and M4, which analytically might not be feasible to implement in many off-the-shelf statistical software such as SPSS.

In implementing the Bayesian analysis, the following priors were assumed: the trend and fixed effects were assigned diffuse priors, while cluster random effects were assumed to follow an exchangeable normal prior with mean of zero, a highly dispersed variance and an inverse gamma hyper-prior. The smooth functions were modelled using penalized splines with second-order random walk difference. For all the models, a random draw of 15,000 samples was carried out with a burn in of 5,000 and thin-in of 10, giving a final sample of 1,000 for parameter estimation.

Convergence of the model was assessed using Rubin–Gelman diagnostics and trace plots. Model comparison was based on the deviance information criterion (DIC), such that a small DIC signified a better model. Two comparable models were assumed to be different if the DIC between them was greater than 10.

Results

Descriptive statistics

A combined sample of 754 children under the age of five years was available from the three surveys for the selected constituencies; however, complete case analysis was based on 537 observations. The prevalence of stunting and underweight is given in Table 1. A significant upward trend in increased risk of stunting and underweight was established ($p<0.05$). The proportion of stunting increased by more than 20% between 1992 and 2000 and stabilized to 25% in 2006/2007. Similar patterns, but slightly lower, of increased underweight were observed between 1992 and 2006/2007.

Table 2 gives a cross-tabulation of the outcomes and background characteristics of respondents, assessed using chi-square test of association. The prevalence of stunting was associated with material deprivation, wealth index, age of the child, birth order of the child, maternal education and years lived at same location. Similar level of association was noted for child underweight. Across all variables, the prevalence of stunting was lower compared with underweight in 1992, but this was reversed in 2000 and 2006/2007 survey periods.

Risk factors of stunting and underweight

Table 3 provides summaries of model estimates of risk factors associated with stunting. A clear trend in risk of stunting was established in all models. More children in the poor areas of Windhoek in 2006/2007 were associated with stunting and underweight compared with 1992. Considering the DIC, M4 was the best with the smallest DIC of 491.29. We therefore report the results based on this model. Stunting was associated with increasing levels of material deprivation (OR=1.53; 95% CI:[1.01, 2.31]) and low assets (OR=1.43), although this was not significant. The risk of stunting also increased with birth order, with second- or third-born children at high risk compared with when a child was fourth-born or higher (OR=1.94; 95% CI:[1.02, 3.19]). The odds of stunting were higher for children born to mothers of primary education relative to those who had secondary or higher education (OR=1.68; 95% CI:[1.02, 3.04]).

Table 4 gives summaries of risk factors of underweight. Again, using model M1, the risk of underweight heightened in 2000 and 2006/2007 compared with 1992 for children in Katutura. Focusing on M4, which was the best model (DIC=446.47), the risk of underweight across years remained high (OR=2.45 in the year 2000 and OR=1.36 for the year 2006/2007), although these were not significant after adjusting for other variables in the model, suggesting interaction.

Table 1. Children nutritional indices between 1992, 2000 and 2006/2007 in Katutura Township, Windhoek

Year of survey	Stunted			Underweight		
	%	Total	Chi-square* (*p*-value)	%	Total	Chi-square (*p*-value)*
1992	7.4	175	31.6 (<0.001)	9.7	175	6.2 (0.044)
2000	31.3	163		18.4	163	
2006/2007	25.1	199		17.6	199	

*The chi-square for trend test.

Table 2. Sociodemographic characteristics of the sampled children in Katutura, Windhoek, according to year of survey and undernutrition outcome [*n*(%)]

	Year 1992		Year 2000		Year 2006/2007		Total*	
Sample characteristics	Stunted *n*=175	Underw. *n*=175	Stunted *n*=163	Underw. *n*=163	Stunted *n*=199	Underw. *n*=199	Stunted *n*=537	Underw. *n*=537
Age of child							*30.6 (<0.01)*	*19.1 (<0.01)*
<6 months	22 (0)	22 (0)	26 (3.8)	26 (0)	32 (6.2)	32 (3.1)	80 (3.8)	80 (1.2)
7–12 months	26 (7.7)	26 (15.4)	22 (18.2)	22 (22.7)	27 (25.9)	27 (7.4)	75 (17.3)	75 (14.7)
13–24 months	44 (11.4)	44 (15.9)	41 (53.7)	41 (24.4)	45 (40.6)	45 (28.9)	130 (34.6)	130 (23.1)
25–59 months	40 (7.5)	40 (10.0)	29 (27.6)	29 (13.8)	32 (21.9)	32 (18.8)	101 (17.8)	101 (13.9)
Age of mother							*0. 3 (0.99)*	*1.2 (0.98)*
<24 years	52 (9.6)	52 (7.7)	42 (21.4)	42 (14.3)	51 (28.3)	51 (25.5)	145 (20.7)	145 (15.9)
25–29 years	49 (2.0)	49 (6.1)	41 (43.9)	41 (28.6)	56 (31.4)	56 (14.3)	146 (22.6)	146 (15.1)
30–34 years	36 (8.3)	36 (8.3)	34 (32.4)	34 (17.6)	42 (21.4)	42 (16.7)	112 (20.5)	112 (14.3)
35–49 years	38 (10.5)	38 (18.4)	46 (28.3)	46 (15.2)	50 (22.0)	50 (14.0)	134 (20.9)	134 (15.7)
Birth last five years							*0.6 (0.45)*	*1.8 (0.3)*
One birth	99 (10.1)	99 (12.1)	109 (33.9)	109 (16.5)	129 (21.7)	129 (17.1)	337 (22.3)	337 (15.4)
Two or more	76 (3.9)	76 (6.6)	54 (25.9)	54 (22.2)	70 (31.4)	70 (18.6)	200 (19.5)	200 (15.0)
Birth order							*5.4 (0.12)*	*6.9 (0.1)*
First-born	47 (10.6)	47 (8.5)	43 (18.6)	43 (18.6)	63 (17.5)	63 (18.4)	153 (15.7)	153 (14.4)
Second-or third-born	63 (4.8)	63 (7.9)	71 (38.0)	71 (15.5)	84 (28.6)	84 (17.9)	218 (24.8)	218 (14.2)
Fourth-born or more	65 (7.7)	65 (12.3)	49 (32.7)	49 (22.4)	52 (28.8)	52 (19.2)	166 (21.7)	166 (17.5)
Mother education							*15.1 (0.07)*	*9.7 (0.08)*
None	24 (16.7)	24 (4.2)	9 (55.6)	9 (22.6)	11 (9.1)	11 (18.2)	44 (22.7)	44 (11.4)
Primary	75 (6.7)	75 (14.7)	35 (42.9)	35 (34.3)	37 (43.2)	37 (29.7)	147 (24.5)	147 (23.1)
Secondary or higher	76 (5.3)	76 (6.6)	119 (26.1)	119 (13.4)	151 (21.9)	151 (14.6)	346 (19.7)	346 (12.4)
Sex of household head							*0.8 (0.31)*	*0.1 (0.95)*
Male	114 (7.0)	114 (10.5)	91 (33.0)	91 (22.0)	111 (22.5)	111 (14.4)	316 (19.9)	316 (15.2)
Female	61 (8.2)	61 (8.2)	72 (29.2)	72 (13.9)	88 (28.4)	88 (21.6)	221 (23.1)	221 (15.4)
Material deprivation							*8.4 (0.04)*	*4.8 (0.028)*
Most deprived	69 (10.1)	69 (13.0)	85 (41.5)	85 (21.5)	76 (31.6)	76 (13.7)	210 (27.6)	210 (19.5)
Least deprived	106 (5.7)	106 (7.5)	98 (24.5)	98 (16.3)	123 (21.1)	123 (13.8)	327 (17.1)	327 (12.5)
Wealth index							*6.1 (0.03)*	*5.5 (0.04)*
Low	44 (6.8)	44 (11.5)	94 (37.2)	94 (24.5)	3 (33.3)	3 (33.3)	141 (27.7)	141 (20.6)
High	131 (7.6)	131 (9.2)	69 (9.2)	69 (10.1)	196 (25.0)	196 (17.3)	396 (18.9)	396 (13.4)
Years lived at present residence							*9.2 (0.07)*	*7.1 (0.09)*
<6 years	22 (0)	23 (4.3)	17 (52.9)	17 (23.5)	87 (29.9)	87 (20.7)	127 (27.6)	127 (18.1)
6–15 years	16 (6.2)	16 (6.2)	24 (33.3)	24 (20.8)	29 (13.8)	29 (13.8)	69 (18.8)	69 (14.5)
>15 years	105 (9.5)	144 (9.7)	120 (28.3)	120 (17.5)	78 (24.4)	78 (15.4)	303 (20.8)	303 (14.9)

*Italicized numbers in the total column refer to the chi-square (*p*-value). Underw = underweight.

Table 3. Risk factors of stunting in children under age of five in Katutura, Windhoek, given are the odds ratios (ORs) and corresponding confidence intervals (CIs)

Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Fixed effects				
Trend				
1992	1.00	1.00	1.00	1.00
2000	5.67 (2.95,10.92)	2.17 (0.33, 14.06)	4.97 (2.49, 9.90)	6.75 (2.43, 18.76)
2006/2007	4.18 (2.18, 8.01)	3.25 (0.46, 24.84)	6.02 (2.65, 13.71)	6.26 (2.01, 19.50)
Material deprivation				
Least deprived		1.00	1.00	1.00
Most deprived		1.83 (1.01, 3.26)	1.62 (1.02, 3.06)	1.53 (1.01, 2.31)
Wealth index				
Poor		1.21 (0.90, 2.50)	1.29 (0.83, 2.11)	1.43 (0.67, 3.07)
Rich		1.00	1.00	1.00
Age of child				
<6 months			0.14 (0.04, 0.54)	
7–12 months			1.02 (0.42, 2.58)	
13–24 months			2.48 (1.18, 5.53)	
25–59 months			1.00	
Birth order				
First-born			0.87 (0.39, 1.95)	0.94 (0.39, 2.21)
Second- to third-born			1.57 (0.99, 2.49)	1.94 (1.02, 3.19)
Fourth-born or above			1.00	1.00
Maternal education				
None			1.20 (0.41, 3.56)	1.29 (0.40, 3.56)
Primary			1.92 (1.01, 3.79)	1.94 (1.01, 3.88)
Secondary/Higher			1.00	1.00
Years lived at present place				
≤5 years			1.68 (1.06, 3.04)	
6–14 years			0.95 (0.48, 1.95)	
15 year or more			1.00	
Random components				
Community variance		0.064 (0.001, 0.35)	0.042 (0.001, 0.24)	0.036 (0.001, 0.21)
Model fit				
Deviance	519.54	511.70	498.02	442.32
DIC	529.51	525.43	524.28	491.29

Table 4. Risk factors of underweight in children under age of five in Katutura, Windhoek, given are the odds ratios (ORs) and corresponding confidence intervals (CIs)

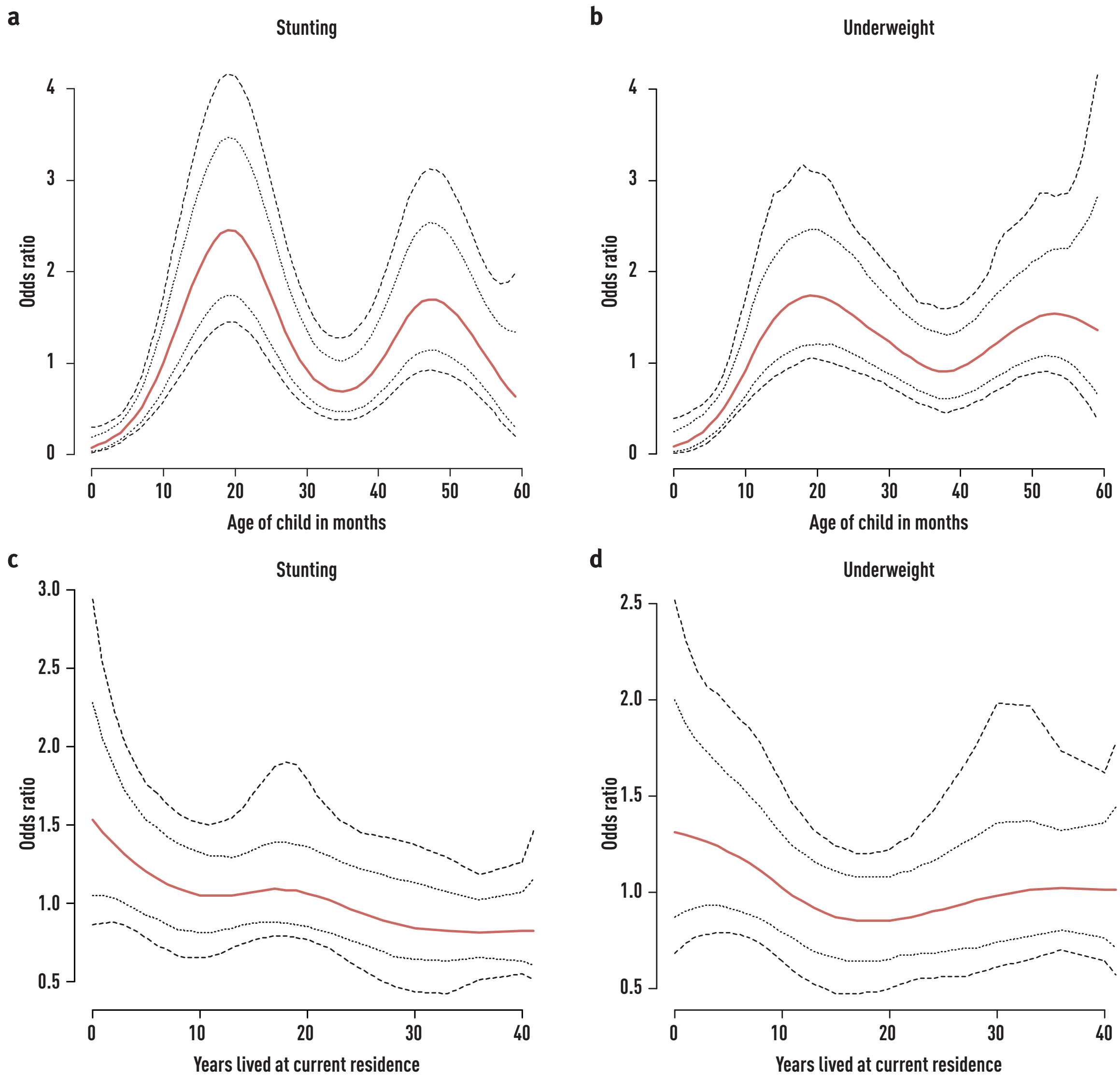
Variable	Model 1 OR (95% CI)	Model 2 OR (95% CI)	Model 3 OR (95% CI)	Model 4 OR (95% CI)
Fixed effects				
Trend				
1992	1.00	1.00	1.00	1.00
2000	1.98 (1.07, 3.68)	2.00 (1.02, 3.19)	2.59 (1.10, 6.11)	2.45 (0.74, 6.18)
2006/2007	2.09 (1.11, 3.97)	1.90 (1.01, 3.90)	1.72 (1.01, 3.42)	1.36 (0.46, 3.95)
Material deprivation				
Least disadvantaged		1.00	1.00	1.00
Most disadvantaged		1.35 (0.57, 3.26)	1.23 (0.64, 2.36)	1.14 (0.50, 2.34)
Wealth index				
Poor		2.18 (0.99, 4.15)	2.55 (1.07, 4.25)	2.16 (1.03, 4.89)
Rich		1.00	1.00	1.00
Age of child				
<6 months			0.07 (0.009, 0.61)	
7–12 months			1.25 (0.64, 3.36)	
13–24 months			2.14 (1.12, 4.84)	
25–59 months			1.00	
Birth order				
First-born			0.84 (0.38, 1.85)	1.05 (0.51, 2.46)
Second- to third-born			0.49 (0.24, 0.98)	0.43 (0.19, 0.97)
Fourth-born or above			1.00	1.00
Maternal education				
None			0.73 (0.73, 2.54)	1.06 (0.28, 2.46)
Primary			2.21 (1.04, 4.15)	1.99 (0.89, 4.45)
Secondary/Higher			1.00	1.00
Years lived at current place				
≤5 years			1.34 (0.83, 2.18)	
6–14 years			0.51 (0.14, 1.74)	
15 year or more			1.00	
Random components				
Community variance		0.25 (0.002, 0.91)	0.36 (0.002, 1.19)	0.32 (0.002, 1.14)
Model fit				
Deviance	452.34	429.21	413.89	384.01
DIC	458.38	456.13	459.12	446.47

In the same Table 4, materially deprived children were at increased risk of underweight (OR=1.14; 95% CI:[0.50, 2.34]), although not significant. However, significant association was observed between underweight and wealth index, with children from poor households at OR=2.16 (95% CI:[1.03, 4.89]), compared with those in resource-rich households. Furthermore, despite a positive association between underweight with birth order, and maternal education, no significant relationships were observed (Table 4).

Figure 1a shows the nonlinear effects of age of child. The odds of stunting were lower between the ages of 0 and 20 months, and rising above 1 at the age of 25 months, and then falling again to age of 35 months. The cyclical pattern repeated between this point to the age of 60 months, with the log-odds remaining within 0 and 1. In Figure 1b, the nonlinear effect of age on underweight is displayed. The shape of the curved line was similar to that obtained for stunting, with a rising risk between ages of 0 to 20 months, falling up to the age of 40 months and the cyclic patterns repeated to the end of the age range.

Figure 1c displays the effect of years living at same place on stunting. In general, the risk of stunting gradually fell for the entire period. This agrees with the fixed effects of the same variable generated in M3, which shows increased odds of stunting for those whose length of stay was less than five years compared with those who stayed 15 years or more (OR=1.68; 95% CI:[1.20, 3.04]; Table 3). The relationship between length of stay and underweight is captured in Figure 1d.

Figure 1. Nonlinear estimates of age of a child on risk of stunting (a) and underweight (b), and of years lived at current residence on risk of stunting (c) and underweight (d)*



*The lines represent the mean (middle), with corresponding 80% and 95% confidence bands (outer lines).

The risk was higher at the beginning and falls to about 15 months, and started picking up. However, the wide margins of the confidence bands suggest this pattern was not significant – again in agreement with the fixed estimates obtained in model M3 (OR=1.34; 95% CI:[0.83, 2.18] in Table 4).

Inter-cluster heterogeneity in stunting and underweight

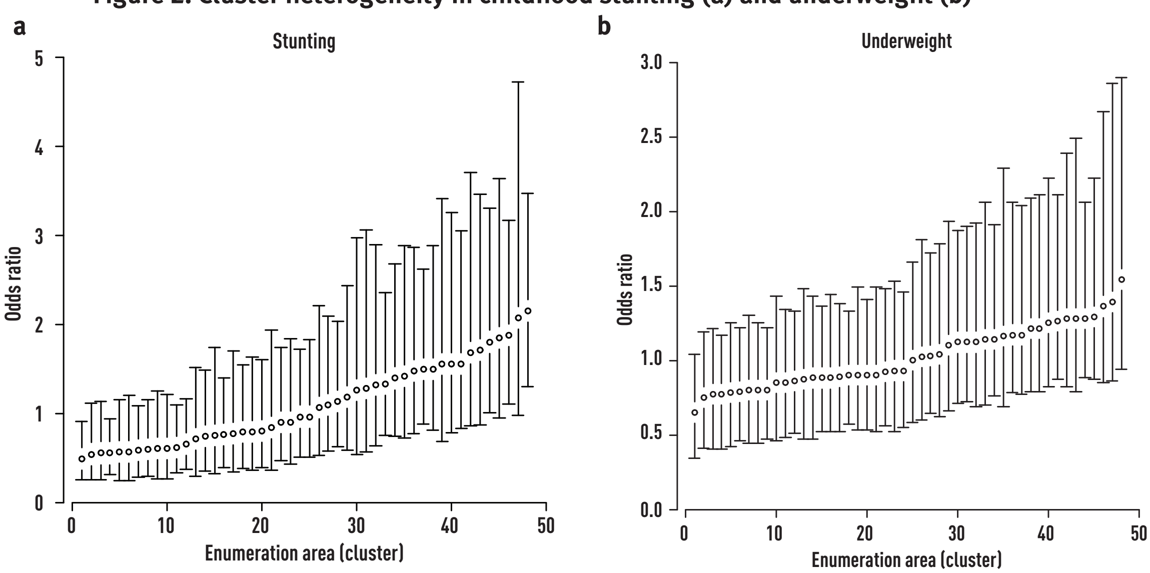
Figure 2a shows a caterpillar plot of risk estimates for each EA. Evidence of substantial heterogeneity across clusters can be observed. The estimated variance component for the clusters was small (coefficient: 0.036; 95% CI:[0.001, 0.21]), suggesting some similarities in risk of stunting for the areas considered. Figure 2b presents a caterpillar plot of cluster estimates of underweight. Some degrees of differences in risk of underweight across clusters were noted. The variance component confirms the same (coefficient: 0.32 in Table 4).

Discussion and Conclusions

We observed that levels and trend in stunting and underweight, in Windhoek, Namibia, between 1992 and 2006/2007, were rising, and overlap with rapid urbanization. Children enumerated in 2006/2007 were 4.2 times more likely to be stunted and 2.1 times more likely to be underweight compared with the year 2000, while malnutrition levels in children recorded in 2000 were 5.7 times more likely to be stunted and 1.9 times more likely to be underweight than those reported in 1992. At the same time, this trend coincides with massive movement of people to urban area, and in Namibia, Windhoek is prime city of choice. Windhoek grew its urban population by 5.4% since 1991 and accounts for 41% of urban dwellers in Namibia.

As most sub-Saharan African cities, Windhoek, is being fed by a rapid rural–urban migration pattern. Generally, these migrants are deprived and marginalized sections of the rural population who move to urban areas in search of better and sustainable livelihoods (Pendleton 1996; Smith et al. 2005; Crush 2013; Pendleton et al. 2014). The consequences of such rapid urbanization are socioeconomic transition (Custodio et al. 2008, 2010), which negatively affects the health of the population, particularly children. The socioeconomic transition emanates from the growing urban inequalities in a form of informal settlements characterized by crowded households, generally deprived in water and sanitation

Figure 2. Cluster heterogeneity in childhood stunting (a) and underweight (b)*



*Measured as odds ratios with corresponding 95% CI limits.

services, creating neigbourhoods that negatively impact child health (Antai and Moradi 2008). Our assertion is that unguided urbanization, as experienced in Windhoek, poses a public health impact to large sections of the migrant population, and even the already established, owing to environmental degradation and lack of access to basic services (Smith et al. 2005).

Similar to other studies (Antai and Moradi 2008), we confirm the evidence that urbanization in African cities is associated with increased ill-health, and this was more pronounced among the extremely deprived urban neigbourhoods. These effects were reduced but remained significant when we adjusted for material deprivation and wealth index (Tables 3 and 4), an important finding that points to the effect of socioeconomic transition and rapid urbanization on the increasing levels of childhood malnutrition. Our results validate earlier findings that roots of ill-health and health inequalities are evidently affected by poverty and social disadvantage (Wilkinson and Marmot 2003; Moradi 2010). Indeed, although the effects of social gradient can be felt in all sectors of society, these effects are more grave at the lower to middle class of socially position, a fact that has been documented in systematic reviews in nutrition (Wilkinson and Marmot 2003; Smith et al. 2005; Moradi 2010).

In this paper, two nutritional indicators were selected to reflect different dimensions of childhood nutritional status and their linkages to food insecurity. Stunting captures the failure to receive adequate nutrition over a long period, whereas underweight accounts for both acute and chronic malnutrition. Both aspects of undernutrition have implications in the life cycle of the child, with long-term cognitive compromise. The linkage between malnutrition and food insecurity is owing to inadequate food consumption or poor absorption or biological use of nutrients consumed. The former can be explained by conditions of illness, or disease or nutrient imbalance (Campbell 1991). While it should be acknowledged that an individual or household can be found to be food-insecure, but not undernourished, evidence in many African setting suggests the existence of the other direction of causal relationship between food insecurity and undernutrition (Cordeiro et al. 2012; Folaranmi 2012).

Urban households are more dependent on food purchase, which, if they have sufficient purchasing power, can lead to a more varied diet and higher reliance on “ready-made” and fast foods, compared with rural households. Food access has a direct impact on dietary diversity and can been seriously affected by rising food and fuel prices, and conflict (Cordeiro et al. 2012; Folaranmi 2012; Crush 2013). Consistent emerging trend indicated that in poorer urban households, women were either feeding their children a poor diet or skipping meals so their children could eat, which has a greater compromise in nutrition (Benson 2004; Labadarios et al. 2011; Pendleton et al. 2014). In the long run, such children are to be stunted and underweight. However, it should be emphasized that this relationship can be complex. Other underlying causes, including inadequate care and poor service delivery, equally impact on childhood health if a household is socioeconomically disadvantaged.

As pointed out by Moradi (2010), it is important to recognize that urban disparities may have been created by social and economic discrimination against black majority, of which its effects are still being felt in Namibia. Although Namibia has a better national income compared with other countries in sub-Saharan Africa, the benefits are not diffusing down to provide better housing, employment opportunities and improved water and sanitation services owing to the aftermath of apartheid system, findings that parallel those found in South Africa (Cameron 2003).

Even if such urban populations have access to better health services, the delicate balance of "putting food on the table" compromises treatment-seeking behaviour when the child's health condition is not life-threatening, and in the long run, leads to deteriorating nutritional status.

The established heterogeneity (Figure 2) speaks of the fact that even among disadvantaged urban areas, disparities do exist, which may help find hotspots of disease burden. There is growing interest to understand the sensitivity of health to the social environment. Social environment is conducive for better nutritional security, of which a compromise would lead to undernutrition (Wilkinson and Marmot 2003). We further demonstrate that the relationship between age of the child and undernutrition, be it stunting and underweight, is varying, with increasing risk as age increases, more pronounced in the first one year of life (Figures 1a and 1b). This changing pattern in risk is often missed, as most models assume fixed effects between age and undernutrition. A similar nonlinear pattern is established for length of stay and undernutrition (Figures 1c and 1d). What is certain from this association is that children of recent migrants are at relatively high risk than those who have stayed in town for more than five years. This fact can be explained by the fact that the longer one stays at a place, the more connected they become – they may get jobs, may establish business and have a better access to resources, ending up with many coping strategies, thus becoming more resilient to food insecurity, even if these are materially challenged (Magisa 2010; Alinovi et al. 2010). Using more rigorous measure of food insecurity combined with focus group discussions, Pendleton et al. (2014) observed that poor urban migrant households in Windhoek are less food-secure, and about 50% had a lower dietary diversity than other households.

Our study is not without limitations. First, the study is based on cross-sectional data, and therefore, the relationship obtained between outcomes and explanatory variables is associative. However, the analysis was based on data pooled across three survey periods: 1992, 2000 and 2006/2007. As such, the effects generated in the model indicate a persistent and strong effect. Second, the composite indicators of urban disadvantage and material deprivation are limited to the available variables in the data, which may not fully be what others have described for such indicators. In our analysis, we have tried to follow previous studies (Antai and Moradi 2010; Barnes et al 2007) to generate indicators similar in elements; as such, the interpretation of the effects of urban disadvantage and material deprivation should correspond. Third, this study only considered two of the three commonly used indicators of childhood undernutrition. It is our view that wasting, which reflects the current nutritional status, is variable and seasonal and fails to capture the long-term consequences associated with persistent food insecurity and may not directly be attributable to food insecurity (Cordeiro et al. 2012; Folaranmi 2012).

In conclusion, the findings suggest that the generally accepted notion that children in urban settings have better nutritional status is refuted. The fact that urban is considered homogenous conceals the extent of poverty and malnutrition. Therefore, any targeting mechanisms in urban areas have to be designed differently, considering that urban livelihoods are heavily dependent on income and employment to meet basic needs, including food.

Our study has a number of policy implications. First, there is a need for nutritional and food security advocacy by encouraging urban areas to be food baskets. Second, increased social support for urban poor by providing child grants and food subsidies, particularly targeting most recent migrants and other vulnerable groups.

Emphasis should also be placed, first, on education for mothers, with appropriate health education not to abandon slightly older children, especially when these are weaned. Second, there is necessity for increasing parents' awareness of children's food and nutritional needs at various stages of development to ameliorate the risk of micronutrient deficiencies. Third, there is need to provide health and preventive care facilities aimed at reducing malnutrition in children.

Namibia is experiencing rapid urbanization, and food insecurity and malnutrition are prevalent (Crush 2013; Pendleton et al. 2014). The trend is the shift in both poverty and malnutrition from rural areas to urban areas, given the massive movement of people from rural areas to urban areas. This paper demonstrates that malnutrition is increasing in the urban areas, and in particular among the poorest. In this analysis, we take note of the discussion on global nutrition transition, which has led to high intake of food that is rich in starch, sugar and fat (de Haen et al. 2011). The nutrition transition has led to declines in the rates of underweight, even for Namibia, but nutritional status of children in terms of access to a well-balanced diet containing all vital nutrients has not improved. Stunting seems to be less susceptible to this bias and more closely reflects children's long-term nutritional status. With increasing urbanization in Namibia, the need to reduce food insecurity and undernutrition should be one of the major focuses for the overall improvement in child health, and the poor urban neigbourhoods should be equally targeted just like the rural area for food security and nutrition programming.

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Notes

1. World Bank (2013) and Chen & Ravallion (2012) document the substantial income growth in Sub-Saharan Africa, estimated to 38% in per capita between 2004 and 2010. Leading to a significant decline in income poverty from 59% in 1993 to 47% in 2008, using the $1.25 poverty line.
2. BMI is the body weight in kilograms divided by height in metres squared (kg/m^2) and is commonly measured in adults to assess underweight, overweight and obesity. The international references are as follows: under-weight=BMI<18.5; overweight=BMI≥2.5; obese=BMI≥3.0. Obese is a subset of overweight.

References

Alinovi, L., M. D'Errico, M. Mane and D. Romano. 2010. "Livelihoods Strategies and Household Resilience to Food Insecurity: An Empirical Analysis to Kenya. European Report on Development." Paper prepared for the conference on "Promoting Resilience Through Social Protection in Sub-Saharan Africa", Dakar, Senegal: The European Report of Development, 28-30 June.

Antai, D. and T. Moradi. 2010. "Urban Area Disadvantage and Under-Five Mortality in Nigeria: The Effect of Rapid Urbanization." *Environmental Health Perspectives* 118(6): 877–83.

Barnes, H., G. Wright, M. Noble and A. Dawes. 2007. *The South African Index of Material Deprivation for Children: Census 2001*. Cape Town: HSRC Press.

Benson, T. 2004. "Africa's Food and Nutrition Security Situation: Where Are We and How Did We Get Here?", Discussion Paper, Washington, DC: International Food Policy Research Institute 2020.

Brezger, A., T. Kneib. and S. Lang. 2005. "BayesX: Analyzing Structure Additive Regression Models." *Journal of Statistical Software* 14(11): 10613.

Cameron, N. 2003. "Physical Growth in a Transitional Economy: The Aftermath of South African Apartheid". *Economics and Human Biology* 1(1): 29–42.

Campbell, C.C. 1991. "Food Insecurity: A Nutritional Outcome or a Predictor Variable?" *The Journal of Nutrition* 121(3): 408–15.

Chen, S. and M. Ravallion. 2012. *An Update to the World Bank's Estimates of Consumption Poverty in the Developing World*. Washington, D.C.: The World Bank Mimeographed.

City of Windhoek. 2005. "Status of Living Conditions in Northwestern Constituencies." Unpublished Reports. Windhoek: City of Windhoek, 2012.

City of Windhoek. 2004. "City Development and Planning." <www.windhoekcc.org.na>.

Cordeiro, LS, P.E. Wilde, H. Semu and F.J. Levinson. 2012. "Household Food Security Is Inversely Associated with Undernutrition among Adolescents from Kilosa, Tanzania." *Journal of Nutrition* 142(9): 1741–47.

Crush, J., B. Frayne and M. McLachlan. 2011. "Rapid Urbanization and the Nutrition Transition in Southern Africa." Urban Food Security Series No.7. Kingston and Cape Town: Queen's University and African Food Security Urban Network (AFSUN).

Crush, J. 2012. "Migration, Development and Urban Food Security." Urban Food Seucrity Series No. 9. Queen's University and African Food Security Urban Network (AFSUN): Kingston and Cape Town.

Crush, J. 2013. "Inner City 'Cleansing' Eats Away Food Security." BusinessDay BDLive. <www.bdlive.co.za>. Downloaded on 12 June 2015.

Custodio, E., M.A. Descalzo, J. Roche, L. Molina, I. Sanchez, M. Lwanga et al. 2010. "The Economic and Nutritional Transition in Equatorial Guinea Coincided with a Double Burden of Over-and Under Nutrition." *Economics and Human Biology* 8(1): 80–87.

Custodio, E., M.A. Descalzo, J. Roche, L. Molina, I. Sanchez, M. Lwanga et al. 2008. "Nutritional Status and Its Correlates in Equatorial Guinea Preschool Children: Results from a Nationally Representative Survey." *Food and Nutrition Bulletin* 29(2): 49–58.

de Haen, H., S. Klasen, S., and M. Qain. 2011. "What Do We Really Know? Metrics for Food Insecurity and Malnutrition." *Food Policy* 36(6):760-69.

Folaranmi, T. 2012. "Food Insecurity and Malnutrition in Africa: Current Trends, Causes and Consequences." Public Health Unit, Consultancy Africa Intelligence. <www.consultancyafrica.com/>.

Food and Agriculture Organization of the United Nations. 2009. "Feeding the World and Eradicating Hunger." World Summit on Food Security, November 16-18, 2009. <www.fao.org/fileadmin/templates/wsfs/Summit/WSFS_Issues_papers>.

Haddad, L., M. Ruel and J. Garrett. 1999. "Are Urban Poverty and Undernutrition Growing? Some Newly Assembled Evidence." *World Development* 27(11): 1891–1904.

Kessides, C. 2005. "The Urban Transition in Sub-Saharan Africa: Implications for Economic Growth and Poverty Reduction." Working Paper Series No. 97. Urban Development Unit, Transport and Urban Development Department, The World Bank, Africa Region. Retrieved November 10, 2012. <www.worldbank.org/afr/wps/wp97.pdf/18/11/08>.

Labadarios, D., Z.J. McHiza, N.P. Steyn, G. Gericke, E.M.W. Maunde, Y.D. Davids and W.A. Parker. 2011. "Food Security in South Africa: A Review of National Surveys." *Bull World Health Organization* 89(12): 891–9.

Levin, C., M. Ruel, S. Morris, D. Maxwell, M. Armar-Klemesu and C. Ahiadeke. 1999. "Working Women in an Urban Setting: Traders, Vendors and Food Security in Accra." *World Development* 27(11): 1977–91.

Magisa, K. 2010. "Community Resilience: An Indicator of Social Sustainability." *Society & Natural Resources: An International Journal* 23(5): 401–16.

Ministry of Health and Social Services (MoHSS) [Namibia] and Macro International Inc. 2008. *Namibia Demographic and Health Surveys 2006/2007*. Windhoek, Namibia and Calverton, Maryland: MoHSS and Macro.

Mitlin, D. and A. Muller. 2004. "Windhoek, Namibia: Towards Progressive Urban Land Policies in Southern Africa." *IDRP* 26 (2): 167–86.

Mitlin, D. and Satterthwaite, D. 2011. "Is There Really So Little Urban Poverty in Sub-Saharan Africa?" CIVIS No. 4, Cities Alliance. Retrieved November 23, 2012. <www.citiesalliance.org/ca/sites/citiesalliance.org/files/civis_March2011.pdf>.

Moradi, A. 2010. "Nutritional Status and Economic Development in Sub-Saharan Africa, 1950-1980." *Economics and Human Biology* 8(1): 16–29.

Namibia Statistics Agency (NSA). 2013. *2011 Namibia Population and Housing Census Main Report*. Windhoek: NSA.

Namibia Statistics Agency (NSA). 2015. *Namibia Labour Force Survey 2014 Report*. Windhoek: NSA.

Pendleton, W. 1996. *Katutura: A Place Where We Stay. Ohio University Centre for International Studies, Monographs in International Studies, Africa Series, Number 65*. Athens: Ohio University Press.

Pendleton, W., J. Crush and N. Nickanor. 2014. "Migrant Windhoek: Rural- Urban Migration and Food Security in Namibia." *Urban Forum* 25(2): 191–205.

Potts, D. 2006. "All My Hopes Are Shattered: Urbanization and Migrancy in an Imploding African Economy – The Case of Zimbabwe." *Geoforum* 37(4): 536–51.

Ravallion, M., S. Chen and P. Sangraula. 2007. "New Evidence on the Urbanization of Global Poverty." *Population and Development Review* 33(3): 667–701.

Rutstein, S.O. and J. Kiersten. 2004. *The DHS Wealth Index. DHS Comparative Reports No.6*. Calverton, Maryland: ORC Macro.

Sanchez, L., L. Denning and G. Nzinguheba. 2009. "The African Green Revolution Moves Forward." *Food Security* 1 (1): 37–44.

Satterthwaite, D., G. McGranahan and C. Tacoli. 2010. "Urbanization and Its Implications for Food and Farming." *Philosophical Transactions of The Royal Society Biological Sciences* 365(1554): 2809–20.

Smith, L.C., M.T. Ruel, A. Ndiaye. 2005. "Why Is Child Malnutrition Lower in Urban Than Rural Areas? Evidence from 36 Developing Countries." *World Development* 33(8): 1285–305.

Sweet, J. 1998. "Livestock – Coping with Drought: Namibia – A Case Study." Paper presented at United Nation Food and Agricultural Organization electronic conference on Livestock: Coping with Drought. Retrieved February 16, 2016. <http://www.fao.org/fileadmin/user_upload/drought/docs/Livestock%20coping%20with%20drought%20Namibia.pdf>.

UNSCN (United Nations Standing Committee on Nutrition). 2012. *Nutrition Security of Urban Populations. A UNSCN Statement on Nutrition*. Retrieved June 12, 2015. <http://www.unscn.org/files/Statements/August_31-_UNSCN_World_Urban_Forum_6-_Statement_final_3108_finalfinal.pdf>.

UN-HABITAT. 2010. *The State of African Cities 2010: Governance, Inequality and Land Markets*. UN-HABITAT: Nairobi.

Wilkinson, R.G. and M. Marmot (Eds). 2003. *Social Determinants of Health: The Solid Facts*, 2nd Edn, WHO: Copenhagen.

WHO. 2006. WHO Child Growth Standards: *Length/Height-for-Age, Weight-for-Age, Weight-for-Length, Weight-for-Height and Body Mass Index-for-Age*. Geneva: WHO. Retrieved October 9, 2013. <www.who.int/childgrowth/standards/technical_report/en/>.

World Bank. 2013. "World Development Indicators Database." Retrieved October 9, 2013. <http://databank.worldbank.org/data/world.development-indicators>.