

# Prevalence and determinants of undernutrition among children under 5-year-old in rural areas: A cross-sectional survey in North Sudan

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## ABSTRACT

**Background:** Child malnutrition is a major public health problem in developing countries. Therefore, the aim of this study was to estimate the prevalence of undernutrition among children <5 years in River Nile state (RNS) in North Sudan. **Subjects and Methods:** A cross-sectional household survey was done in four localities in RNS. Using Multistage Cluster sampling, 1635 under 5 years' children had participated. Pretested questionnaire and anthropometric measures were used during data collection. The analysis was done using SPSS software program version 21 and World Health Organization (WHO) Anthro 2005 software. Indices were reported in z-scores and compared with the WHO 2005 reference population to determine the nutritional status of children. **Results:** Among 1,447 surveyed children, the prevalence of stunting, underweight, and wasting were 42.5%, 32.7%, and 21%, respectively. Stunting was highest among the 48–60 months of age group (82.5%). Boys had poorer indicators of undernutrition in comparison to girls. Geographically stunting was more prevalent in Berber locality. Infectious diseases (gastroenteritis and respiratory symptoms) and incomplete vaccination were significantly associated with wasting ( $P = 0.007$ ,  $P = 0.013$ , and  $P = 0.008$ ). Poor socioeconomic status ( $P = 0.043$ ), poorer household sanitation ( $P = 0.022$ ), large family size, lack of family spacing, and infants weaned suddenly were regarded as risk factors for undernutrition. **Conclusion:** There was a high prevalence of undernutrition in the 4<sup>th</sup> and 5<sup>th</sup> year of life in RNS population, with significant gender imbalance. Our survey highlighted the importance of urgent need to improve child health in this region.

**Keywords:** Children, prevalence, stunting, Sudan, undernutrition

## Introduction

Malnutrition remains a serious problem to child survival, growth, and development in under-developed countries. Protein–energy

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malnutrition and micronutrient deficiency are most common types of malnutrition.<sup>[1]</sup> Malnutrition is the main cause of morbidity and mortality in infants and children under 5 years of age.<sup>[2]</sup> In general, the nutritional status of children under 5 years of age can be used as an indicator of the health and nutrition of the community.<sup>[3-5]</sup>

Globally, the prevalence of stunting, underweight, and wasting in children <5 years are 26%, 16%, and 8%, respectively.<sup>[6,7]</sup> The World Health Organization (WHO) estimates that approximately 150–200 million children aged under 5-year in developing countries are underweight and stunted.<sup>[8]</sup> It has been estimated that approximately one out of every eight of Under-5 children dies due to malnutrition in Sub-Saharan Africa.<sup>[9]</sup> Epidemiological studies conducted in developing countries have identified several factors associated with undernutrition, including low birth weight, inadequate exclusive breastfeeding, birth spacing, birth rank, and environmental factors such as parental education, socioeconomic status, sanitation, the standard of living, health services, vaccination, and infectious disease.<sup>[4,10-18]</sup>

Sudan is one of low-middle income countries in sub-Saharan Africa. Poverty, food insecurity, conflicts and civil war, climate change, displacement, and endemicity of infectious diseases are considered as risk factors contributing to Malnutrition. The 2010 Sudan Household Health Survey (SHHS)–Round 2 showed that 35% children of under 5 years were stunted nationwide, 16% were wasted, and 30% were underweight.<sup>[19]</sup> Malnutrition rates have not improved at all over the past two decades. Sudan is unlikely achieved the millennium development goal (halving 1990 rates of child underweight by 2015).<sup>[20]</sup> Two reasons justify the interest of this study: first, the separation of southern part of Sudan occurred after Sudan Referendum in 2010 was changed many of vital indicators in north Sudan, for example, economic, political, and even health indicators. This survey can assess the magnitude of undernutrition and its risk factors in River Nile State (RNS), and second, the household survey gives more reliable data for estimating the prevalence and risk factors of undernutrition compared to hospital-based study.

## Subjects and Methods

### Study setting

This study was conducted in RNS, north of Sudan. RNS lies between latitudes 16°–22° and longitudes 32°–36°, covering an area of about 124,000 km<sup>2</sup>. The population is about 1,250,000. More than two-thirds of the populations are resident in the rural areas; about 37% of the populations are children <14 years old.<sup>[19]</sup> The state is divided into 7 municipalities/localities and about 24 administrative units.

### Study design, sampling technique, and sample size

This cross-sectional community-based survey was conducted in rural areas in RNS during September–December 2014. Participants were 1635 children under 5-year of age selected through door-to-door visits using cluster and multistage sampling.

By simple random sampling, 4 localities out of 7 were selected. Based on population divided, 35 villages out 350 were selected. Then, proportion Sampling was performed in 35 villages of rural areas by clustering. Then according to 50% predicted prevalence of undernutrition, 95% confidence interval (CI), and  $\pm 5\%$  error and using the formula  $n = Nz2pq/d2(N-1)+z2pq$ , and also with the usage of total population per each locality, the sample size was estimated 384 for each locality. Total sample size was obtained 1536. Thereafter, all eligible children from house to house visits were included. Inclusion criteria were healthy children aged 0–60 months and voluntary willing to participate in this study, children who had chronic debilitating diseases were excluded from the study.

Ethical approval for the study was obtained from the Ethical Committee of the State Ministry of Health. The mothers or child legal guardians were informed about the aim of the study, and a written consent was obtained before data collection. Participant's confidentiality was observed during all stages of the survey. No harm was imposed on any participant. Children who needed urgent care were referred to the nearest health facility. This study contributed to the welfare of children recruited for this study. Preliminary results and recommendations were disseminated to health authorities in RNS.

### Data collection

Two types of instruments were used for data collection: A pretested questionnaire and anthropometric measurements. The characteristics of socioeconomic status, family size, breastfeeding practices, and types of weaning, vaccination status, and current history of child's diseases were obtained by the pretested questionnaires. Interviews were conducted in the local language; each session lasted between 15 and 25 min.

We used anthropometric measures for weight, height, and mid-upper arm circumference. Weight was recorded while the subjects were minimally clothed using a digital weighing scale with 0.10 kg accuracy. For Height and length children were measured barefooted using the measuring board for babies and toddlers with 0.10 cm accuracy. All measuring instruments were calibrated before use. Training for data collectors (5<sup>th</sup> year medical students-Nile Valley University) was done before field work and this included both theoretical and practical sessions. Each group of students was composed of four members.

### Definitions

Underweight - Weight-for-age (W/A) is used to describe a situation where a child weighs less than expected, given his or her age. W/A reflects body mass relative to age. And, therefore, reflects current and acute as well as chronic malnutrition. W/A is commonly used for monitoring growth and to assess changes in the magnitude of malnutrition over time. Moderate and severe - below minus two standard deviations (SDs) from median W/A of reference population; severe-below minus three SDs from median W/A of the reference population.<sup>[9,12,21,22]</sup>

Wasting - Weight-for-height (W/H) refers to a situation where a child has failed to achieve sufficient W/H. W/H is normally used as an indicator of current nutritional status. Wasting may be the consequence of starvation or severe disease. It can also be due to chronic conditions or a combination of both. Moderate and severe - below minus two SDs from median W/H of reference population.<sup>[9,12,21,22]</sup>

Stunting - Height-for-age (H/A) is used to describe a condition in which children fail to gain sufficient height, given their age. Stunting is an extremely low H/A score. Stunting is often associated with long-term factors such as chronic malnutrition, especially protein-energy malnutrition, and frequent illness. It is, therefore, an indicator of the past growth failure and is often used for a long-term planning of policies and intervention programs in nonemergency situations. Stunting is very sensitive to socioeconomic status. Moderate and severe - below minus two SDs from median H/A of reference population.<sup>[9,12,21,22]</sup>

### Statistical analysis

Data were cleaned, managed, and analyzed by SPSS software program version 21 (IBM Statistics, Chicago, IL, USA). Then, the anthropometric indices were calculated using the WHO Anthro software (version 3.2, Geneva, Switzerland). Cutoff points were used to assess the degree of wasting, stunting and underweight, determined respectively by weight-for-height (WHZ), height-for-age (HAZ), and weight-for-age (WAZ) minus two SDs or below (<-2 SD).<sup>[23]</sup> For each indicator, all children are included in the evaluation with a plausible z-score (defined under Survey options). Percentages below median based on weight-dependent indicators are defined as <-3 SD or edema, and <-2 SD or edema. The % <-2SD includes % <-3SD. Chi-squared test was used to compare the association between proportions.  $P \leq 0.05$  was considered statistically significant.

## Results

### Demographic and socioeconomic characteristics

A total of 1635 children under 5 (0–60 months) years of age were enrolled in this study. Of them, 1081 (66.1%) were boys and 554 (33.9%) were girls. The mean age of children ( $\pm$ SD) was 30.34 ( $\pm$ 15.44) months with males being slightly younger 30.67 ( $\pm$ 15.94) months than females 29.69 ( $\pm$ 14.40) months. Children from low and medium socioeconomic status were the majority (90%). Table 1 shows the demographic and socioeconomic characteristics of the study subjects.

### Indicators of nutritional status of children

Anthropometric measurements were available for 1,447 of the 1,635 children surveyed. Stunting was found in 42.5% (95% CI 39.7–45.3) of the children while 32.7% (95% CI 30.5–35.1) were underweight, and 21% (95% CI 19.2–22.8) were wasted. Severe stunting was found in 28.2% (95% CI 25.7–30.7) of the children; severe underweight

**Table 1: Demographic and socioeconomic characteristics of the study subjects: River Nile State, Sudan (n=1447)**

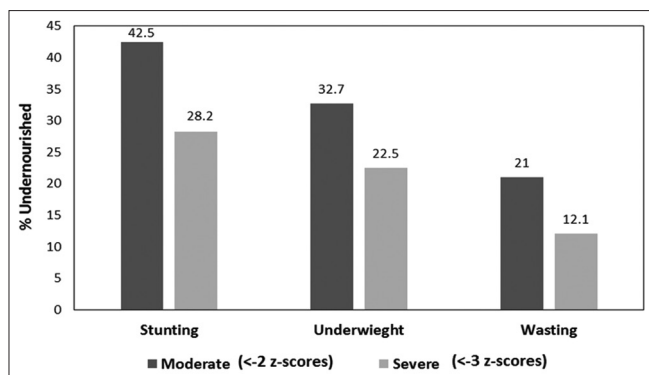
Characteristic	Frequency (%)
Child's gender	
Male	1081 (66.1)
Female	554 (33.9)
Region/locality	
El Damer	1168 (71.4)
Berber	311 (19)
Abo Hamad	129 (7.9)
Atbara	27 (1.7)
Mother's education	
Illiterate	117 (7.2)
Khalwa* and primary school	646 (39.5)
High school	754 (46.1)
College	118 (7.2)
Household head	
Father	1601 (97.9)
Mother	7 (0.4)
Both	15 (0.9)
Others	12 (0.7)
Father's occupation	
Farmer	434 (26.7)
Employee	165 (10.1)
Free worker	932 (57)
Others	101 (6.2)
Family size	
1-4 member	1264 (77.3)
>4 member	371 (22.7)
Family spacing (years)	
<2	732 (44.8)
2-3	614 (37.6)
>3	289 (17.7)
Family income	
<300 SDG (low)	239 (14.6)
300-700 SDG (medium)	1234 (75.4)
>700 SDG (good)	162 (9.9)
Source of safe water	
Pipe	1631 (99.8)
Deep well	2 (0.1)
Others	2 (0.1)
Availability of household latrine	
Yes	1588 (97.1)
No	47 (2.9)

\*Khalwa is an informal religious education

in 22.5% (95% CI 20.3–24.6); and severe wasting in 12.1% (95% CI 10.4–13.8) [Figure 1 and Table 2].

### Wasting

Was the lowest indicators of undernutrition among the under 5-year surveyed children. Moderate wasting was most common (33.3%) among children aged 0–6 months, and was the lowest (16.1%) in children aged 37–47 months. However, there was no statistical association between age and wasting. A similar proportion (21.2%) of boys was wasted as girls (20%) [Table 2]. Geographically, Atbara locality had the highest prevalence of wasting 24.0% ( $\chi^2 = 216.969$ ,  $P = 0.000$ ) [Table 3].



**Figure 1:** Prevalence of severe and moderate under-nutrition: River Nile State, Sudan (n = 1447)

### Stunting

The prevalence of stunting among children aged 0–60 months was 42.5%, it was sustained high throughout all age groups and then reached the peak at the age of (48–60 months) (51.4%) [Figure 2]. Severe stunting was found in 28.2% of the children [Figure 1]. The proportion (45.3%) of boys stunted was higher than girls (37.2%) [Table 2] geographically, the prevalence of stunting in children under 5 years was more prevalent at Berber Locality (38.5%) ( $\chi^2 = 548.354, P = 0.000$ ) [Table 4].

### Underweight

The moderate prevalence of underweight (low W/A) was 32.7%; 22.5% of the children were severely underweight. Children aged 48–60 months had the greatest likelihood (50.5%) of being underweight [Table 2]. This difference was significant when compared with all other age groups. Geographically, the prevalence of underweight was highest at Abo Hamad locality (39.2%), and differences between this region and all other regions were statistically significant ( $\chi^2 = 398.614, P = 0.001$ ) [Table 5].

The household morbidity surveillance indicated that majority of the children had an illness 2 weeks before the interviews. The prevalence of the top four disease symptoms reported were: respiratory symptoms (cough) (82.3%), symptoms of gastroenteritis (diarrhea) (71.2%), fever (34.6%), and symptoms of Measles (12.4%) [Table 6]. There were statistical associations observed between wasting and report of recent illness mainly gastroenteritis and respiratory symptoms ( $P = 0.007$  and  $P = 0.013$ ).

The majority of children’s mothers did exclusive breastfeeding (62.1%). Moreover, contained breastfeeding up to 2 years of child age (64.0%) [Table 6]. We asked about mother’s attitude when the child had diarrhea; whether they provide less or more amount of foods or drinks. A few number of mothers (3.6%) decreased the amount of food and drinks while a child had diarrhea. The large majority (87.2%) of the children ate three or more meals per day [Table 6]. There were no significant differences in the feeding practices during illness and nutritional status. However, the prevalence of undernutrition was higher

**Table 2: Anthropometric measurement in under 5 children: River Nile State, Sudan (n=1536)**

Anthropometric measurement**	n	Percentage	95% CI	Percentage	95% CI
		<-2SD		<-3SD	
<b>Weight-for-length/height - wasting</b>					
Age (months)					
0-5	6	33.3	0-79.4	33.3	0-79.4
6-11	157	24.4	17.5-31.7	18	12-24
12-23	373	23.9	19.4-28.3	14.5	10.8-18.2
24-35	304	18.4	13.9-22.9	9.5	6.1-13
36-47	245	16.7	11.9-12.6	7.8	4.2-11.3
48-60	362	20.5	16.4-24.6	12	8.5-15.5
Gender					
Male	944	21.2	18.6-23.8	13.2	11-15.4
Female	503	20	16.4-23.7	10	7.3-12.8
Total	1447	21	19.2-22.8	12.1	10.4-13.8
<b>Length/height-for-age - stunting</b>					
Age (months)					
0-5	3	33.3	0-100	33.3	0-100
6-11	137	41.2	31.3-51.1	30	20.6-39.4
12-23	315	38.4	32.5-44.3	26.2	20.4-32
24-35	341	38.1	33.2-43	29.2	24.2-34.2
36-47	270	41.3	34.6-48	17.8	12.9-22.7
48-60	381	51.4	47.8-55	33.1	27.9-38.3
Gender					
Male	967	45.3	41.6-49	29	25.9-32.1
Female	480	37.2	32.4-42	26.7	22.3-31
Total	1447	42.5	39.7-45.3	28.2	25.7-30.7
<b>Weight for age - underweight</b>					
Age (months)					
0-5	3	33.3	0-100	33.3	0-100
6-11	133	26.6	17.8-33.4	15.8	9.2-22.4
12-23	345	24.9	20.2-29.6	15.9	11.9-19.9
24-35	324	29	23.9-34.1	17.6	13.3-21.9
36-47	264	39.8	33.7-45.9	25.8	20.3-31.2
48-60	378	50.5	35.4-45.6	32.5	27.7-37.4
Gender					
Male	954	32.9	29.9-35.9	23.3	20.5-26
Female	493	23.3	28-36.5	20.9	17.2-14.6
Total	1447	32.7	30.5-35.1	22.5	20.3-24.6

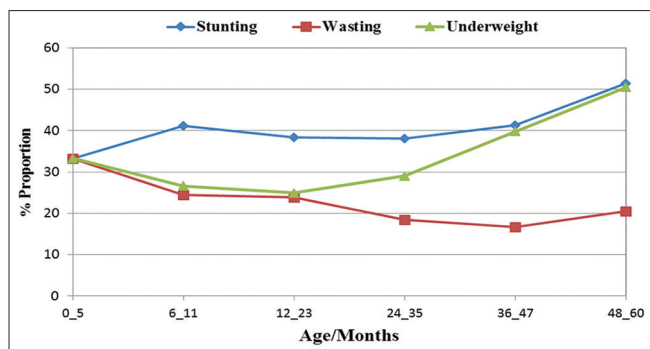
CI: Confidence interval; SD: Standard deviation

**Table 3: Prevalence of wasting, by region: River Nile State, Sudan (n=1447)**

Location	Total number	Wasting (Z <-2SD)		Mean±SD
		Moderate (Z <-2SD)	Severe (Z <-3SD)	
El Damar	1008	23.0	15.5	-0.28±2.19
Berber	300	12.7	4.0	-0.07±1.70
Abo Hamad	113	19.6	5.4	-0.33±1.75
Atbara	26	24.0	4.0	-0.13±2.10

$\chi^2=216.969, P=0.000$ . SD: Standard deviation

among infants weaned suddenly ( $P = 0.017$ ) and those to whom bottle feeding was introduced ( $P = 0.013$ ). In this study, we found a statistical correlation between the poor socioeconomic status ( $P = 0.043$ ) and poorer household sanitation ( $P = 0.022$ ).



**Figure 2:** Prevalence of nutrition indicators by age group in months: River Nile State, Sudan (n = 1447)

## Discussion

In this study, we have reported on the prevalence and determinants of under 5 children undernutrition in a rural population based on a cross-sectional survey. Knowing the prevalence rates of underweight, wasting, and stunting in under 5-year-old children is important for determining the overall health of the community. In addition, this will help in monitoring achievements toward mid-decade goals for nutrition and child health set by international organizations.<sup>[24,25]</sup> It also provides data for health policymakers to set the health priorities. The latest worldwide prevalence estimates of stunting and underweight among children under-5 years of age witnessed significant decrease since 1990.<sup>[10]</sup> In contrast, all indicators of undernutrition in Sudan were obviously high. For instance, the prevalence estimates for children under 5 years of age for stunting was 35%, for underweight was 32%, and for wasting was 16% (according to SHHS, 2010).<sup>[9]</sup>

In this study, these figures were almost increased. This may be explained by the fact that study participants in our cohort are from rural areas, a situation that may aggravate undernutrition. This study identified chronic malnutrition was more prevalent than acute malnutrition. The findings of this survey determined that there was a higher prevalence of stunting among children living in RNS when compared to overall country prevalence, this may be an indicator of poverty in rural communities. These high rates of stunting observed in this study (42.5%) were similar to those observed in Tanzania (44.2%) and north India (46.9%).<sup>[26,27]</sup> Infants aged 0–5 months had a significantly lower risk of being stunted than children in older age groups 48–60 months, this may be attributed to the fact that the prevalence of stunting becomes more obvious after the 2<sup>nd</sup> year of life; concurrent with an introduction of the family diet, as children become more able to feed themselves and therefore, can easily be exposed to food-borne pathogens and that food may not be available at adequate amounts.<sup>[28]</sup> On the other hand, younger children may be protected by the mother's immune system at birth or breastfeeding may be sufficient to meet the physical demands of the growing children.<sup>[28]</sup>

In this study, the prevalence of stunting was higher among boys compared to girls, a finding that is similar to that reported in

**Table 4: Prevalence of stunting, by region: River Nile State, Sudan (n=1447)**

Location	Total number	Stunting (Z < -2SD)		Mean±SD
		Moderate (Z < -2SD) (%)	Severe (Z < -3SD) (%)	
Berber	311	38.5	22.7	-1.35±2.17
Abo Hamad	129	37.3	32.5	-0.38±3.48
Atbara	18	33.3	27.8	-0.36±3.65
El Damar	989	34.1	28.1	-1.25±2.76

$\chi^2=548.354, P=0.000$ . SD: Standard deviation

**Table 5: Prevalence of underweight, by region: River Nile State, Sudan (n=1447)**

Location	Total number	Underweight (Z < -2SD)		Mean±SD
		Severe (Z < -3SD) (%)	Moderate (Z < -2SD) (%)	
Berber	299	11.7	26.1	-0.96±1.78
Abo Hamad	120	29.2	39.2	-0.85±2.86
Atbara	24	20.8	25.0	-0.35±2.74
El Damar	1004	24.9	34.1	-1.06±2.49

$\chi^2=398.614, P<0.001$ . SD: Standard deviation

**Table 6: Medical history and feeding pattern of the study subjects: River Nile State, Sudan (n=1635)**

Characteristic	Yes, n (%)	No, n (%)
History of child illness in last 2 weeks		
Gastroenteritis symptoms (diarrhea)	1164 (71.2)	471 (28.8)
Respiratory symptoms (cough)	1345 (82.3)	290 (17.7)
Fever symptoms	566 (34.6)	1069 (65.4)
History of measles	202 (12.4)	1433 (87.6)
Vaccination	1596 (97.6)	39 (2.4)
Completeness of vaccination	1165 (72.9)	431 (27.0)
Child received Vitamin A	1542 (94.3)	93 (5.7)
Characteristic	Frequency, n (%)	
Mother's approach child with diarrhea		
Go to health center	1384 (84.6)	
Use local medication	117 (7.2)	
Decrease food intake	59 (3.6)	
Increase food intake	28 (1.7)	
Others	47 (2.9)	
Characteristic	Yes, n (%)	No, n (%)
Exclusive breastfeeding	1016 (62.1)	619 (37.9)
Use of bottle feeding	961 (358.8)	674 (41.2)
Characteristic	Frequency, n (%)	
Time of weaning (years)		
<2	589 (36.0)	
≥2	1046 (64.0)	
Type of weaning		
Sudden	247 (15.1)	
Gradual	1388 (84.9)	
Number of meals/day		
<3 meals/day	210 (12.8)	
≥3 meals/day	1425 (87.2)	

10 Sub-Saharan African countries.<sup>[29]</sup> The exact reason behind this may not be so clear; however, as boys spend most of the

time outdoor, in contrast to girls who are most of the time indoor, therefore, girls may receive more care by their families. Some authors suggested that boys were more influenced by environmental stress than girls.<sup>[29]</sup> The risk of stunting is higher in all localities in RNS, and particularly so among children living in poorer household sanitation ( $P = 0.022$ ), and overcrowded conditions ( $P = 0.021$ ). The poor Socioeconomic status had a statistical association with undernutrition ( $P = 0.043$ ), this finding was similar to other studies.<sup>[30,31]</sup>

Wasting results from recent illness and/or insufficient dietary intake.<sup>[32]</sup> Undernutrition and childhood morbidity have a synergistic relationship. In this study, children with a history of illness with infectious diseases (gastroenteritis and respiratory symptoms), and incomplete vaccination had a statistically significant relationship with wasting ( $P = 0.007$ ,  $P = 0.013$ , and  $P = 0.008$ ), respectively. These relationships were similar to those reported from Kenya and Ethiopia.<sup>[32,33]</sup> Most of the studied mothers were breastfeeding up to 2 years of age. However, the exclusive breastfeeding for an infant <6 months of age was still below the WHO recommendations.<sup>[34]</sup>

The findings of this study were alarming, highlighting the worsening nutritional situation in one of the north Sudan states. Therefore, we recommend urgent interventions to be carried out by health policymakers including raising awareness of the local community about observing the nutritional indicators in primary health-care units.

This study is not without limitations. First, there may be recall bias for some questions concerning feeding practices. Second, being conducted in rural communities, this study may not allow generalizations to be made about the whole community of RNS. In addition, the exclusion of children who were sick at the time of study conduction may have exerted an effect on the overall prevalence, despite their limited number. However, this study is novel and is the first of its type in north Sudan states, therefore, the data provided may constitute a database for future studies.

## Conclusion

Undernutrition in RNS population is considered as an unresolved crisis. Stunting was the predominant nutritional problem. Older boys were more affected by undernutrition. Many risk factors were contributing to undernutrition; poor socioeconomic status, household sanitation, large family size, family spacing, and infants weaned before 2 years of age, children morbidity and incompleteness of vaccination doses. This report contributes to the growing scientific consensus that tackling childhood stunting is a high priority.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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