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Prevalence and determinants of underweight among children under five years in Southern African countries: A comparative study

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Shirley ML. Mathabatha

Department of Population Studies and Demography, North-West University, Mahikeng Campus, Mahikeng, South Africa

For Correspondence: Email: *25514415@mynwu.ac.za*

Abstract

Underweight is a public health issue that affects children in low-middle income countries. It is defined as low weight for age. The study aimed to examine factors associated with underweight among children under five years in SADC. The study used Demographic and Health Surveys conducted in Lesotho (2014), Malawi (2015-16), South Africa (2016) and Zambia (2018). The study population consisted of children under the age of five years: 1869 in Lesotho, 5786 in Malawi, 1416 in South Africa and 9689 in Zambia. Chi-square test and logistic regression were used to establish social and demographic factors associated with underweight. The study results show that Malawi and Zambia had high prevalence (11.7% and 11.8%) of underweight as compared to Lesotho and South Africa (10.3% and 5.9%) respectively. It is therefore suggested by this study that the predominant factors such as child's age, child's sex, birth weight, mother's education, and household income to be considered by policymakers and stakeholders when implementing programmes and policies to reduce underweight. Furthermore, the study emphasizes the importance of multisectoral interventions that address the basic, underlying, and immediate causes of malnutrition to reduce the prevalence of underweight among children under five years. *(Afr J Reprod Health 2026; 30 [21]: 27-39).*

Keywords: Malnutrition, Undernutrition, Southern Africa, Public health

Résumé

L'insuffisance pondérale constitue un problème de santé publique qui touche les enfants dans les pays à revenu faible ou intermédiaire. Elle se définit comme un poids insuffisant par rapport à l'âge. Cette étude visait à examiner les facteurs associés à l'insuffisance pondérale chez les enfants de moins de cinq ans au sein de la SADC. Elle s'est appuyée sur les Enquêtes démographiques et de santé (EDS) menées au Lesotho (2014), au Malawi (2015-2016), en Afrique du Sud (2016) et en Zambie (2018). La population étudiée était composée d'enfants de moins de cinq ans : 1 869 au Lesotho, 5 786 au Malawi, 1 416 en Afrique du Sud et 9 689 en Zambie. Le test du khi-carré et la régression logistique ont été utilisés pour déterminer les facteurs sociodémographiques associés à l'insuffisance pondérale. Les résultats montrent que le Malawi et la Zambie présentent une prévalence élevée d'insuffisance pondérale (respectivement 11,7 % et 11,8 %), comparativement au Lesotho (10,3 %) et à l'Afrique du Sud (5,9 %). L'étude suggère donc que les décideurs politiques et les parties prenantes devraient prendre en compte des facteurs déterminants — tels que l'âge et le sexe de l'enfant, son poids à la naissance, le niveau d'instruction de la mère et le revenu du ménage — lors de l'élaboration de programmes et de politiques visant à réduire l'insuffisance pondérale. Par ailleurs, l'étude souligne l'importance d'interventions multisectorielles qui s'attaquent aux causes fondamentales, sous-jacentes et immédiates de la malnutrition, afin de réduire la prévalence de l'insuffisance pondérale chez les enfants de moins de cinq ans. *(Afr J Reprod Health 2026; 30 [21]: 27-39).*

Mots-clés: Malnutrition, sous-nutrition, Afrique australe, santé publique

Introduction

Underweight is a public health issue that affects children in low-middle income countries. Underweight is defined as low weight for age measured by -2 standard deviation[1]. This explains that an underweighted child is identified to be too thin for their age.[2] states that poor nutrition among children causes poor mental health, delays in development and cognitive impairment, which is a violation of child's human rights. These can consequently cause problems with social skills and

opportunities making it difficult for such children to succeed later in their careers and in society[2,3]. The 2016 Demographic and Health Survey (DHS) report for South Africa indicates that 5.9% of children under the age of five years are underweight[4]. Moreover, the findings of the report in Malawi indicate that 11.7% of children under the age of five years were underweight[5]. The Zambia Statistics Agency (ZSA) reported that about 11,8 % of these children are underweight[6]. Furthermore, about 10,3 % of these children in Lesotho were underweight[7].

Literature has also shown that there is inconsistency in the relationship between child's sex and underweight among children under five years. Several studies such as[8-10] have found a positive statistical correlation between child's sex and underweight. However, studies such as[3,11-13] found no statistical evidence or relationship between child's sex and underweight. Similarly, the relationship between child's age and underweight has shown inconsistency among the studies. Researchers such as[8,12,13] have found a significant relationship between child's age and underweight. However, other studies such as[14] found no statistical evidence regarding child's age and underweight. The UNICEF framework identifies causes of malnutrition in children as being attributed to basic causes (societal level), underlying causes (household or family level), and immediate causes (individual level) factors, providing a comprehensive view of how different factors contribute to child malnutrition with challenges at one level influencing other levels. The basic causes of child malnutrition can be classified as economic, environmental, or socio-political factors[15]. The underlying causes of malnutrition limit the ability of households and individuals to obtain proper nutrition at the community level. Inadequate food intake and illness are the immediate causes of childhood malnutrition[15].

The nutritional status of children, especially in the Southern Africa context, is of importance in the continent's development agenda. This study aims to investigate the socio-demographic factors associated with underweight among children under five years of age in SADC countries. By examining socio-demographic factors, the study will be able to identify areas or specifically countries where interventions and programs should be focused and strengthened to improve children's nutrition and reduce underweight among children under five years. This can further lead to a better understanding of the importance of good nutrition, hygiene, and healthcare practices to prevent underweight.

Methods

Sources of data

The setting

This study included children under the age of five from four countries in Southern Africa: Malawi, South Africa, Lesotho, and Zambia which are in Southern African Developing Communities. These countries were chosen because of their diverse economic situations and common concerns in child health and nutrition.

Sources of data

This study was based on the most recent Demographic and Health Surveys (DHS) conducted in the four Southern African countries: namely, Lesotho, Malawi, South Africa, and Zambia, around the period 2014-2018. While more recent DHS datasets are available for certain countries, they do not cover the entire study region for a consistent timeframe. To ensure cross-country comparability and minimize temporal bias, which can arise from shifting socioeconomic conditions or health policies, this study utilizes surveys conducted between 2014 and 2018. This period represents the recent dataset available across all selected countries, providing a stable baseline for comparative analysis. These datasets were weighted and merged to determine the prevalence and associated factors of child underweight in the region. The DHSs are a nationally representative survey that collects data on demographic and health indicators like mortality, morbidity, family planning service utilization, fertility, maternal and child health. The data were downloaded from the DHS website https://dhsprogram.com/data/available-datasets.cfm. The DHSs have different datasets for men, women, children, birth, and household. For this study, the Household Member Recode (PR) and Children's Recode (KR) files of the DHS were used. The two datasets were merged to combine child anthropometric and health information with relevant household and maternal characteristics, thereby facilitating the examination of the determinants of under-five malnutrition at the child,

maternal, father's characteristics and household level factors.

Study variables

Outcome variable

Underweight is the dependent variables of study. The variable was coded as a binary in this study as '0' if a child is not underweight which is defined by a Z-score greater than or equal to -2 SD, and "1" if a child is underweight and was defined by a Z-score less than -2 SD.

Explanatory variables

The study included 14 independent variables guided by the UNICEF conceptual framework; the variables were divided into three categories: immediate causes, underlying causes and basic causes. The immediate causes included child's age which included children under five years and in this study were categorized into 0-11 months, 12-23 months, 24-35 months, 36-47 months and 48-59 months, child's sex categorized as male and female, birth order, which was categorized as 1, 2-3 and 4+ and birth weight was categorized as low birth weight and not low (normal) birth weight. Mother's age was categorized into 15–19, 20–29, 30–39, and 40–49 years, mother's level of education as no education, primary and secondary+, mother's employment status as working and not working and father's employment status as working and not working. Underlying causes included sex of head of the household categorized as male and female, household income categorized as poor, average, and rich, source of water as piped and not piped, toilet facility as improved and not improved. Lastly the basic causes included Community poverty and was constructed as a community-level variable by first identifying households belonging to the poorest and poorer wealth quintiles. The proportion of poor households within each survey cluster was then calculated. The resulting cluster-level proportions were then divided into tertiles and categorised as low, moderate, and high community poverty.

Data management and analytical methods

Stata version 16 was utilized to analyses the data. Before the analysis, data quality checks were performed. No missing data were identified among the study variables. However, anthropometric measurements coded by the DHS as implausible or flagged observations (codes 9996, 9997, and 9998) were treated as missing and excluded from the relevant analyses. Therefore, all analyses were restricted to children with valid anthropometric measurements for the outcome under investigation. The univariate analyses were used to show the percentage distribution of background characteristics; bivariate and multivariate logistic regression analyses were used to establish the relationship between independent and dependent variables. In addition, the level of significance was determined using the confidence interval of 95% with a significance level of 5%. Bivariate analysis used with Pearson Chi square test to examine the relationship between the dependent variables (underweight) and the independent variables. Variables that were not significant at bivariate analysis (mother's employment status, fathers' employment status and sex of head of the household) were excluded in the logistic analysis. All analyses accounted for the complex DHS sampling design. Sampling weights were derived from the DHS household weight variable (hv005) and normalised by dividing by 1 000 000. Survey-adjusted analyses were performed using the primary sampling unit (hv021) and stratification variable (hv023) through the Stata survey (svy) commands. Before fitting the multivariable logistic regression models, multicollinearity among explanatory variables was assessed using Variance Inflation Factors (VIFs). No evidence of problematic multicollinearity was detected, with a mean VIF of 1.29 and all individual VIF values below 2.0. Thus, all selected explanatory variables were retained in the final analyses.

The logistic regression predicts the likelihoods measured by probabilities, odds, and log-odds function as means to link the dependent variable to the set of independent variables[16]. The regression coefficient indicates the degree of change in the dependent variable for every one-unit of change in the independent variable. Meaning that the regression coefficient increases the natural logarithm (log-odds) for a one-unit increase in the independent variable when all other variables are constant[17]. The relationship of the selected factors with the dependent variable were identified and interpreted through the exponential Beta coefficient (Exp β), which is the odds associated with underweight.

Ethics approval and consent to participate

This study is an analysis of secondary data collected during the 2014-2018 by major DHS. The ICF Institutional Review Board (ICF) conducts an ethical evaluation and approves the protocols and questionnaires for the regular procedures for the DHS surveys. The ICF in the host countries will undertake the review of the country-specific DHS survey protocols. Furthermore, this study also obtained ethical approval from the Basic and Social Sciences Research Ethics Committee (BASREC) of the North-West University with ethics number (NWU- 00905-25-A7) approved on 05/02/2025.

Results

Characteristics of the study sample

Table 1 presents the distribution of the study population by background factors. In Lesotho most children were female children (52.3%) aged 24-35 months (21.9%). Most of these children were born in the first birth category (59.1%) and born with normal birth weight (95.3%). In terms of mother's age most mothers were aged 20-29 (40.3%) and majority had secondary education (41.2%). Furthermore, majority of mothers were also found to be not working (71.8%), while most of the fathers were found to be working (55.2%). Moreover, most households were male headed households (67.5%). Majority of the households in Lesotho were poor (43.9%) and living in low community poverty (35.1%). With regards to source of drinking water, the results show that majority of households in Lesotho had piped water (67.2%). With regards to toilet facilities, most households (82.8%), had not improved toilet facilities. With regards to place of residence, Lesotho had majority of rural places (75.8%) and minority of urban places (24.2%).

In Malawi, most children were females (51.3%) aged 36-47 months (21.4%). Most of these children were also born in the first birth category (35.4%) and were born with a normal (not low) birth weight (91.2%). Like Lesotho, most mothers in Malawi were aged 20-29 (49.8%), also had primary education (61%). Differently majority of mothers in Malawi were working (62.4%) and the fathers were working (70.5%). Most households were male headed households (72.1%) and were also poor (47.1%). Differently in Malawi most households had not piped water (81.9%). The community poverty status had high poverty status (42.6%). With regards to toilet facilities, most households in Malawi (97%) had not improved toilet facilities. Majority of places in Malawi were also rural (87.5%) and minority were urban (12.5%).

In South Africa, most children were males (50.9%) and were reported to be aged 48-59 months (21.6%). Likewise, (52.6%) of children were born in the first birth category. Furthermore, majority of children were born with normal (not low) birth weight (89.5%). Moreover, majority of mothers were aged 20-29 years (40.6%) and had secondary+ education (73.1%). Furthermore, most mothers (78%) were not working, and most fathers (77.8%) were also not working. Most of the households (56.4%) were female headed households and were poor households (49.9%). Majority of the community had moderate poverty status (36.5) and had had piped water (82.4%). Furthermore, almost half of households had improved toilet facilities (53.1%). Majority of places were urban (50.9%) and minority were rural (49.1%).

In Zambia, most children were females (50.5%) and were aged 36-47 months (20.5%). Most of the children were born in the 1st birth category (36.9%) and were born with normal (94%) not low birth weight. Moreover, majority of mothers were aged 20-29 years (45%) and had primary education (47.7%). Most mothers were not working and (48.5%) and most fathers (64.3%) were working. Furthermore, majority of the households (79.4%) were male headed households and were also poor households (47%). Most of community were moderate poverty status (36.5%). Most households had not piped water (72.9%). With regards to toilet facilities, most households (86.6%) had not improved toilet facilities and most of the places of residence were rural (65.5%).

Figure 1 shows the prevalence of underweight and non-underweight children across the study countries. The results show that the prevalence of underweight among children under five years were high in Malawi 11,7% and Zambia 11,8%, followed by Lesotho 10,3% and relatively low in South Africa 5,9%.

Table 2 presents a comparison of underweight prevalence among children under five years according to background characteristics. The results show that child's age, child's sex, birth order, birth weight, mother's age, mother's

Table 1: Distribution of study participants

Variables	Lesotho		Malawi		South Africa		Zambia	
	No.	%	No.	%	No.	%	No.	%
Child's age								
0-11 months	320	17.1	1107	19.1	251	17.8	1964	20.3
12-23 months	362	19.4	1114	19.3	295	20.9	1923	19.8
24-35 months	410	21.9	1168	20.2	265	18.7	1980	20.4
36-47 months	394	21.1	1238	21.4	298	21.0	1991	20.5
48-59 months	383	20.5	1159	20	306	21.6	1832	18.9
Child's sex								
Male	892	47.7	2820	48.7	721	50.9	4801	49.5
Female	977	52.3	2966	51.3	695	49.1	4889	50.5
Birth order								
1	1105	59.1	2051	35.4	745	52.6	3580	36.9
2-3	542	29.0	2038	35.2	522	36.8	3018	31.1
4+	222	11.9	1697	29.3	149	10.5	3092	31.9
Birth weight								
Not low	1781	95.3	5274	91.2	1267	89.5	9111	94.0
Low birth	88	4.7	511	8.8	149	10.5	578	6.0
Mother's age								
15-19	95	5.1	361	6.2	74	5.2	718	7.4
20-29	753	40.3	2879	49.8	574	40.6	4361	45.0
30-39	381	20.4	1663	28.7	355	25.1	3034	31.3
40-49	641	34.3	883	15.3	413	29.2	1575	16.3
Mother's education								
Primary education	674	36.1	3527	61.0	109	7.7	4625	47.7
Secondary +	770	41.2	1113	19.2	1035	73.1	3489	36.0
No education	425	22.8	1146	19.8	272	19.2	1576	16.3
Mother's employment								
Not working	1341	71.8	2173	37.6	1105	78	4991	51.5
Working	528	28.2	3613	62.4	311	22.0	4698	48.5
Father's employment								
Not working	1031	55.2	1708	29.5	1102	77.8	3461	35.7
Working	838	44.8	4078	70.5	314	22.2	6228	64.3
Sex of head of household								
Male	1262	67.5	4170	72.1	617	43.6	7694	79.4
Female	607	32.5	1615	27.9	799	56.4	1995	20.6
Source of water								
Piped water	1256	67.2	1047	18.1	1166	82.4	2630	27.1
Not piped	613	32.8	4739	81.9	250	17.6	7059	72.9
Toilet facility								
Not improved	1548	82.8	5614	97.0	664	46.9	8389	86.6
Improved	321	17.2	172	3.0	752	53.1	1300	13.4
Household income								
Poor	820	43.9	2724	47.1	706	49.9	4550	47.0
Middle	392	21	1126	19.5	344	24.3	1851	19.1
Rich	657	35.1	1936	33.5	366	25.8	3288	33.9
Community poverty status								
Low	657	35.1	1614	27.9	445	31.4	2869	29.6
Moderate	635	34	1709	29.5	516	36.5	3541	36.5
High	577	30.9	2464	42.6	455	32.1	3280	33.8
Place of residence								
Urban	453	24.2	726	12.5	721	50.9	3341	34.5
Rural	1416	75.8	5060	87.5	695	49.1	6348	65.5
Underweight								

No	1676	89.7	5108	88.3	1333	94.1	8544	88.2
Yes	193	10.3	678	11.7	83	5.9	1145	11.8
Total	1869	100	5786	100	1416	100	9689	100

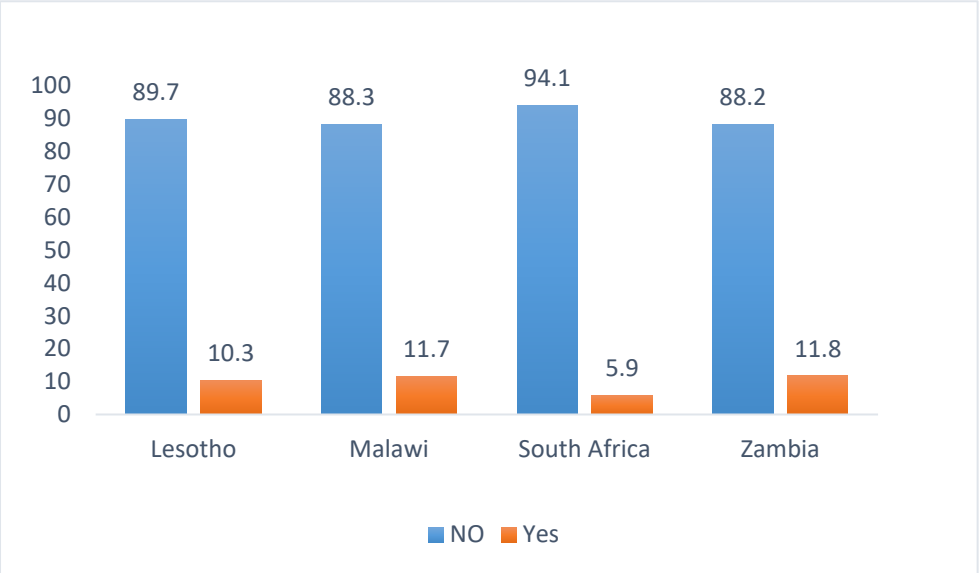


Figure 1: Prevalence of underweight by country

educational level, source of water, toilet facilities, household income, community poverty, and type of place of residence were statistically associated (P<0.05) with underweight.

The results show that in Lesotho birth weight, mothers' education, and household income, were statistically associated (P<0.05) with underweight. Children born with low birth weight had high prevalence of underweight (31.8%) compared to children born with normal (not low) birth weight. Mothers with primary education had high prevalence of underweight children (13.9%) while mothers with secondary+ education had low prevalence of underweight children (7.6%). Children from poor household income had high prevalence of underweight (14.1%) and children from rich household income had low prevalence of underweight (6.3%).

Moreover, the findings show that in Malawi, factors such as child's age, child's sex, birth order, birth weight, mother's age, mother's education, source of water, toilet facilities, household income and place of residence were statistically associated (P<0.05) with underweight. The prevalence of underweight was high among children 36-47 months (13.8%) and low prevalence was among children 0-11 months (8.7%). Furthermore, the results indicate that male children had high prevalence of underweight (13%) while female children had low prevalence of underweight (10.5%). In terms of birth order children born in 4th and above category had high prevalence of underweight (12.8%) and children born in 2nd – 3rd category had low prevalence of underweight (9.9%). Mothers aged 40-49 years had high prevalence of underweight children (16.2%) while those aged 15-19 years had low prevalence of underweight children (9.2%). Moreover, mothers with no education had high prevalence of underweight children (14.4%) and mothers with secondary+ education had low prevalence of underweight (8.4%). Furthermore, the results show that households that with not piped water had high prevalence of underweight children (12.1%) while households with piped water had low prevalence of underweight children (9.8%). With regards to toilet facilities, households that have not improved toilet facilities had high prevalence of underweight children (11.9%) while households that improved toilet facilities had low prevalence of underweight children (4.4%). Likewise, children from poor household income had high prevalence of underweight (13.5%) and children from rich household income had low prevalence of underweight (9.1%). Furthermore, children from rural areas had high prevalence of underweight

Table 2: Bivariate analysis of factors associated with underweight among children under five

Variables	Lesotho		Malawi		South Africa		Zambia	
	Yes %	χ2	Yes %	χ2	Yes %	χ2	Yes %	χ2
Child's age								
0-11 months	9.5	0.88	8.7	30.82***	6.1	3.32	9.4	21.86***
12-23 months	11		10.4		6.2		14.6	
24-35 months	11.3		11.8		4.9		12.1	
36-47 months	8.3		13.8		5.2		12.4	
48-59 months	11.3		13.5		6.9		10.5	
Child's sex								
Male	12.5	6.67	13	5.45**	6.7	0.58	13.5	15.87***
Female	8.3		10.5		5.1		10.2	
Birth order								
1	9.2	2.57	12.7	6.51*	4.9	3.28	12.5	0.74
2-3	11.8		9.9		7.2		11.3	
4+	12.3		12.8		6.1		11.5	
Birth weight								
Not low	9.4	31.76***	10.8	69.32***	4.8	46.35***	10.9	102.99***
Low birth	28.9		21.4		15.1		26.2	
Mother's age								
15-19	10.9	2.43	9.2	9.69**	0.9	3.79	15.2	7.86*
20-29	11.9		11.3		4.5		11.7	
30-39	9.5		10.6		7.8		11.4	
40-49	8.8		16.2		7.1		11.5	
Mother's educational level								
No education	9.5	17.60***	14.4	16.16***	5.2	0.3	13.5	18.96***
Primary education	13.9		11.9		5.8		12.5	
Secondary+	7.6		8.4		6.1		10.1	
Mother's employment status								
Not working	10.4	1.55	11.4	1.31	6.1	0.06	12.5	3.02
Working	10.1		11.9		5		11	
Father's employment status								
Not working	10.3	0.02	12.9	2.56	6.6	2.28	11.9	0.64
Working	10.3		11.2		3.4		11.8	
Sex of head of household								
Male	10.7	2.39	11.8	0.46	6.5	0.52	12	0.05
Female	9.5		11.6		5.4		11.1	
Source of water								
Piped water	10.1	0.6	9.8	8.4***	6.4	3.99**	9.8	16.28***
Not piped	10.6		12.1		3.4		12.6	
Toilet facility								
Not improved	10.5	0.56	11.9	6.34**	6.3	0.54	12	9.49***
Improved	9.2		4.4		5.5		10.3	
Household income								
Poor	14.1	25.96***	13.5	25.96**	6.6	3.94	14.1	49.44***
Middle	9		11.9		5.6		9.3	
Rich	6.3		9.1		4.9		10	
Community poverty status								
Low	11.2	5.33	10.6	1.27	5.7	0.73	10.2	18.44***
Moderate	8.9		12.3		8		11.2	
High	10.8		12		3.7		13.9	
Place of residence								
Urban	8.2	3.52	7.9	8.56***	5.8	0.32	10.8	6.74***

Rural	11		12.3		6		12.4	
Total	10.3	1,869	11.7	5,786	5.9	1,416	11.8	9,689

Source: Own computations from DHS data

Note: χ^2 = chi-square *** p<.001; ** p<.01; * p<.05.

(12.3%) while children from urban areas had low prevalence of underweight (7.9%).

In South Africa, the results show that birth weight and source of water were statistically associated (P<0.05) with underweight. Children born with low birth weight had high prevalence of underweight (15.1%) compared to children born with normal (not low) birth weight. Households with piped water had prevalence of underweight children (6.5%) while households with not piped water had low prevalence of underweight children (5.4%).

In Zambia the finding indicates that child's age, child's sex, birth weight, mother's age, mother's education, source of water, toilet facilities, household income, community poverty, and place of residence were statistically associated (P<0.05) with underweight. The prevalence of underweight was high among children aged 12- 23 months (14.6%) and low among children aged 0-11 months. Moreover, the prevalence of underweight was high among male children (13.5%) and low among female children (10.2%). Children born with low birth weight had high prevalence of underweight (26.2%) compared to children born with normal (not low) birth weight. Mothers aged 15-19 years had high prevalence of underweight children (15.2%) while those aged 30-39 years had low prevalence of underweight children (11.4%). Mothers with no education had high prevalence of underweight children (13.5%) and mothers with secondary+ education had low prevalence of underweight children. Households with not piped water had high prevalence of underweight children (12.6%) while households with piped water had low prevalence of underweight children (9.8%). Similarly, households that have not improved toilet facilities had high prevalence of underweight children (12%) and households that improved toilet facilities had low prevalence of underweight children (10.3%). Children from poor household income also had high prevalence of underweight (14.1%) and children from rich household income had low prevalence of underweight (10%). With regards to community poverty, children from high community poverty had high prevalence of underweight (13.9%) and children form low community poverty had low prevalence of underweight (10.2%). Likewise, children from rural areas had high prevalence of underweight (12.4%) and children from urban areas had low prevalence of underweight (10.8%).

Determinants of underweight among children under five years

Table 3 presents the binary logistic regression results showing the relationship between underweight and children under five years by background characteristics. The results show that in Lesotho child's sex, birth weight, and household income were the predominant factors associated with underweight among children under five years. Male children were 1.52 OR= [95% CI: 1.05-2.19] more likely to be underweight as compared to female children. Moreover, children born with low birth weight were 4.31 OR= [95% CI: 2-37-7-83] more likely to be underweight as compared to children born with not low (normal) birth weight. Furthermore, children from middle and rich household income were 0.62 OR= [95% CI: 0.41-1.11] and 0.75 OR= [95% CI: 0.49-1.15] less likely to be underweight as compared to children from poor household income. The results show that in Malawi child age, child's sex, birth weight, and household income were the predominant factors associated with underweight among children under five years. Children aged 36-47 months and 48-59 months were 1.57 OR= [95% CI: 1.12-2.22] and 1.54 OR= [95 % CI: 1.09-2.17] more likely to be underweight as compared to children 0-11 months old. Male children were 1.32 OR= [95% CI: 1.1-1.57] more likely to be underweight as compared to female children.

Furthermore, children born with low birth weight were 2.45 OR= [95% CI: 1.86-3-21] more likely to be underweight as compared to children born with not low (normal) birth weight. Children from rich household income were 0.71 OR= [95% CI: 0.53-0.94] less likely to be underweight as compared to children who were from poor household income. The study results further indicate that in South Africa birth weight, mother's

Table 3: Binary logistic regression for the determinants of underweight among children under five years

Variables	Lesotho Odds Ratio	[95% Conf. Interval]	Malawi Odds Ratio	[95% Conf. Interval]	South Africa Odds Ratio	[95% Conf. Interval]	Zambia Odds Ratio	[95% Conf. Interval]
Child's age								
0-11 months®	1		1		1		1	
12-23 months	1.20	[0.69-2.07]	1.19	[0.83-1.72]	0.97	[0.39-2.42]	1.74***	[1.39-2.18]
24-35 months	1.26	[0.68-2.35]	1.33	[0.94-1.89]	0.64	[0.26-1.57]	1.43***	[1.16-1.77]
36-47 months	0.96	[0.56-1.66]	1.57**	[1.12-2.2]	0.68	[0.26-1.74]	1.47***	[1.15-1.86]
48-59 months	1.39	[0.72-2.68]	1.54**	[1.09-2.17]	1.02	[0.47-2.22]	1.24	[0.98-1.57]
Child's sex								
Male	1.52**	[1.05-2.19]	1.32***	[1.1-1.57]	1.25	[0.7-2.22]	1.43***	[1.23-1.66]
Female®	1		1		1		1	
Birth order								
1®	1		1		1		1	
2-3	1.34	[0.78-2.32]	0.84	[0.65-1.1]	1.37	[0.73-2.58]	0.94	[0.77-1.16]
4+	1.49	[0.74-2.99]	1.16	[0.87-1.56]	0.69	[0.25-1.88]	0.95	[0.75-1.19]
Birth weight								
Not low®	1		1		1		1	
Low birth	4.31***	[2.37-7.83]	2.45***	[1.86-3.21]	4.48***	[2.03-9.87]	3.08***	[2.43-3.89]
Mother's age								
15-19	1.54	[0.54-4.37]	0.60	[0.34-1.03]	0.06***	[0.01-0.36]	1.45*	[1.08-1.95]
20-29	1.46	[0.77-2.77]	0.75	[0.55-1.03]	0.25***	[0.09-0.69]	1.08	[0.81-1.44]
30-39	0.96	[0.46-1.97]	1.02	[0.42-0.88]	0.53	[0.22-1.31]	1.07	[0.80-1.42]
40-49®	1		1		1		1	
Mother's education								
Primary education®	1		1		1		1	
Secondary+	0.69	[0.42-1.13]	0.86	[0.63-1.17]	0.95	[0.4-2.3]	0.87	[0.72-1.04]
No education	1.18	[0.59-2.38]	1.05	[0.79-1.39]	0.49	[0.13-1.77]	1.18	[0.97-1.43]
Source of water								
Piped water®	1		1		1		1	
Not piped	0.86	[0.57-1.29]	0.86	[0.62-1.18]	0.44*	[0.2-0.96]	1.22	[0.91-1.64]
Toilet facilities								
Not improved®	1		1		1		1	
Improved	0.96	[0.6-1.52]	0.45	[0.19-1.05]	1.00	[0.54-1.85]	1.12	[0.8-1.56]
Household income								
Poor®	1		1		1		1	
Middle	0.62*	[0.4-0.97]	0.87	[0.68-1.12]	0.65	[0.29-1.46]	0.61***	[0.49-0.76]
Rich	0.4**	[0.23-0.71]	0.71**	[0.53-0.94]	0.42	[0.14-1.26]	0.65***	[0.49-0.85]
Community poverty								
Low®	1		1		1		1	
Moderate	0.67	[0.41-1.11]	1.04	[0.8-1.34]	1.37	[0.7-2.7]	1.02	[0.8-1.3]
High	0.75	[0.49-1.15]	0.92	[0.7-1.2]	0.61	[0.28-1.32]	1.21	[0.95-1.55]
Place of residence								
Urban®	1		1		1		1	
Rural	0.86	[0.47-1.57]	1.24	[0.75-2.04]	0.98	[0.49-1.96]	0.7	[0.52-0.95]

Note: *** p<.001; ** p<.01; * p<.05; CI = confidence interval; ® = reference category

age and source of water were the major factors associated with underweight among children under five years. Children born with low birth weight were 4.48 OR= [95% CI: 2.03-9.87] more likely to be underweight as compared to children born with not low (normal) birth weight. Moreover, mothers aged 15-19 years and those 20-29 years were 0.06 OR= [95% CI: 0.01-0.36] and 0.25 OR= [95% CI: 0.09-0.69] less likely to have children with underweight as compared to mothers aged 40-49 years. Children from households that had not piped water were 0.44 OR= [95% CI: 0.2-0.96] less likely to be underweight as compared to children from households that have piped water. Moreover, the results indicate that in Zambia child's age, child's sex, birth weight, mother's age and household income were the predominant factors associated with underweight among children under five years.

Children aged 12-23 months were 1.74 OR= [95% CI: 1.39-2.18] more likely to be underweight as compared to children aged 0-11 months. Moreover, male children were 1.43 OR= [95% CI: 1.23-1.66] more likely to be underweight as compared to female children. Children born with low birth weight were 3.08 OR= [95% CI: 2.43-3.89] more likely to be underweight as compared to children born with not low (normal) birth weight. Mothers aged 15-19 years were OR= [1.45 95% CI: 1.08-1.95] more likely to have underweight children as compared to mothers aged 40-49 years old. Furthermore, children from middle and rich household income were 0.61 OR= [95% CI: 0.49-0.76] and 0.65 OR= [95% CI: 0.49-0.85] less likely to have underweight children as compared to children who were from poor household income.

Discussion

The study aim was to determine the socio-demographic factors associated with underweight among children under five years in Southern Africa Developing countries specifically Lesotho, Malawi, South Africa, and Zambia. The study was advised by the UNICEF conceptual framework for the selection of the study variables which were immediate, underlying, and basic causes of underweight among children under five years. The results show that the prevalence of underweight in Lesotho, Malawi, South Africa, and Zambia was 10.3%, 11.7%, 5.9% and 11.8% respectively which are similar with the results from Demographic and Health survey of these countries. The findings of the study show that there were several factors that were statistically associated with underweight such as (child's age, child's sex, birth weight, mother's educational level, and household income) among children under five years. Various studies have also found similar results[11,18-20].

The results show that children aged 36-47 months were more likely to be underweight as compared to children aged 0-11 months. The results are comparable with studies in Tanzania and Bangladesh [10,21] that also found that the odds of underweight increases with age. This is further explained by the fact that children become more responsible for feeding themselves in the third year of life after being introduced to the family food, which could result in insufficient consumption of protein and energy. Moreover, the study results show that male children were more likely to be underweight as compared to female children. This results are comparable to studies in Ethiopia [22,23] that found child's sex is significantly correlated to underweight and male children having higher odds of underweight compared to female children. A systematic review and meta-analysis study by [24] found that out of 23 studies, 18 of them found that boys are more likely to be underweight as compared to girls with 14% higher odds. Although much has not been done in literature to explain in-depth of sex differences with underweight, it can be broadly explained by biological differences among male children and female children, gender dynamics which can be influenced by parents and caregivers, preferential feeding practices and children's behaviours.

The study findings have further indicated that birthweight is an important predictor of underweight among children under five years. Consistence with other studies[25-27], the findings show that children born with low birth weight were more likely to be underweight as compared to children born with not low (normal) birth weight. Children born with low birth weight are more vulnerable than those born with a normal birth weight, which explains the high association between low birth weight and underweight status observed in this study. It is notable that children with low birth weights are more likely to experience growth difficulties, which raises the possibility that they may continue to be underweight throughout their childhood and possibly into adulthood. Low birth weight children are also more likely than their normal-weight counterparts to experience physical developmental difficulties and medical issues as a result of the ongoing undernutrition.

Children born to teenage mothers 15-19 years had higher odds of be underweight as compared to children born to mothers aged 40-49 years. Consistence with a study a systematic and meta-analysis study by [28] and a study in Zambia [29] that found that teenage mothers are more likely to give birth to underweight children as compared to older mothers. A study in Ghana by [30] further explained that teenage mother are less capable and powered of nursing and nurturing children, not only due to social and economic challenges but also that their bodies is incapable for the development and carrying of a foetus as well as not being psychological ready to nurse babies after delivery.

Moreover, the results show that mother's educational level is correlated to child's underweight. Underweight decreases as mother's education increases. Consistence with studies in Africa [31-33] the results show that mothers with secondary+ education were less likely to have underweight children as compared to mothers with no education. A study in Bangladesh by [34] explained this further by stating that mothers with higher levels of education have more authority and can make important decisions on the dietary diversity of their families and the health of their children. Similarly, another study in Bangladesh by [19] strongly motivated that education improves the process capacity of a mother and that educated mothers are more likely to comprehend medical information, such as the dosage amounts recommended by a doctor, and they are able to read, understand, and implement health advice from newspapers and other sources. These abilities can help mothers to make better decisions for their children's health by empowering them to make well informed choices regarding their diet and medical care. The study findings further show that underweight decreases as household income increases. Children from rich household income were less likely to be underweight as compared to children from poor household income. The results are consistence with other studies [19,21,22,33,35,36] that also found a strong correlation on the relationship between underweight and household income. As expected, children from rich household income are more exposed to variety and sufficient food as compared to children from poor household income. Furthermore, due to affordability of good health facilities, improved environmental backgrounds, sufficient and nutritious food for children in rich household income, it is more likely that these children will be underweight as compared to their counterparts from poor household income.

Strengths and limitations of the study

The findings of this study should be considered with some caution. First, the information regarding the underweight of children and its associated factors was collected from mother's recall. As such, such information is prone to recall bias and social desirability. Nonetheless, to minimize the recall bias in the study, we restricted our sample for birth of women in the past five years preceding the survey. Second the study could not identify causal relationship between the outcome variable and predictors due to the cross-sectional nature of the study design. This study could not assess potential factors mediating the association between maternal characteristics and underweight in children. Third, like with most demographic variables, underweight is associated with so many variables and not all of them have been used in this study. As such there is need for more studies to explore the relationship of underweight with the remaining variables. In addition, future research is needed using longitudinal data to understand the mechanism behind the occurrence of underweight children in Southern African Developing countries. Despite these limitations, this study provides important insights on factors associated with underweight in children, which may be useful for policymaking to reduce the incidence of underweight in the four countries.

Conclusions

The study has shown that underweight is a health problem in Southern Africa more precisely the developing countries that this study proposed, which is Lesotho, Malawi, South Africa and Zambia. Factors such as child's age, child's sex, birth weight, mother's educational level, and household income were found to be the most predominant determinants of underweight among children under five years. The prevalence of underweight recorded in this study was 10.3% in Lesotho, 11.7% in Malawi, 11.8% in Zambia and 5.9% in South Africa respectively. It is therefore suggested by this study that the study's predominant factors should be considered by policymakers and stakeholders when implementing programmes to reduce underweight. The findings of this study emphasis the need for integrated, multisectoral interventions to reduce underweight among children under five years in SADC countries. Children aged 36–47 months were at greater risk of being underweight, governments and health systems should strengthen nutrition programmes by ensuring nutrition counselling, and complementary feeding interventions throughout early childhood. The strong association between low birthweight and childhood underweight highlights the importance of improving maternal health before and during pregnancy. As such, policymakers should prioritise

integrated programs that improve women's health before conception, delay teenage pregnancies, improve maternal education, and to also improve household economic resilience. These integrated initiatives are critical for eliminating childhood malnutrition and accelerating progress toward Sustainable Development Goals 2.

Authors' contributions

Shirley Maria Lerato Mathabatha has contributed to the proposal writing, conceptualization of the manuscript as well as the analysis and interpretations of the data.

Availability of data and materials

The dataset, which contains data from the DHS, is freely available to qualified researchers. The researcher has registered and has been granted permission to download and use the data solely for the purpose of the registered project. The data is available and accessible upon request at https:// https://dhsprogram.com/Data/.

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Declarations

I, Shirley Maria Lerato Mathabatha, declare that this work titled "Prevalence and determinants of underweight among children under five years in Southern African Developing Countries: (A comparative study)" is my original research work, and has never been submitted for any degree or examination in any other university or institution. I declare that the information contained in this document is a true copy of my thesis and has been approved for submission by my thesis supervisor. This work was supervised by Prof Martin Palamuleni from the Department of Population Studies and Demography in North-West University.

Competing interests

The authors declare no competing interests.

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