International Journal of Multidisciplinary Research and Growth Evaluation.

Convergence of Stunting and Diarrhoea among Children in Peri-Urban Lusaka: A Cross-Sectional Study of Prevalence and Predictors

Whisper Hansakali [1*], Austin Mwange [2]
[1] Lecturer, Natural Resources Development College (NRDC), Great East Road Campus, Lusaka, Zambia/PhD Student, The University of Zambia (UNZA), Institute of Distance Education, Lusaka, Zambia
[2] Lecturer, The University of Zambia (UNZA), Graduate School of Business (GSB), Great East Road Campus, Lusaka, Zambia

* Corresponding Author: **Whisper Hansakali**

Article Info

ISSN (online): 2582-7138
Volume: 05
Issue: 05
September-October 2024
Received: 25-08-2024
Accepted: 11-09-2024
Page No: 869-875

Abstract

Background: In Zambia, stunting and diarrhoea—largely avoidable conditions—are significant contributors to death in children under five years of age. Large-scale studies commonly compare these variables between urban and rural settings, although they frequently neglect to consider the substantial socio-economic differences present within urban populations. This study sought to investigate the prevalence and co-occurrence of stunting and diarrhoea in peri-urban regions of Lusaka.

Method: A cross-sectional study approach was utilized, focusing on 239 homes in Lusaka East, a peri-urban area of Zambia's capital city. The research concentrated on homes with a minimum of one kid between the ages of 6 and 23 months. Data collection utilized structured questionnaires distributed to guardians, documenting socio-demographic variables and sanitation practices. Children's anthropometric measures were standardized utilizing height-for-age z-scores (HAZ). The research employed bivariate and multivariable logistic regression analysis to investigate factors associated with malnutrition and diarrhoea.

Results: The study included 232 children, with 53.8% (n=125) identified as female and 46.2% (n=107) as male. The median age of the children was 13 months (IQR ±8), whereas the median age of their guardians was 26 years (IQR ±9.5). The prevalence of stunting and diarrhoea was 24.1% (95% CI: 18.7–30.2%) and 19.4% (95% CI: 14.5–25.1%), respectively, with the highest rates observed in children aged 12 to 23 months. Significant predictors of stunting were identified as child gender (aOR: 0.45, 95% CI: 0.23–0.89), sanitation type (aOR: 2.35, 95% CI: 1.08–4.52), and the marital status of the guardian (aOR: 1.17, 95% CI: 1.01–2.88). In children with diarrhoea, gender (aOR: 0.41, 95% CI: 0.18–0.89) and the guardian's marital status (aOR: 2.80, 95% CI: 1.14–6.89) were identified as significant predictors.

Conclusion: In conclusion, the study identified a significant prevalence of stunting, alongside a high incidence of diarrhoea in stunted children, potentially elevating the risk of childhood mortality. This highlights the necessity of strengthening primary healthcare services and improving community health education, with an emphasis on the early detection of stunting and the prevention of diarrhoea, especially in economically disadvantaged peri-urban areas in Zambia.

DOI: https://doi.org/10.54660/.IJMRGE.2024.5.5.869-875

Keywords: Stunting, Diarrhoea, Peri-urban communities, Malnutrition and Sanitation

Introduction

In low and middle-income countries, child development is frequently hindered by malnutrition and infectious diseases, with diarrhoea and stunting being significant contributors to morbidity and mortality in children under five. In sub-Saharan Africa, limited access to clean water, insufficient sanitation facilities, and restricted primary healthcare services intensify these issues. Stunting, defined as a height deficit in relation to a child's age, presents considerable risks to cognitive development and long-term productivity. Additionally, diarrhoea continues to be a significant factor in child mortality. Large-scale studies often compare stunting and diarrhoea in rural and urban settings; however, they frequently neglect the socio-economic disparities and

health inequalities present within peri-urban communities.

In Zambia, fast urbanization has resulted in the expansion of peri-urban areas surrounding major cities such as Lusaka, generating enclaves of poverty characterized by insufficient access to key services. These settings increase the hazards of malnutrition and diarrhoea; nevertheless, extensive data on the intersection of these concerns in peri-urban regions is still scarce. Current research highlights the correlation between stunting and recurrent diarrhoeal episodes, indicating that chronic diarrhoea hinders a child's growth and heightens vulnerability to additional health issues. Comprehending the presence and interaction of these disorders is essential for informing public health initiatives and attaining Sustainable Development Goals (SDGs), especially those focused on diminishing inequities and enhancing child health outcomes. This study aims to ascertain the prevalence of stunting and diarrhoea and to investigate the socio-demographic and sanitation-related factors affecting these illnesses among children aged 6 to 23 months in peri-urban regions of Lusaka, Zambia. The study targets this vulnerable group to elucidate the intersecting health difficulties encountered by children in underprivileged neighborhoods and to guide measures for early detection, prevention, and intervention.

Child development in low and middle income countries (LMIC) is often characterized by diarrhoea, one of the most common causes of morbidity and mortality among children under the age of five (Irena *et al*., 2011, Ogbo *et al*., 2017) [16, 26]. The impact of diarrhoea on the health of children is significant, especially in sub-Saharan Africa where access to clean water is limited, hygiene and sanitation facilities are poor, and readily accessible primary health care remains a challenge (Ahs *et al*., 2010, Bennett *et al*., 2014) [1, 3]. Stunting, a related problem, poses remarkable risk to the health of under-5 children (Said-Mohamed *et al*., 2015) [30]. Broadly defined as a deficit in height relative to the age of the child (De Onis and Branca, 2016) [9], stunting negatively impacts the cognitive development of children and reduces their economic productivity in adulthood (Prendergast and Humphrey, 2014, Sudfeld *et al*., 2015) [29, 35].

The co-occurrence of diarrhoea and stunting in various communities in sub-Saharan Africa may be due to shared risk factors or an interaction of shared extrinsic factors. For instance, rapid urbanization of cities in sub-Saharan Africa has led to the emergence of urban poverty (Shifa and Leibbrandt, 2017) [32]. This, coupled with urban-related inequalities to health care access (Alcock *et al*., 2015) [2], inadequate water and sanitation, nutrition transition, and lack of economic security (Watson, 2015, Jones *et al*., 2018) [17] among peri-urban settlements increases the risk of diarrhoea and stunting among children in these areas.

Lusaka, the capital city of Zambia, has observed rapid population growth leading to the establishment of several peri-urban settlements where the urban poor live (Hubbard *et al*., 2020) [15]. With a population constituting 15.5% of the country's total (2.95/19.12 million) (Populationstat, 2021) [28], Lusaka's recent rapid population increase has been attributed to rural-urban migration, with many people moving to the city in search of jobs and a better livelihood (Simwanda *et al*., 2020) [33]. This continued rural-urban migration has resulted in poor access to water and sanitation services and increased risk of water-borne infections such as diarrhoea (Hubbard *et al*., 2020) [15]. While some recent studies have reported an increased risk of malnutrition in several peri-urban areas across the globe (Matsungo *et al*., 2017, Jones *et al*., 2018) [21, 17], there remains a paucity of information that explores the convergence of diarrhoea and stunting, and the factors associated with these health outcomes in peri-urban areas of Zambia.

Several studies based on the Demographic Health Survey (DHS) have presented the prevalence of stunting and diarrhoea in rural and urban areas (Poda *et al*., 2017, Zambia Statistics Agency - ZSA *et al*., 2020, Claudine *et al*., 2021) [27, 6]. However, such macro-characterization of stunting and diarrhoea tends to mask the actual prevalence of these health outcomes in urban areas especially in peri-urban areas due to emerging pockets of urban poverty, and socioeconomic disparities (Shifa and Leibbrandt, 2017) [32] which may influence health outcomes such as diarrhoea and stunting in these areas. Examining these health outcomes and their associated factors in peri-urban areas is essential to understanding the progress made towards achieving the 10th Sustainable Development Goal (SDG 10) which focuses on reducing inequalities (Kuhn, 2020) [19]. Earlier studies have shown that height deficits are linked to the prevalence of diarrhoea (Checkley *et al*., 2008) [5], while persistent diarrhoea has been observed to lead to growth retardation. Thus, the current study sought to determine the prevalence and overlap of stunting and diarrhoea in peri-urban areas of Lusaka East.

Methods

Study setting and research design

Lusaka is the administrative capital of Zambia. For political and administrative purposes, the city has been divided into constituencies, which are are further sub-divided into wards. Munali constituency has four wards namely Munali, Kalingalinga, Chakunkula, and Chainda. These wards consist of communities from which households were sampled. We used a multi-stage stratified cluster random sampling method to select household from communities which were nested in the wards. Three of the four constituency wards namely Kalingalinga, Chakunkula, and Chainda were included in the study. Two communities from each ward were selected to participate in the study. To select households from each community, we used the proportional random sampling method. This was done to ensure that each household from the selected communities had an equal chance of being selected. For inclusion, the selected households had to have at least one child aged 6 to 23 months.

Study design and participants

We conducted a cross-sectional household survey to assess health outcomes and sanitation conditions among households of peri-urban areas of Munali constituency in Lusaka. Data was collected using a structured questionnaire via face-to-face interviews with guardians of children who had agreed to participate in the study. Based on previous studies that evaluated the risk factors of stunting and diarrhoea (Irena *et al*., 2011, Mzumara *et al*., 2018) [16, 23], the questionnaire comprised subsections with questions relating child-level variables (Age, gender, weight, height). The age of the children was confirmed by their guardians and verified with the child's under-five (or road to health) card. Furthermore, using the WHO 2006 reference (De Onis and Blössner, 2003) [7], we computed Z-scores for stunting. Here, we defined stunting as -2 z-score for height for age (De Onis and Branca, 2016, De Onis *et al*., 2019) [9, 8]. Household socio-demographic variables (community, gender of guardian,

guardian's education, occupation, marital status, income, number of people in household, expenditure on accomodation and food), maternal variables and proximal variables (duration of exclusive breastfeeding, age at complementary feeding, daily food intake, vitamin A supplementation in the last 6 months) and sanitation characteristics. The level of education was classified as primary (beginner: grades 1 to 7), secondary (grades 8 to 12) and tertiary (college or university qualification) as defined by the Zambia Ministry of General Education. Exclusive breastfeeding meant the child received only breast milk, with no other fluids or liquids for nutrition in the first six months of life (WHO, 2019). Complementary food was defined as the food given to the child, in addition to breast milk, meant to meet the child's excess energy and nutrient demands (WHO, 2021). Sanitation was classified as improved or unimproved according to the WHO-UNICEF core questions relating to drinking water and sanitation (WHO, 2006). Furthermore, data on diarrhoea was determined as having three or more episodes of watery stool within 24 hours and not more than 14 days before the survey as indicated elsewhere (Kinyoki *et al*., 2017, Hubbard *et al*., 2020) [15].

The study participants were residents of the selected communities which were nested in wards. In the study, we included children aged 6 months to 23 months and their legal guardians (aged 18 years and older). All participants in the study were required to submit written informed consent. Sample size calculations are based on a 95% confidence interval and using the equation proposed by Lwanga *et al*. (1991) as $n= Z^2(1-p)/ \varepsilon^2 p$ where p=prevalence and ε= relative precision and n is the sample size. The relative precision for the study was between 5–10% of the true prevalence ($0.05<\varepsilon<0.10$) and reported a diarrhoea prevalence of 67.3% (Irena *et al*., 2011) [16]. A total of 239 guardian/children pairs were sampled from the study communities.

Ethical clearance was given by Excellence in Research Ethics in Science Converge Independent Review Board (ERES IRB) based in Zambia and participants signed consent sheets before participating in the study.

Statistical analysis

Data analysis was done using Stata/SE 17.0 (Stata Corporation, College Station, TX, USA). Descriptive statistics were used to summarize categorical variables. A bivariate analysis was used to evaluate factors that were associated with stunting. Furthermore, univariate and multivariate analyses were run to examine the association and effect of the factors that were identified in the bivariate analysis. This was done for each of the two outcome variables. Because of possible correlations from the three-level sampling; especially households within the communities that were in wards, we used a generalized linear mixed model to determine the stunting among children who had diarrhoea and those who did not have diarrhoea. To build our model, stepwise forward selection method was used. We began with childs characteristics such as age and gender together with the household socio-demographic characteristics. In the second step, we added guardian characteristics which we considered to be intermediate variables. In this final model, we considered the socio-demographic factors that had been observed to have an influence at the multivariate level. We observed that the inter class correlation (ICC) when children with stunting were analysed in the presence of diarrhoea, a clustering effect was observed thus a generalized linear mixed models (GLMM) with the community as the random effect was used.

Results

The study included 232 children. Of these, 53.8% (n=125) were female and 46.2% (n=107) were male. The median age of the children was 13 months (iqr±8). In addition, the median age of the children's guardians was 26 years ((iqr±9.5). The majority (70.7%, n=164) of the guardians were married while 0.86% (n=2) were widowed. The highest level of education attained by most guardians was secondary education (51.3%, n=119) while 5.2% (n=12) had no formal education. Other socio-demographic characteristics relating to the children and caregivers are summarized in Table 1.

Table 1: Characteristics of the study participants and their correlation with stunting

Variable	Stunted (Freq (%))		P-value
Age	Yes	No	
6-8 months	9 (19.2%)	38 (80.8%)	0.463
9-11 months	10 (20.8%)	38 (79.2%)	
12-23 months	37 (27%)	100 (73%)	
Gender of child			
Male	73 (68.2%)	34 (31.8%)	**0.012**
Female	103 (82.4%)	22 (17.6%)	
Number of solid meals			
One	19 (82.6%)	4 (17.4%)	**0.005***
Two	15 (68.2%)	7 (31.8%)	
Three	37 (60.7%)	24 (39.3%)	
More than 4	105 (83.3%)	21 (16.7%)	
Age at complementary feeding			
Before 6 months	71 (78.9%)	19 (21.1%)	0.596
At 6 months	90 (73.2%)	33 (26.8%)	
After 6 months	15 (78.9%)	4 (21.1%)	
Vitamin A supplement			
Yes	151 (76.3%)	47 (23.7%)	0.888
No	15 (71.4%)	28.6%)	
Don't know	10 (76.9%)	3 (23.1%)	
Sanitation			
Improved	102 (85%)	18 (15%)	**0.001**
Unimproved	74 (66.1%)	38 (33.9%)	

Age of caregiver			
13-19 years	17 (70.8%	7 (29.2%)	0.828
20-29 years	103 (76.3%)	23 (23.7%)	
30-39 years	56 (76.7%)	17 (23.3%)	
40-49 years			
Level of education of the guardian			
None	7 (58.3%	5 (41.7%)	0.158
Primary	47 (70.2%)	20 (29.8%)	
Secondary	93 (78.2%)	26 (21.8%)	
Tertiary	29 (85.3%)	5 (14.7%)	
Marital status of the guardian			
Married	127 (77.45)	37 (22.6%)	**0.028***
Single	44 (78.6%)	12 (21.4%)	
Divorced	5 (41.7%)	7 (58.3%)	
Expenditure on food			
Less than K1000	106 (72.6%)	40 (27.4%)	0.374
K1001-2000	52 (80%)	13 (20%)	
K2001-K3000	14 (82.4%)	3 (17.6%)	
Above K3001	4 (100%)	0(0%)	
Expenditure on accomodation			
Less than K1000	107 (69.1%)	48 (30.9%)	**0.006***
K1001-2000	33 (91.7%)	3 (8.3%)	
K2001-K3000	27 (87.1%)	4 (12.9%)	
Above K3001	9 (90%)	1 (10%)	
Household size			
1-2 people	1 (100%)	0(0%)	0.557
3-4 people	51 (72.2%)	22 (27.8%	
Above 5 people	118 (77.6%)	34 (22.4%)	
No of children under 5 years			
1 child	111 (75%)	37 (25%)	0.09
2 children	60 (81.1%)	14 (18.9%)	
More than 3 children	5 (50%	5 (50%)	

Prevalence of diarrhoea and stunting

Fifty-six (Prev: 24.1%; 95% CI: 18.7-30.2%) of the children were stunted. The study also observed that 45 (Prev: 19.4%; 95% CI: 14.5-25.1%) of the children had diarrhoea. Of these, 16 (Prev: 35.6; 95% CI: 23.0-50.5) were stunted. Furthermore, stunting (Prev: 27.0%; 95% CI: 20.2–35.1) and diarrhoea (Prev: 24.1; 17.6–31.9%) were more prevalent among children aged 12 – 23 months and least among children aged 6-8 months.

Factors influencing stunting

Among variables observed to be associated with stunting in the bivariate analysis, gender of the child (OR: 0.45; 95% CI: 0.25–0.84), sanitation (OR: 2.91, 95% CI: 1.54–5.49), marital status of the guardian (OR: 1.55: 95% CI: 1.09–2.55) and amount of money spent on accomodation (OR: 0.51; 95% CI: 0.31–0.82) were observed to have been significantly associated with stunting (Table 2). In a multivariate logistic regression model, the gender of the child (aOR 0.45, 95% CI: 0.23–0.89) was associated with stunting. We observed that female children (aOR: 0.36; 95% CI: 0.197–0.796) were less likely to be stunted compared to their male counterparts. We further observed that sanitation (aOR: 2.35; 95% CI: 1.08–4.52) was a significant predictor of stunting. Children from households with unimproved sanitation (aOR: 2.06; 95% CI: 1.94–4.52) were highly likely to be stunted compared to those from households with improved sanitation. Also, children whose guardians were divorced (aOR: 1.17; 95% CI: 1.01-2.88) were more likely to be stunted compared to those whose guardians were married (Table 2).

Table 2: Factors associated with stunting in a Univariate and Multivariate analysis.

Variable	Unadjusted Model			Adjusted model		
	OR	p-value	95% CI	aOR	p-value	95% CI
Gender						
Male	Reference					
Female	0.46	0.013	0.24–0.85	0.39	0.009	0.19–0.79
Sanitation						
Improved	Reference					
Unimproved	2.91	0.001	1.54–5.49	2.06	0.043	1.93–4.52
Marital status						
Married	Reference					
Single	0.94	0.86	0.45–1.95	0.98	0.96	0.44–1.20
Divorced	3.81	0.011	1.44–6.03	1.17	0.023	1.01–2.88
Expenditure on accomodation						
Less than K1000	Reference					
K1001-2000	0.21	0.011	0.05–0.69			
K2001-K3000	0.33	0.049	0.11–0.99			
Above K3001	0.24	0.191	0.03-2.01			

Factors influencing stunting among children with diarrhoea

Using the same models, we adjusted for the potential clustering effect of the communities. Our results showed that among those who had diarrhoea, gender (aOR: 0.41; 95% CI: 0.18– 0.89) and marital status of the guardian (aOR: 2.80; 95% CI: 1.14–6.89) were the main predictors of stunting among children while sanitation was not a significant predictor (aOR: 2.47: 95% CI: 0.49–4.89). Among the significant predictors, we observed that female children with diarrhoea (aOR: 0.37; 95% CI: 0.16–0.83) were less likely to be stunted compared to males while children from divorced guardians (aOR: 1.03; 95% CI: 1.44-4.48) were more likely to be stunted compared to those coming from households where the guardians were married (Table 4).

Table 4: Factors influencing stunting among children with and without diarrhoea

Random effect								
Group name	**Estimate**	**Std err**		**95%CI**				
Community	1.012	0.472		0.409-2.528				
	With diarrhoea				Without diarrhoea			
Stunted	OR	Std err	p-value	95% CI	OR	Std err	p-value	95%CI
Gender								
Male	Reference							
Female	**0.367**	**0.153**	**0.016**	**0.162- -0.832**	0.467	0.344	0.302	0.109–1.982
Sanitation								
Improved	Reference							
Unimproved	2.346	1.107	0.071	0.928-4.917	2.091	1.534	0.315	0.496–5.815
Marital status								
Married	Reference							
Single	0.817	0.493	0.683	0.311-2.149	2.324	1.974	0.321	0.439–3.287
Divorced	**1.027**	**0.905**	**0.021**	**1.438- -4.481**	3.410	2.098	0.093	0.731–5.616

Discussion

Our study presents the results of a cross-sectional study done to investigate the interaction between diarrhoea and stunting among children in peri-urban areas of Lusaka. The study findings indicate that stunting remains a widespread public health problem in peri-urban areas despite having been viewed as a rural problem (Hoffman *et al*., 2017) [13]. In addition, our results found that children with diarrhoea were highly likely to be stunted, an observation that was also done by Menon *et al*. (2000) [21]. Furthermore, our observations in the current study agree with the results of earlier studies carried out in similar environments which observed increased risk of diarrhoea in peri-urban areas of low-middle income countries (Myint *et al*., 2016, Ntila *et al*., 2017, Hubbard *et al*., 2020) [22, 24, 15]. Accordingly, we propose the strengthening of community-level interventions to prevent the surge of these health conditions.

Compared with the WHO prevalence threshold for stunting (De Onis *et al*., 2019) [9], our results suggest that stunting remains a significant public health problem in peri-urban areas of Lusaka. Results from the 2018 DHS survey showed that the prevalenve of stunting among children aged 0-6 months was 19% while among those aged 18-23 months, it was 46% (Zambia Statistics Agency - ZSA *et al*., 2020). Our results, from a micro-geographical scale, have shown a similar trend in the prevalence of stunting; stunting was higher (27%) among those who were aged 12-23 months compared to those aged 6-8 months (19.2%). This observation maybe due to dietery changes and translation to complementary feeding. According to WHO (2003), a shift from breast milk to complementary food coupled with adverse child-care practices such as infrequent and poor feeding may negatively affect the nutritional status of children. Poor complementary feeding practices and quality of complementary diets observed in peri-urban areas, (Ntila *et al*., 2017) [24] have been observed to lead to stunting among children (Du Plessis *et al*., 2013) [10]. Thus, our study findings, together with those of other authors suggest that reducing the risk of stunting as children grow may be dependent on increased levels of knowledge of good complementary feeding and dietary practices among guardians of children.

We observed that the risks of stunting were high among those who had diarrhoea, consistent with observations that have been made elsewhere (Bhutta *et al*., 2008, Habaasa, 2015, Sobgui *et al*., 2018) [4, 12, 33]. This outcome suggests the need for strengthening programs that focus on child health. Although interventions focusing on the provision of nutritional supplementation have been implemented and advocated for, their effect on the control of diarrhoea may be limited especially among children with stunting. Therefore, to improve the health outcome of the diarrhoea-stunted children, health education among caregivers, especially those who are divorced, and behaviour change campaigns should be enhanced. In addition, improvement in people's health seeking behaviour and early treatment of diarrhoea, combined with nutritional intervention should also be promoted.

Our results point to a high prevalence of stunting and diarrhoea in communities with peri-urban areas. Furthermore, we show that the risk of stunting among children with diarrhoea from these areas was high, an observation directly linked to household socioeconomic status (Fernald and Neufeld, 2007) [11]. An earlier study by Sawaya *et al*. (1998) [30] suggested that childhood stunting is highly linked to chronic disease in adulthood. Therefore, the convergence of childhood stunting and diarrhoea observed in this study increases the risk of detrimental health outcomes of the affected children as they grow. Both stunting and diarrhoea remain major public health problems in Zambia, especially among children from low income families living in peri-urban areas. According to Menon *et al*. (2000) [21], socio-economic differences in urban areas are greater than those in rural areas. These differences increase the risk of stunting among children due to inadequate nutrition. Therefore, efforts to improve linear growth of children must

be coupled with improved sanitation.

We are cognizant that the prevalence of stunting and risk of diarrhoea among children that has been observed in this study may be influenced by several associated socio-demographic characteristics and other transient community-related factors. Notwithstanding these limitations, the study contributes to the body of knowledge that suggests that rapid urbanization leading to urban poverty and the creation of peri-urban areas may lead to structural inequalities in urban areas thus increasing the risks of malnutrition and diarrhoea among children. Also, the 24.1% prevalence of stunting found in this study may indicate the deeper structural and socio-demographic inequalities associated with rapid urbanisation, and reflects the compromised nutrition among children in deprived communities of Zambia. Therefore, there is a need for coordinated efforts tailored towards addressing peri-urban poverty to reduce adverse health outcomes among children living in disadvantaged communities.

Conclusion

This study underscores the critical public health concern of stunting and its association with diarrhoea in children aged 6 to 23 months in peri-urban regions of Lusaka, Zambia. The results indicate that stunting persists, with children suffering from diarrhoea facing an increased risk of growth retardation. Gender, guardian marital status, and sanitary conditions were revealed as important predictors of stunting. The results indicate that targeted interventions focusing on both nutritional deficits and the enhancement of sanitary standards are essential for alleviating these combined health issues. Enhancing community health initiatives and improving education on complementary feeding practices could substantially decrease the prevalence of stunting and diarrhoea in these at-risk populations. A comprehensive approach that addresses both dietary and environmental determinants is crucial for attaining permanent enhancements in child health and well-being in peri-urban Zambia.

References

1. Ahs J, Tao W, Löfgren J, Forsberg BC. Diarrhoeal diseases in low-and middle-income countries: Incidence, prevention and management. The Open Infectious Diseases Journal. 2010;4.
2. Alcock G, Das S, More NS, Hate K, More S, Pantvaidya S, Osrin D, Houweling TA. Examining inequalities in uptake of maternal health care and choice of provider in underserved urban areas of Mumbai, India: a mixed methods study. BMC Pregnancy and Childbirth. 2015;15:1-11.
3. Bennett S, George A, Rodriguez D, Shearer J, Diallo B, Konate M, Dalglish S, Juma P, Namakhoma I, Banda H. Policy challenges facing integrated community case management in Sub-Saharan Africa. Tropical Medicine & International Health. 2014;19:872-882.
4. Bhutta ZA, Ahmed T, Black RE, Cousens S, Dewey K, Giugliani E, Haider BA, Kirkwood B, Morris SS, Sachdev H. What works? Interventions for maternal and child undernutrition and survival. The Lancet. 2008;371:417-440.
5. Checkley W, Buckley G, Gilman RH, Assis AM, Guerrant RL, Morris SS, Mølbak K, Valentiner-Branth P, Lanata CF, Black RE. Multi-country analysis of the effects of diarrhoea on childhood stunting. International Journal of Epidemiology. 2008;37:816-30.
6. Claudine U, Kim JY, Kim E-M, Yong T-S. Association between sociodemographic factors and diarrhoea in children under 5 years in Rwanda. The Korean Journal of Parasitology. 2021;59:61.
7. De Onis M, Blössner M. The World Health Organization global database on child growth and malnutrition: methodology and applications. International Journal of Epidemiology. 2003;32:518-26.
8. De Onis M, Borghi E, Arimond M, Webb P, Croft T, Saha K, De-Regil LM, Thuita F, Heidkamp R, Krasevec J. Prevalence thresholds for wasting, overweight and stunting in children under 5 years. Public Health Nutrition. 2019;22:175-9.
9. De Onis M, Branca F. Childhood stunting: a global perspective. Maternal & Child Nutrition. 2016;12:12-26.
10. Du Plessis LM, Kruger H, Sweet L. Complementary feeding: a critical window of opportunity from six months onwards. South African Journal of Clinical Nutrition. 2013;26
11. Fernald LC, Neufeld LM. Overweight with concurrent stunting in very young children from rural Mexico: prevalence and associated factors. European Journal of Clinical Nutrition. 2007;61:623-32.
12. Habaasa G. An investigation on factors associated with malnutrition among under-five children in Nakaseke and Nakasongola districts, Uganda. BMC Pediatrics. 2015;15:1-7.
13. Hoffman D, Cacciola T, Barrios P, Simon J. Temporal changes and determinants of childhood nutritional status in Kenya and Zambia. Journal of Health, Population and Nutrition. 2017;36:27.
14. Hubbard SC, Meltzer MI, Kim S, Malambo W, Thornton AT, Shankar MB, Adhikari BB, Jeon S, Bampoe VD, Cunningham LC. Household illness and associated water and sanitation factors in peri-urban Lusaka, Zambia, 2016–2017. npj Clean Water. 2020;3:1-7.
15. Irena AH, Mwambazi M, Mulenga V. Diarrhoea is a major killer of children with severe acute malnutrition admitted to inpatient set-up in Lusaka, Zambia. Nutrition Journal. 2011;10:1-6.
16. Jones AD, Hoey L, Blesh J, Janda K, Llanque R, Aguilar AM. Peri-urban, but not urban, residence in Bolivia is associated with higher odds of co-occurrence of overweight and anemia among young children, and of households with an overweight woman and stunted child. The Journal of Nutrition. 2018;148:632-42.
17. Kinyoki DK, Manda SO, Moloney GM, Odundo EO, Berkley JA, Noor AM, Kandala NB. Modelling the ecological comorbidity of acute respiratory infection, diarrhoea and stunting among children under the age of 5 years in Somalia. International Statistical Review. 2017;85:164-76.
18. Kuhn H. Reducing inequality within and among countries: realizing SDG 10—a developmental perspective. Sustainable Development Goals and Human Rights. 2020;5:137-53.
19. Lwanga SK, Lemeshow S, Organization WH. Sample size determination in health studies: a practical manual. Geneva: World Health Organization; 1991.
20. Matsungo TM, Kruger HS, Faber M, Rothman M, Smuts CM. The prevalence and factors associated with stunting among infants aged 6 months in a peri-urban South African community. Public Health Nutrition. 2017;20:3209-18.

21. Menon P, Ruel MT, Morris SS. Socio-economic differentials in child stunting are consistently larger in urban than in rural areas. Food and Nutrition Bulletin. 2000;21:282-9.
22. Myint SLT, Khinthet W, Khaymar M, Phyusin A, Aye Y. Estimation of acute diarrhoea and acute respiratory infections among children under five years who lived in a peri-urban environment of Myanmar. OSIR Journal. 2016;6:13-8.
23. Mzumara B, Bwembya P, Halwiindi H, Mugode R, Banda J. Factors associated with stunting among children below five years of age in Zambia: evidence from the 2014 Zambia demographic and health survey. BMC Nutrition. 2018;4:1-8.
24. Ntila S, Siwela M, Kolanisi U, Abdelgadir H, Ndhlala A. An assessment of the food and nutrition security status of weaned 7–12 months old children in rural and peri-urban communities of Gauteng and Limpopo Provinces, South Africa. International Journal of Environmental Research and Public Health. 2017;14:1004.
25. Ogbo FA, Agho K, Ogeleka P, Woolfenden S, Page A, Eastwood J, Group GCHRI. Infant feeding practices and diarrhoea in sub-Saharan African countries with high diarrhoea mortality. PloS One. 2017;12
26. Poda GG, Hsu C-Y, Chao JC-J. Factors associated with malnutrition among children <5 years old in Burkina Faso: evidence from the Demographic and Health Surveys IV 2010. International Journal for Quality in Health Care. 2017;29:901-8.
27. Populationstat. Lusaka Zambia Population [Online]. Available from: https://populationstat.com/zambia/lusaka [Accessed 12.12.2021].
28. Prendergast AJ, Humphrey JH. The stunting syndrome in developing countries. Paediatrics and International Child Health. 2014;34:250-65.
29. Said-Mohamed R, Micklesfield LK, Pettifor JM, Norris SA. Has the prevalence of stunting in South African children changed in 40 years? A systematic review. BMC Public Health. 2015;15:1-10.
30. Sawaya AL, Grillo LP, Verreschi I, Carlos Da Silva A, Roberts SB. Mild stunting is associated with higher susceptibility to the effects of high fat diets: studies in a shantytown population in Sao Paulo, Brazil. The Journal of Nutrition. 1998;128:415S-20S.
31. Shifa M, Leibbrandt M. Urban poverty and inequality in Kenya. In: Urban Forum. Springer; 2017. p. 363-85.
32. Simwanda M, Murayama Y, Ranagalage M. Modeling the drivers of urban land use changes in Lusaka, Zambia using multi-criteria evaluation: An analytic network process approach. Land Use Policy. 2020;92:104441.
33. Sobgui CM, Fezeu LK, Diawara F, Diarra H, Afari-Sefa V, Tenkouano A. Predictors of poor nutritional status among children aged 6–24 months in agricultural regions of Mali: a cross-sectional study. BMC Nutrition. 2018;4:1-13.
34. Sudfeld CR, McCoy DC, Danaei G, Fink G, Ezzati M, Andrews KG, Fawzi WW. Linear growth and child development in low-and middle-income countries: a meta-analysis. Pediatrics. 2015;135
35. Victora CG, Barros FC, Kirkwood BR, Vaughan JP. Pneumonia, diarrhoea, and growth in the first 4 y of life: a longitudinal study. International Journal of Epidemiology. 2005;34:550-9.
36. Victora CG, de Onis M, Capaul M, Karczowski L, Korte R, Onyango AW, *et al*. Worldwide timing of growth faltering: revisiting implications for interventions. Pediatrics. 2010;125
37. Victora CG, Hallal PC, Azevedo MR, Lima RC. Diminishing the socio-economic inequities in child malnutrition: a review of interventions in Brazil. Paediatrics and International Child Health. 2012;32:78-88.
38. Wamani H, Astrøm AN, Peterson S, Tumwine JK, Tylleskär T. Boys are more stunted than girls in sub-Saharan Africa: a meta-analysis of 16 demographic and health surveys. BMC Pediatrics. 2007;7:1-8.
39. Wong R, Palloni A. Aging in Mexico: emerging patterns and implications for the future. Demographic Research. 2006;15:1-26.