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A multilevel analysis of factors associated with stunting among children under five years in Lesotho: a study of the lesotho multiple cluster indicator survey 2018

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Abstract

Background The United Nations Children's Fund (UNICEF) states that inadequate nutrition during the first 1,000 days of a child's life can contribute to stunted growth. Lesotho is currently experiencing a high prevalence of malnutrition across all age groups. Therefore, this study aims to investigate the prevalence and multilevel factors associated with stunting among children under five in Lesotho.

Methods The study used the Lesotho Multiple Cluster Indicator Survey of 2018. The data was analysed using STATA version 14 software, and a multilevel logistic regression model was fitted. The Wald adjusted odds ratio (WAOR) with a *P*-value < 0.05 was also taken to indicate statistical significance.

Results The prevalence of stunting was 33.6% [95% CI 31.6 33.6] amongst the children under five years old in Lesotho. At an individual level, the odds of stunting are lower for the children that did not receive the minimum acceptable diet (MAD) (WAOR = 0.52; CI: 0.3, 0.9), the children born with greater than 3.8 kg birth weight (WAOR = 0.51; CI: 0.4, 0.6), and those that did not have respiratory infections (WAOR = 0.61; CI: 0.4, 1.0) compared to their counterparts. At the household level, the likelihood of stunting was the lowest for education beyond secondary (WAOR = 0.26; CI: 0.2, 0.4), the fifth household wealth (WAOR = 0.34; CI: 02, 03), the safe sources of drinking water (WAOR = 0.72; CI: 06, 09) and inadequate toilet facilities (WAOR = 0.62; CI: 0.5, 0.7) compared to their counterparts. Higher odds were observed amongst the children from rural areas (WAOR = 1.95; CI: 1.3, 2.1), and mothers not residing within the household (WAOR = 1.30; CI: 1.1, 1.6) compared to their counterparts. At the community level, decreased odds were associated with the children from the communities with high community maternal education (WAOR = 0.69; CI: 0.6, 0.8) and the community male education (WAOR = 0.56; CI: 0.5, 0.7), as well as those in the communities with low safety of drinking water sources (WAOR = 0.73; CI: 0.3, 0.5), adequate toilet facilities (WAOR = 0.66; CI: 0.5, 0.8) and high maternal media exposure (WAOR = 0.37; CI: 0.3, 0.5) compared counterparts. The children from communities with high community poverty were two times (WAOR = 2.04; CI: 1.7, 2.5) more likely to be stunted.

Conclusion The findings suggest targeting community food availability and knowledge acquisition. Expanding information availability through mass media would improve the nutritional status of children in Lesotho.

Keywords Multilevel, Child malnutrition, Stunting, Childhood

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Introduction

The growth pattern of a healthy, well-fed child is reflected in positive changes in their height and weight [1]. However, this is not the case for most children in the world. The impact of child malnutrition is more pronounced in low- and middle-income countries, particularly in South Asia and Sub-Saharan Africa (SSA) [2–5]. According to the United Nations Children's Fund (UNICEF), poor nutrition in the first 1,000 days of a child's life can lead to stunted growth. Stunting refers to a child who is too short for their age [6]. It is the failure to grow, both physically and cognitively, because of chronic (recurrent) malnutrition [6].

The adverse outcomes of child malnourishment affect the individual, their family members and their communities, as they are long-term and irreversible. Common childhood illnesses are more deadly to malnourished children, and survivors experience repeated illnesses and stunted growth [7–9, 11]. The health and physical consequences of prolonged states of malnourishment amongst the children are lower intellectual quotients, delayed cognitive development, greater behavioural problems, deficient social skills and susceptibility to contracting diseases [10, 20].

Global, continental and national resolutions have been in place to address child malnutrition. However, Lesotho is currently experiencing a double burden of malnutrition and overnutrition across all age groups [13]. In 2009, 39% of children under the age of five in Lesotho were stunted [1, 14]. By 2014, the prevalence had decreased to 33%, but it slightly increased to 34.5% in 2018 [1]. Despite this recent rise, the overall trend shows an improvement from 44% in 2004.

Although stunting in Lesotho has been well documented, there is a lack of research on its multilevel determinants. Therefore, this study seeks to report on the prevalence of stunting amongst the children under five and identify the multilevel factors associated with stunting in Lesotho.

Methodology

Data source and study design

The analysis was based on the Lesotho Multiple Indicator Cluster Survey (MICS-2018). As part of the Global MICS programme, the survey was conducted by the Lesotho Ministry of Development Planning in collaboration with the Department of the Bureau of Statistics and the United Nations Children's Fund (UNICEF). The Lesotho MICS is a multistage stratified sampling survey based on the Lesotho Census of Population and Housing of 2016 enumeration areas (EAs). This sample was designed to meet the objectives of the survey by providing an estimate for a larger number of indicators at the national level. The detailed sampling methodology of the survey is presented in the MICS' main report [13]. Data were collected between April and September 2018, and the MICS covered several modules and indicators across households. This study used the children aged 0–17 dataset, with a sample size of 3,256 children under five.

Data variables

Dependent variables

Anthropometric *Z*-scores assigned to children in surveys determine the dependent variables. The assignment of anthropometric *Z*-Scores is based on the World Health Organization (WHO) Child Growth Standards that are developed through interpolation functions that consider the sex, age, height (in centimetres) and weight of the child (in kilograms) [13]. Stunted growth in children is defined as a height-for-age below negative two standard deviations of the reference population's median [1, 13, 15].

Independent variable

This study follows the UNICEF framework to analyse the factors associated with child health and nutrition [23, 72]. There are three levels of predictors, namely: immediate (individual), underlying (household) and basic (community) variables. Table 1 shows immediate, underlying and basic predictors of stunting as per the framework used. It also highlights the coding and explanation of these variables. Communities were grouped based on clusters, and the 40% threshold for categorising them as having "low proportions" or "high proportions" was determined using the overall mean stunting estimate of 40%.

Data analyses

The data analysis was carried out in three stages: descriptive analysis, bivariate analysis and multilevel logistic regression. The descriptive analysis of all the independent variables involved calculating frequencies, percentages and confidence intervals to assess statistical differences and p-values. Next, a chi-square test (bivariate analysis) was performed to identify the variables that were statistically significant for inclusion in the main model, using a 95% confidence interval (p-value < 0.05). Multilevel logistic regression was then applied to examine the factors associated with stunting, accounting for the hierarchical and clustered nature of the dataset. This clustering can introduce multilevel dependency or correlation amongst observations, potentially affecting model parameter estimates [16]. To analyse the data, five models were developed. The first model (null or empty model) was conducted without explanatory variables to establish the baseline odds of stunting and variance. In the second model, immediate variables were included; the

Table 1 Variable Definition

Immediate variables	Coding
Minimum acceptable diet (MAD)	1 = Did not receive MAD 2 = Received MAD
Child sex	1 = Male 2 = Female
Child weight at birth	1 = Less than and equal to 2.5 kg (below average weight/ low birth weight) 2 = 2.6 kg to 3.8 kg (Average weight) 3 = Greater than and equal to 3.9 kg (Above average weight)
Diarrhoea	1 = Yes 2 = No
Respiratory infection	1 = Yes 2 = No
Underlying variables	
Household size	1 = 2–4 2 = 5 +
Place of residence	1 = Urban 2 = Rural
Maternal residential status	1 = In the household 2 = Not in the household
Sex of household head	1 = Male 2 = Female
Household wealth	1 = Poorest 2 = Second 3 = Middle 4 = Fourth 5 = Richest
Maternal age (years)	1 = 15–19 2 = 20–24 3 = 35 +
Maternal education	1 = Primary or None 2 = Secondary education 3 = Beyond Secondary education
Sources of drinking water	1 = Unsafe 0 = Safe
Adequate toilet facilities	1 = Inadequate 0 = Adequate
Basic variables	
The proportion of children who received medical attention in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of fully immunised children in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of mothers who received antenatal care in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of mothers with positive attitudes towards intimate partner violence in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of households that owned land and/or livestock in the communities	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of mothers in the community with at least a secondary education in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of males in households with at least a secondary level education in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of female-headed households in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of poor households in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%

Table 1 (continued)

Immediate variables	Coding
Proportion of maternal media exposure in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of households with access to safe drinking water in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%
The proportion of households with access to adequate toilet facilities in the community	1 = Low = Less than or equal to 40% 2 = High = Greater than 40%

Source: Adapted from Bureau of Statistics, 2019

third accounted for underlying variables, while the fourth incorporated basic variables. The last model (fifth) combined all variables—immediate, underlying and basic. In this final model, the variables with a p-value of less than 0.05 were considered statistically significant to stunting.

Fixed and random effects parameters

The aforementioned models also calculated the fixed and random effects parameters. These fixed effects parameters were used to measure association and baseline-adjusted odds ratios, while the mixed effects parameters, such as the intra-cluster correlation (ICC), median odds ratio (MOR) and proportional change in variance (PCV), will be used to determine the extent of variation in stunting that can be attributed to community- and household-level factors. The ICC quantifies the proportion of total variance in stunting, which is explained by clustering at different levels [19]. The MOR interprets the between-cluster heterogeneity in stunting risk by comparing the odds of stunting for the children from different clusters [19]. The PCV assesses the proportion of variance explained by including variables in the models, indicating how much of the observed variability in stunting can be attributed to the factors considered [19]. These measures help to determine the contribution of hierarchical clustering in explaining disparities in stunting and evaluate the effectiveness of the included predictors in reducing unexplained variability [17, 18]). All statistical analyses were conducted using STATA 15 software with the (xtmelogit) command.

Descriptive analysis

Table 2 presents all three level factors and their association (chi-square p-value) with stunting at bivariate analysis. In Lesotho, a third (33.6%) of those under 5 were stunted. All variables with a p-value less than 0.05 from Chi-Square were considered statistically significant and associated with stunting. Dietary intake, child weight at birth and respiratory infections were immediate variables significantly associated with stunting. Underlying variables associated with stunting were the place of residence, the households' wealth index, maternal education and residential status, water sources and toilet facilities. For basic community variables, community immunisation, community maternal and male education, community food security, community drinking water source safety, community toilet facilities adequacy and community media exposure, were statistically significantly associated with stunting. All variables that were statistically significant in Table 2 were further tested using Adjusted Wald Statistics, where one variable (community immunisation) was excluded from the main model.

Multilevel analysis

Table 3 presents the main model of level one (immediate variables), level two (underlying variables) and level three (basic variables). With all the factors controlled for in the multilevel analysis at an individual level, the odds are lower for the children that did not receive MAD (WAOR = 0.5; CI: 0.3, 0.9), born with greater than 3.8 kg birth weight (WAOR = 0.5; CI: 0.4, 0.6), and those that did not have respiratory infections two weeks before the survey (WAOR = 0.6; CI: 0.4, 1.0) compared to their counterparts. At the household level, the likelihood of stunting was lowest for education beyond secondary (WAOR = 0.3; CI: 0.2, 0.4), fifth household wealth (WAOR = 0.3; CI: 02, 03), safe sources of drinking water (WAOR = 0.7; CI: 06, 09) and inadequate toilet facilities (WAOR = 0.62 CI: 0.5, 0.7) compared to their counterparts. Higher odds were observed among Children from rural areas (WAOR = 2.0; CI: 1.3, 2.1), and mothers not residing within the household (WAOR = 1.3; CI: 1.1, 1.6) compared to their counterparts. At community level, decreased odds were associated with the children from the communities with high community maternal education (WAOR = 0.7; CI: 0.6, 0.8) and community male education (WAOR = 0.6; CI: 0.5, 0.7), as well as those in the communities with low safety of drinking water sources (WAOR = 0.7; CI: 0.3, 0.5), adequate toilet facilities (WAOR = 0.7; CI: 0.5, 0.8) and high maternal media exposure (WAOR = 0.4; CI: 0.3, 0.5) compared counterparts. The children from the communities with high community poverty were two times (WAOR = 2.0; CI: 1.7, 2.5) more likely to be stunted.

Table 2 Prevalence of Stunting among Children under Five: Lesotho 2018 (N = 3256)

Variables	Not stunted			Stunted			*P*-value
	%	N	CI	%	N	CI	
Immediate variables							
Dietary intake							
Did not receive MAD	59.1	402	(54.8,63.4)	40.9	278	(36.6,45.2)	0.011
Received MAD	70.4	141	(62.6,77.2)	29.6	59	(22.8,37.4)	
Child sex							
Male	64.5	1028	(61.1,67.7)	35.5	567	(32.3,38.9)	0.085
Female	68.2	1132	(65.6,70.7)	31.8	529	(29.3,34.5)	
Child weight at birth							
< = 2.5 kg	47.4	79	(2.8, 4.8)	52.6	87	(27.1,32.1)	0.000
2.6 kg—3.8 kg	68.8	638	(6.1,10.9)	31.2	290	(23.6,29.5)	
> = 3.8 kg	66.8	1444	(4.2,6.2)	33.2	719	(26.5,30.6)	
Diarrhoea							
Yes	66.5	187	(59.4,73.0)	33.5	94	(27.0,40.6)	0.963
No	66.3	1966	(64.1,68.5)	33.7	996	(31.5,35.9)	
Respiratory infection							
Yes	62.8	831	(59.6,66.0)	37.2	492	(34.0,40.5)	0.002
No	68.7	1320	(66.3,71.1)	31.3	601	(28.9,33.7)	
Underlying Variables							
Household size							
2–5	67.0	852	(63.3,70.5)	33.0	420	(29.5,36.7)	0.644
5 +	66.0	1309	(63.4,68.5)	34	676	(31.6,36.7)	
Place of residence							
Urban	72.1	958	(68.6,75.4)	27.9	370	(24.6,31.4)	0.000
Rural	62.4	1201	(59.8,64.9)	37.6	726	(35.1,40.2)	
Household heads							
Male	63.2	1314	(65.0,70.0)	36.8	632	(30.0,35.0)	0.156
Female	64.3	846	(61.2,67.9)	35.7	463	(32.1,38.8)	
Household wealth							
Poorest	55.7	412	(52.2,59.2)	44.3	327	(40.8,47.8)	0.000
Second	62.3	438	(58.0,66.5)	37.7	265	(33.5,42.0)	
Middle	65.6	434	(60.5,70.3)	34.4	228	(29.7,39.5)	
Fourth	71.0	425	(65.1,76.2)	29.0	174	(23.8,34.9)	
Richest	81.5	452	(76.3,85.8)	18.5	103	(14.2,23.7)	
Maternal age							
15–24	64.0	534	(60.2,67.7)	36.0	300	(32.3,39.8)	0.266
25–34	68.3	808	(64.9,71.5)	31.7	375	(28.5,35.1)	
35 +	66.8	330	(64.3,68.8)	33.2	164	(28.0,38.8)	
Mother's residential status							
In the household	67.3	1868	(64.9,69.6)	32.7	909	(30.4,35.1)	0.008
Not in the household	61.1	293	(57.0,65.0)	38.9	186	(35.0,43.0)	
Maternal education							
Primary or none	61.2	578	(55.7,64.5)	38.8	367	(35.5,42.3)	0.000
Secondary	67.1	926	(63.7,70.3)	32.9	454	(29.7,36.3)	
Beyond secondary	82.6	227	(75.0,88.3)	17.4	48	(11.7,25.1)	
Safety of drinking water							
Unsafe	60.4	347	(55.6,65.0)	39.6	228	(35.0,44.4)	0.007
Safe	67.6	1813	(65.3,70.0)	32.4	868	(30.1,34.7)	

Table 2 (continued)

Variables	Not stunted			Stunted			P-value
	%	N	CI	%	N	CI	
Toilet facilities adequacy							
Inadequate	59.3	580	(55.7,62.9)	40.7	398	(37.1,44.3)	0.000
Adequate	69.4	1580	(66.6,72.0)	30.6	698	(28.0,33.4)	
Basic variables							
Community health seeking behaviour (%)							
Low	65.9	1478	(63.3,68.3)	34.1	766	(31.7,36.7)	0.558
High	67.4	682	(63.0,71.5)	32.6	330	(28.5,37.0)	
Community immunisation (%)							
Low	66.0	1449	(63.2,68.6)	34.0	747	(31.4,36.8)	0.005
High	67.1	712	(63.6,70.4)	32.9	349	(29.6,36.4)	
Community antenatal care (%)							
Low	60.2	78	(47.8,72.1)	39.4	50	(27.9,52.2)	0.600
High	64.0	561	(60.4,67.4)	36.0	315	(32.6,39.6)	
Community food security (%)							
Low	67.6	1497	(68.5,76.4)	32.4	718	(23.6,31.5)	0.054
High	64.1	663	(61.2,66.1)	35.9	372	(33.9,38.8)	
Community maternal education (%)							
Low	60.3	621	(57.2,63.4)	39.7	408	(36.6,42.8)	0.000
High	69.1	1539	(66.3,71.8)	30.9	687	(28.2,33.7)	
Community male education (%)							
Low	61.8	1096	(59.0,64.5)	38.2	677	(35.5,41.0)	0.000
High	71.8	1065	(68.4,74.9)	28.2	419	(25.1,31.6)	
Female-headed communities (%)							
Low	66.1	1840	(64.0,68.2)	33.3	943	(31.8,36.0)	0.642
High	67.7	320	(61.0,73.8)	32.3	153	(26.2,39.0)	
Community poverty							
Low	71.5	1419	(68.4,74.3)	28.5	567	(25.7,31.6)	0.000
High	58.4	742	(55.1,61.5)	41.6	529	(38.5,44.9)	
Female media exposure in the community							
Low	62.9	1615	(60.5,65.3)	37.1	952	(34.7,39.5)	0.000
High	79.1	546	(74.0,83.4)	20.9	144	(16.6,26.0)	
Community sources of drinking water							
Low	60.8	367	(55.6,65.8)	39.2	236	(34.2,44.4)	0.014
High	67.6	1794	(65.3,69.8)	32.2	859	(30.2,34.7)	
Community toilet facilities adequacy							
Low	60.2	697	(56.9,63.4)	39.8	461	(36.6,43.2)	0.000
High	69.8	1464	(66.8,72.6)	30.2	634	(27.4,33.3)	

CI: confidence interval

Measure of variation

Table 4 presents the measures of variation across Models 1 to 5. In the empty model (Model 1), the baseline odds of stunting were 0.4317, representing the likelihood of stunting before incorporating any independent variables. The results highlight that household-level effects were more pronounced than community-level effects. Consistently, household variance and intra-cluster correlation (ICC) exceeded community-level values. The household ICC in the empty model was 26.75%, compared to 5.58% at the community level, reinforcing the significant role of household conditions in determining stunting outcomes. As more variables were introduced across the models, the variance at both levels decreased, suggesting that immediate, underlying and community-level factors help to explain

Table 3 Immediate, underlying and community factors associated with stunting: Lesotho 2018

	Model 1 (empty model)		Model 2: immediate variables		Model 3: household variables		Model 4: community variables		Model 5: immediate, household and community variables	
Immediate variables	**WAOR (95% CI)**	***P*-value**	**WAOR (95% CI)**	***P*-value**	**WAOR (95% CI)**	***P*-value**	**WAOR (95% CI)**	***P*-Value**	**WAOR (95% CI)**	***P*-Value**
Dietary intake										
No MAD (RC)			1.00	1.00					1.00	1.00
MAD			0.39 (0.2,0.6)	0.000					0.5 (0.3,0.9)	0.027
Child weight at birth										
< 2.6 kg (RC)			1.00	1.00					1.00	1.00
2.6 kg—3.8 kg			0.34 (0.2,0.5)	0.002					0.8 (0.6,0.9)	0.000
≥ 3.9 kg			0.43 (0.3,0.6)	0.005					0.5 (0.4,0.6)	0.000
Respiratory infection										
Yes (RC)			1.00	1.00					1.00	1.00
No			0.76 (0.6,0.9)	0.003					0.6 (0.4,1.0)	0.004
Underlying variables										
Place of residence										
Urban (RC)					1.00				1.00	1.00
Rural					1.7 (1.3,2.1)	0.000			2.0 (1.3,2.1)	0.000
Household wealth										
Poorest (RC)					1.00	1.00		1.00	1.00	1.00
Second					0.8 (0.6,1.1)	0.135			0.7 (0.6,0.9)	0.013
Middle					0.7 (0.5,0.9)	0.016			0.5 (0.4,0.7)	0.000
Fourth					0.4 (0.3,0.6)	0.000			0.4 (0.3,0.5)	0.000
Richest					0.4 (0.2,0.6)	0.000			0.2 (0.2,0.3)	0.000
Maternal residential status										
Resides in household (RC)					1.00	1.00			1.00	1.00
Not residing in household					1.0 (0.8,1.3)	0.014			1.3 (1.1,1.6)	0.034
Maternal educational attainment										
Primary or none (RC)					1.00	1.00			1.00	1.00
Secondary					0.9 (0.7,1.2)	0.512			0.7 (0.6,0.9)	0.003
Beyond secondary					0.5 (0.3,0.9)	0.011			0.3 (0.2,0.4)	0.000
Safety of drinking water										
Unsafe (RC)					1.00	1.00			1.00	1.00
Safe					0.9 (0.7,1.2)	0.025			0.7 (0.6,0.9)	0.013
Adequacy of toilet facilities										
Inadequate (RC)					1.00	1.00			1.00	1.00
Adequate					0.9 (0.7, 1.1)	0.014			0.6 (0.5,0.7)	0.000

Table 3 (continued)

	Model 1 (empty model)		Model 2: immediate variables		Model 3: household variables		Model 4: community variables		Model 5: immediate, household and community variables	
Immediate variables	**WAOR (95% CI)**	***P*-value**	**WAOR (95% CI)**	***P*-value**	**WAOR (95% CI)**	***P*-value**	**WAOR (95% CI)**	***P*-Value**	**WAOR (95% CI)**	***P*-Value**
Basic variables										
Community female education										
Low (RC)							1.00	1.00	1.00	1.00
High							0.9 (0.7, 1.1)	0.004	0.7 (0.6,0.8)	0.000
Community male education										
Low (RC)							1.00	1.00	1.00	1.00
High							1.0 (0.7, 1.3)	0.008	0.6 (0.5,0.7)	0.000
Community poverty										
Low (RC)							1.00	1.00	1.00	1.00
High							1.5 (1.2, 1.9)	0.001	2.0 (1.7,2.5)	0.000
Community safe drinking water										
Low (RC)							1.00	1.00	1.00	1.00
High							0.5 (0.4, 0.7)	0.000	0.7 (0.6,0.9)	0.017
Community toilet facilities										
Low							1.00	1.00	1.00	1.00
High							0.9 (0.4, 0.7)	0.062	0.7 (0.5,0.8)	0.000
Female community media exposure0										
Low (RC)							1.00	1.00	1.00	1.00
High							0.9 (0.7, 1.2)	0.018	0.4 (0.3,0.5)	0.000

WAOR: Wald adjusted odds ratio, CI: Confidence Interval

Table 4 Results from the random intercept model—the measure of variability

Measures of variation	Model 1 (empty)	Model 2 (immediate variables)	Model 3 (underlying variables)	Model 4 (community variables)	Model 5(immediate, underlying and community variables)
Stunted (baseline odds)	0.4317				
Proportional change in variance (PCV), (Community)	0.2506	0.7780	0.2248	0.3690	0.2019
Proportional change in variance (PCV), (household)	0.9506	2.1366	0.8143	0.9659	0.7926
ICC (%) (community)	5.58%	7.15%	1.26%	3.12%	1.03%
ICC (%) (household)	26.75%	61.11%	17.83%	24.53%	16.90%
MOR (median odds ratio)	1.65	1.75	1.25	1.44	1.22
Model fit statistics (Chi2 (2)	37.93	8.84	7.64	24.90	6.51
P-value	0.000	0.0120	0.0219	0.0000	0.0387

a substantial portion of the variation in stunting even though residual household-level differences remain significant. Additionally, the Median Odds Ratio (MOR), which quantifies the unexplained heterogeneity between the clusters (households or communities), was 1.65 in Model 1. This means that, if a child were moved to a randomly selected household with a higher risk of stunting, their odds of being stunted would increase by 65%. Across the models, the MOR decreased, reaching 1.22 in the final model (Model 5).

Discussion

The prevalence of stunting in Lesotho was 33.6%, 95% CI (0.3365 0.316) in 2018. This was very close to that of West Africa (33.9%) [24]. However, it was lower than that of Burundi (54.6%), Nigeria (47.6%), Nepal (47%), India (43%), Kenya (39%), Rwanda (38%), Central Africa (37.8%), Mozambique (37%) and Democratic Republic of Congo (35.2%) [24–27].

In this study, at an individual level, the children who had a Minimum Acceptable Diet (MAD) the day before the survey and those with low birth weight (LBW) and respiratory infections were more likely to be stunted than their counterparts. This was observed in South Ethiopia, Rwanda, Ecuador, Mexico, Rwanda, Mozambique, and Malawi, where the children who did not receive the MAD were more likely to be stunted compared to their counterparts [12, 28–32] Moreover, Cruz García et al. (2017) indicated that the children born with LBW are born with low reserves of vital growth nutrients, such as vitamin A, zinc and iron [28]. They are also prone to contact diseases and infections, such as diarrhoea, anaemia and respiratory infections, thereby increasing their likelihood of becoming stunted [33, 34]

At the household level, the children in rural areas, poor households, households with non-resident mothers, maternal education with primary or no education, unsafe sources of drinking water and inadequate toilet facilities were more likely to be stunted. Poverty in Lesotho is deeply entrenched in rural areas, where 70% of the population resides [21, 35]. More than half of the population in Lesotho's rural areas is poor [35]. Amegbor et al. (2020) indicated that there is an association between different indicators of childhood malnutrition and the region of residence to the regional socio-economic differences [36]. In low- and middle-income countries, such as Uganda, Indonesia, Kenya and Niger, the children in the rural areas were more likely to be stunted compared to those in urban areas [36, 37]. Economic and social environments, and their inequality are important reasons for the child malnutrition [38]. This was also observed in Bangladesh, Ecuador, Cambodia, India, Ethiopia, Nigeria, Nepal, Parahmantan, Haiti, Burkina Faso, Malawi, Iran, Zimbabwe, Mozambique and Peru [33, 36, 38–42]. In relation to maternal residential status, this was also reported in China, Bangladesh and Guatemala [43–45]. Migration is often considered an important way of improving livelihood conditions for the households and individuals [45]. Historically, migration has been a male phenomenon in most countries, particularly in Lesotho [46]. However, in recent years, there has been an increase in female migration noted in several contexts in Africa, many of whom are mothers [46]. In most cases, the children of these migrants are often left behind with extended family, such as grandparents, uncles and aunts, because of unstable income and unfriendly housing in host areas [45].

In this study, the sources of drinking water and toilet facilities were the determinants of stunting at the household and community level. Water, sanitation and hygiene variables are intertwined. At the household level, the same was reported in 172 countries, including Pakistan and Ethiopia, where the children from the households with access to unsafe drinking water, were more likely to be stunted [22, 29, 61–63]. The lack of access to safe drinking water sources affects the children's health and well-being through repeated diarrhoeal infections [47, 63]. In Lesotho, many communities do not have access to safe drinking water. Despite exporting water to South Africa (contributing to 8–10% of the country's gross domestic product), about 63% rural domestic communities do not have access to safe drinking water, thus forcing them to use unprotected sources of drinking water with many having to travel more than 30 min to collect the unsafe water [64, 65]. Nearly 85% of the rural population use traditional drinking water sources, such as open reservoirs, springs and open wells [64]. These water sources are normally contaminated with E-Coli that causes stomach and intestinal illnesses, including diarrhoea and nausea, even leading to stunting and death [62, 64]. Water can be contaminated through environmental enteric dysfunction (EED) and soil-transmitted helminths [64]. Intestinal worms (soil-transmitted helminths) can predispose the children to stunting through direct contact or through dust [64]. Pollution of the water sites can also be due to sanitation facilities, such as pit latrines and open defecation along the boundaries of the water source, as these may contaminate the water with faecal pathogens [48].

At the community level, the children from the communities with high proportions of adequate toilet facilities were less likely to being stunted than the children in the communities with low proportions of adequate toilet facilities. In Mozambique, Burkina Faso, Indonesia, Mali, Rwanda, Bangladesh, Brazil, Cambodia, Tanzania and Ethiopia studies, India's poor household hygienic practices, such as access to safe water, handwashing using soup and other sanitation practices, increased the risk of stunting [48–53]. A large proportion of Lesotho's population remains without access to proper water and sanitation services [54]. The International Labour Organisation (ILO) (2020) has highlighted that, in Lesotho, most people are also subjected to poor drainage facilities and agreements for solid waste disposal with around 30% of the population openly defecating [55]. Sanitation issues are more complicated than any other underlying and basic variables because one and/or more inadequate toilet facility in the community can contaminate the water of a larger group of people. Inadequate sanitation facilities contribute to the increasing contamination of food and drinking water, so the children living in a household without a proper toilet are more likely to be stunted [49–51].

At the community level, the children from the communities with high proportions of poor households, low proportions of males in the households with males and mothers with at least secondary education, safe sources of drinking water, adequate toilet facilities and maternal media exposure were more likely to be stunted. It is well documented that educated mothers have greater knowledge of appropriate care practices that improve the nutritional status of their children [56, 58, 59]. Therefore, the children in the communities with a high proportion of educated women are more likely to be healthier than those in the low-proportion communities. Neighbourhoods constitute the key determinants of socioeconomic disparities in health as they shape individual opportunities and expose residents to multiple risks and resources [59]. In the neighbourhoods with high proportions of educated women, social interactions are key to the dissemination of information in bettering the lives of the children in that neighbourhood [60]. Further, the educated households reproduce neighbourhood characteristics by choosing the neighbourhoods with the people with the similar educational levels and affluence [60]. In contrast, exposure to mass media is important as a source of knowledge [66]. There is a gap in the literature on how community maternal media exposure impacts the child malnutrition. However, what is known is that mass media provides information that is essential to amplify the people's knowledge and awareness regarding issues of day-to-day life [66]. Mass media also has a greater role in building health and nutrition-related behaviours, attitudes, as well as promoting socio-cultural and economic development, which might contribute to improving the nutritional outcomes of the children [67, 68]. In Indonesia, mass media also strengthened the role of frontline workers, as well as reinforcing their status as experts, depicting them as educated, trusted and reliable people [68]. It also promoted health seeking behaviour and appropriate childcare practices [69]. This was also found in Sub-Saharan Africa, Bangladesh, China, Pakistan, Indonesia and Tanzania [66, 67, 70, 71].

The study shares a common limitation of cross-sectional studies, which cannot establish causal relationship between stunting and the independent variables, but an association. The information was also self-reported by the mothers/caregivers, making it subject to recall and social-desirability bias. Further, the community variables were created using the clusters derived from the Enumeration Areas, which might also be subject to coverage error. Again, the community variables created through aggregating information within enumeration areas might have not accurately represented the variables they are proxies of. Again, because the study used the secondary data, there was a restricted availability of exposure variables.

Conclusion

This study aimed to find the determinants of stunting in Lesotho at three levels—individual, household and community level. At an individual level, minimum acceptable diet, child weight at birth and respiratory infections were the factors associated with stunting. At the household level, the place of residence, household wealth, maternal educational attainment and residential status, as well as the sources of drinking water and toilet facilities, were also the factors associated with stunting. Moreover, at the community level, the proportions of mothers and males in the household with at least secondary education, the proportions of poor households in the community, the maternal media exposure, the safe sources of drinking water and the adequate toilet facilities in the community were the factors associated with stunting. The findings suggest that the interventions to improve the child nutrition should be level specific. At the individual level, the general health of the mother and child from birth is important. At the household and community levels, poverty alleviation and expanding media coverage should be the targets. Overall, by addressing the identified individual, household and community barriers, decision makers can develop targeted interventions to improve the child nutrition in Lesotho.

Abbreviations

EAs	Enumeration areas
ICC	Inter-cluster correlation
ILO	International labour organisation
LBW	Low birth weight
LDHS	Lesotho demographic health survey
MAD	Minimum acceptable diet
MICS	Multiple indicator cluster survey
MOR	Median odds ratios
PVC	Proportional change in variance
SSA	Sub-Saharan Africa
UNICEF	United Nations children's fund
WAOR	Wald adjusted odds ratios
WHO	World health organisation

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Author contributions

The study was designed by NL and KV. TT and ML were involved in the revision of the paper as well as the editing of the final manuscript.

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Availability of data and materials

The study used the LMICS 2018 dataset which is publicly available on the MICS data official website https://mics.unicef.org/surveys with all respondents identifier information removed.

Declarations

Ethics approval and consent to participate

This study was conducted under the ethical principles stated in the Helsinki Declaration. The authors communicated with the UNICEF MICS team in 3 UN Plaza, New York, USA, and were granted permission to download and use the LMICS dataset. Further, the author received ethical approval from the University of KwaZulu-Natal, Durban, South Africa, to use the MICS datasets. The approval was obtained from the Human and Social Sciences Research Ethics Committee (HSSREC/00002395/2021).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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