Original Research

Trends and patterns of stunted only and stunted-underweight children in Malawi: A confirmation for child nutrition practitioners to continue focusing on stunting

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Abstract

Aim

To analyse the trends and patterns of stunted only and stunted-underweight children in Malawi between the 2000 and 2015.

Methods

The study used the 2000 and 2015 Malawi Demographic and Health Survey data and employed bivariate and multivariate statistical analysis techniques to explore the difference in the levels of stunted only and stunted-underweight children and key socio-economic factors between 2000 and 2015 and identify key attributes of being stunted only and being stunted-underweight.

Results

The percentage of stunted only was 37.2% in 2000 and 26.8% in 2015 and the stunted-underweight percentage was 14.5% in 2000 and 8.8% in 2015. Out of the 6.9% children classified as wasted, 2.4% were also underweight and stunted, 2.4% were underweight and 2.1% did not have any other forms of undernutrition. The analysis did not identify any children that were both stunted and wasted. Only 0.7% in 2000 and 0.4% in 2015 were underweight and free of any other forms of undernutrition. There were improvements in mother education level and mother weight during this time-period which may explain the improvements in child nutritional status.

Conclusion

The most common form of undernutrition is stunting and nearly all children that are underweight are also stunted. Child nutrition practitioners and health professionals should consider focusing on tackling child stunting.

Key words: child under-nutrition, stunting, stunted-underweight, underweight, Malawi, multilevel.

Introduction

Despite the fact that 97% of countries monitor child growth through the underweight measure and 41% use the stunting measure, in populations with high levels of child stunting, early detection of growth faltering is best achieved through the use of length for age (stunting) than weight for age (underweight)[1,2]. Recent estimates reveal that in Malawi, 37% of children under the age of five years are stunted, 12% are underweight and 3% are wasted[3]. However another study indicate that between 1992 and 2015, child stunting levels in Malawi declined from 54.6% to 32.6% and the percentage of underweight children declined from 24.7% to 10.7%[4]. It is less common for researchers and professionals to report the percentage of children that are affected by both stunting and underweight and no study in Malawi has analysed the trends in the percentage of children that suffer from stunting only and the ones that suffer from a combination of stunting and underweight. Nevertheless, evidence shows that children can be affected by both stunting and underweight[5].

This paper examines the co-existence of stunting and underweight in Malawian children and explores how the trends in the groupings of children that suffer from stunting only and those affected by both underweight and stunting have changed between the years 2000 and 2015 and makes recommendations for a change of focus of the common measures of child undernutrition in Malawi and populations with high levels of child stunting.

Methodology

This study used the 2000 and 2015 Malawi Demographic and Health Survey data. Anthropometric measurements for children aged 0 to 59 months were obtained from 11,926 children in the 2000 study and from 5,385 children in 2015. The surveys also collected data on child characteristics; child's age, sex, preceding birth interval, size at birth, household characteristics; mother education level and household wealth status and location variables; region, urban/rural residence and ethnicity. Further details of study design and data collection are reported on the National Statistical Office of Malawi website: http://www.nsomalawi.mw/.

Variables of Analysis

Response Variables

The initial step involved identifying groups of children that are affected by a single measure of undernutrition: stunted, underweight or wasted. Stunted children were defined as those with a height for age z score of less than -2 standard deviations, underweight children had a weight for age z score of less than -2 standard deviation and wasted children had a weight for height z score of less than -2 standard deviations[6,7]. The second step identified the stunted-underweight group of children as those that were both stunted and underweight. The modelling focussed on stunting and underweight because most undernourished children are affected by these two conditions. For the response variables, a binary variable was used that took the value 1 when a child is stunted only

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or stunted-underweight and 0 otherwise.

Explanatory Variables

The choice of explanatory variables was guided by findings from previous studies, conceptual frame works on child nutritional status and data available in the two surveys[8-10]. Table 1 presents the distribution of the explanatory variables that were included in the multivariate analysis after showing a statistically significant association in the bivariate analysis.

Chi square tests of Association were carried out to determine if the percentage of stunted only and stunted-underweight children differed significantly between the years 2000 and 2015 and to determine if there is a significant association between factors that are known to influence stunting only and stunted-underweight to facilitate the choice of variables for inclusion in the multivariate analysis. Multilevel logistic regression analysis was employed to identify factors that are significantly associated with child stunting only and stunted-underweight and how the factors have changed between the years 2000 and 2015 MDHS. Multilevel modelling ensures that estimates are robust in hierarchical data such as those used in this study.

Modelling framework

The modelling used the logit link $log_e\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right)$ a function that models the probability that a child i in household or community j is stunted or stunted-underweight. Considering a two-level random intercept model for child *i* nested within a household or community *j*, this may be represented as follows;

$$log_e\left(\frac{\pi_{ij}}{1-\pi_{ij}}\right) = \beta_0 + \beta_1 x_{1ij} + \beta_2 ({x_1}^2)_{ij} + \beta_3 x_{2ij} \ldots + \beta_6 x_{5ij} + \beta_7 z_{1ij} + \ldots \beta_{14} z_{7ij} + u_{0j} \quad (1)$$

$$u_{0j} \sim N(0, \sigma_{\mu 0}{}^2)$$

Where χ and z represent explanatory variables at child or higher level respectively for the probability that child *i* in household or community *j* is stunted or stunted-underweight. The model includes the term $(\chi_1)^2$ to account for non-linearity of the relationship between age and a child's nutritional status reported in previous studies[11], β_1 to β_{14} are coefficients for explanatory variables χ_1 to χ_5 and z_1 to z_7. U_{0j} is either the household level or the community-level random effect, which represents the variation of nutrition status for children from different households or communities and is assumed to be normally distributed with mean equal to 0 and variance equal to $\sigma\mu 0^2$.

Results

Stunted only and Stunted-underweight (2000 and 2015 MDHS Data)

The first step employed in the identification of the "stunted only" (stunted children that are not affected by other forms of child undernutrition) and those affected by stunting and underweight (stunted-underweight), was to transform the stunted, underweight and wasted variables. The value for stunted children variable was changed from 1 to 10, representing children with a height for age z score less than -2 standard deviations and 0 otherwise, from 1 to 100 for underweight children (weight for age z score of less -2 standard deviations) and 0 otherwise and finally from 1 to 1000 for wasted children (weight for height z score of less than -2 standard deviations) and 0 otherwise. A variable was then computed by adding the three transformed variables called Total under-nutrition.

The Total undernutrition variable was categorised as follows:

10 = stunted only

100 = underweight only

1000= wasted only

1100= underweight + wasted

110 = stunted + underweight

1110= stunted + underweight + wasted

Findings of this analysis are shown in Table 2 and further illustrated in the Venn diagram shown in Figure 1.

The percentage of children that are stunted only was 37.2% in 2000 and 26.8% in 2015 after accounting for the stunted-underweight children. The percentage of stunted-underweight children was 14.5% in 2000 and 8.8% in 2015. The percentage of underweight-wasted was 2.4% in 2000 and 0.8% in 2015. Out of the 6.9% children categorised as wasted in 2000, 2.1% did not have any additional forms of undernutrition. Similarly, in 2000 out of the 2.7% identified as wasted, 1% did not have other forms of undernutrition. Only 0.7% and 0.4% in 2000 and 2015 respectively were underweight but not affected by other types of child undernutrition. The percentage of children affected by all three types of child undernutrition (wasted, underweight and stunted) was 2.4% in 2000 and 0.9% in 2015. Interestingly the analysis did not identify a group of children that were affected by both stunting and wasting (stunted-wasted). The decline in the levels of stunting and those affected by the stunting and underweight between the years 2000 and 2015 was statistically significant.

Trends in selected socio-economic indicators between 2000 and 2015

The UNICEF's conceptual framework for child's nutritional status recognises maternal education, access to safe water, good sanitation and child diarrhoea as some of the factors that influence child undernutrition[12]. The same is supported by empirical research[11,13,14].

This section reviews the trends in the percentage of households with access to safe water and toilet and percentage of mothers with secondary education or higher, mother height and mother weight and percentage of children that were born of small size which influence children's nutritional status by comparing levels for 2000 and 2015[13,15-22]. The results (Table 3) show that there has been a lot of improvement in these socio-economic indicators between 2000 and 2015; the percentage of mothers with secondary education went up from 6.4% to 21.1%, the percentage of households without a toilet declined from 18.4% to 5.7% and the percentage of households with access to safe water increased from 47.1% to 85.6%. There was a small increase in the mothers mean weight from 53.9Kgs to 55.5Kgs but the mean height of mothers did not change significantly. The percentage of children that were born smaller than average size hardly changed between these two time points.

Results of the Multilevel Logistic Regression for the Stunted only and Stunted-underweight, 2000 and 2015 MDHS

The results of the household and community level variance in the stunted only and the stunted-underweight models showed significant community level (group of villages) variance amongst stunted children in 2000 and 2015, and among children affected by both stunting and underweight

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Table 1. Distribution of Explanatory Variables

Variable	2000 MDHS	2015 MDHS
Child Sex	N (11,926)	N (5,379)
Male	49.9	49.3
Female	50.1	50.7
Size at birth	N (11,841)	N (5,335)
Very large	8.7	8.1
Above average	16.6	25.6
Average	58.5	50.6
Smaller than average	12.1	11.6
Very small	4.1	4.1
Had diarrhoea	N (10,185)	N (5,358)
Yes	17.2	20.6
No	82.8	79.4
Preceding birth interval	N (11,926)	N(5,368)
First births	24.5	24.8
9 to 36 months	45.3	29.8
37 months or more	30.2	45.5
Mother education level	N (11,926)	N (5,379)
No education	29.7	12.7
Primary education	63	65
Secondary education or higher	7.3	22.3
Wealth status	N (11,895)	N (5,379)
Poorest	10.2	23.8
Below average	25.3	22.1
Average	23	19.3
Above average	25.9	18.9
Wealthiest	15.6	15.9
Region	N (11,926)	N(5,379)
North	16.2	17.9
Centre	36.8	34.6
South	46.9	47.5
Residence	N (11,926)	N(5,379)
Urban	17.5	16.2
Rural	82.5	83.7
Ethnicity	N (11,921)	N (5,379)
Chewa	28.2	31.3
Tumbuka, Nkhonde, Tonga	14.8	14.8
Lomwe	18.4	17.4
Yao	13.3	13.8
Ngoni	14.6	11.8
Sena and other	10.7	11.9

in 2000. The community level variance was not statistically significant among the stunted-underweight children in 2015. The household level variance was only significant amongst the stunted-underweight children in 2015. The multilevel logistic regression results presented in Table 4 are based on models that account for correlation of being stunted only amongst children within communities in the 2000 and 2015 MDHS data and correlation of being stunted-underweight in the 2000 MDHS data and correlation of being stunted-underweight within households in the 2015 MDHS data. The results of the multilevel logistic regression results reveal that the following factors were significantly associated with stunting and stunted-underweight in the year 2000 and 2015; child's age, child's sex, preceding birth interval, household wealth status, residence (rural/urban), mother height and mother weight.

The relationship between stunting and child's age and between stunted-underweight and child's age was non-linear (Figure 2). The predicted probability of being stunted only and that of being stunted-underweight was lowest amongst children aged 0 to 6 months, increased with age and peaked around the ages of 24 to 42 months and declined in those aged over 4 years of age. Female children were less likely to be stunted or stunted-underweight compared to male children. There was a significant interaction in the relationship between age and sex and being stunted only in 2000 such that the predicted probability of being stunted only was higher in boys than females in children aged less than three years but lower for male children than female children aged over three years. This age and sex interaction did not exist amongst the stunted only children in 2015. In contrast, there was no age and sex interaction in how these two variables relate with the stunted-underweight in 2000, and in 2015 the interaction was not statistically significant. The odds of being stunted only or being stunted-underweight were lower in children that had a longer preceding birth interval (over 36 months) compared to those with a shorter preceding birth interval. Children from wealthier households were less likely to be stunted only or be stunted-underweight compared to children from poorer households. Children from rural areas had higher odds of being stunted only and higher odds of being stunted-underweight than children from urban areas. The 2015 data indicated that an increase in mother height by 1cm would be associated with a reduction in the odds of being stunted only by 6% and in the odds of being stunted-underweight by 7% and a 1Kg increase in the weight of the mother would be associated with a decline in the odds of being stunted only by 2% and the odds of being stunted-underweight by 3%.

Children that were born of small size were more likely to be stunted-underweight. In 2000, the odds of stunted only were lower amongst all ethnicities compared to the Chewa but the difference in the odds was only significantly different from the Tumbuka, Tonga and Nkhonde.

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Table 2 Percentage of children by nutrition status: 2000 and 2015

Nutrition status	2000		2015	
	Count	Percentage	Count	Percentage
Not undernourished (0)	3808	40.6	3141	61.3
Stunted (10)	3489	37.2	1374	26.8
Underweight (100)	66	0.7	21	0.4
Stunted and underweight (110)	1357	14.5	452	8.8
Wasted (1000)	198	2.1	50	1.0
Wasted and Underweight (1100)	229	2.4	42	0.8
Wasted, Underweight and Stunted (1110)	224	2.4	47	0.9
Total	9372	100.0	5127	100.0

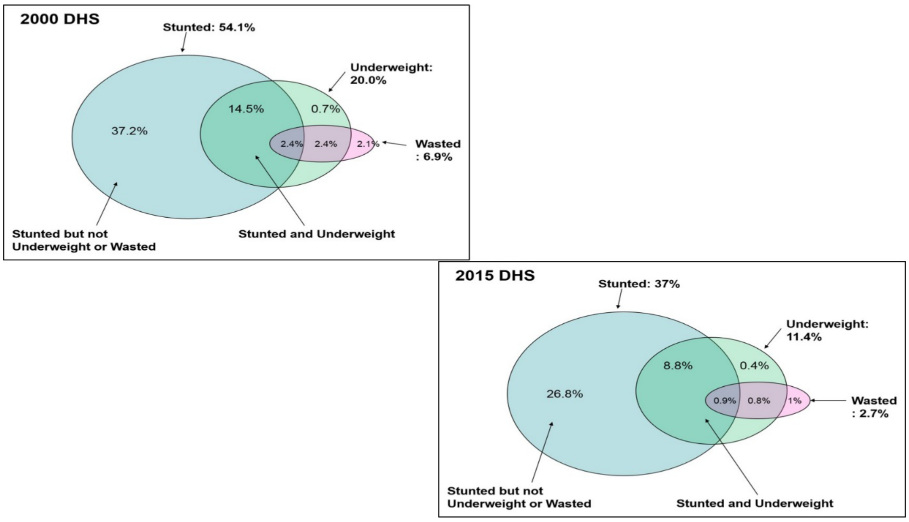

Table 3:Trends in selected socio-economic indicators 2000 and 2015 MDHS

Variable	2000	2015
% of households using Protected source of water	47.1	85.6
% of households with no toilet	18.4	5.7
% of mothers with secondary education or higher	6.4	21.1
% of children who were smaller than average at birth	16.7	16.1
	Mean (95% CI)	Mean(95% CI)
Mean weight for mothers in kilograms	53.9 (53.8, 54.2)	55.5 (55.3, 55.8)
Mean height for mothers in centimetres	155.8 (155.7,155.9)	156.1 (156.0,156.3)

Table 4: Multilevel logistic regression results for stunted only and stunted-underweight for 2000 and 2015 MDHS data

Variable	2000 MDHS Data Odds of being stunted only (95% CI)	2000 MDHS Data Odds of being stunted and underweight (95%CI)	2015 MDHS Data Odds of being stunted only (95% CI)	2015 MDHS Data Odds of being stunted and underweight (95%CI)
Age squared	0.57 (0.52,0.60)***	0.57(0.53,0.63)***	0.68(0.63,0.74)***	0.74(0.65,0.84)***
Age	1.81(1.66,1.95)***	1.69(1.56,1.84)***	1.07(0.85,1.36)	1.46(1.29,1.64)***
Age*Female	1.18(1.06,1.31)**	-	1.11(0.96,1.29)	-
Female Child	0.84(0.76,0.94)**	0.64(0.55,0.74)***	0.79(0.68,0.91)**	0.77(0.62,0.95)*
Preceding birth interval: Reference is 37 months or more				
9 to 36 months	1.15(1.02,1.29)*	1.33(1.12,1.58)**	1.33(1.13,1.59)**	1.60(1.25,2.06)***
First births	1.31(1.13,1.52)***	1.53(1.24,1.89)***	1.23(1.03,1.47)*	1.07(0.80,1.42)

Table 4 Cont....

Size at birth				
Larger than average	1.05(0.85,1.29)	1.02(0.73,1.44)	0.77(0.58,1.01)	0.91(0.55,1.49)
Average	1.14(0.95,1.37)	1.69(1.26,2.27)***	0.87(0.67,1.13)	1.30(0.82,2.07)
Smaller than average	1.53(1.21,1.94)***	3.06(2.17,4.32)***	1.13(0.83,1.56)	3.17(1.91,5.28)***
Very small	1.32(0.93,1.89)	3.92(2.56,6.20)**	1.37(0.90,2.09)	4.30(2.37,7.81)***
Diarrhoea: Reference is no diarrhoea				
Had diarrhoea	1.04(0.91,1.21)	1.36(1.12,1.65)**	1.12(0.94,1.34)	1.23(0.94,1.62)
Wealth status: Reference is Poorest				
below average	0.75(0.61,0.91)**	0.80(0.61,1.05)	0.99(0.81,1.22)	0.71(0.52,0.96)*
average	0.73(0.59,0.89)**	0.63(0.48,0.84)***	0.82(0.66,1.02)	0.73(0.53,1.01)
above average	0.59(0.48,0.72)***	0.49(0.37,0.65)***	0.83(0.67,1.04)	0.57(0.40,0.81)**
wealthiest	0.48(0.38,0.60)***	0.29(0.20,0.40)***	0.64(0.50,0.84)**	0.48(0.32,0.73)***

Similarly, in 2015, the odds of being stunted only were lower among all ethnicities compared to the Chewa but the difference was only statistically significant from the Lomwe, the Sena and 'Other' tribes. The analysis did not establish any major differences in the factors that are associated with being stunted only and those associated being stunted-underweight. However, in the 2015, more factors were significantly associated with being stunted-underweight than stunted only. For example, size at birth was a significant factor associated with stunted-underweight but not stunted only, all categories of the wealth status variable were associated with being stunted-underweight but only the wealthiest category had statistically significant lower odds of being stunted only compared to the poorest. A one unit increase in mother height and mother weight was associated with a bigger decline in the odds of being stunted-underweight compared to the decline in the odds of being stunted only.

Discussion

The problem of double burden of malnutrition (undernutrition and over-nutrition) has been widely studied[23-26] but the co-existence of stunting and underweight in children has not received equivalent attention. By identifying children that are affected by both stunting and underweight in Malawi, a lower estimate for the stunted only children is obtained, 37.2% in 2000 and 26.8% in 2015. Nearly all children that are underweight are also stunted. The estimate for the stunted-underweight is 14.5% in 2000 and 8.8% in 2015. After computing the percentage affected by both stunting and underweight less than 1% (0.7% in 2000 and 0.4% in 2015) of children are underweight and free of other kinds of undernutrition. It is therefore apparent that the common measures of child undernutrition of stunting and underweight reported in policy documents ignore the existence of children that are doubly affected by the undernutrition problem; stunted-underweight. The fact that less than 1% of children suffer from underweight only, questions the use of the underweight in assessing child undernutrition in Malawi.

Among the factors that were significantly associated with being stunted only and stunted-underweight, improvements were noted on mother education level and mother weight. The importance of these factors in child nutritional status is well established[13,17,18,20,27,28]. However, a key factor, size of child at birth did not change significantly between 2000 and 2015[21, 29,30]. Children's nutritional status may be determined by their mother's nutritional status before pregnancy, during pregnancy and even by their mother's nutritional status when they were children themselves as shown by the significance of the mother height, mother weight and size of child at birth in both the stunted only and stunted-underweight models. Children may suffer undernutrition in their mother's womb and be born with poor nutritional status[30].

The non-linear association between child undernutrition and child' age reported in this study is consistent with previous studies and is explained by reduced nutrition intake as the child grows older[11,31]. The finding that male children are more likely to have a poorer nutritional status than female children aligns with previous studies[9,21)]. The female body is more efficient than a male body in energy use due to biological differences[32] and male children suffer more from illnesses that female children[33]. The higher likelihood of children from rural areas suffering from child undernutrition observed in this study are due to poor access to health services and low levels of socio-economic status in rural households[8,34].

Conclusion and Recommendations

In Malawi, nearly all children that are underweight are also stunted warranting the need for policy makers to focus on tackling child stunting. The declining levels of child undernutrition in Malawi between 2000 and 2015 may be explained by improvements in socio-economic indicators during the same period. Further improvements in socio-economic conditions are likely to significantly reduce child under-nutrition levels in Malawi and more especially those that are affected by both stunting and underweight.

Ethics Approval

The study used publicly available anonymised data such that there was no need to seek ethical approval.

Consent of Publication

NA

Availability of Data and Material

NA

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Competing Interests

The author has no conflicts of interests to declare in this submission.

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