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Original Article

Determinants of child stunting in the Royal Kingdom of Bhutan: an in-depth analysis of nationally representative data

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Abstract

Stunting is associated with poor survival and development in children. Our analysis identifies the factors most significantly associated with child stunting in Bhutan using a nationally representative sample of 2085 children 0–23 months old. We find that 27.5% of children were stunted and almost half (42.6%) of the stunted children were severely stunted. Children's mean height-for-age *z*-score deteriorated significantly with age (from –0.23 in infants 0–5 months old to –1.60 in children 18–23 months old) and levels of severe stunting were significantly higher among boys. Multivariate regression analysis indicates that children from the Eastern/Western regions had a 64% higher odds of being stunted than children from the Central region (OR 1.64; 95% CI 1.29–2.07); similarly, children from the two lower wealth quintiles had 37% higher odds of being stunted than children from the two upper wealth quintiles (OR 1.37; 95% CI 1.00–1.87). Children whose mothers received three or fewer antenatal care visits during the last pregnancy had a 31% higher odds of being stunted (OR 1.31; 95% CI 1.01–1.69) while children whose mothers did not receive antenatal care from a doctor, nurse or midwife had a 51% higher odds of being stunted (OR 1.51; 95% CI 1.18–1.92). Recommended complementary feeding practices tended to be associated with lower odds of stunting, particularly in the first year of life. Specifically, children who were not fed complementary foods at 6–8 months had about threefold higher odds of being severely stunted than children who were fed complementary foods (OR 2.73; 95% CI 1.06–7.02).

Keywords: stunting, growth, height, children, feeding, Bhutan.

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Introduction

Global estimates show that 26% of children under age 5 (i.e. 165 million) have stunted growth due to chronic nutrition deprivation. The same sources indicate that stunting is the cause of an estimated 1 million child deaths annually (Black *et al*. 2013). In addition, stunting in early childhood is associated with adverse functional consequences, including poor cognition and educational performance, reduced lean body mass, short adult stature, lower productivity, reduced earnings and, when accompanied by excessive weight gain later in childhood, increased risk of chronic diseases (Victora *et al*. 2008; Dewey & Begum 2011; Black *et al*. 2013).

South Asia is at the epicentre of the global child stunting crisis. According to UNICEF, 38% of South Asia's underfives are stunted. Levels of child stunting in South Asia are comparable to those in sub-Saharan Africa (38%) and three times higher than those in East Asia and the Pacific (12%) or Latin America (11%) (UNICEF 2014). The Royal Kingdom of

Bhutan – or Druk Yul (Land of the Thunder Dragon) – is no exception. Bhutan's Multiple Indicator Survey (BMIS) in 2010, the latest nationally representative survey on the nutrition situation of children in Bhutan, indicated that one-third (33.5%) of the country's 0–59-month-old children were stunted (height-for-age < –2 SD) (Bhutan National Statistics Bureau, United Nations Children's Fund, United Nations Population Fund 2011). Thus, Bhutan falls in the category of countries with a high prevalence of stunting in children under 5 (range 30.0–39.9%) (De Onis *et al*. 2012).

Globally, it is acknowledged that most stunting in low-income and middle-income countries happens during the 1000-day period that spans from conception to age 2 years of life (Dewey & Vitta 2013). BMIS showed a steep rise in the prevalence of stunting during the first 24 months of life – from 18.7% in children 0–11 months old to 35.9% in children 12–23 months old – levelling off thereafter (37.4% in children 24–59 months old).

Thus, the objective of our analysis is threefold: (1) to characterise the epidemiology of stunting in infants and young children 0–23 months old in Bhutan; (2) to identify the factors that are most significantly associated with stunting in Bhutanese children 0–23 months old; and (3) to identify priority areas for policy, programme and research in the context of the post-2015 agenda for children.

Methods

We use data from BMIS, which are available for public use (UNICEF 2011). BMIS – the customised version of UNICEF's Multiple Indicator Cluster Survey with the addition of the Demographic and Health Survey (DHS) to suit the data needs of Bhutan – is a nationally representative household survey conducted by Bhutan's National Statistics Bureau in 2010. The sample for BMIS was designed to provide estimates for indicators on the situation of women and children living in urban and rural areas in the three regions (Central, Eastern and Western) and 20 Dzongkhags (districts) of the country.

A detailed description of the survey design, sample selection, survey tools and data collection can be found elsewhere (Bhutan National Statistics Bureau, United Nations Children's Fund, United Nations Population Fund 2011). In brief, the urban and rural areas within each Dzongkhag were identified as the main sampling strata and the sample was selected in two stages. Within each stratum, a specified number of Chiwogs (municipalities) in the rural areas and blocks in the urban areas were randomly selected as enumeration areas with probability proportional to size. Household listing was carried out within the selected enumeration areas and a systematic random sample of 20 households was drawn in each enumeration area.

Three questionnaires were used in the survey: (1) the household questionnaire to collect information on all *de jure* (usual residents) household members, the household and the dwelling; (2) the women's questionnaire administered in each household to all women aged 15–49 years old; and (3) the children questionnaire administered to mothers or caretakers in the household. The survey received ethical clearance from the Research Ethics Board of Health and the National Statistical Bureau. Data collection took place from April to August 2010. Individual consent to participate in the survey was given by the child's caregiver; 15 400 households were included in the

Key messages

- Over a quarter (27.5%) of Bhutanese children 0–23 months old were stunted and almost half (42.6%) of the stunted children were severely stunted.
- The odds of stunting were highest among children from households in the two poorer wealth quintiles and those from the Eastern and Western regions.
- Use of antenatal/delivery health care by women and age-appropriate complementary feeding in the first year of life were protective against stunting.
- Poor complementary feeding may be a major determinant of stunting in Bhutan. Filling the knowledge gap on the quality of complementary feeding practices is an urgent priority.

survey, which achieved a household response rate of 98.4% and a child response rate of 97.5%.

For our analysis, data from the child data set, which contains one record for every eligible child born in the 5 years prior to the survey (children 0–59 months of age), were adjusted for cluster sampling and sampling weights. The analysis included children between the ages of 0 and 23 months. Children with missing or implausible anthropometric data were not included in the analytical sample. Stunting and severe stunting were defined, respectively, as the proportion of children whose height-for-age *z*-score (HAZ) was below –2 (moderate and severe stunting) or below –3 (severe stunting) standard deviations of the median height-for-age of the World Health Organization Child Growth Standards (WHO 2006).

Analyses were performed using Stata statistical software (StataCorp., 4905 Lakeway Drive, College Station, Texas 77845 USA), Release 12, 2011. We used sample weights to adjust standard errors for the complex survey design of BMIS. In models using stunting or severe stunting as the dependent variables, we report on odds ratios and 95% confidence intervals from logistic regression models. In models that regressed the exposure variables on linear growth (HAZ) as the outcome variable, we report on regression coefficients and 95% confidence intervals around point estimates from multiple linear regression. For all tests, *P*-values< 0.05 were considered statistically significant.

Findings

The survey included a representative sample of 2404 children 0–23 months old. The analysis presented here pertains to the 2085 children (86.7%) for whom information on height – and therefore on HAZ, stunting and severe stunting – was available. For 46 children, information on mother's age, marital union, household head's education, and/or asset observation was missing either because the mother/caregiver was not at home at the time of the interview (41 cases) or was not able or refused to provide the information (5 cases). Of these 46 children, 20 were stunted and 26 were not stunted. Thus, we assumed that these observations were randomly distributed across the sample.

Table 1 summarises the socio-economic characteristics of the children included in the analysis. The following findings are of particular relevance to our analysis: 72.2% of children were weighed at birth; of them, 8.3% had a low birthweight (<2500 g); 6.5% were born to adolescent mothers (15–19 years old) and 33.4% were born to mothers who were married or entered a marital union before age 18; over 60% were born to mothers and/or household heads with no formal education (62.3% and 64.3%, respectively); over one-third (36.7%) lived in households that used unimproved sanitation facilities; over one-third (37.2%) were born to mothers who did not receive antenatal care from a doctor, nurse, midwife or skilled personnel; and more than half (58.1%) were born to mothers whose last delivery was not attended by a doctor, nurse, midwife or skilled personnel.

Table 2 summarises feeding practices among the children included in the analysis. The following findings are of particular relevance: only 58.3% of children were breastfed within 1 h of birth; less than half (44.6%) of infants 0–5 months old were exclusively breastfed; 70.6% of infants 6–8 months old were fed complementary foods and only 71.2% of children 6–23 months old were fed a minimum number of times per day (68.1% among children 12–23 months old); and almost all children (93.8%) continued to be breastfed at 1 year while only two-thirds (66.5%) continued to be breastfed at 2 years.

Bivariate analysis: associations between exposure and outcome variables

Table 3 indicates that the prevalence of stunting in children 0–23 months old was 27.5% while the prevalence of severe stunting was 11.7%: thus, 42.6% of the stunted children were severely stunted. The prevalence of severe stunting was significantly higher among boys than girls (13.7% vs. 9.7%) and the proportion of stunted boys who were severely stunted was significantly higher than the proportion of stunted girls who were severely stunted (47.9% vs. 39.6%, respectively). Age-wise, the prevalence of stunting was significantly higher among children 12–23 months old than among infants 0–11 months old (36.7% vs. 17.7%) and so was the prevalence of severe stunting (14.3% vs. 9.0%)

Table 1. Distribution of children 0–23 months old by socio-economic characteristics. Bhutan, 2010

	Proportion (%)	Number (*N*)
Birthweight		
Weighed at birth	72.2	1422
Not weighed at birth	27.8	548
Birthweight ≥ 2500 g	91.7	1297
Birthweight < 2500 g	8.3	118
Mother's age (years)		
15–19	6.5	132
20–24	28.8	587
25–29	31.5	643
29–39	28.2	576
≥40	5.0	101
Mother's education		
None	62.3	1298
Primary education	14.4	301
Secondary education	23.3	486
Education of HH head		
None	64.3	1334
Primary education	14.7	305
Secondary education	21.0	436
Number of HH members		
≤4	28.7	596
>4	71.3	1479
Mother's marital union		
Married/in union	94.1	1919
Widowed/divorced/separated/never married/never in union	5.9	120
Water, hygiene and sanitation in the HH		
HH uses improved sources of drinking water	96.0	1993
HH uses an improved sanitation facility	63.3	1314
HH has a place for handwashing with water and soap available	75.7	1574
Mother's contraception		
Mother (or her partner) uses a contraceptive method	64.0	1276
Mother's ANC		
ANC during last pregnancy provided by a doctor/nurse/midwife	62.8	1207
ANC care during last pregnancy provided by others	37.2	715
ANC visits during last pregnancy ≤3	22.9	437
ANC visits during last pregnancy ≥4	77.1	1474
Assistance at/place of last delivery		
Assisted by a doctor/nurse/midwife/skilled personnel	41.9	828
Not assisted by a doctor/nurse/midwife/skilled personnel	58.1	1147
Took place in a health facility (public or private)	60.2	1188
Took place at home/other than a health facility (public/private)	39.8	786
Early marriage		
Mother was married or entered a marital union before age 18 years	33.4	674

ANC, antenatal care; HH, household.

(data not presented). The mean HAZ deteriorated significantly with children's age, declining from –0.23 in infants 0–5 months old to –1.60 in children 18–23 months old (Figs 1,2).

The prevalence of stunting was significantly higher in rural than in urban areas (28.5% vs. 25.0%). Regionally, the prevalence of stunting and severe stunting was highest in the Eastern region (32.9% and 14.3%, respectively) and lowest in the Central region (20.1% and 7.4%, respectively). Similarly, the proportion of stunted children was significantly higher in the two poorer wealth quintiles than in the two richer wealth quintiles (31.7% vs. 21.4%, respectively; data not presented) (Table 3).

Table 2. Breastfeeding and complementary feeding practices in children 0–23 months old. Bhutan, 2010

	Proportion (%)	Number (*N*)
Breastfeeding practices		
% of children 0–23 months old breastfed within 1 h of birth	58.3	1201
% of children 0–23 months old breastfed within 1 day of birth	93.8	1828
% of children 0–23 months old who received prelacteal feeds	8.3	181
% of children <6 months old who are exclusively breastfed	46.6	194
% of children <6 months old who are predominantly breastfed	65.3	281
% of children 12–15 months old who are breastfed	93.8	331
% of children 20–23 months old who are breastfed	66.5	224
% of children 0–23 months old who are appropriately breastfed	67.4	1380
Complementary feeding practices		
% of children 6–8 months old who are fed complementary foods	70.6	219
% of children 6–23 months old who are breastfed and receive CFoods	76.1	1225
% of children 6–23 months old who receive CFoods a minimum number of times per day	71.2	970
% of children 6–11 months old who receive CFoods a minimum number of times per day	78.6	317
% of children 12–23 months old who receive CFoods a minimum number of times per day	68.1	653
% of children 0–23 months old who are fed with a bottle with a nipple	11.4	231

CFoods, complementary foods.

Table 4 indicates that linear growth (HAZ) was significantly poorer among children with a birthweight < 2500 than among those with a birthweight ≥ 2500 g (–1.03 vs. –0.86, respectively). Linear growth tended to be poorer and the prevalence of stunting tended to be higher where feeding practices, access to health services, parental education, and/or sanitation were poor (Tables 4,5).

Feeding

The prevalence of stunting was significantly higher among children who were breastfed within 1 h of birth, were exclusively or predominantly breastfed in the first 6 months of life, and/or were not fed complementary foods in a timely manner.

Health

The prevalence of stunting was significantly higher among children born to mothers who benefited from few (≤3) antenatal visits; did not receive antenatal care from a doctor, nurse or midwife; did not deliver in a health facility; or were not attended by a doctor, nurse or midwife.

Education

The prevalence of stunting was significantly higher among children whose mothers entered a marital union before they were 18 years old, mothers without any formal education, and/or born to families where the household head did not have any formal education.

Sanitation

The prevalence of stunting was significantly higher among children from larger households (>4 members) and those living in households that used unimproved sanitation facilities.

Multivariate regression analysis: identifying the main determinants of child stunting in Bhutan

Multivariate regression analysis – after controlling for potential confounding – indicated that two child variables were significantly associated with stunting: age and sex. Children 12–23 months old had a threefold odds of being stunted (OR 3.11; 95% CI 2.45–3.94) and a twofold odds of being severely stunted (OR 2.15; 95% CI 1.55–2.96) than infants 0–11 months old. Similarly, boys had a 42% higher odds of being severely stunted than girls (OR 1.42; 95% CI 1.04–1.94) (Table 6).

Two household variables were significantly associated with child stunting: region and wealth index. Children from the East/Western regions had a 64% higher odds of being stunted (OR 1.64; 95%

Table 3. Prevalence of stunting/severe stunting and mean HAZ in children 0–23 months old by sex, age, residence and wealth quintile. Bhutan, 2010

	Proportion (%) of children stunted (HAZ < –2)	Proportion (%) of children severely stunted (HAZ < –3)	Proportion (%) of stunted children severely stunted	Children's mean HAZ	Number (*N*)
Gender					
Male	29.5	13.7	46.4	–0.93	1080
Female	25.5	9.7	38.1	–0.92	1005
P-value	0.06	0.02		0.56	
Age (months)					
0–5	20.4	9.4	45.8	–0.23	479
6–11	15.3	8.8	57.2	–0.45	534
12–17	34.1	11.8	34.5	–1.35	545
18–23	39.4	16.9	42.9	–1.60	527
P-value	0.00	0.00		0.00	
Residence					
Urban	25.0	13.2	53.0	–0.86	468
Rural	28.5	11.1	38.8	–0.95	1617
P-value	0.01	0.40		0.11	
Region					
Western	28.9	12.7	43.8	–0.90	688
Central	20.1	7.4	36.8	–0.77	843
Eastern	32.9	14.3	43.4	–1.12	554
P-value	0.00	0.00		0.00	
Wealth index					
Poorest	31.1	10.0	32.2	–1.22	413
Second	32.3	13.4	41.6	–1.03	446
Middle	30.0	13.3	44.4	–1.01	438
Fourth	22.9	9.6	41.8	–0.75	413
Richest	19.6	11.4	58.2	–0.54	329
P-value	0.00	0.02		0.00	
Total	27.5	11.7	42.6	–0.92	2085

HAZ, height-for-age *z*-score.

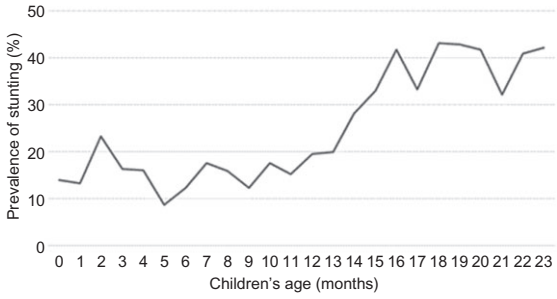

Fig. 1. Prevalence of stunting in children 0–23 months old. Bhutan, 2010.

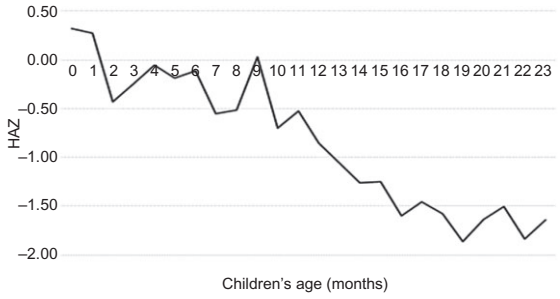

Fig. 2. Height-for-age *z*-score in children 0–23 months old. Bhutan, 2010.

CI 1.29–2.07) and double the odds of being severely stunted (OR 2.12; 95% CI 1.51–2.99) than children from the Central region. Similarly, children from the two lower wealth quintiles had a 37% higher odds of being stunted (OR 1.37; 95% CI 1.01–1.87) and 88% higher odds of being severely stunted (OR 1.88; 95% CI 1.19–2.96) than children from the two higher wealth quintiles (Table 6).

Two maternal variables were significantly associated with child stunting: antenatal care and assistance

Table 4. Prevalence of stunting/severe stunting and mean HAZ in children 0–23 months old by socio-economic characteristics. Bhutan, 2010

	Proportion (%) of children stunted (HAZ < –2)	Proportion (%) of children severely stunted (HAZ < –3)	Proportion (%) of stunted children severely stunted	Children's mean HAZ
Birthweight				
Weighed at birth	26.3	12.1	46.1	–0.86
Not weighed at birth	29.5	10.3	35.0	–1.03
P-value	0.06	0.32		0.01
Birthweight ≥ 2500 g	25.8	11.4	44.4	–0.82
Birthweight < 2500 g	31.9	20.0	62.9	–1.31
P-value	0.29	0.18		0.01
Mother's age (years)				
15–19	18.1	5.5	30.2	–0.62
20–24	29.1	13.7	47.2	–1.05
25–29	24.2	11.5	47.6	–0.80
29–39	29.1	11.4	39.1	–0.92
≥40	24.6	7.1	28.9	–0.90
P-value	0.25	0.35		0.05
Mother's education				
None	29.2	11.8	40.4	–0.98
Primary	25.8	8.4	32.5	–0.84
Secondary	22.3	13.5	60.4	–0.80
P-value	0.00	0.06		0.00
HH head's education				
None	29.2	10.5	36.0	–0.97
Primary	25.6	12.1	47.3	–1.00
Secondary	22.9	14.4	62.9	0.14
P-value	0.00	0.90		0.00
Number of HH members				
≤4	23.6	12.3	52.1	–0.84
>4	28.7	11.5	40.1	–0.95
P-value	0.00	0.42		0.07
Mother's marital union				
Married/in union	26.5	16.5	62.3	–0.88
Not married/in union	28.9	11.3	39.1	–1.29
P-value	0.19	0.07	36.84	0.01
HH water, sanitation and hygiene				
HH uses improved sources of drinking water	27.0	11.8	43.7	–0.92
HH uses unimproved sources of drinking water	27.3	11.1	40.7	–0.74
P-value	0.76	0.36		0.71
HH uses improved sanitation facilities	25.8	12.3	47.7	–0.85
HH uses unimproved sanitation facilities	29.5	10.7	36.3	–1.04
P-value	0.00	0.31		0.00
HH has place for handwashing; water + soap available	27.0	12.2	45.2	–0.91
HH has no place for handwashing; water/soap not available	27.8	10.4	37.4	–0.99
P-value	0.68	0.87		0.65
Mother (or partner's) use of contraception				
Mother (or partner) uses contraception	23.7	10.9	45.9	–0.99
Mother (or partner) does not use contraception	28.4	12.0	42.2	–0.72
P-value	0.19	0.86		0.02
Mother's use of ANC				
ANC was provided by a doctor/nurse/midwife	24.4	11.9	48.8	–0.8
ANC was provided by others	31.5	11.7	37.3	–1.09
P-value	0.00	0.42		0.00
ANC visits during the last pregnancy ≤3	32.3	16.1	49.8	–0.85
ANC visits during the last pregnancy ≥4	25.3	10.8	42.7	–1.11
P-value	0.00	0.00		0.01
Mother's assistance at/place of delivery				
Mother's last delivery was assisted by a doctor/nurse/midwife	27.0	13.8	51.1	–0.96
Mother's last delivery was not assisted by a doctor/nurse/midwife	27.4	10.1	36.7	–0.87
P-value	0.05	0.66		0.31
Mother's place of delivery				
Mother delivered her last child in a health facility (public or private)	25.6	12.1	47.3	–0.84
Mother delivered her last child at home/not in a facility (public or private)	29.3	11.1	37.9	–1.04
P-value	0.00	0.03		0.00
Early marriage				
Mother was married or entered a marital union before age 18	30.1	10.8	36.0	–0.99
Mother was married or entered a marital union at age ≥18	24.8	11.8	47.6	–0.85
P-value	0.01	0.73		0.05

ANC, antenatal care; HAZ, height-for-age *z*-score; HH, household.

Table 5. Prevalence of stunting/severe stunting and mean height-for-age (HAZ) in children 0–23 months old by feeding practices. Bhutan, 2010

	Proportion (%) of children stunted (HAZ < –2)	Proportion (%) of children severely stunted (HAZ < –3)	Proportion (%) of stunted children severely stunted	Children's mean HAZ
Breastfeeding practices				
Breastfed within 1 h of birth	29.2	13.1	44.9	–1.0
Not breastfed within 1 h of birth	24.3	9.4	38.7	–0.8
P-value	0.00	0.01		0.01
Breastfed within 1 day of birth	27.3	11.3	41.5	–1.0
Not breastfed within 1 day of birth	24.4	14.1	57.9	–0.9
P-value	0.20	0.78		0.78
Received prelacteal feeds	23.8	13.9	58.5	–0.9
Did not receive prelacteal feeds	27.8	11.5	41.4	–1.0
P-value	0.21	0.59		0.89
Is exclusively breastfed (0–5 months)	25.1	10.4	41.4	–0.4
Is not exclusively breastfed (0–5 months)	16.3	8.4	51.5	–0.1
P-value	0.00	0.12		0.02
Is predominantly breastfed (0–5 months)	24.6	11.4	46.3	–0.4
Is not predominantly breastfed (0–5 months)	12.5	5.6	44.8	0.02
P-value	0.01	0.12		0.35
Is breastfed (12–15 months)	30.4	9.4	30.8	–1.2
Is not breastfed (12–15 months)	33.2	22.8	68.6	–1.6
P-value	0.29	0.37		0.37
Is breastfed (20–23 months)	31.6	13.8	43.6	–1.6
Is not breastfed (20–23 months)	38.7	14.0	36.1	–1.4
P-value	0.12	0.14		0.03
Is appropriately breastfed (0–23 months)	28.5	11.7	41.1	–1.0
Is not appropriately breastfed (0–23 months)	25.4	11.6	45.7	–0.8
P-value	0.00	0.01		0.00
Complementary feeding practices				
Receives complementary foods (6–8 months)	12.5	7.6	60.8	–0.3
Does not receive complementary foods (6–8 months)	23.0	16.9	73.4	–0.7
P-value	0.04	0.07		0.04
Is breastfed and receives CFoods (6–23 months)	28.9	11.7	40.5	–1.1
Is not breastfed and/or does not receive CFoods (6–23 months)	31.2	14.8	47.4	–1.3
P-value	0.09	0.47		0.08
Receives CFoods a minimum number of times per day (6–23 months)	29.1	13.0	44.7	–1.1
Does not receive CFoods a minimum number of times per day	32.2	11.1	34.5	–1.2
P-value	0.26	0.57		0.19
Is fed with a bottle with a nipple (0–23 months)	25.8	12.2	47.3	–1.0
Is not fed with a bottle with a nipple (0–23 months)	30.3	12.5	41.3	–1.2
P-value	0.44	0.52		0.96

CFoods, complementary foods; HAZ, height-for-age *z*-score.

Table 6. Adjusted OR of child, maternal and household characteristics in relation to stunting and severe stunting for children 0–23 months old. Bhutan, 2010

	Stunting Adjusted OR (95% CI)	Severe stunting Adjusted OR (95% CI)
Age (months)		
0–11	1.0 (Reference)	1.0 (Reference)
12–23	3.11	2.14
	2.45–3.94	1.55–2.96
Gender		
Female	1.0 (Reference)	1.0 (Reference)
Male	1.22	1.42
	0.98–1.53	1.04–1.94
Residence		
Urban	1.0 (Reference)	1.0 (Reference)
Rural	1.01	0.88
	0.72–1.42	0.55–1.39
Region		
Central	1.0 (Reference)	1.0 (Reference)
Eastern/Western	1.64	2.12
	1.29–2.07	1.51–2.99
Wealth index		
Richer/Richest	1.0 (Reference)	1.0 (Reference)
Poorer/Poorest	1.37	1.88
	1.01–1.87	1.19–2.96
Mother's education		
Secondary	1.0 (Reference)	1.0 (Reference)
None	0.84	0.63
	0.61–1.17	0.41–0/97
Household head's education		
Secondary	1.0 (Reference)	1.0 (Reference)
None	1.16	0.86
	0.82–1.64	0.54–1.38
Number of household members		
≤4	1.0 (Reference)	1.0 (Reference)
>4	1.09	0.96
	0.84–1.43	0.67–1.38
Water, hygiene and sanitation		
Household uses unimproved sanitation facilities	1.0 (Reference)	1.0 (Reference)
Household uses improved sanitation facilities	0.99	1.09
	0.77–1.27	0.77–1.55
Who provides antenatal care		
Antenatal care was provided by a doctor/nurse/midwife	1.0 (Reference)	1.0 (Reference)
Antenatal care was provided by others	1.51	0.99
	1.18–1.92	0.70–1.42
Number of antenatal care visits		
Number of antenatal care visits during the last pregnancy ≥4	1.0 (Reference)	1.0 (Reference)
Number of antenatal care visits during the last pregnancy ≤3	1.31	1.60
	1.01–1.69	1.13–2.26
Mother's assistance at delivery		
Mother's last delivery was assisted by a doctor/nurse/midwife	1.0 (Reference)	1.0 (Reference)
Mother's last delivery was not assisted by a doctor/nurse/midwife	0.88	0.73
	0.66–1.17	0.50–1.08
Mother's place of delivery		
Mother delivered her last child in a health facility (public or private)	1.0 (Reference)	1.0 (Reference)
Mother delivered her last child at home/not in a facility	1.17	1.54
	0.86–1.60	1.02–2.32
Early marriage		
Mother was married or entered a marital union at age ≥18	1.0 (Reference)	1.0 (Reference)
Mother was married or entered a marital union before age 18	1.25	1.00
	0.98–1.58	0.71–1.40
Early initiation of breastfeeding		
Breastfed within 1 h of birth	1.0 (Reference)	1.0 (Reference)
Not breastfed within 1 h of birth	0.76	0.62
	0.60–0.95	0.44–0.86
Age-appropriate breastfeeding (months)		
Is appropriately breastfed (0–23)	1.0 (Reference)	1.0 (Reference)
Is not appropriately breastfed (0–23)	0.78	0.83
	0.61–1.00	0.58–1.17

OR, odds ratio.

at delivery. Children whose mothers received three or fewer antenatal care visits during the last pregnancy had a 31% higher odds of being stunted (OR 1.31; 95% CI 1.01–1.69); children whose mothers received antenatal care other than from a doctor/nurse/midwife had a 51% higher odds of being stunted (OR 1.51; 95% CI 1.18–1.92); and children whose mothers delivered at home/not in a facility had a 54% higher odds of being severely stunted (OR 1.54; 95% CI 1.02–2.32) (Table 6).

Children who were not breastfed within 1 h of birth had a lower odds of being stunted than their peers (OR 0.76; 95% CI 0.60–0.95; Table 6). Infants 0–11 months old who were not appropriately breastfed for their age (exclusive breastfeeding for infants < 6 months old and non-exclusive breastfeeding for children 6–23 months old) had a lower odds of being stunted (OR 0.54; 95% CI 0.36–0.82; data not presented); this was largely due to the significantly lower odds of stunting in infants 0–5 months old who were not exclusively breastfed (OR 0.40; 95% CI 0.19–0.82; data not presented). Conversely, infants 0–11 months old who were not appropriately complementary fed (no complementary feeding for infants <6 months old and complementary feeding for children 6–23 months old) for their age had a higher odds of being stunted (OR 1.81; 95% CI 1.23–2.66) or severely stunted (OR 1.73; 95% CI 1.03–2.93); this was largely due to the ~3-fold higher odds of severe stunting in infants 6–8 months old who were not fed complementary foods in a timely manner (OR 2.73; 95% CI 1.06–7.02) (data not presented).

The models regressing the exposure variables on linear growth (HAZ) indicated that the likelihood of poor linear growth was significantly higher among children from the Eastern and Western regions, children from the two poorer wealth quintiles, children born to mothers who received prenatal care other than from a doctor/nurse/midwife, and children born to mothers who gave birth at home and/or whose delivery was not assisted by a doctor/nurse/midwife ($P < 0.05$) (Table 7).

Table 7. Associations between exposure variables and linear growth measured as HAZ in children 0–23 months old. Bhutan, 2010

Independent variable	Coefficient
Age	
0–11 months vs. 12–23 months	1.21*** (1.05 to 1.37)
Residence	
Rural vs. urban	–0.22 (–0.01 to 0.45)
Region	
Eastern/Western vs. Central	–0.24** (–0.40 to –0.08)
Wealth index	
Poorer/Poorest vs. richer/richest	–0.37*** (–0.60 to –0.15)
Mother's education	
None vs. secondary	0.17 (–0.06 to 0.40)
Household head's education	
None vs. secondary	–0.22 (–0.46 to 0.03)
Marital status	
Married/in union vs. not married/in union	0.26 (–0.10 to 0.62)
Number of household members	
≤4 vs. <4	0.07 (–0.11 to 0.26)
Water, hygiene and sanitation	
Unimproved sanitation vs. improved sanitation	0.05 (–0.13 to 0.23)
Who provides antenatal care	
Other than a doctor/nurse/midwife vs. doctor/nurse/midwife	(–0.31)*** (–0.49 to –0.14)
Number of antenatal care visits	
≤3 vs. ≥4	–0.16 (–0.36 to 0.04)
Early marriage	
Mother married <18 vs. ≥18	–0.08 (–0.24 to 0.09)
Mother's assistance at delivery	
Not a doctor/nurse/midwife vs. a doctor/nurse/midwife	0.23** (0.02 to 0.44)
Mother's place of delivery	
Not in a health facility vs. in a health facility	–0.25** (–0.48 to –0.02)
Early initiation of breastfeeding	
Not within 1 h of birth vs. within 1 h of birth	0.14 (–0.02 to 0.30)
Appropriate breastfeeding	
Is appropriately breastfed vs. not	–0.18 (–0.41 to 0.04)
Age-appropriate complementary feeding	
Is appropriately complementary fed vs. not	–0.12 (–0.35 to 0.11)

HAZ, height-for-age *z*-score. ***$P < 0.01$; **$P < 0.05$.

Discussion

The prevalence of stunting in Bhutanese children under 5 declined from 61% in 1988 (Zangmo *et al.*

2012) to 48% in 1999 (Ministry of Health, Royal Kingdom of Bhutan 1999) and further to 35% in 2008 (Ministry of Health, Royal Kingdom of Bhutan 2008). In 2010, BMIS showed that by age 24 months, 35.9% of children had stunted growth (Bhutan National Statistics Bureau, United Nations Children's Fund, United Nations Population Fund 2011), indicating that stunting sets very early in children's life. We used data from BMIS to characterise the epidemiology of stunting in infants and young children 0–23 months old in Bhutan, identify the factors that are most significantly associated with stunting in Bhutanese children 0–23 months old, and, on the basis of these findings, prioritise areas for policy, programme and research action.

We find that over one-fourth (27.5%) of Bhutanese children under 2 were stunted and almost half (42.3%) of the stunted children were severely stunted. The mean HAZ deteriorated with children's age, and the prevalence of stunting in infants 0–11 months old was significantly lower than in children 12–23 months old (17.7% vs. 36.7%). Studies in nine countries in Africa, Asia and the Caribbean have reported similar findings (Jones *et al*. 2014), reflecting the chronic/cumulative nature of nutrition deprivation in infancy and early childhood. Multivariate regression analysis indicated that the odds of severe stunting were significantly higher in boys than in girls. Studies in Bangladesh, Ghana and Indonesia, among others, have also documented a 10–30% higher odds of stunting in boys than in girls (Hong 2007; Semba *et al*. 2008).

Poor linear growth and stunting in children were particularly prevalent in the Eastern/Western regions – where the odds of severe stunting in children were double than in the Central region – and among children from the poorer wealth quintiles, with about twice the odds of severe stunting than in children from the richer quintiles. Studies in Asia and Africa have shown that – like in the present case in Bhutan – children from the poorer households had significantly higher odds of stunted growth even after adjustment for other household, maternal and child variables (Hong *et al*. 2006; Hong 2007).

Women's access to maternity health care emerges as key predictor of poor linear growth and stunting in children. Children whose mothers had less/no access to health services during pregnancy and/or delivery had poorer linear growth and higher odds of stunting. Studies in Bangladesh have also indicated that the odds of stunting were higher in children whose mothers did not receive antenatal care and/or were not attended by a skilled health professional when they gave birth (Hong *et al*. 2006).

The inverse association of the breastfeeding variables with child stunting is counter-intuitive. However, studies in other countries have found that breastfeeding indicators were associated with stunting and/or poorer linear growth (HAZ) in children; for example, studies in Bangladesh and Ghana have reported higher stunting rates in children who were exclusively breastfed for a longer time or breastfed beyond 11 months (Hong *et al*. 2006; Hong 2007); a recent analysis of DHS data in India has shown that indicators of optimal breastfeeding were not positively associated with children's linear growth and/or a reduced odds of stunting (Menon *et al*. 2013); finally, a multi-country analysis of DHS data to assess the association of WHO's infant and young child feeding indicators with child anthropometry in nine countries has shown negative associations between breastfeeding indicators and child growth: exclusive breastfeeding under 6 months was negatively associated with HAZ in seven of the nine data sets and was significant in Ethiopia and Kenya; continued breastfeeding at 1 year was negatively associated with HAZ in all countries and was significant in Ethiopia and Zimbabwe (Jones *et al*. 2014). The association of early initiation of breastfeeding with higher odds of stunting in the first 2 years of life is counter-intuitive and deserves further investigation. However, this finding should not be interpreted to mean that early initiation of breastfeeding is not important for child well-being, as the neonatal and infant survival benefits of early initiation of breastfeeding are well established (Edmond *et al*. 2006, 2007, 2008; Mullany *et al*. 2008).

Conversely, in our analysis, the timely introduction of complementary foods and age-appropriate complementary feeding practices in infancy were positively associated with a lower odds of stunting in Bhutanese children. Studies have indicated that

complementary feeding indicators are positively associated with HAZ and a reduced risk of stunting; in Zambia, the timely introduction of solid foods was positively associated with HAZ (Ali *et al*. 2012), while in Bangladesh it was positively associated with HAZ and a reduced odds of stunting in children 6–8 months old (Zongrone *et al*. 2012). A minimum diet diversity in children 6–23 months old was positively associated with HAZ in Bangladesh and India and with lower odds of stunting in India (Zongrone *et al*. 2012; Menon *et al*. 2013). More importantly, one recent study including pooled data from 14 low-income countries found that all of the WHO indicators on complementary feeding (except the indicator defining minimum meal frequency) were associated with a significantly lower probability of a child being stunted (Marriot *et al*. 2012).

Conclusion

Our analysis indicates that a significant proportion of Bhutanese children fail to achieve their growth and development potential as indicated by the high levels of stunting and severe stunting in infants and young children 0–23 months old.

Our analysis of the epidemiology – extent, severity, distribution and drivers – of child stunting in Bhutan provides national leaders and programme managers with important insights for the effective allocation of human and financial resources to policies and programmes aiming to improve linear growth and reduce stunting in children. Our analysis indicates that such policies and programmes need to prioritise three groups of children and women, particularly in the Eastern and Western regions: (1) the youngest: children under 2 (and children born to women who were married before age 18); (2) the poorest: children under 2 in the poorer wealth quintiles and their mothers; and (3) the excluded: children and women without access to essential nutrition, health and care services.

Finally, it will be important to develop a better understanding of the prevailing infant and young child feeding practices in the country and how these relate to children's growth and development in the first 2 years of life. Evidence shows that the largest proportion of stunting in low-income countries occurs during the complementary feeding period (6–23 months), the ~500 day transition time from exclusive breastfeeding to consuming a wide range of family foods while breastfeeding continues (WHO 1998). Our analysis indicates that the mean HAZ of Bhutanese children deteriorated by a factor of 7 (from –0.23 to –1.60) over the complementary feeding period, suggesting that poor complementary foods and feeding practices may be major determinants of stunted growth in Bhutan. Yet, to the best of our knowledge, no population-based representative data have ever been collected on the quality of complementary foods and feeding practices in infants and young children in Bhutan. In the context of the post-2015 agenda for children, filling this knowledge gap appears as an urgent priority if Bhutan is to design and implement successful evidence-based programmes to prevent child stunting and its associate consequences.

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Conflicts of interest

The authors declare that they have no conflict of interest. The opinions expressed on this paper are those of the authors and do not necessarily represent an official position by UNICEF.

Contributions

VMA designed the study, led data analysis, data interpretation and manuscript writing. NB led data management. KP contributed to manuscript writing. All authors have read and approved the final manuscript.

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