MATERNAL SHORT STATURE, HOUSEHOLD SOCIO-ECONOMIC STATUS AND STUNTING AMONG UNDER-TWO CHILDREN ATTENDING AN IMMUNIZATION CLINIC AT A TERTIARY HOSPITAL IN KATHMANDU, NEPAL

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ABSTRACT

Stunting or poor linear growth affects about 25% of children under five globally. Poor linear growth may occur due to lack of nutrients or due to hormonal influences. This study has investigated the relationship between maternal stature, household socio-economic status and linear growth among children below two years of age visiting the immunization clinic at an urban tertiary hospital in Kathmandu, Nepal. An observational cross-sectional analytical study was carried out through a face-to-face interview of mothers with a pretested standardized proforma. Anthropometric measurement of mother and child dyads was carried out to assess the nutritional status. Nutritional anthropometry tool in Epi-Info version 7.2.0.2 was used to calculate height-for-age z-scores (HAZ) based on the WHO 2007 reference data. A cut-off of –2 z-scores was used to define stunting (<-2HAZ). Linear regression was used to study the correlation between maternal anthropometric indices and HAZ scores. Univariate logistic regression was used to assess potential predictors. Among 396 mother-child dyads, with 186 female children, the prevalence of low birth weight was 7% (95% CL: 5.1% to 10.3%) and stunting was 4.5% (95% CL: 2.9 to 7.0). Proportion of mothers with short stature (<145 cm) was 7.5% (95% CL: 5.3% to 10.5%). Maternal height had a higher correlation with HAZ in comparison to weight (r 0.24, P<0.0001 vs 0.09, P=0.04). The mean HAZ score among infants (<6 months) was 1.25, 0.22 among those aged 6-11 months and -0.15 among those 12 months and above. Preterm birth (P=0.03), low birthweight (P<0.001) and being underweight (P=0.001) were associated with stunting. Though a low prevalence of stunting was seen, the downward shift in HAZ indicated a deficit in linear growth at the population level. This reflected the utility of HAZ as a population level marker for child undernutrition. As the prevalence of stunting among under-five children has continued to decline in Nepal, eliminating the downward shift in linear growth among under-two children can be prioritized. Potential areas of research include identification of appropriate cut-offs for maternal short stature and exploration of the epidemiological association between ponderal and linear growth among children in the local context. A consistent access to care during the antenatal period, child delivery and improved child feeding practices may have helped to improve the nutritional status among the under-two children. Assessment of linear growth along with weight gain needs to be emphasized during growth monitoring.

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INTRODUCTION

Body dimensions reflect a cumulative exposure to diet and illness. Among children due to rapid change in body size, proportions and differences between the genders, appropriate reference standards are used to make comparisons. The commonly used indices for child undernutrition are underweight (low weight for age), stunting (low height for age) and wasting (low weight for height).[1] Each of these represent different types of nutritional insult to the child. As weight is easy to measure, weight for age is the most widely used indicator to assess child growth and development. A low weight for age suggests recurrent episodes of illness and or starvation with an increased risk of child mortality. A low weight for height suggests more recent illness or a failure to gain weight or a loss of weight. A low height-for-age z-score (HAZ) occurs more commonly in the first two or three years of life and is associated with repeated exposure to poor sanitation, low nutrient intake and adverse economic conditions.[2]

Stunting is defined as the height for age which is greater than two standard deviations below the median for the international reference of children aged less than 60 months.[3] It has been interpreted as a state of chronic or past malnutrition. Poor linear growth may occur due to lack of nutrients or due to hormonal influences.[1] Studies on secular trends in height with migration to more affluent areas suggest that genetic constitution is not the primary determinant of adult stature. Exclusive breast feeding can optimize natural growth as well as availability of safe pure water and hygienic preparation of food. Child undernutrition has also been associated with socioeconomic inequalities. Stunting, caused by experiences of chronic nutritional deprivation, affects approximately 25% of children under five globally (approximately 156 million children).[4] While global trends suggest a decline over the past twenty years; the prevalence of stunting continues to be greater in South Asia and sub-Saharan Africa.[5] Following the global trend, stunting in Nepal has declined from 68% in 1995 to 57% in 2001 and 41% in 2011. The NDHS reported a prevalence of about 36% in 2016.[6]

Maternal short stature, adolescent pregnancy and inadequate birth spacing can also contribute to stunting.[7] Maternal stature is an indicator of the mother's nourishment and nutrition in the past. Short maternal stature (<145 cm) has been associated with low birth weight.[8] Poor linear growth or stunting, has been identified as a modifiable risk factor for under-five children to attain developmental potential.[9,10] The sustainable development goals for Nepal has proposed to reduce stunting among children to 1% by the year 2030. Targeted interventions will be needed in order to reduce the under nutrition among women and under five children.[11] However, declining rates of stunting have been accompanied by reduction of inequalities in only 19% of the countries. The first thousand days of life from conception to the second year of a child offer a crucial window of opportunity. As the major deficit in linear growth occurs in the first 2 to 3 years, once this window is lost, children may continue to grow but may not achieve their potential height.[12] This study aimed to identify the proportion of mothers with short stature, prevalence of low birth weight and stunting among children under two years of age. An assessment of stunting in relation to maternal anthropometry and socio-economic status may help us to interpret its significance as a population level marker for child undernutrition in Nepal.

MATERIALS AND METHODS

An observational cross-sectional analytical study was conducted in the immunization clinic at the Community Medicine out-patient department in Nepal Medical College and Teaching Hospital, Kathmandu, Nepal from February 2021 to September 2021. Ethical clearance was obtained from NMC-IRC (Ref no. 032-077/078). An estimated sample size of 384 was calculated assuming 35.8% prevalence of stunting within 95% confidence limits and a 5% margin of error.[6] A convenient sampling technique was used to enrol 400 children under-two years of age and their mothers who visited the immunization clinic during the study period after obtaining verbal consent. A pretested standardized proforma was used to gather information regarding antenatal care, maternal and child health and child feeding practices via a face-to-face interview with the mothers. The household socio-economic status was assessed through the modified Kuppuswamy scale adapted for use in Nepal.[13]

Anthropometric assessment of mother and child was carried out to assess their nutritional status. Maternal weight was measured with a weighing scale that is placed on a flat surface without slippers and reported in kilograms (kg). Infant were weighed on a pan-type weighing scale with minimal clothing. Older children were weighed on the same scale as the mothers. Maternal height was measured with a stadiometer that was placed against a wall. The vertical head piece was adjusted to rest on the

top of the woman's head. The observed height was reported in centimetres (cm). For children up to two years old height was measured by recumbent length using an infantometer. Nutritional status of under-five child was classified according to the indicators weight for age, height for age and weight for height. Using weight for age, the child was classified as normal weight, underweight and overweight. Using height for age, the child was classified as stunted or normal height. Using weight for height the child was classified as wasted and not wasted. The terms height and height-for-age z-score (HAZ) has been used in this paper though recumbent length, rather than standing height, was measured and the terms "length" and "length-for-age" are typically used for children under two years of age.

Data Analysis: The data was entered in an excel spreadsheet and analysed using Epi-Info version 7.2.0.1 and Stata 15 licensed software. Nutritional anthropometry tool in Epi-Info was used for analysis of anthropometric measures. Weight, height, and age data were used to calculate weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WtHtZ) z-scores based on WHO 2007 reference data. A cut-off of –2 z-scores was used to define undernutrition. The distribution of the variables was explored and extreme outliers (5 z-scores) were identified and 4 mother-child dyad records were removed from the dataset. Among 396 mother-child dyads, the prevalence of low birthweight and stunting was reported with 95% CI. Linear regression was used to study the correlation between maternal height, weight, and child height and weight and HAZ scores. The means of HAZ, WAZ and WtHtZ scores were graphed by completed month and the smoothed values using the kernel-weighted local polynomial smoothing algorithm in Stata so as to study their distribution. Strength of the association between potential predictors and stunting was determined by bivariate logistic regression analysis. Further multi-variate analysis was not carried out due to the low prevalence of stunting.

RESULTS

Among 396 under two years children, with 186 female children, the prevalence of stunting was 4.5% (95% CL: 2.9 to 7.0%). The prevalence of underweight and wasting was 3.5% (95% CL: 3% to 8%) and 10.6% (95% 7.9 to 13.9%) respectively. There was a significant association between being underweight and stunting (Table 1). Among the 396 mothers, two thirds were between 25 to 34 years of age. The proportion

Table 1: Prevalence of underweight, stunting and wasting among under-2 years children (n=396)

	Stunting			
	No n (%)	Yes n (%)	Total	P value
Under-weight				
No	371 (98.2)	11 (61.1)	382	<0.001
Yes	7 (1.8)	7 (38.9)	**14 (3.5)**	
Wasting				
No	337 (89.1)	17 (95.0)	354	0.40
Yes	41 (10.8)	1 (5.0)	**42 (10.6)**	
Total	376	**18 (4.5)**	396	

Table 2: Socio-demographic characteristics of mother-child dyads (n=396)

Variables	n	%
Maternal height categories		
<145	30	7.54
145 – 149	66	16.58
150 and above	302	75.88
Maternal age categories (n=396)		
18-24	79	19.95
25-34	273	68.94
35-49	44	11.11
Maternal occupation		
Homemaker	317	79.65
Working outside home	81	20.35
SES categories		
Low	159	39.95
Middle	226	56.78
Upper	13	3.27
Child Gender		
Male	212	53.27
Female	186	46.73
Maternal education		
Illiterate	42	10.55
Primary	122	30.65
Secondary	57	14.32
Higher secondary	88	22.11
Undergraduate	65	16.33
Postgraduate	24	6.03
Ethnicity		
Brahmin/Chhetri	108	27.14
Adivasi/Janajati	246	61.81
Newar	33	8.29
Others	11	2.76
Total	**398**	**100.00**

Table 3: Maternal and child health care characteristics (n=396 mother child dyads)		
Variable	**n**	**%**
Antenatal visits		
Nil	2	0.5
1	3	0.8
2	3	0.8
3	6	1.5
4 and above	383	96.5
Gestational age (n=397)		
Term	366	92.6
Preterm	29	7.3
Place of delivery		
Home	22	5.5
Hospital	376	94.5
Birth Order		
1	176	44.2
2	174	43.7
3 and above	48	12.1
Birth weight		
≥2500 g	367	92.6
<2500 g	29	7.3
Complementary feeding		
No	169	42.9
Yes	227	57.0
Exclusive breast feeding		
Yes	291	73.8
No	104	26.1
Total	**396**	**100.00%**

of mothers with short stature (<145 cm) was 7.5% (95% CL: 5.3% to 10.5%) and three fourths of the mother's height was 150 cm and above. Four fifths of the mothers were homemakers; about two thirds were of *Adivasi/Janajati* ethnicity. About 6% had attained higher level of education. About 34% belonged to households with lower socio-economic status (Table 2).

The prevalence of low birth weight was 7% (95% CL: 5.1% to 10.3%). A majority of the mothers (96.5%) had visited a health care facility for antenatal care for four or more than four times and delivered their child at a hospital (94.5%). A majority of the deliveries occurred at term (92.6%). An equal proportion of children were firstborn (44%) and second born (44%). Almost three fourths of the mothers reported that they were either breastfeeding or had breastfed their babies exclusively. Over half (57%) had begun complementary feeding (Table 3).

The distribution of maternal and child age and anthropometric indices is shown in Table 4. There was a highly significant difference in the mean height for age and weight for height z-scores (P value <0.0001) in relation to age categories. The mean HAZ score among infants (<6 months) was 1.25, 0.22 among those aged 6-11 months and -0.15 among those 12 months and above (Table 5). Child age had a moderately strong negative correlation (r=-0.42, P<0.0001); while birthweight had a moderately strong positive (r=0.34, P<0.0001) and current child weight had a low correlation (r=0.14, P=0.01) with height for age z-score respectively. There was a highly significant correlation between

Table 4: Distribution of maternal and child age and anthropometric indices (n=396 mother child dyads)					
Variables	**Min**	**Median**	**25%**	**75%**	**Max**
Maternal					
Height (cm)	139.5	153.5	150	158	170
Weight (kg)	37	62	54	70	115
BMI (kg/m2)	15.1	26.5	23.5	29.3	46.9
Child					
Age (months)	<1	4	2	10	23
Birth weight (g) n=397	1400	3200	2800	3500	4500
Height (cm)	47	65	60	73	93
Weight (kg)	2.75	7	5.5	9.5	43
WAZ	-4.51	0.40	-0.27	1.21	3.49
HAZ	-4.60	0.76	-0.43	1.79	4.87
WtHtZ	-6.85	-0.05	-1.04	0.79	4.17

Table 5: Mean scores of child undernutrition indicators in relation to age (n=396 children)

| Undernutrition indicator	Obs	Mean	Std Dev	Anova P value
Height for age Z score				
<6 months	224	1.2481	1.5699	
6-11 months	76	0.2187	1.2665	<0.0001
12 -23 months	96	-0.1488	1.6029	
Weight for age Z score				
<6 months	224	0.458	1.2261	
6-11 months	76	0.1543	1.1861	0.156
12 -23 months	96	0.4033	1.1023	
Weight for Height Z score				
<6 months	224	-0.6416	1.5985	
6-11 months	76	0.1297	1.3485	<0.0001
12 -23 months	96	0.6503	1.1689	

Table 6: Correlation between height-for-age Z score, age and anthropometric indices (n=396 mother child dyads)

| Variable	HAZ (β)	r	r²	95% CI for β	P value
Child age (months)	-0.12	-0.42	0.15	-0.148 to -0.092	<0.0001
Birth weight (kg)	1.239	0.34	0.14	0.93 to 1.549	<0.0001
Child weight (adjusted for age)	0.137	0.14	0.02	0.071 to 0.204	0.014
Weight for Age Z	0.75	0.5216	0.30	0.635 to 0.865	<0.0001
Weight for Height Z	-0.401	-0.3557	0.14	-0.498 to -0.305	<0.0001
Maternal age (years)	-0.004	0.0136	0.00	-0.038 0.031	0.787
Maternal height	0.068	0.24	0.06	0.04 to 0.095	<0.0001
Maternal weight	0.015	0.09	0.01	0.001 to 0.029	0.04
Maternal BMI	0.002	0.0044	0.00	-0.034 to 0.039	0.9301
Kuppuswamy SES score	0.008	0.03	0.00	-0.022 to 0.039	0.549

(HAZ-Height for age Z score, β beta coefficient, r Spearman's correlation coefficient, r² coefficient of variation, CI confidence interval)

## Table 7: Univariate logistic regression for predictors of stunting (n=396 mother child dyads)

Outcome variable: **Stunting**

Term	Odds Ratio	95%	C.I.	Coefficient	S.E.	Z-Statistic	P-Value	LRT
Low birth weight (Yes/No)	8.07	2.95	22.02	2.087	0.512	4.0748	<0.001	0.0003
Gestational age (Preterm/Term)	3.52	1.09	11.32	1.25	0.596	2.1112	0.03	0.05
Maternal stature (>150 cm/<145 cm)	0.24	0.07	0.82	-1.400	0.618	1.5911	0.1116	0.02
Underweight (Yes/No)	33.04	10.0	112	3.518	0.615	5.712	<0.001	<0.001
SES (Upper/Lower)	0.47	0.13	1.36	-0.944	0.461	-2.0456	0.23	0.20
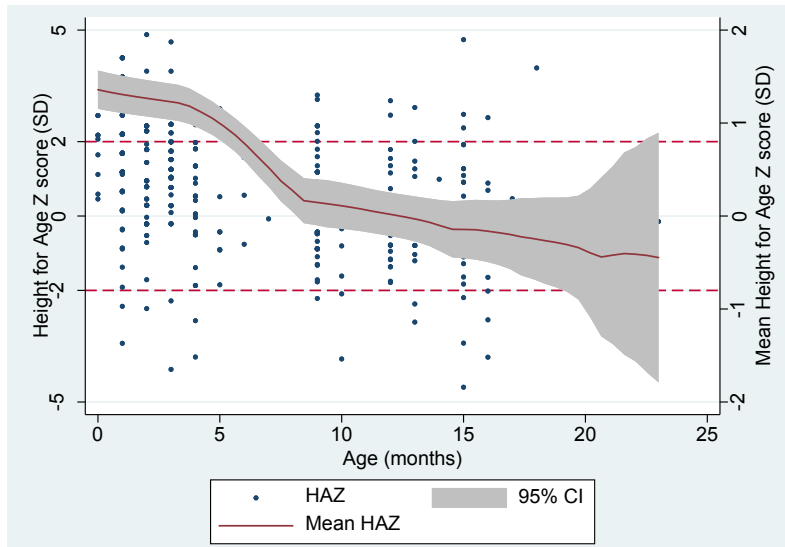
Fig. 1: Mean height-for-age z-scores relative to the WHO 2007 standard by completed month and kernel-weighted local polynomial smoothed values with 95% confidence interval. Data from $n = 396$ children
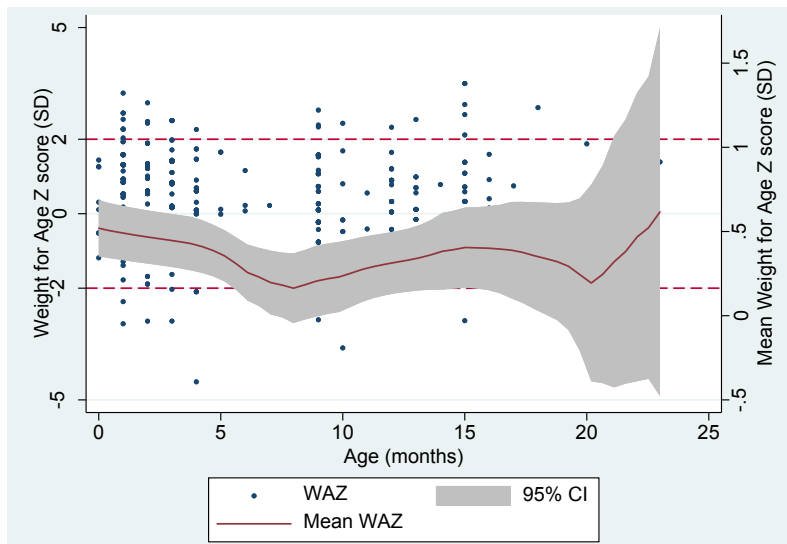
Fig.2: Mean weight-for-age z-scores relative to the WHO 2007 standard by completed month and kernel-weighted local polynomial smoothed values with 95% confidence interval. Data from $n = 396$ children
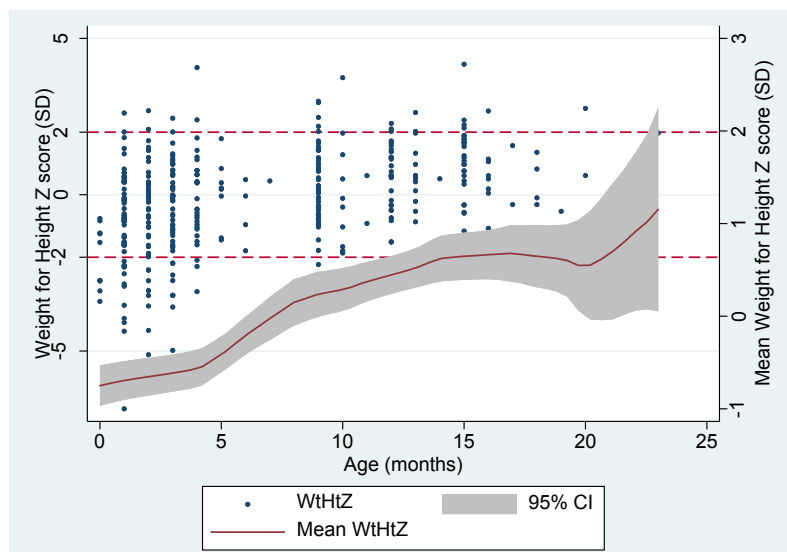
Fig. 3: Mean weight-for-height z-scores relative to the WHO 2007 standard by completed month and kernel-weighted local polynomial smoothed values with 95% confidence interval. Data from $n = 396$ children

weight for age and height for age (P<0.001), as well as between weight for height and height for age Z scores (P<0.001). While weight for age and height for age had a moderately strong positive correlation (r=0.52); there was a moderately strong negative correlation (r=0.35) between weight for height and height for age (Table 6). The distribution of HAZ scores showed a downward shift; while WAZ scores were stable and WtHtZ scores showed an upward shift in relation to child age (Fig. 1,2&3).

Among the maternal anthropometric indices, maternal height had a higher correlation with HAZ in comparison to weight (r 0.24 vs 0.09) (Table 6). The odds of stunting were increased among children with a low birth weight (OR 8.0 95% CI: 2.9 to 22.0), those born preterm (OR 3.5 95% CI: 1.09 to 11.3) and those with low weight for age (OR 33.0 95%CI: 10 to 112). A non-significant decreased odds of stunting was seen among children whose mothers' height was 150 cm and above in comparison to those whose mothers' height was less than 145 cm and among children from the upper socio-economic status (Table 7).

DISCUSSION

The study findings reflect a lower prevalence of stunting (3% to 7%) among the under-two years children visiting an urban health care facility for immunization. These findings were consistent with the evidence from the Demographic and Health surveys in Nepal that the rate of decrease in stunting was higher in urban areas (18%) in comparison to the rural areas (10%).[6] More recently, the Multiple Indicator Cluster Survey in 2019 found that stunting had decreased to 32% while wasting was at 12% and underweight was 2.8%.[14] There was a higher access to antenatal care (96%) and institutional deliveries (94%) among mothers who participated in the study in comparison to the national access (56%). Among other countries with a high burden of stunting such as Indonesia and Pakistan, stunting among children has been associated with less than three or four antenatal visits among mothers.[15, 16] Thus, access to care during the antenatal period, child delivery and improved child feeding practices (with 75% of mothers reporting exclusive breast feeding) may have helped to improve the nutritional status among the under-two children.[17]

The study findings revealed that maternal height (r=0.24) had a higher correlation with child linear growth in comparison to maternal

weight (r=0.09). The correlation between maternal and child stature may reflect their shared genetic and social pool of determinants.[18] Evidence from data across 54 low- and middle-income countries found that for a unit increase in maternal height (1 cm) the risk of stunting among under-five children decreased by 4%.[19]

Hence, maternal height may be a simple tool to screen for child undernutrition. Most studies have used 145 cm as a cut-off for maternal short stature. However, with improvement in maternal nutritional status, identification of appropriate cut-offs for maternal short stature could be a potential area of research in the local Nepal context.[8,20]

The similar proportions (about 7%) of mothers with short stature, babies born with low weight and prevalence of stunting (3% to 7%) among the children reflected the intergenerational cycle of malnutrition. Small women are known to be at a greater risk of delivering an infant with low birth weight and infants of low birth weight or retarded intrauterine growth tend be smaller as adults.[21,22] However, this was lower than the national average for the prevalence of low birth weight (12% to 13%) in Nepal.[3] There is consistent evidence from systematic reviews that birthweight was significantly associated with mortality, stunting and wasting among under-five children. Demographic health surveys in South Asia and Africa have reported a similar association between maternal stature, low birthweight and child stunting.[23–27]

However, there are several potential misuses and misinterpretations of stunting as a child undernutrition indicator.[28] The low prevalence of stunting may understate the magnitude of the problem of growth faltering at the population level as even those children with a HAZ >-2 may have experienced growth faltering. It is important to emphasize that a HAZ of <-2 is not a threshold marker of malnutrition or disease for any single individual child. It is recommended that any assessment of children classified as stunted or non-stunted should be complemented by the use of metrics such as slope of decline in mean HAZ with age. A height for age distribution has to be critically reviewed by researchers as well as public health professionals.[29]

According to the WHO growth standards, among a population of healthy young children, the mean growth curve is expected to be at the median.[3] In the present study, the weight for age scores were consistently above the median, the weight for height scores began with a deficit but shifted above the median.

However, a downward shift was seen in the distribution of height for age scores with higher scores among children below six months and scores below the median among children who were 12 months or older. This downward shift indicated a deficit in linear growth at the population level. A population-level height deficit may reflect growth impairment caused by a deficient environment such as poor diet, inadequate care and poor health to which the population of children have been exposed. Such a shift has been observed in many low- and middle-income countries.[12,30]

Exploring the relationship between the child nutritional indicators in the current study, children who were underweight for age were more likely to have a lower height for age score. However, there was a negative correlation between height for age and weight for height Z scores. Given the multidimensional nature of child nutritional status, height-for-age and weight-for-height reflect distinct biological processes, namely, linear and ponderal growth. Evidence on the epidemiological association between linear and ponderal growth among children has been inconsistent and needs further exploration.[31–34] However, the widespread use of weight for age during growth monitoring may lead to an underestimation of the inequalities in child nutrition.[35]

Furthermore, no significant association was observed between socio-economic status or child gender and linear growth. In Nepal, low socioeconomic status, teenage pregnancies and social disparities in access to health care during pregnancy, childbirth and the postpartum period have been identified as risk factors for stunting among children.[35,36] National level data analysis in Nepal has suggested that improvements in maternal nutritional status and access to care during prenatal, antenatal and post-natal period over the past two decades may have reduced stunting among children in Nepal.[37–39] So, the continuum of care to mother and child may have helped to reduce inequalities associated with socio-economic status in the study population.[8]

Study limitations: The increment in length from birth was not documented among the children as the birth length was not recorded or not known to the mother. The observed associations between child undernutrition indicators cannot be inferred as causal due to the cross-sectional nature of the data.

In conclusion, there was a lower prevalence of stunting among children below two years visiting an urban tertiary centre for immunization. Low birth weight, preterm birth and being underweight were found to be significant predictors of stunting among children. This study has demonstrated the utility of HAZ and maternal stature as a population level marker for child undernutrition. As Nepal has continued to make significant progress in under-five child undernutrition indicators, eliminating the downward shift in linear growth among under-two children can be prioritized. Moreover, the relationship of child undernutrition indicators needs to be examined through data obtained from prospective cohort studies so as to understand the temporal association between ponderal and linear growth. Monitoring the growth of children less than two years of age provides the opportunity for suitable interventions. Assessment of linear growth along with weight gain needs to be emphasized during growth monitoring.

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