Risk factors for undernutrition among children 0–59 months of age in Myanmar

Yunhee Kang¹ | Jihye Kim²

¹ Center for Human Nutrition, Johns Hopkins School of Public Health, Baltimore, Maryland, USA

² Department of Medical Nutrition, Graduate School of East-West Medical Science, Kyung Hee University, Yongin, South Korea

Correspondence

Jihye Kim, PhD, Department of Medical Nutrition, Graduate School of East-West Medical Science, Kyung Hee University, 1732 Deogyong-daero, Giheung-gu, Yongin, Gyeonggi-do 17104, South Korea.
Email: kjhye@khu.ac.kr

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Abstract

The prevalence of childhood stunting in Myanmar is one of the highest among the countries of Southeast Asia. Cross-sectional data from the Myanmar Demographic Health Survey 2015–2016 were used to examine risk factors for stunting, wasting, and underweight among children aged 0–59 months. The prevalence of stunting, wasting, and underweight was 29.0%, 7.3%, and 19.2%, respectively. Accounting for sampling design and weights, multivariable logistic regression was conducted with 35 household, maternal, and child characteristics. Current pregnancy and maternal height <145 cm, home delivery, child's small birth size recalled by mother, and older age (ref: 0–5 months) predicted both stunting and underweight. Larger than average birth size was protective for all stunting, wasting, and underweight. Maternal body mass index <18.5 kg m⁻² was a common risk factor for wasting and underweight. Lower wealth quintiles, maternal engagement in nonagricultural occupation, and male child predicted stunting only. Younger child age and not receiving vitamin A supplementation in the previous 6 months were risk factors for wasting only. Regional variation was also seen, with a higher odds of stunting in the West-South Region, North-East States, and West States, compared with the Central Regions. In Myanmar, socio-economic and demographic factors, poor maternal nutritional status, and living in certain geographical locations are affecting children's undernutrition. It is recommended that interventions for growth faltering focus on the first 1,000 days of life; optimum maternal nutrition be ensured during and before pregnancy and at adolescence; societal support be provided for mothers in poverty or engaged in nonagriculture; and region-specific undernutrition pathways be understood.

KEYWORDS

children, Myanmar, risk factor, Southeast Asia, stunting, wasting

1 | INTRODUCTION

Stunting in early childhood leads to an increased risk of mortality and infectious morbidity, poor cognitive development among toddlers, and an increased risk of noncommunicable diseases and poor productivity during adulthood (Black et al., 2008). Globally, 151 million children under 5 years old were stunted in 2018, and

out of them, approximately 10% (14.9 million) were found in Southeast Asia (UNICEF, World Health Organization [WHO], & World Bank, 2018).

Myanmar is a lower middle-income country, with a gross national income per capita of \$5,530 that demonstrates poor human development with a rank of 145 out of 188 countries in 2015 (United Nations Development Programme, 2016). Under a

military regimen for six decades, the country underwent worsening of overall infrastructure, poor socio-economic conditions, and a deterioration of public health and nutritional status (Davis, Mullany, Schissler, Albert, & Beyrer, 2015; Parmar et al., 2014). Currently, the country has one of the highest rates of stunting and underweight in children under 5 years old in the Association of Southeast Asian Nations. More than half of children (58%) were anaemic (Myanmar Ministry of Health and Sports [MoHS] & ICF, 2017), and micronutrient deficiencies were prevalent (Thwin, 2001). Between 2000 and 2015, only a modest reduction was found in the prevalence of stunting, from 33.9% to 29.2% (MoHS & ICF, 2017).

However, a new civilian government entered in 2011 and has since made extensive social and economic changes with a commitment to reducing undernutrition (Myanmar Institute for Integrated Development, 2018). The country joined the Scaling Up Nutrition Movement in 2013 and became the second country in the Asia Pacific region to adopt the Zero Hunger Challenge in 2014 (Food and Agriculture Organization Regional Office for Asia and the Pacific, 2015). Nutrition was recognized as “the lifeblood” of Myanmar’s children and “part of the country’s development program” in the country’s first-ever National Coordination Meeting on Nutrition in 2017 (Scaling Up Nutrition, 2015).

This national nutrition agenda can be strengthened by in-depth country-specific information, but only a few population-based studies are available, mostly of vulnerable subpopulations, such as suboptimal feeding behaviours and high anaemia in the Kachin, Shan, and Kokang self-administered zones (Zhao et al., 2015; Zhao et al., 2016) and poor health status and access to health services in eastern Myanmar (Parmar et al., 2014). Beyond universally identified basic and underlying determinants and geographically fragmented studies, evidence at the entire population level will deepen our understanding about undernutrition and its various determinants in the country.

In this backdrop, we aimed to examine risk factors for stunting, wasting, and underweight among children aged 0–59 months in Myanmar at the household, maternal, and child level, using data from a nationally representative survey.

2 | METHODS

2.1 | Data source

This study used data from the Myanmar Demographic Health Survey (MDHS) 2015–2016, the first DHS in the country. The detailed sampling frame of the MDHS 2015–2016 is described elsewhere (MoHS & ICF, 2017). Briefly, a total of 4,000 primary sampling units was drawn from the 76,990 primary sampling units in the entire country, as a stratified sample with probability proportional to size. Seven states and eight regions were separated into rural and urban areas, each of which formed a separate sampling stratum. As a result, 30 sampling strata were created, where samples were

Key messages

- Prevalence of stunting among children aged 0–59 months in Myanmar is high (29%) among the Southeast Asian nations.
- Stunting and underweight shared risk factors such as short maternal stature, current pregnancy, home delivery, child’s small birth size, and older child age. Socio-economic factors, geographical variation, and child sex may affect stunting only.
- Focusing on the first 1,000 days of life, ensuring optimum nutrition of children under 24 months of age and women during pregnancy, preconception, and at adolescence, providing societal support for mothers in poverty and who are engaged in nonagriculture; and understanding region-specific undernutrition pathways are recommended in Myanmar.

selected independently in each sampling stratum. At the first stage, a total of 442 clusters were selected as sample clusters from the master sample. At the second stage, 30 households were selected from each of the 442 selected clusters using equal probability systematic sampling. A total of 13,238 households were selected, and of those, 12,885 women were interviewed with structured questionnaires about their socio-economic and demographic information and maternal and child health practices and were measured for anthropometry.

Our study was based on data for all 4,550 children, aged 0–59 months, whose age information was available in the MDHS data set. Anthropometric z scores and undernutrition were calculated from length/height ($n = 4,231$) and weight data ($n = 4,320$), excluding z scores outside biologically reasonable ranges (WHO Multicentre Growth Reference Study Group, 2006). As a result, 87.5%, 87.1%, and 87.6% of children were included in the risk factor analysis for stunting ($n = 4,213$), wasting ($n = 4,197$), and underweight ($n = 4,217$), respectively.

2.2 | Dependent variables: Stunting, wasting, and underweight

In the MDHS 2015–2016, children younger than 24 months of age were measured for recumbent length, and children 24 months or older were measured for standing height using a Shorr Productions measuring board. Child weight was measured by lightweight SECA mother–infant scales with a digital screen. Stunting, wasting, or underweight was defined as height-for-age, weight-for-height, and weight for age scores more than two standard deviations below the median of the population standard.

2.3 | Predictor variables

On the basis of the UNICEF malnutrition framework (UNICEF, 1997) and literature review (Table S1), a total of 35 characteristics at the household level, maternal level, and child level were selected as potential risk factor variables. Eight household characteristics were selected: residence (urban/rural), administrative areas (seven states and eight regions), wealth quintiles, use of improved drinking water sources, use of improved sanitation facilities, family size, number of children under 5 years old living in the household, and sex of household head. For further risk factor analysis, the seven states and eight regions in the country were recategorized into eight areas on the basis of geographical location: Central Regions (Magway, Mandalay, and Naypyidaw Regions), Yangon, North Region (Sagaing Region), South Regions (Bago and Tanintharyi Regions), West-South Region (Ayeyarwady Region), North-East States (Kachin and Shan States), East States (Kayah, Kayin, and Mon States), and West States (Chin and Rakhine States). Wealth quintiles derived by principle component analysis in the MDHS 2015–2016 were used in this study (MoHS & ICF, 2017). The categorization of improved drinking water sources or sanitation facilities followed the criteria of the MDHS 2015–2016 (MoHS & ICF, 2017).

The following 16 maternal characteristics were included: age, highest education level, occupation (agriculture, not working, and nonagriculture [professionals/skilled or unskilled manual/self-employed/sales]), residency with her husband/partner, current pregnancy, short stature (height <145 cm), body mass index (BMI [kg m^{-2}]; thin: $\text{BMI} < 18.5$; normal: $18.5 \leq \text{BMI} < 25.0$; and overweight or obese: $\text{BMI} \geq 25.0$), anaemia, smoking, number of antenatal visits during last pregnancy, location of most recent delivery, currently breastfeeding, experience of previous child death, safe disposal of child's stool, exposure to media (TV, newspaper, or radio) at least once a week, and women empowerment. A score of women empowerment (range: 0–5) was generated on the basis of two domains of (a) maternal participation in decision making on respondent's health care, what to do with money husband earns, large household purchases, and visits to family or relatives and (b) overall attitude towards domestic violence (Na et al., 2018). The empowerment score was divided into the lower 50 percentiles (low) and the upper 50 percentiles (high).

The following 11 child characteristics were included: sex; age (0–5 months, 6–23 months, and 24–59 months); birth order (1st, 2nd–4th, or ≥ 5 th), perceived birth size on the basis of maternal recall (average, larger than average, or smaller than average; Akombi et al., 2017), whether the child was breastfed within 1 hr after birth, episodes of diarrhoea/cough/fever in the past 2 weeks, vitamin A supplementation in the past 6 months, ever having taken iron pills, sprinkles syrup, or pills in the past 7 days, and having intestinal parasites in the previous 6 months.

2.4 | Statistical analysis

Survey weights and clustering by sampling units provided by the MDHS 2015–2016 were taken into account for in all complex survey

analyses. The prevalence of undernutrition was presented according to child sex, residence (urban/rural), wealth quintiles, and maternal education. Accounting for complex survey design elements, logistic regression analyses were performed to calculate odds ratios (ORs) and 95% confidence intervals (CIs) for the risk of child undernutrition. Geographical location was included as a dummy variable in the regression. At first, univariate logistic regression was conducted to identify variables associated with each undernutrition outcome (Table S2). Next, variables selected in the univariate regression (judged by $P < 0.05$ or 95% CI for ORs) were included in multivariable regression analysis. Variables with adjusted risk having $P < 0.05$ in the multivariable model were considered to be associates of the outcome. Further sensitivity analyses were conducted among subgroups: (a) children with nonpregnant mothers as pregnancy may affect some of the other covariates (i.e., maternal BMI) and (b) children aged 6 to 23 months with complementary feeding information such as minimum dietary diversity defined as four or more food group consumption or age-specific minimum acceptable diet (WHO, 2008). We checked that the range of the variance inflation factor for each logistic regression model was acceptable. All statistical analyses were conducted using Stata version 14 (StataCorp LP, College Station, TX, USA).

2.5 | Ethical approval

This study was deemed to be exempt from Institutional Review Board review, as this study involved secondary data analyses.

3 | RESULTS

3.1 | Selected household, maternal, and child characteristics

Out of 4,550 children, 77.6% lived in rural areas. A total of 80.6% of the households used improved water sources, and 40.9% used improved sanitation facilities. Approximately half of the households (53.4%) had fewer than six family members, and 83% of the households had a male household head (Table 1).

Almost half of mothers (52.0%) were aged 15–24 years old, and 28.9% were older than 35 years. Among the mothers, 17.9% had no formal education, and 36.3% had some secondary or higher education. At the time of the survey, 93.1% of them were living with a husband/partner. Only 14.4% of mothers were engaged in agricultural practices; almost half were engaged in nonagricultural work; and 37% did not work. A total of 4.5% were pregnant, 7.2% were shorter than 145 cm, 11.8% were thin ($\text{BMI} < 18.5$), and 24.7% were overweight or obese ($\text{BMI} \geq 25.0$). Nearly half (44.6%) were anaemic. A total of 62.3% had delivered their babies at home; only 37.7% used public or private health facilities; and 59.7% of mothers disposed of their child's stool safely. The proportion of empowered women was moderate at 69.1%.

At the child level, nearly half of the children were male, 10.0% were 0–5 months of age, 30.7% were 6–23 months of age, and the

TABLE 1 Characteristics at the household, maternal, and child level among children 0–59 month of age in the Myanmar Demographic and Health Survey 2015–2016 ($n = 4,550$)

Characteristics	Weighted % ^a
Household level	
Residence	
Urban	22.4
Rural	77.6
Area	
Magway Region	7.2
Mandalay Region	10.1
Naypyidaw Union Territory	2.2
Yangon Region	10.2
Sagaing Region	11.0
Bago Region	8.7
Tanintharyi Region	3.1
Ayeyarwady Region	13.2
Kachin State	3.9
Shan State	14.2
Kayah State	0.8
Kayin State	3.4
Mon State	3.4
Chin State	1.5
Rakhine State	7.1
Wealth quintile	
Lowest	29.6
Second	22.1
Middle	16.9
Fourth	17.1
Highest	14.4
Male household head	83.9
Family size	
1–5	53.4
≥ 6	46.6
No. of children <5 years living in the household	
1	61.4
≥ 2	38.6
Use of improved water sources ^b	80.6
Use of improved sanitation facilities ^c	40.9
Maternal level	
Age (years)	
15–24	52.0
25–34	19.1
35–49	28.9
Highest educational level	
No formal education	17.9

(Continues)

TABLE 1 (Continued)

Characteristics	Weighted % ^a
Primary (some or completed)	45.9
Secondary (some or completed)	28.6
Higher than secondary	7.7
Occupation ^d	
Agriculture (self-employed/employed)	14.4
Not working	37.0
Nonagriculture	48.7
Currently residing with husband/partner	93.1
Currently pregnant	4.5
Height <145 cm	7.2
Body mass index (kg m^{-2})	
Thin ($\text{BMI} < 18.5$)	11.8
Normal ($18.5 \leq \text{BMI} < 25.0$)	63.5
Overweight/obese ($\text{BMI} \geq 25.0$)	24.7
Anaemia	44.6
Smoking	2.1
Experience of previous child death	15.1
Antenatal visit during last pregnancy	
0–3 times	34.5
≥ 4 times	65.5
Location of most recent delivery	
Home	62.3
Health facilities	37.7
Currently breastfeeding	57.3
Safe disposal of child's stool ^e	59.7
Exposure to media (TV, radio, or newspaper) at least once a week	58.4
Women empowerment	
Low	30.9
High	69.1
Child level	
Sex	
Male	52.0
Female	48.0
Age (months)	
0–5	10.0
6–23	30.7
24–59	59.3
Birth order	
1st	35.2
2nd–4th	51.5
4th or lower	13.3
Perceived birth size	
Average	63.7

(Continues)

TABLE 1 (Continued)

Characteristics	Weighted % ^a
Larger than average	24.1
Smaller than average	12.3
Breastfed within 1 hr after birth	70.1
Diarrhoea in the previous 2 weeks	10.5
Cough in the previous 2 weeks	16.2
Fever in the previous 2 weeks	16.1
Vitamin A supplementation in the previous 6 months	49.7
Iron pills, sprinkles, or syrup in the previous 7 days	7.7
Drugs for intestinal parasites in the previous 6 months	38.5

Abbreviation: BMI, body mass index.

^aSampling design and weights of Myanmar Demographic Health Survey 2015–2016 were adjusted in the estimation of proportion using the Stata syntax “svyset.”

^bImproved drinking water sources included piped into dwelling/yard/plot, public tap/standpipe, tube well/borehole, protected well/spring, rainwater, and bottled water, as presented in Myanmar Demographic Health Survey 2015–2016.

^cImproved sanitation facilities included flush to piped sewer system, flush to septic tank/pit latrine, ventilated improved pit latrine, pit latrine with slab, or composting toilet, as presented in Myanmar Demographic Health Survey 2015–2016.

^dNonagriculture occupations included professional/technical, clerical, sales, services, and skilled or unskilled manual.

^eSafe disposals included using toilet/latrine or buried.

remaining 59.3% were 24–59 months of age. Regarding birth size, 24.1% were perceived to be larger than average, and 12.3% were smaller than average. Among the children, 10.5%, 16.2%, and 16.1% had diarrhoea, cough, and fever, respectively, in the 2 weeks preceding the survey. Regarding nutrition services provided to children, almost half of children received vitamin A supplementation, 38.5% received an anthelmintic drug in the previous 6 months, and only 7.7% took iron supplements in the previous 7 days.

3.2 | Anthropometric status

The prevalence of stunting, wasting, and underweight among children 0–59 months of age was 29.0%, 7.3%, and 19.2%, respectively. The prevalence of stunting increased with child age; only 6.3% of the children were stunted at 0–5 months of age, but the prevalence tripled to 20.4% at 6–23 months of age, and roughly four out of 10 children were stunted at 24–59 months (Figure 1). The prevalence of stunting was higher among male children than female children (30.7% vs. 27.2%) and among rural residences than urban residences (31.6% vs. 19.8%) but decreased with wealthier quintiles (37.6% in the lowest to 15.5% in the highest). The prevalence of stunting varied from 18.2% in Yangon Region to 39.6% in Kayah State (Figure 2). The prevalence of wasting was higher in urban than in rural areas (9.3% vs. 6.7%) and varied by administrative region, from 2.7% in Kayah State to 14.3% in Rakhine State, but there was no clear trend according to wealth quintiles or by child sex (Figures S1 and S2). The prevalence of underweight was lower in urban areas than in rural areas (15.1% vs. 20.4%) and decreased with higher wealth quintiles, from 25.3% in the lowest quintile to 12.3% in the highest quintile (Figure S3). The prevalence of underweight varied by administrative region, from 1.4% in Kayah State to 33.3% in Ayeyarwady Region (Figure S4).

3.3 | Risk factors for stunting

Multivariable analysis showed the OR for stunting significantly increased with lower wealth quintiles (OR = 1.75–1.99), compared with the highest quintile (Table 2). Compared with living in Central Regions, living in North-East States, the West-South Region, and West States showed a 59%, 58%, and 43% higher odds of child stunting (OR = 1.59, 95% CI [1.17, 2.17]; OR = 1.58, 95% CI [1.08, 2.31]; and OR = 1.43, 95% CI [1.02, 1.20], respectively). Children in households with six or more members had 41% higher odds of stunting than those in households with fewer members (OR = 1.41, 95% CI [1.13, 1.75]).

FIGURE 1 Prevalence of stunting among children 0–59 months of age by age, sex, residence, and wealth quintiles in the Myanmar Demographic Health Survey 2015–2016 ($n = 4213$). Out of 4,550 children with age data, missing values for height ($n = 319$) or outlying values outside biologically reasonable ranges were excluded (height-for-age score < -6 or height-for-age score > 6 [$n = 18$])

FIGURE 2 Prevalence of stunting by administrative region among children 0–59 months of age in the Myanmar Demographic Health Survey 2015–2016 ($n = 4213$). CR, Central Regions; ES, East States; NES, North-East States; NR, North Region; SR, South Regions; WS, West States; WSR, West-South Region; Y, Yangon. Out of 4,550 children with age data, missing values for height ($n = 319$) or outlying values outside biologically reasonable ranges were excluded (height-for-age score < -6 or height-for-age score > 6 [$n = 18$])

At maternal level, engagement in nonagricultural work was associated with a 1.3-fold higher odds of stunting compared with being engaged in agricultural work (OR = 1.31; 95% CI [1.02, 1.69]). Current pregnancy was related to a more than twofold higher odds of stunting (OR = 2.13; 95% CI [1.39, 3.27]). Short maternal height (< 145 cm) showed a 2.5 times higher odds of having a stunted child compared with taller mothers (≥ 145 cm; OR = 2.53; 95% CI [1.91, 3.35]). Compared with delivery at health facilities, home delivery was associated with 34% higher odds of stunting (OR = 1.34; 95% CI [1.06, 1.69]).

At the child level, female children had a lower risk of being stunted than male children (OR = 0.75; 95% CI [0.62, 0.86]). Older child age predicted stunting; the odds became higher from fourfold among children from 6 to 23 months of age (95% CI [2.32, 5.94]) to ninefold among those 24 to 59 months of age (95% CI [5.21, 14.1]), compared with 0–5 months of age. Compared with children perceived to be average size at birth by their mothers, the odds of stunting were higher among those with a smaller than average birth size (OR = 1.85; 95% CI [1.44, 2.39]) and lower among those with a larger than average birth size (OR = 0.77; 95% CI [0.61, 0.96]).

In a subgroup analysis excluding children with pregnant mother ($n = 235$), the results of multivariable logistic regression were consistent between original group and subgroup of children with nonpregnant mother (Table 3). Among children 6 to 23 months of age, the consumption of four or more food groups or the intake of minimum age-specific acceptable diet was not associated with any undernutrition indicator including stunting (Table 4).

3.4 | Risk factors for wasting

Multivariable analysis showed that the odds of stunting were lower among children living in the West States (OR = 0.47; 95% CI

[0.22, 0.96]), compared with the Central Regions, but showed no difference when compared with living in other areas (Table 2).

Maternal BMI < 18.5 was associated with 58% higher odds of child wasting, compared with normal BMI (OR = 1.55; 95% CI [1.03, 2.33]). The odds of wasting were lower for children 24–59 months of age (OR = 0.54; 95% CI [0.35, 0.84]), compared with children 0–5 months of age. Children with a larger than average birth size showed lower odds of wasting, compared with average birth size (OR = 0.65; 95% CI [0.44, 0.98]). Not having vitamin A supplementation in the previous 6 months was associated with 41% higher odds of wasting, compared with being supplemented with vitamin A (OR = 1.41; 95% CI [1.02, 1.96]).

3.5 | Risk factors for underweight

Compared with living in the Central Regions, living in the South Regions showed lower odds of child underweight (OR = 0.61; 95% CI [0.42, 0.87]; Table 2). However, the odds of child underweight did not significantly differ among the other areas. Current pregnancy was associated with 56% higher odds of child underweight, compared with nonpregnancy status (OR = 1.56; 95% CI [1.03, 2.37]). Maternal height < 145 cm was associated with a twofold higher odds of child underweight, compared with taller mothers (≥ 145 cm; OR = 2.06; 95% CI [1.46, 2.89]). Maternal BMI < 18.5 had 43% higher odds of child underweight (OR = 1.43; 95% CI [1.05, 1.94]), whereas BMI ≥ 25.0 was associated with lower odds of underweight (OR = 0.61; 95% CI [0.47, 0.80]). Delivery at home had 55% higher odds of underweight compared with health facility delivery (OR = 1.55; 95% CI [1.20, 2.00]).

The odds of underweight became higher with older age: compared with 0–5 months, the age ranges of 6–23 months and 24–59 months showed twofold (OR = 1.87; 95% CI [1.12, 3.19]) and threefold (OR = 3.11; 95% CI [1.86, 5.20]) higher risks of underweight,

TABLE 2 Multivariable logistic regression of risk factors for stunting, wasting, and underweight among children 0–59 months of age in the Myanmar Demographic Health Survey 2015–2016^{a,b}

Characteristics	Stunting (HAZ < -2; n = 4,213) ^c			Wasting (WHZ < -2; n = 4,197) ^d			Underweight (WAZ < -2; n = 4,217) ^e		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Household level									
Wealth quintile (ref: highest)	1.00								
Fourth	1.26	[0.87, 1.83]	.23						
Middle	1.75	[1.16, 2.64]	<.01						
Second	1.82	[1.21, 2.76]	<.01						
Lowest	1.99	[1.27, 3.13]	<.01						
Geographical location (ref: Central Regions [Magway/Mandalay/Naypyidaw])	1.00			1.00			1.00		
Yangon	1.05	[0.69, 1.59]	.82	1.66	[0.94, 2.91]	.08	1.00	[0.65, 1.54]	.99
North Region (Sagaing)	1.05	[0.72, 1.52]	.80	0.88	[0.45, 1.74]	.72	0.61	[0.42, 0.87]	<.01
South Regions (Bago/Tanintharyi)	0.98	[0.72, 1.33]	.87	1.03	[0.60, 1.74]	.93	1.00	[0.74, 1.36]	.98
West-South Region (Ayeyarwady)	1.58	[1.08, 2.31]	.02	0.47	[0.22, 0.96]	.04	1.40	[0.95, 2.06]	.09
North-East States (Kachin/Shan)	1.59	[1.17, 2.17]	<.01	0.63	[0.34, 1.19]	.16	0.75	[0.51, 1.11]	.15
East States (Kayah/Kayin/Mon)	1.23	[0.89, 1.68]	.20	0.81	[0.49, 1.33]	.40	0.88	[0.63, 1.23]	.45
West States (Chin/Rakhine)	1.43	[1.02, 1.20]	.04	1.54	[0.90, 2.65]	.12	1.47	[0.91, 2.38]	.11
Family size (ref: <6)	1.00								
≥6	1.41	[1.13, 1.75]	<.01						
Maternal level									
Occupation (ref: agriculture)	1.00								
Not working	0.93	[0.72, 1.21]	.58						
Nonagriculture work	1.31	[1.02, 1.69]	.03						
Current pregnancy (ref: no)	1.00						1.00		
Yes	2.13	[1.39, 3.27]	<.01				1.56	[1.03, 2.37]	.04
Height (ref: ≥145 cm)	1.00						1.00		
<145 cm	2.53	[1.91, 3.35]	<.001				2.06	[1.46, 2.89]	<.001
BMI (ref: 18.5 ≤ BMI < 25.0)				1.00			1.00		
Thinness (BMI < 18.5)				1.55	[1.03, 2.33]	.04	1.43	[1.05, 1.94]	.02
Overweight/obese (BMI ≥ 25.0)				0.92	[0.63, 1.35]	.67	0.61	[0.47, 0.80]	<.001
Location of most recent delivery (ref: health facilities)	1.00						1.00		
Home	1.34	[1.06, 1.69]	.01				1.55	[1.20, 2.00]	<.01

(Continues)

TABLE 2 (Continued)

Characteristics	Stunting (HAZ < -2; n = 4,213) ^c			Wasting (WHZ < -2; n = 4,197) ^d			Underweight (WAZ < -2; n = 4,217) ^e		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
Child level									
Sex (ref: male)	1.00								
Female	0.75	[0.62, 0.86]	<.001						
Age (months; ref: 0–5 months)	1.00			1.00			1.00		
6–23	3.71	[2.32, 5.94]	<.001	0.66	[0.42, 1.04]	.08	1.87	[1.12, 3.12]	.02
24–59	8.56	[5.21, 14.1]	<.001	0.54	[0.35, 0.84]	.01	3.11	[1.86, 5.20]	<.001
Perceived birth size (ref: average)	1.00			1.00			1.00		
Larger than average	0.77	[0.61, 0.96]	.02	0.65	[0.44, 0.98]	.04	0.56	[0.44, 0.72]	<.001
Smaller than average	1.85	[1.44, 2.39]	<.001	0.95	[0.63, 1.43]	.80	2.36	[1.81, 3.08]	<.001
Vitamin A supplementation in the previous 6 months (ref: yes)				1.00					
No				1.41	[1.02, 1.96]	.04			

Abbreviations: BMI, body mass index; CI, confidence interval; HAZ, height-for-age score; OR, odds ratio; WAZ, weight-for-age score; WHZ, weight-for-height score.

^aOut of 4,550 children with age information, missing or outlying values outside biologically reasonable ranges were as follows: stunting (missing [n = 319]; outliers height-for-age score < -6 or height-for-age score > 6 [n = 18]), wasting (missing [n = 230]; outliers WHZ < -5 or WHZ > 5 [n = 123]), and underweight (missing [n = 230]; outliers WAZ < -6 or WAZ > 6 [n = 103]).

^bSurvey design and weights of Myanmar Demographic Health Survey 2015–2016 were accounted for in the models using Stata syntax “svyset.” Only the variables that showed a significant association with the outcomes of interest in the multivariable logistic regression were presented in the table.

^cThe following variables were included in the final multivariable logistic regression model: wealth quintiles, geographical location, use of improved water sources, use of improved sanitation facilities, family size, maternal education, maternal smoking, maternal occupation, maternal short height (<145 cm), maternal BMI, current pregnancy, number of antenatal visits during pregnancy, location of child delivery, currently breastfeeding, child age, child sex, birth order, child birth size recalled by mother, and vitamin A supplementation in the past 6 months. In the process of removing the predictor with the highest P value, the following variables were removed from multivariable logistic regression: residence (rural/urban), exposure to media (TV, radio, or newspaper) at least once a week, and having deworming drugs in the past 6 months.

^dThe following variables were included in the final multivariable logistic regression model: wealth quintiles, geographical location, maternal age, maternal occupation, maternal BMI, maternal anaemia, child age, child birth size recalled by mother, and vitamin A supplementation in the past 6 months. In the process of removing the predictor with the highest P value, the variable of having deworming drugs in the past 6 months was removed from the multivariable logistic model.

^eThe following variables were included in the final multivariable logistic regression model: residence (rural/urban), wealth quintiles, geographical location, maternal education level, current pregnancy, maternal short height (<145 cm), maternal BMI, maternal anaemia, number of antenatal visits during pregnancy, location of child delivery, exposure to media (TV, radio, or newspaper) at least once a week, child age, birth order, and child birth size recalled by mother. In the process of removing the predictor with the highest P value, the variable of having deworming drugs in the past 6 months was removed in the multivariable logistic model.

TABLE 3 AOR and significance level of risk factors for stunting among (a) all children 0–59 months of age and (b) subgroup children whose mother was not pregnant at the time of survey in Myanmar Demographic Health Survey 2015–2016

Characteristics	All children (n = 4,213) ^a			Subgroup (n = 3,978)		
	AOR	95% CI	P	AOR	95% CI	P
Household level						
Wealth quintile (ref: highest)	1.00			1.00		
Fourth	1.26	[0.87, 1.83]	.23	1.24	[0.84, 1.84]	.28
Middle	1.75	[1.16, 2.64]	.01	1.71	[1.13, 2.60]	.01
Second	1.82	[1.21, 2.76]	.01	1.84	[1.20, 2.80]	.01
Lowest	1.99	[1.27, 3.13]	<.01	1.98	[1.26, 3.12]	<.01
Geographical location (ref: Central Regions [Magway/Mandalay/Naypyidaw])	1.00			1.00		
Yangon	1.05	[0.69, 1.59]	.82	0.98	[0.62, 1.55]	.94
North Region (Sagaing)	1.05	[0.72, 1.52]	.80	1.08	[0.74, 1.58]	.69
South Regions (Bago/Tanintharyi)	0.98	[0.72, 1.33]	.87	0.99	[0.72, 1.35]	.94
West-South Region (Ayeyarwady)	1.58	[1.08, 2.31]	.02	1.56	[1.05, 2.31]	.03
North-East States (Kachin/Shan)	1.59	[1.17, 2.17]	<.01	1.67	[1.21, 2.30]	<.01
East States (Kayah/Kayin/Mon)	1.23	[0.89, 1.68]	.20	1.32	[0.96, 1.81]	.09
West States (Chin/Rakhine)	1.43	[1.02, 1.20]	.04	1.47	[1.04, 2.09]	.03
Family size (ref: <6)	1.00			1.00		
≥6	1.41	[1.13, 1.75]	<.01	1.37	[1.09, 1.72]	<.01
Maternal level						
Occupation (ref: agriculture)	1.00			1.00		
Not working	0.93	[0.72, 1.21]	.58	0.93	[0.70, 1.19]	.51
Nonagriculture work	1.31	[1.02, 1.68]	.03	1.31	[1.02, 1.70]	.04
Current pregnancy (ref: no)	1.00			—		
Yes	2.13	[1.39, 3.27]	<.01	—		
Height (ref: ≥145 cm)	1.00			1.00		
<145 cm	2.53	[1.91, 3.35]	<.001	2.61	[1.98, 3.49]	<.001
BMI (ref: 18.5 ≤ BMI < 25.0)						
Thinness (BMI < 18.5)						
Overweight/obese (BMI ≥ 25.0)						
Location of most recent delivery (ref: home)	1.00			1.00		
Health facility	0.75	[0.59, 0.94]	.01	0.73	[0.58, 0.93]	.01
Child level						
Sex (ref: male)	1.00			1.00		
Female	0.75	[0.62, 0.86]	<.001	0.73	[0.61, 0.87]	<.001
Age (months; ref: 0–5 mo)	1.00			1.00		
6–23	3.71	[2.32, 5.94]	<.001	3.73	[2.32, 6.00]	<.001
24–59	8.56	[5.21, 14.1]	<.001	8.68	[5.24, 14.4]	<.001
Perceived birth size by maternal recall (ref: average)	1.00			1.00		
Larger than average	0.77	[0.61, 0.96]	.02	0.74	[0.58, 0.93]	.01
Smaller than average	1.85	[1.44, 2.39]	<.001	1.93	[1.49, 2.50]	<.001
Vitamin A supplementation (ref: yes)						
No	0.86	[0.70, 1.06]	.16	0.88	[0.70, 1.10]	.25

Abbreviations: AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval.

^aOut of length/height (n = 4,231) and weight (n = 4,320) data, z scores were estimated and converted to undernutrition indicators. Outlying values outside biologically reasonable ranges were excluded (height-for-age score <−6 or height-for-age score >6 [n = 18]).

TABLE 4 Univariate logistic regression of risk factors for stunting, wasting, and underweight among children 6–23 months of age in the Myanmar Demographic Health Survey 2015–2016

Characteristics	Stunting (n = 1,289)			Wasting (n = 1,281)			Underweight (n = 1,293)		
	OR	95% CI	P	OR	95% CI	P	OR	95% CI	P
MDD ^a	1.20	[0.80, 1.81]	.38	0.72	[0.39, 1.33]	.29	0.84	[0.54, 1.31]	.44
MAD ^b	0.94	[0.59, 1.52]	.81	0.67	[0.30, 1.48]	.32	1.00	[0.59, 1.71]	.99

Abbreviations: CI, confidence interval; MAD, minimum acceptable diet; MDD, minimum dietary diversity; OR, odds ratio.

^aDefined as proportion of children 6–23 months of age who received four or more food groups out of seven groups: (a) grains, roots, and tubers; (b) legumes and nuts; (c) dairy products (milk, yoghurt, and cheese); (d) flesh foods (meat, fish, poultry, and liver/organ meats); (e) eggs; (f) vitamin A-rich fruits and vegetables; and (g) other fruits and vegetables.

^bDefined as proportion of children 6–23 months of age who received a minimum acceptable diet. For breastfed children 6–23 months of age, minimum acceptable diet was defined as at least the minimum dietary diversity and the minimum meal frequency during the previous day. For nonbreastfed children 6–23 months of age, minimum acceptable diet was defined as at least two milk feedings and at least the minimum dietary diversity and the minimum meal frequency during the previous day.

respectively. A larger than average birth size was negatively associated with child underweight (OR = 0.56; 95% CI [0.44, 0.72]), whereas a smaller than average birth size was positively related to underweight (OR = 2.36; 95% CI [1.81, 3.08]).

4 | DISCUSSION

This study examined the risk factors of undernutrition among children 0–59 months of age in Myanmar, using nationally representative data from the MDHS 2015–2016. Current pregnancy, maternal height <145 cm, delivery at home, child's smaller than average birth size, and older child age were common risk factors for both stunting and underweight. Maternal BMI < 18.5 predicted child wasting and underweight. Lower wealth quintiles, maternal engagement in nonagricultural occupation, and male child were risk factors only for stunting. Not having vitamin A supplementation in the past 6 months and younger child age predicted wasting only. The odds of stunting were higher in the West-South Region, North-East States, and West States, compared with Central Regions, whereas the odds of wasting and underweight were lower in the West-South Region and South Regions, respectively. On the contrary, larger than average birth size was a common protective factor for all three undernutrition indicators. Stunting and underweight shared many risk factors in this population, but wasting did not. The result suggests that a pathway through which child's stunting or underweight occur is determined by combination of maternal nutrition, socio-economic, and environmental factors, whereas wasting is driven mainly by maternal nutritional status.

4.1 | Child age and sex

The risk of Myanmar children being stunted and underweight increased with age. The result was consistent with a generally observed deceleration in linear growth through 2 years of age that was largely irreversible thereafter in resource-poor settings (Victora, de Onis, Hallal, Blossner, & Shrimpton, 2010). Our result stresses the importance of appropriate timing to intervene in the development of

child stunting, focusing on the first 1,000 days, before 24 months of age in the country (Shrimpton et al., 2001).

According to a meta-analysis study of DHS data from 10 sub-Saharan African countries, the risk of stunting was higher by 18% (95% CI [1.14, 1.22]) among male children (Wamani, Astrom, Peterson, Tumwine, & Tylleskar, 2007). Similarly, gender bias favouring girls in the prevalence of stunting was found in neighbouring Asian countries including Cambodia, Bangladesh, and India (Fenske, Burns, Hothorn, & Rehfuess, 2013; Ikeda, Irie, & Shibuya, 2013; Mistry et al., 2019).

4.2 | Maternal nutritional status

A transgenerational link in which maternal nutritional status (height, BMI, and child's birth size) predicts child's poor growth is expected in this population. Maternal undernutrition puts the child at a greater risk for low birthweight, preterm birth, and small-for-gestational age, which results in increased risk for undernutrition later in childhood (Black et al., 2013). In a study using data from the DHS and national nutrition survey in South Asian countries, maternal short height (<145 cm) and lower BMI (<18.5) were associated with a 3.3-fold and 1.6-fold, respectively, higher risk of stunting among children 6 to 23 months of age (Kim, Mejia-Guevara, Corsi, Aguayo, & Subramanian, 2017). Similar to our study result, smaller than average birth size perceived by the mother, as a proxy for low birthweight, predicted stunting or underweight in certain low-income countries (Akombi, Agho, Hall, et al., 2017; Akombi, Agho, Merom, Hall, & Renzaho, 2017; Chirande et al., 2015; Tiwari, Ausman, & Agho, 2014).

Unbalanced or micronutrient-deficient diet and poor health care during pregnancy lead to poor weight gain and anaemia among mothers (Imdad & Bhutta, 2011). Nutrition during adolescence as well as pregnancy or preconception is important as mother's height is determined by the second growth spurt. Neglected health and nutrition care or early onset of conception during adolescence would result in suboptimum height gain, followed by increased risk of offspring stunting (S. Vir, 1990).

Ensuring that women are not undernourished during pregnancy, preconception, and from adolescence is recommended to prevent

child stunting during the first 1,000 days (S. C. Vir, 2016; WHO, 2016). However, information on women's diet, morbidity, weight gain during pregnancy, and exposure to nutrition interventions during adolescence or pregnancy were limited in the MDHS 2015–2016. During pregnancy, iron tablets or syrup were used by only 12% of women with BMI < 18.5, compared with 60.6% of those with normal BMI. This suggests improving accessibility to iron supplementation may benefit the nutrition of undernourished mothers. Given that 19% of mothers aged 25–49 years old in this population were married before 18 years old (MoHS & ICF, 2017), preventing child marriage and delaying age of first conception are recommended to ensure optimum height gain among adolescent girls (WHO, 2016).

4.3 | Delivery location

Facility delivery might allow for more chances to have appropriate and timely obstetric and medical care and to receive information about childcare (Pacagnella et al., 2014). Similar results were found in a cross-sectional study in Western China (Wang et al., 2017) and in a study using the Bangladesh DHS (Hong, Banta, & Betancourt, 2006). In our study population, mothers who delivered at home also exhibited lower utilization of antenatal and post-natal services than those with facility delivery (data not shown). Given the current low percentage of facility delivery (37.7%), it is recommended that physical or social barriers in utilizing antenatal, institutional delivery, and post-natal care be identified and the quality of the services at health facilities be improved.

4.4 | Maternal occupation

In the MDHS 2015–2016, the proportion of mothers engaged in nonagriculture was almost half, whereas only 14.4% had an occupation that involved agriculture. Out of these mothers, half of them were engaged in unskilled manual labour, 29.3% were in sales, and 8.1% were professionals. Occupations requiring excessive physical activity may be associated with child's small birth size among pregnant women (Rao et al., 2003). Heavy physical workload could prevent mothers from allocating enough time and energy to childcare (Jones, Agudo, Galway, Bentley, & Pinstrip-Andersen, 2012). In Myanmar, further studies are needed to examine the effect of workload by type of occupation and barriers that hamper optimal child caring among women with nonagricultural occupations, particularly during pregnancy.

4.5 | Household wealth status

Socio-economic status predicted stunting in many low- and middle-income countries (Greffeuille et al., 2016), and it has had a lasting impact on children's linear growth (Krishna et al., 2015; Krishna, Mejia-Guevara, McGovern, Aguayo, & Subramanian, 2018). Nutritional inequity exists by socio-economic status, and improvement in the lowest wealth group was less than that of the wealthiest group over time (Restrepo-Mendez, Barros, Black, & Victora, 2015). In Myanmar, mothers in lower wealth quintiles had less opportunity to obtain

higher education and reported limited access and utilization of antenatal and post-natal services (MoHS & ICF, 2017). Mothers with low BMI (<18.5) belonged to lower wealth quintiles, which might limit their access to nutritious foods and nutritional information. Equitable income allocation and social protections targeting poor women may increase their food purchasing power and autonomy to control household resources for themselves and their children's nutrition (S. C. Vir, 2016).

4.6 | Variation in geographical location

The risk for stunting was higher in the North-East States (Kachin/Shan), West-South Region (Ayeyarwady), and West States (Chin/Rakhine), compared with the Central Region. Plausible reasons for the high risk of stunting in these regions include continuous armed conflicts since 2011 in the North-East States (Kachin/Shan) and West States (Rakhine; The Asia Foundation, 2017) and frequent cyclones and flooding in the West States (Chin) and West-South Region (Ayeyarwady). Civil strife affects nutritional status among children and women through displacement, economic degradation, or lack of access to health and nutrition services (Guha-Sapir, van Panhuis, Degomme, & Teran, 2005; Sapir, 1993). Natural disaster devastates community infrastructure and the food production system and results in economic loss (Food and Agriculture Organization, 2018). In-depth studies are needed to understand the area-specific mechanisms that lead to child undernutrition.

The present study has several limitations. First, this cross-sectional data structure does not support any causal relationships between the identified risk factors and undernutrition indicators. Second, certain potential undernutrition determinants were not analysed in this study as the variables were not collected for the entire population of children 0–59 months of age. Such examples include women's ever iron supplementation (82.2% of the surveyed sample were assessed), post-natal check-up (85.0%), child anaemia (77.7%), and reported birthweight (45.4%; MoHS & ICF, 2017). Third, certain information such as child morbidity depended on the mother's recall, which can differ from true clinical diagnosis of the diseases. Lastly, the DHS data did not include information about premature birth, such as small for gestational age, or environmental enteric dysfunction, maternal diet, maternal and child micronutrient status, and household food insecurity, which are known to be critical predictors of child stunting.

In conclusion, the present study examined risk factors for child undernutrition in Myanmar. In the context that in-depth nutrition data are scarce at the population level, the study findings provide comprehensive epidemiological information. The following recommendations would contribute to addressing child undernutrition in Myanmar: (a) implement evidence-based nutrition interventions to prevent child stunting before 24 months, focusing on the first 1,000 days of life; (b) ensure optimum maternal nutritional status during pregnancy, preconception, and adolescence; (c) improve accessibility and quality of antenatal and institutional delivery services; (d) address socio-economic inequality and provide prioritized health and nutrition

services among those with low wealth status; (e) support women engaged in nonagriculture occupations in providing appropriate childcare; and (f) understand the area-specific mechanisms of child undernutrition to design effective nutrition policies and programmes.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

CONTRIBUTIONS

The authors' responsibilities were as follows: YK and JK designed the current study; YK conducted the data analysis for this study and wrote the manuscript; JK reviewed the manuscript and substantially contributed to the interpretation of the results; and JK had primary responsibility for the final content. All authors read and approved the final manuscript.

ORCID

Yunhee Kang <https://orcid.org/0000-0002-8184-9166>

Jihye Kim <https://orcid.org/0000-0002-3280-7381>

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

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