BMJ Open Risk factors and regional variations of malnutrition among children under 5 in Myanmar: cross-sectional analyses at national and subnational levels

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ABSTRACT

Objective The levels, distributions of child malnutrition and its potential risk factors are not very well known in Myanmar. The objectives included in this study were: to estimate the current national and subnational prevalence of four types of malnutrition (stunting, wasting, underweight and overweight) among children under 5 in Myanmar; to identify potential risk factors associated with each type of malnutrition and to investigate how the identified risk factors' distributions explained the regional disparities in malnutrition prevalence.

Design/methods Data from the Myanmar Demographic and Health Survey 2015–2016 were used to estimate the prevalence of four types of malnutrition at both national and subnational levels (15 regions). Logistic regression models were applied to examine the association between each type of malnutrition and its risk factors, including child's factors, parental social status and household conditions. The risk factor-adjusted prevalence of the malnutrition was estimated at the subnational level based on the estimated parameters from the regression models.

Results The national prevalence of stunting, wasting, underweight and overweight in children under 5 was estimated to be 29.1% (95% CI 27.7% to 30.6%), 6.8% (6.0% to 7.6%), 18.3% (17.0% to 19.5%) and 1.5% (1.1% to 1.9%), respectively. Substantial regional variations in the prevalence of each type of malnutrition were observed. Several risk factors of each type of malnutrition were identified, including low birth weight (LBW) and inadequate maternal nutritional status. Except for overweight, regional variations largely persisted even after adjustment for the risk factors investigated.

Conclusion The prevalence of malnutrition among children under 5 is still high in Myanmar, most commonly stunting. Targeted interventions aimed at prevention of LBW, improving the maternal nutritional status, in addition to other sociodemographic conditions should be encouraged urgently. Further research is necessary to investigate the potential sources of regional variation in prevalence of malnutrition among children under 5 in the country.

INTRODUCTION

Malnutrition, defined by WHO as any deficiencies, excess or imbalances in a person's

Strengths and limitations of this study

- This is the first study to report the prevalence of malnutrition among children under 5 in Myanmar at the national and subnational level using nationally representative data.
- We identified several risk factors of malnutrition, which might be useful for designing interventions aiming to improve nutritional status among children in Myanmar.
- Measuring variation in malnutrition at subnational level and its potential contributing factors is critical to understand the existing disparities in malnutrition across the country and formulate tailored strategies and policies to effectively manage malnutrition.
- The cross-sectional and observational nature of the study did not allow to identify factors that are causally related to malnutrition.

intake of nutrients,¹ constitutes many cases of morbidity and mortality in children under 5, especially in developing countries.² Almost 50% of total deaths among children under 5 are attributable to undernutrition.³ Malnutrition also impacts the economic growth of nations by causing loss in productivity.⁴

During the last three decades, the epidemiology of malnutrition has changed considerably worldwide: undernutrition has decreased while overnutrition has increased.⁵ The coexistence of different forms of malnutrition can be seen within the countries, and a double burden of undernutrition and overnutrition has become increasingly common in many parts of the world.⁶ Most countries have committed to achieve the World Health Assembly global nutrition targets by 2025 and the Sustainable Development Goals, ending malnutrition by 2030.⁷ These commitments and goals present an unparalleled opportunity for action in countries.

Myanmar is a country with a high burden of malnutrition.³ A total of 50.4% of total deaths

among children under 5 in the country in 2017 were attributable to potentiating effects of malnutrition.⁸ Myanmar is making significant efforts to address the nutrition situation. In May 2013, the country joined the global Scaling Up Nutrition (SUN) movement, a global movement led by countries to eliminate all forms of malnutrition in the world by 2030.⁹ Based on the guiding principles of the SUN movement that 'everyone has a right to food and good nutrition', the Government of Myanmar formulated the Myanmar National Action Plan for Food and Nutrition Security in 2015.⁹ Through it, the government and its partners planned to work together through collective multisectoral and multistakeholder action to accelerate the reduction in and eradication of food insecurity and undernutrition.⁹

However, important knowledge gaps regarding malnutrition in Myanmar remains, which hamper these efforts. While national prevalence of malnutrition has been presented, the prevalence and the potential variations on the subnational level (regions) is not known. Since Myanmar is a very diverse country both geographically and ethnically, simply exploring the malnutrition only at the national level might cause underestimation of the depth of the problem. The persistent malnutrition issues cannot be tackled effectively if the regional disparity is not thoroughly evaluated within the country.^{10 11} In addition, studies assessing risk factors of malnutrition have used small samples from specific locations and are thus not generalisable to the national population.

The aim of the study was to provide data that can be used to design interventions for reducing malnutrition among children under 5 of Myanmar. We expect that the results of this study will help the policy makers and programme managers to be aware of to what extent malnutrition is affecting the children under 5 at the national level by which risk factors, and since we have used geographical mapping method for every region, it is easier to notice which regions require more attention than explanation with just data. The objectives of this study were: (1) to estimate the current national and regional prevalence of four types of malnutrition (stunting, wasting, underweight and overweight) among children under 5 in Myanmar; (2) to identify potential risk factors associated with each type of malnutrition and (3) to investigate how the identified risk factors' distributions explained the regional variations in malnutrition prevalence.

Methods

Data

In this study, we used secondary data from the 2015–2016 Myanmar Demographic and Health Survey (MDHS), a nationally representative, cross-sectional household survey conducted by Ministry of Health and Sport and its partners. MDHS included the household questionnaires and the women's questionnaires. The sampling design of MDHS was a stratified two-stage sampling in which 30 areas (15 urban areas and 15 rural areas) across 15 regions were used as strata. In the first stage, 442 clusters

were selected from each stratum, with equal probability sampling and with independent selection. In the second stage, 30 households were selected from each cluster by equal probability systematic sampling. The response rate was 98% for the household questionnaires and 96% for the women's questionnaires. The survey collected information on maternal characteristics, child health, mortality data, family planning services and attitudes towards gender-based violence. For all children under 5 at the time of survey participation, anthropometric measurements (height and weight) were collected. The details of sampling methods and questionnaires were described in Myanmar DHS report.¹²

Population and measurement

Target population

A total of 4286 children under 5 were included in MDHS. After excluding those with incomplete anthropometric measurements ($n=559$), remaining 3727 children under 5 were included in the study population.

Primary outcomes

The primary outcomes of this study were (1) stunting (low height-for-age), (2) wasting (low weight-for-height), (3) underweight (low weight-for-age) and (4) overweight (high weight-for-height). Stunting is a sign of chronic malnutrition mainly due to inadequate nutrition during first 1000 days from pregnancy to the child's second birthday.¹³ Wasting is considered a more acute manifestation of malnutrition which is due to inadequate nutrition or illness leading to weight loss.¹² Underweight is an indicator for both acute and chronic undernutrition.¹² Overweight indicates a higher energy intake than expenditure.⁵

For the assessment of child nutritional status, the standardised Z-score developed by WHO was used.¹⁴ A child who has a Z-score of height-for-age, weight-for-height and weight-for-age below (-2 SD) of the median of the WHO reference population was considered short for his/her age (stunted), light for his/her height (wasted) and light for his/her age (underweight), respectively.¹⁴ A Z-score for weight-for-height above ($+2$ SD) of the median of the WHO reference population was defined as overweight.¹⁴

Covariates

The covariates included in our analyses consisted of a three-level hierarchy: individual, household and community levels. The individual level variables were: child's age (categorised as <6 , 6–11 months, 12–23 months, 24–35 months, 36–47 months or 48–59 months), child's gender (male or female), mother's body mass index (underweight <18.5 kg/m², normal 18.5–24.9 kg/m², overweight 25–30 kg/m² or obese 30–50 kg/m²), mother's and father's education (no education, primary, secondary or more than secondary) and duration of preceding birth interval (zero (first births): 0 months, short: 9–24 months, medium: 25–48 months or long: 49 months and above). We also considered child's birth weight. In the

Table 1 Demographic characteristic of the study population

Variables	Weighted number of children (n)	Percent (95% CIs)
Child's age (months)		
<6	338	9.1 (8.2 to 10.0)
6–11	374	10.0 (9.1 to 11.0)
12–23	782	21.0 (19.7 to 22.3)
24–35	706	18.9 (17.7 to 20.2)
36–47	803	21.5 (20.3 to 22.9)
48–59	725	19.5 (18.2 to 20.8)
Child's gender		
Male	1921	51.5 (49.9 to 53.1)
Female	1806	48.5 (46.9 to 50.1)
Preceding birth interval*		
Zero (first births)	1097	29.4 (28.0 to 30.9)
Short	297	8.0 (7.1 to 8.9)
Medium	845	22.7 (21.3 to 24.0)
Long	1489	39.9 (38.4 to 41.5)
Breastfeeding practice		
Exclusive	1391	37.3 (35.8 to 38.9)
Non-exclusive	2275	61.0 (59.5 to 62.6)
Never	62	1.7 (1.2 to 2.1)
Mother's body mass index		
Underweight	446	12.0 (11.0 to 13.1)
Normal	2353	63.3 (61.7 to 64.8)
Overweight	718	19.3 (18.1 to 20.6)
Obese	201	5.4 (4.7 to 6.2)
Mother's education		
No education	618	16.6 (15.4 to 17.8)
Primary	1758	47.2 (45.6 to 48.8)
Secondary	1064	28.6 (27.1 to 30.0)
Higher	288	7.7 (6.9 to 8.6)
Father's education		
No education	606	16.5 (15.4 to 17.8)
Primary	1532	41.8 (40.2 to 43.4)
Secondary	1316	35.9 (34.4 to 37.5)
Higher	212	5.8 (5.1 to 6.6)
Birth weight		
Low birth weight	465	13.0 (11.9 to 14.1)
Normal	3114	87.0 (85.7 to 88.1)
Sociodemographic status		
Poorest	1100	29.5 (28.1 to 30.9)
Poorer	844	22.7 (21.3 to 24.0)

Continued

Table 1 Continued

Variables	Weighted number of children (n)	Percent (95% CIs)
Middle	643	17.3 (16.1 to 18.5)
Richer	625	16.8 (15.6 to 18.0)
Richest	516	13.8 (12.8 to 15.0)
Area of residence		
Urban	819	22.0 (20.7 to 23.3)
Rural	2908	78.0 (76.7 to 79.3)
Administrative regions		
Kachin	145	3.9 (3.3 to 4.5)
Kayah	28	0.8 (0.5 to 1.1)
Kayin	132	3.5 (3.0 to 4.2)
Chin	56	1.5 (1.2 to 2.0)
Sagaing	439	11.8 (10.8 to 12.9)
Taninthayi	122	3.3 (2.7 to 3.9)
Bago	348	9.3 (8.4 to 10.3)
Magway	279	7.5 (6.9 to 8.4)
Mandalay	391	10.5 (9.5 to 11.5)
Mon	133	3.6 (3.0 to 4.2)
Rakhine	266	7.2 (6.4 to 8.0)
Yangon	402	10.8 (9.8 to 11.8)
Shan	398	10.7 (9.7 to 11.7)
Ayeyarwaddy	500	13.4 (12.4 to 14.5)
Naypyitaw	88	2.4 (1.9 to 2.9)

*Preceding birth interval: zero (first births): 0 month, short '9–24 months', medium '25–48 months', long '49 months and above'.

DHS survey, the question 'was the newborn very large, larger than average, average, smaller than average, or very small?' were asked to mothers. Birth weight is not usually recorded at birth in developing countries, and mothers' recall for child's birth size is commonly used as a proxy for birth weight.¹⁵ In a previous study conducted in Bangladesh, 90% of the mothers could correctly assess whether their newborn had low birth weight (LBW) or not.¹⁶ In this study, as with the previous study, we categorised the birth weights into LBW (mothers' recall of size of baby: very small or smaller than average) and non-LBW (average, larger than average, very large).^{15 16}

Household level variables included sociodemographic status, which was presented by wealth quintiles available in MDHS and in five categories: poorest, poorer, middle, richer and richest. Community level variables included areas of residence (urban and rural) and administrative regions.

Statistical analysis

Crude prevalence estimates

Prevalence of stunting, wasting, underweight and overweight in children under 5 was estimated at the national

Figure 1 Crude prevalence of stunting (A), wasting (B), underweight (C) and overweight (D).

level and in each region separately. To control the effect of hierarchical sampling procedure in MDHS, unless indicated otherwise, numbers of samples and prevalence presented in this study were estimated, taking into account the sampling weights.

Risks factor analyses

Multivariable logistic regression analyses were conducted for risk factor identification for each of the four outcomes. Variable selection was performed using backward-stepwise method. Models were constructed separately for each malnutritional status: stunting, wasting, underweight and overweight.

Adjusted prevalence estimates

Based on the estimated parameters from the regression models, adjusted prevalence of the outcomes for each region was estimated in reference to the national average values for the risk factors. These regression-based, adjusted prevalence estimates were mapped to explore geographic variation in the country, showing regional variations not explained by the risk factors used in the study. All analyses were performed in Stata V.15/SE and the mapping was constructed in QGIS V.2.18.^{17 18}

Patient and public involvement

Due to the study's retrospective nature using the secondary data from MDHS, no patients were involved in the study design or conduct of the study. There are no plans for dissemination of the outcomes of this research to the MDHS participants.

Table 2 Estimated prevalence of malnutrition among the study population

Variables	Weighted number of children (n)	Percent (95% CIs)
Stunting		
Stunted	1079	29.1 (27.7 to 30.6)
Not stunted	2629	70.9 (69.4 to 72.3)
Wasting		
Wasted	250	6.8 (6.0 to 7.6)
Not wasted	3448	93.2 (92.4 to 94.0)
Underweight		
Underweight	679	18.3 (17.0 to 19.5)
Not underweight	3042	81.8 (80.4 to 82.9)
Overweight		
Overweight	55	1.5 (1.1 to 1.9)
Not overweight	3643	98.5 (98.1 to 98.9)

RESULTS

Population characteristics

Table 1 shows the demographic characteristics of the study population (n=3727). Mean age was 29 months (SD 17); 51.5% were male. The weighted number of LBW children was 465 (13.0%). In total, 29.5% of the children were from the poorest families while 13.8% were from the richest families; and 78.0% were rural residents.

Crude prevalence estimates at national and subnational level

Taking into account the sampling strategy using sample weights and clustering, national prevalence of stunting, wasting, underweight and overweight in 2015–2016 in Myanmar was estimated to be 29.1% (95% CIs 27.7% to 30.6%), 6.8% (6.0% to 7.6%), 18.3% (17.0% to 19.5%) and 1.5% (1.1% to 1.9%), respectively (table 2). Figure 1 presents the subnational prevalence of each type of malnutrition in the country, where numbers on an interval scale have equal intervals (as many as it can allow the variation in all regions). There were substantial regional variations in malnutrition, ranging from 19.1% (15.5% to 23.2%) to 41.1% (29.1% to 54.3%) for stunting, from 2.7% (0.6% to 12.7%) to 12.9% (9.2% to 17.3%) for wasting, from 12.4% (9.6% to 15.8%) to 32.1% (26.7% to 38.0%) for underweight and from 0.0% (0.0% to 0.0%) to 4.2% (2.6% to 6.7%) for overweight. High crude prevalence of stunting, wasting and underweight were observed in remote areas. For example, the highest crude prevalence of stunting was observed in Chin (41.1%, 29.1% to 54.3%) followed by Kayah (40.4%, 24.3% to 58.9%), while Rakhine had the highest prevalence of wasting (12.9%, 9.2% to 17.3%) and underweight (32.1%, 26.7% to 38.0%). In contrast, high prevalence of overweight was observed in high economic capital area, Yangon (4.2%, 2.6% to 6.7%). Unlike other outcomes, there were no overweight case found in Mon and Nay Pyi Taw (capital) regions. Detailed prevalence

(exact values) of malnutrition for each region can be found in online supplementary table 1 for stunting and wasting and in online supplementary table 2 for underweight and overweight.

Risk factors of malnutrition

Table 3 shows adjusted ORs (AORs) and 95% CI for stunting, wasting, underweight and overweight. In multi-variable analyses, adjusted for covariates, stunting and underweight were significantly and positively associated with LBW, with AORs of 2.06 (95% CI 1.65 to 2.58, $p<0.001$) and 2.81 (2.24 to 3.53, $p<0.001$) in reference to non-LBW children. The statistically significant associations of wasting and overweight with LBW were not observed. In addition, children who had obese mothers had significantly lower odds of having stunted children (0.53, 0.35 to 0.79, $p<0.05$) than those having a mother in normal weight. Underweight mothers tended to have more wasted and underweight children compared with mothers with normal weight (1.64, 1.09 to 2.48, $p<0.05$; and 1.34, 1.03 to 1.75, $p<0.05$, respectively).

After adjustment for covariates, the odds of stunting and underweight were the lowest in <6-month-old children (AORs 0.15, 95% CI 0.09 to 0.23, $p<0.001$ and 0.27, 0.17 to 0.41, $p<0.001$), respectively, in reference to 48–59-month-old children. Meanwhile, there were no significant differences observed in odds of overweight among different age groups. However, the odds of wasting in <6-month-old children were 1.99 (1.25 to 3.16, $p<0.01$) times higher, in reference to 48–59-month-old children. Compared with children who were born after short preceding birth interval (9–24 months), first born children and children born after long preceding birth interval had lower odds of stunting (0.62, 0.46 to 0.85, $p<0.01$ and 0.62, 0.47 to 0.83, $p<0.01$), respectively. Compared with the children from middle wealth index group, those from richest group had 0.59 times lower odds of stunting (0.41 to 0.84, $p<0.01$) after adjusted for covariates. Wasting was also significantly and negatively associated with wealth index in which children from richer group were lower odds (0.58, 0.34 to 0.98, $p<0.05$) compared with those from middle wealth index group.

Adjusted subnational prevalence and unexplained regional variation

Figure 2 presents the subnational adjusted prevalence of each type of malnutrition in reference to the national average values for the risk factors based on the estimated parameters from the regression models above. The cut-off points on scales for prevalence mapping were same with figure 1 (crude prevalence map) for better comparability between crude and adjusted prevalence of each outcome. Homogeneous prevalence of wasting was observed throughout the middle regions from north to south, and the highest prevalence was observed in Yangon (11.0%, 95% CI 7.5% to 14.6%) followed by Rakhine (9.9%, 6.3% to 13.5%) and Tanintharyi (9.2%, 3.9% to 14.6%). Similarly, the regional variation of stunting and overweight remained after the adjustment. Meanwhile, the adjusted prevalence of underweight showed narrowed variations and decreased

prevalence in northern and eastern parts. Detailed adjusted prevalence of malnutrition for each region can be found in online supplementary table 1 for stunting and wasting and in online supplementary table 2 for underweight and overweight.

DISCUSSION

We estimated the prevalence of malnutrition among children under 5 at both the national and subnational levels in Myanmar, using nationally representative data and identified risk factors of malnutrition. This is the first study to include geographical mapping and discussed about regional variation in the prevalence of malnutrition. The prevalence of stunting, wasting, underweight and overweight were 29.1% (95% CI 27.7% to 30.6%), 6.8% (6.0% to 7.6%), 18.3% (17.0% to 19.5%) and 1.5% (1.1% to 1.9%), respectively.

In comparison with the reported prevalence of stunting and wasting in 1991 (53.6% and 12.7%), underweight in 1990 (32.5%) and of overweight in 1997 (9.7%) from the WHO's Global Observatory Data,¹⁹ there has been a substantial reduction in these conditions.¹⁹ Even though recent increase in prevalence was seen in other southeast Asian countries like Indonesia from 5.1% in 2004 to 11.5% in 2016 and Thailand from 7.3% in 2006 to 8.2% in 2016, Myanmar did not show increasing prevalence of overweight among children.²⁰ There were substantial variations in malnutrition prevalence across regions. Regions with more urban areas had lower prevalence of malnutrition (Yangon, Nay Pyi Taw). In some areas, the regional prevalence was much higher than the national prevalence. The regional variations persisted even after adjustment for risk factors including sociodemographic conditions.

Regional variations in nutritional status has mostly been seen in the countries where universal health coverage (UHC) has not yet been achieved.¹¹ Myanmar is one of the countries that has not yet fully achieved UHC, and the healthcare services coverage is still approximately 50%–80%.²¹ In terms of national nutrition actions coverage, only 3 out of 20 actions achieved 80% of targeted population coverage; salt iodisation, deworming, and health, nutrition and hygiene education in school.²² Low coverage was mostly seen in remote and civil conflict affected areas like Kachin, Chin and Rakhine. Another explanation for regional variations in nutritional status is that regional governments do not have full authority to handle the nutritional issues within their regions even though health sector decentralisation was introduced in 1965.²³ Most decisions are still made by the central government; this may complicate effective interventions tailored for each region.²³

Several risk factors of malnutrition were identified in this study, including LBW and mother's nutrition. The main reason for LBW in most of the developing countries was found to be intrauterine growth retardation (IUGR) rather than prematurity.²⁴ Most of the IUGR cases were associated with maternal factors, such as, nutrition and diet during pregnancy, young maternal age, low maternal height and

Table 3 ORs and 95% CI of stunting, wasting, underweight and overweight

Variables	Stunting	Wasting	Underweight	Overweight
Child's age (months)				
<6	0.15 (0.09 to 0.23)***	1.99 (1.25 to 3.16)**	0.27 (0.17 to 0.41)***	2.52 (1.00 to 6.39)
6–11	0.31 (0.22 to 0.45) ***	0.67 (0.37 to 1.22)	0.46 (0.31 to 0.67)***	1.84 (0.71 to 4.73)
12–23	0.71 (0.55 to 0.92) **	1.12 (0.73 to 1.71)	0.58 (0.44 to 0.76)***	1.27 (0.53 to 3.02)
24–35	1.44 (1.13 to 1.83) **	0.72 (0.45 to 1.64)	0.89 (0.68 to 1.17)	0.29 (0.08 to 1.10)
36–47	1.20 (0.95 to 1.50)	0.68 (0.43 to 1.08)	0.88 (0.68 to 1.14)	0.65 (0.24 to 1.74)
48–59	1.00	1.00	1.00	1.00
Child's gender				
Male	1.00	1.00	1.00	1.00
Female	0.79 (0.67 to 0.93) **	0.81 (0.61 to 1.08)	0.86 (0.72 to 1.02)	0.40 (0.21 to 0.74)**
Preceding birth interval*				
Zero (first births)	0.62 (0.46 to 0.85) **	–	0.71 (0.50 to 0.99)*	–
Short	1.00	–	1.00	–
Medium	0.88 (0.65 to 1.18)	–	0.77 (0.55 to 1.07)	–
Long	0.62 (0.47 to 0.83) **	–	0.67 (0.48 to 0.92)*	–
Mother's body mass index				
Underweight	1.09 (0.87 to 1.38)	1.66 (1.12 to 2.46)*	1.31 (1.03 to 1.69)*	1.00 (0.34 to 2.93)
Normal	1.00	1.00	1.00	1.00
Overweight	0.84 (0.68 to 1.04)	0.96 (0.63 to 1.41)	0.65 (0.49 to 0.84)**	1.97 (1.02 to 3.79)*
Obese	0.53 (0.35 to 0.79) *	1.32 (0.72 to 2.43)	0.36 (0.20 to 0.63)***	2.87 (1.06 to 7.77)*
Mother's education				
No education	1.00	–	–	–
Primary	0.99 (0.78 to 1.26)	–	–	–
Secondary	0.71 (0.53 to 0.95) *	–	–	–
Higher	1.02 (0.65 to 1.63)	–	–	–
Father's education				
No education	1.00	1.00	1.00	–
Primary	0.76 (0.60 to 0.97) *	0.66 (0.44 to 0.99)*	0.62 (0.48 to 0.79)***	–
Secondary	0.75 (0.58 to 0.98) *	0.93 (0.61 to 1.44)	0.63 (0.48 to 0.83)**	–
Higher	0.85 (0.52 to 1.40)	0.84 (0.41 to 1.71)	0.98 (0.60 to 1.61)	–
Birth weight				
Normal	1.00	1.00	1.00	1.00
Low birth weight	2.06 (1.65 to 2.58) ***	1.36 (0.92 to 2.00)	2.81 (2.24 to 3.53)***	1.73 (0.81 to 3.73)
Sociodemographic status				
Poorest	1.18 (0.92 to 1.52)	1.11 (0.72 to 1.73)	1.11 (0.83 to 1.48)	0.82 (0.26 to 2.59)
Poorer	1.23 (0.95 to 1.58)	0.79 (0.50 to 1.26)	1.11 (0.82 to 1.48)	2.19 (0.84 to 5.68)
Middle	1.00	1.00	1.00	1.00
Richer	0.96 (0.72 to 1.27)	0.58 (0.34 to 0.98)*	0.99 (0.71 to 1.37)	1.65 (0.61 to 4.50)
Richest	0.59 (0.41 to 0.84) **	0.99 (0.59 to 1.63)	0.81 (0.55 to 1.19)	1.67 (0.60 to 4.65)
Administrative regions				
Kachin	1.57 (0.97 to 2.52)	0.23 (0.08 to 0.67)**	0.89 (0.50 to 1.56)	0.55 (0.14 to 2.19)
Kayah	2.17 (0.91 to 5.15)	0.24 (0.03 to 2.19)	1.04 (0.37 to 2.95)	0.94 (0.09 to 9.15)
Kayin	0.93 (0.55 to 1.56)	0.38 (0.16 to 0.88)*	0.65 (0.36 to 1.19)	0.76 (0.22 to 2.58)
Chin	1.92 (1.10 to 3.65) *	0.20 (0.04 to 1.01)	0.81 (0.36 to 1.81)	0.81 (0.14 to 4.65)

Continued

Table 3 Continued

Variables	Stunting	Wasting	Underweight	Overweight
Sagaing	1.04 (0.72 to 1.50)	0.35 (0.19 to 0.63)***	0.70 (0.45 to 1.08)	0.41 (0.15 to 1.06)
Tanintharyi	0.97 (0.57 to 1.65)	0.75 (0.36 to 1.58)	1.19 (0.66 to 2.14)	0.45 (0.08 to 2.44)
Bago	0.94 (0.64 to 1.37)	0.47 (0.28 to 0.81)	1.13 (0.75 to 1.72)	0.07 (0.01 to 0.52)
Magway	0.85 (0.56 to 1.28)	0.40 (0.21 to 0.76)**	1.11 (0.71 to 1.73)	0.40 (0.12 to 1.36)
Mandalay	1.12 (0.78 to 1.62)	0.55 (0.33 to 0.91)*	0.93 (0.61 to 1.41)	0.45 (1.17 to 1.18)
Mon	1.18 (0.71 to 1.98)	0.44 (0.19 to 0.99)*	1.28 (0.73 to 2.23)	–
Rakhine	1.29 (0.86 to 1.94)	0.79 (0.45 to 1.38)	1.76 (1.14 to 2.72)*	0.08 (0.01 to 1.04)
Yangon	1.00	1.00	1.00	1.00
Shan	1.37 (0.95 to 1.98)	0.25 (0.13 to 0.49)***	0.67 (0.43 to 1.03)*	0.12 (0.03 to 0.58)
Ayeyarwaddy	1.66 (1.17 to 2.34)*	0.19 (0.10 to 0.38)***	1.58 (1.07 to 2.33)*	0.37 (0.12 to 1.12)
Naypyitaw	0.71 (0.37 to 1.35)	0.45 (0.17 to 1.21)	0.78 (0.38 to 1.62)	–

*Preceding birth interval: zero (first births): 0 month, short '9–24 months', medium '25–48 months', long '49 months and above'; * $p < 0.05$,

** $p < 0.01$, *** $p < 0.001$.

weight and presence of diseases (eg, hypertension).²⁵ IUGR–LBW affects the child throughout his/her life and associates with higher incidence of type two diabetes, hypertension and cardiovascular disease.²⁶ The study showed that LBW was a significant risk factor for childhood undernutrition even after being adjusted for well-known risk factors, such as, mothers' and fathers' education and different

socioeconomic status. Therefore, LBW should be considered as one of important risk factors for stunting and underweight among children under 5.

As observed in previous studies from other countries, children from poorest families were at higher risk of malnutrition, in particular stunting.^{16 27} In this study, children from richest group were nearly half time lower odds of being stunted compared with those from middle groups (reference). It is widely known that poverty and malnutrition reinforce each other and efforts to address malnutrition in the poorest groups are much needed.⁴ One of the thing that we can exclude depending on the result of this study is that we did not find any double burden of malnutrition, such as maternal overweight and child underweight/stunting.

Limitations of this study

Our study has limitations. First, the observational nature of the study did not allow for assessing causal relationships between risk factors and malnutrition. Second, birth weight was categorised based on the mother's recall of the birth size of the child; this might have introduced recall bias as well as uncertainty regarding the specificity and generalisability of this exposure. This is a well-known limitation of the DHS surveys. Third, even though we have assessed the possibility of unexplained risk factors' presence, we could not identify which factors are responsible.

CONCLUSION

This study has provided prevalence estimates of stunting, wasting, underweight and overweight among children under 5 at the national as well as the subnational level in Myanmar. Prevalence of the different types of malnutrition varied markedly across regions of the country. This variation persisted even after adjustment for the identified risk factors of each type of malnutrition. Several risk factors of malnutrition were identified, including LBW and

Figure 2 Adjusted prevalence of stunting (A), wasting (B), underweight (C) and overweight (D). Birth weight, child's age and gender, parental education, mother's body mass index, preceding birth interval and sociodemographic status were adjusted.

inadequate maternal nutritional status. There is plenty of scope for reducing the burden of malnutrition among children under 5 in Myanmar by addressing these risk factors. Future interventions aimed at improving the nutritional status of children under 5 in Myanmar should consider the regional variations in prevalence. Further research is needed to investigate the potential sources of regional variation in prevalence of malnutrition in children under 5 in the country.

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