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Prevalence and regional variations of coexistence of child stunting and maternal overweight or obesity in Myanmar

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Abstract

Objective: The current study aimed to investigate double burden of malnutrition within households at the national and subnational levels and to identify its association with sociodemographic factors in Myanmar.

Design: All the variables were extracted from children's file of the Myanmar Demographic and Health Survey 2015–2016. Children under five were identified as stunted based on a height-for-age < -2 SD below the WHO reference median. Maternal overweight/obesity was defined as a BMI ≥ 23 kg/m^2. A stunted child with an overweight/obese mother (SCOM) was classified as a double-burden household.

Setting: A national household survey in Myanmar.

Participants: Children under five and their mothers (*n* 3954 pairs).

Results: Mean ages of children and mothers were 29 (SE 0·14) months and 30·9 (SE 0·32) years, respectively. National prevalence of childhood stunting and maternal overweight/obesity was 28·0 % and 39·4 %, respectively, and the prevalence of SCOM was 9·1 %. Significant regional differences were found in SCOM, ranging from 3·6 % in Naypyitaw to 12 % in Kachin and Mon and 14·6 % in Kayah. In the multinomial logistic regression analysis, relative to neither a stunted child nor an overweight/obese mother, child's age, maternal age, maternal experience of a teen birth, short mothers, mothers with primary education and in middle or rich wealth tertiles, and some regions (Kachin, Kayah, Shan, Sagaing, Taninthayi, Ayeyarwaddy, Mon and Yangon) were associated with greater odds of SCOM.

Conclusions: The current study showed a relatively high national prevalence of SCOM and significant regional variations. Overarching policies and programmes with culturally sensitive strategies need to be formulated and implemented.

Keywords
Child stunting
Maternal overweight/obesity
Double burden of malnutrition
Myanmar demographic and health survey

Several low- and middle-income countries (LMIC) are experiencing nutritional, demographic and socio-economic transitions due to economic development in the last few decades[1,2]. The transitions reflect the relative nutrition concerns of a country through changes in traditional food patterns and the amount and intensity of physical activities with economic growth[3]. The rapid changes in diet and physical activity patterns have resulted in an increasing prevalence of overweight and obesity in all age groups[4]. Even though the number of undernourished children aged under five has fallen in many countries, the under-nutrition persists as a major public health problem[4]. Global progress to reduce these forms of malnutrition is not rapid enough to meet internationally agreed nutrition targets[4].

The co-existing of over-nutrition with under-nutrition, defined as a double burden of malnutrition (DBMN) within individuals, households or populations, has emerged as a growing problem in LMIC[5–9]. Through its effects on health, such as an increased risk of non-communicable diseases[10], the DBMN contributes to serious negative economic impacts on individuals and populations[11], such as a rise in health care costs, a decrease in productivity and economic retardation of a country, which in turn can perpetuate a cycle of poverty and ill health[11]. The complex burden of malnutrition demands an increase in focus on all forms of malnutrition from predominantly undernutrition or single sides of malnutrition. Greater efforts are necessary to achieve the internationally agreed

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targets, such as the World Health Assembly global nutrition targets and the United Nations Decade of Action on Nutrition by 2025[12], and the Sustainable Development Goals (SDG) of ending hunger and all forms of malnutrition (SDG2) and ensuring healthy lives and well-being for all at all ages (SDG3) by 2030[13] to improve maternal and child health[13,14].

Myanmar is the largest country in mainland Southeast Asia and is bordered to the west by Bangladesh and India, to the north by China and to the east by Laos and Thailand[15]. Being a country bordering with five countries, Myanmar has a diverse culture and tradition. More than one-third of the whole population in Myanmar is composed of more than 130 ethnic minority groups with eight major groups[15]. Its total population increased from 26·4 million in 1970 to 53·4 million in 2017[16]. It is classified as a lower middle-income country[16], with the estimates of gross national income per capita rose from 170 USD in 2002 to 1210 USD in 2017. Great gains have been made in child nutrition during the Millennium Development Goals. For example, there was a decline in stunting from 40·8 % in 2000 to 29·4 % in 2016[17]. Yet, the prevalence still remained high[18]. In addition, overweight or obesity of women of reproductive age (defined by a BMI $\geq$ 25 kg/m^2) is on the rise from 20·2 % in 1999 to 35·1 % in 2015[17]. Despite a growing number of studies on DBMN in LMIC, to the best of the author's knowledge, only one study in Myanmar has investigated the national prevalence (5·54 %) of a stunted child with an overweight/obese mother[19]. The study defined maternal overweight or obesity as a BMI $\geq$ 25 kg/m^2, as in other studies in the Southeast Asia region[5,9,19–23]. Due to an increased risk of non-communicable diseases at lower BMI levels in Asians than in non-Asians[24], to identify Asians who may have non-communicable diseases or be at risk for future non-communicable diseases, the use of the modified cut-off points of BMI was recommended by WHO. Moreover, with the very diverse ethnicities and different levels of economic development among regions in Myanmar, simply estimating the DBMN only at the national level might underestimate the depth of the problem and thus impede a country's ability to achieve SDG.

The aims of the current study were to investigate the prevalence of DBMN at the national and subnational levels in Myanmar, and to identify the sociodemographic factors associated with the DBMN in Myanmar, where nutritional transition has been taking place. The results of the current study will help policymakers and programme managers to understand the extent DBMN affected households at the national and subnational levels and the associated factors. Furthermore, the findings may inform the design of culturally and regionally sensitive interventions which will contribute to achieve the SDG targets by 2030.

Methods

The current study performed a secondary analysis using the data from the 2015–2016 Myanmar Demographic and Health Survey (MDHS), which was the first DHS in Myanmar. It was conducted by the Ministry of Health and Sports and was funded by the United States Agency for International Development and the Three Millennium Development Goal Fund. The MDHS was conducted using a frame from the Myanmar Population and Housing Census 2014, provided by the Department of Population, the Ministry of Immigration and Population of Myanmar. The survey was based on a stratified two-stage sample design in order to allow estimates of core indicators at the national level, in urban and rural areas, and for each of the fifteen administrative regions of Myanmar. At the first stage, urban and rural areas (123 and 319 clusters, respectively) in the fifteen administrative regions were identified as the main sampling strata. At the second stage, a fixed number of thirty households were drawn from a household list within each selected cluster using equal probability systematic sampling. Among the selected households (n 13 260), 12 500 households were interviewed (97·8 % response rate). In the interviewed households, all women aged 15–49 years and all men aged 15–59 years who were either permanent residents of the selected households or visitors who stayed in the household the night before the survey were eligible to be interviewed. Of 13 454 women eligible for the individual women's questionnaire in the interviewed households, a total of 12 885 women successfully completed the women's questionnaire on maternal and child health behaviours and outcomes (95·8 % response rate)[25].

The current study analysed children's data file (children aged <5 years of interviewed women) in which children were screened to meet the eligibility criteria by the survey team. Of the initial sample (4815 unweighted mother–child pairs), mothers who were currently pregnant (n 281), who were under 18 years of age (n 14) and who did not have implausible anthropometric data (n 61) were excluded from the analysis. Children without the anthropometric measures needed to estimate the indicator for stunting (height-for-age) (n 505) were also excluded. The final analytical sample included a total of 3954 unweighted mother–child pairs. The data sets of the MDHS are free to download and were accessed from the DHS website after the permission to use the MDHS data in this analysis was obtained from Opinion Research Corporation Macro Inc. Details of these MDHS have been described elsewhere[25].

Nutritional status of the mother and the child

Based on anthropometric guidelines provided by experts from the DHS Program, field supervisors and editors

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participated in training and standardisation programmes before data collection. Trained personnel measured body weights and heights of all children under the age of 5 years and women aged 15–49 years using standard scales and measuring boards recommended by UNICEF. Height measurements were carried out using a Shorr Productions measuring board. Children younger than 24 months were measured lying down on the board (recumbent length), and standing height was measured for older children. Weight measurements were taken using lightweight SECA scales with digital screens, designed and manufactured under the guidance of UNICEF[25].

There is no uniform definition of DBMN indicators. In most studies of DBMN at household level, maternal overweight or obesity was defined by a BMI at or above 25·0 kg/m^2. Due to an increased risk of CVD and diabetes at lower BMI levels in Asians than in non-Asians, the WHO in 2004 recommended using a modified threshold of BMI at or over 23 kg/m^2 rather than 25 kg/m^2 to define overweight for Asians[24]. Therefore, in the current study, maternal weight status was categorised into underweight (BMI < 18·5 kg/m^2), normal weight (18·5–22·9 kg/m^2), overweight (23·0–27·4 kg/m^2) and obesity (≥27·5 kg/m^2). Child stunting was defined as a length/height-for-age Z score < −2 SD from the median of the WHO Child Growth Standards[26]. Based on their respective nutritional assessment for child stunting and maternal overweight/obesity, each mother and child pair was classified into one of the four categories: (i) non-stunted child and non-overweight/obese mother (NSCNOM); (ii) stunted child with non-overweight/obese mother (SCNOM); (iii) non-stunted child and overweight/obese mother (NSCOM) and (iv) stunted child with overweight/obese mother (SCOM).

Covariates

A variety of sociodemographic factors in the levels of child, mother and family associated with either child stunting, maternal overweight or the DBMN from literature were employed in the current study: for the child factors, child's sex[18,19,27,28] and age[18,19,28]; for the maternal factors, current age[19,29], educational attainment[19,27,28,30], native language of mother[29,30], working status of mothers[28,29], number of children ever born[29], short height of mother as a proxy for prior stunting experience[28,29] and maternal age at first delivery <20 years old[31]; and for the family/community factors, wealth index[18,19,22], place of residence[22,28] and regions[18,27].

The variables were categorised as follows and included in the analyses: for child factors, child's sex (boys or girls) and age (0–12, 13–24, 25–36, 37–48 or 49–59 months); for maternal factors, current age (18–24, 25–34 or 35–49 years), age at first delivery <20 years old (no or yes), short stature (<150 cm or ≥150 cm), educational attainment (no education, primary school or secondary/higher), native language (Myanmar or non-Myanmar), working status (no or yes) and number of children ever born (<2 or 2+); and for family/community factors, wealth index tertiles (poor, middle or rich), place of residence (rural or urban areas) and fifteen administrative regions. The administrative regions of Myanmar comprise seven regions (Ayeyawady, Bago, Magway, Mandalay, Sagaing, Taninthayi and Yangon), seven states (Chin, Kachin, Kayah, Kayin, Mon, Shan and Rakhine) and Union Territory (Naypyitaw). Each state reflects the dominant ethnic group in each respective region[32]. A subnational analysis was undertaken by the fifteen administrative regions.

Statistical analysis

The current study performed the analyses using the SAS version 9.4 (SAS Institute Inc.). Taking into account the complex sample survey data composition, its PROC SURVEY commands were used with primary sampling units, stratification and sample weights. As the current study excluded some mother–child pairs by the exclusion criteria, an unconditional subpopulation analysis, restricting the estimation to subgroups of interest, was performed. For example, the current study treated the exclusion conditions presented and missing values as category 0 of the subpopulation indicators and the population of interest as category 1.

The outcome variables were the four categories of DBMN in mother–child pairs (NSCNOM, SCNOM, NSCOM and SCOM). Descriptive statistics were used to illustrate sociodemographic factors and the dependent variables. Prior to the analysis, multicollinearity tests were performed for all independent variables. The current study employed a variance inflation factor of <2·5 to determine that multicollinearity was not a problem. A χ^2 test was performed to analyse the differences between independent and dependent variables. The current study used multivariate multinomial logistic regression in which the dependent variables had four categories (SCNOM, NSCOM, SCOM and the comparison group (NSCNOM)) and the regression model simultaneously included all covariates. Adjusted OR and 95 % CI were used to assess the strength of the associations between independent and dependent variables. Statistical significance was determined at the 5 % level of significance.

Results

Table 1 shows the general characteristics of under-five children and mother pairs (3954 pairs). The mean ages of children and mothers were 29(SE 0·14) months and 30·9 (SE 0·32) years, respectively. About half of the children were boys (52 %) and under 2 years of age (42·5 %). A third of mothers delivered the first baby under 20 years (28·1 %) and had a short stature <150 cm (31·4 %). A majority of

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Table 1 Distribution of double burden of malnutrition in mother–child pairs by child, maternal and family factors*

	Total		NSCNOM	SCNOM	NSCOM	SCOM	
	n	Wt. %	Wt. %	Wt. %	Wt. %	Wt. %	*P*-value
	3954	100·0	41·7	18·8	30·3	9·1	
Child characteristics							
Gender							
Boys	2059	52·0	40·4	20·6	29·7	9·2	0·0827
Girls	1895	48·0	43·2	16·9	30·9	9·0	
Age groups							
0–12 months	897	21·8	61·2	7·0	28·5	3·3	**<0·0001**
13–24 months	797	20·7	42·5	18·5	32·2	6·8	
25–36 months	767	19·3	31·1	25·7	28·6	14·6	
37–48 months	816	20·5	34·6	21·3	31·1	13·0	
49–59 months	677	17·6	36·8	23·4	31·2	8·7	
Maternal characteristics							
Maternal age (years)							
18–25	703	18·1	53·1	18·5	21·7	6·6	**<0·0001**
25–35	2037	51·8	42·4	18·7	30·5	8·5	
35–49	1214	30·1	33·8	19·3	35·1	11·8	
Maternal age at first delivery							
≥20 years	2812	71·9	43·0	17·0	31·4	8·5	**0·0007**
<20 years	1142	28·1	38·5	23·4	27·5	10·7	
Short stature of mother							
≥150 cm	2630	68·6	42·7	15·9	33·8	7·6	**<0·0001**
<150 cm	1324	31·4	39·5	25·3	22·6	12·6	
Educational attainment							
No education	650	16·4	44·2	29·4	18·5	8·0	**<0·0001**
Primary school	1796	47·4	40·9	20·4	28·4	10·3	
Secondary or higher	1508	36·2	41·7	11·9	38·2	8·2	
Marital status							
Living with spouse	3776	95·6	41·8	18·6	30·5	9·1	0·3328
Living without spouse	178	4·4	39·7	24·5	25·3	10·5	
Native language of mother							
Myanmar	3122	85·3	41·5	17·3	32·2	9·0	**<0·0001**
Non-Myanmar	832	14·7	43·0	27·7	19·5	9·7	
Working mothers							
No	1873	44·0	44·1	15·8	31·6	8·5	**0·0056**
Yes	2079	56·0	39·9	21·2	29·3	9·6	
No. of children ever born							
<2	2168	61·4	40·0	16·3	33·7	10·0	**<0·0001**
2+	1786	38·6	44·5	22·8	25·0	7·7	
Familial factors							
Place of residence							
Urban	822	21·8	38·2	9·5	43·2	9·1	**<0·0001**
Rural	3132	78·2	42·7	21·4	26·7	9·1	
Wealth index							
Poor	1300	32·3	45·2	28·2	18·9	7·7	**<0·0001**
Middle	1320	32·4	42·1	19·6	28·2	10·1	
Rich	1334	35·3	38·3	9·5	42·7	9·5	
Administrative regions							
Kachin	270	3·6	32·1	22·3	33·6	12·0	**<0·0001**
Kayah	309	0·7	41·9	25·2	18·2	14·6	
Kayin	293	3·5	45·8	18·2	28·0	7·9	
Chin	372	1·4	40·1	32·1	20·5	7·4	
Sagaing	313	12·2	41·9	14·9	32·5	10·7	
Taninthayi	281	3·2	39·8	14·7	34·5	10·9	
Bago	254	9·7	47·3	16·5	28·6	7·6	
Magway	238	7·8	46·9	18·1	27·4	7·5	
Mandalay	227	10·5	46·9	17·3	29·0	6·7	
Mon	213	3·5	39·7	14·8	33·3	12·2	
Rakhine	284	6·9	43·1	27·5	20·6	8·9	
Yangon	217	10·9	33·6	6·6	49·7	10·1	
Shan	212	10·4	40·6	25·9	24·0	9·4	
Ayeyarwaddy	256	13·2	38·8	25·0	26·2	10·1	
Naypyitaw	215	2·4	48·3	19·3	28·8	3·6	

NSC-NOM, non-stunted child and non-overweight/obese mother; SC-NOM, stunted child and non-overweight/obese mother; NSC-OM, non-stunted child and overweight/obese mother; SC-OM, stunted child and overweight/obese mother.
*Bold values indicate statistical significance ($P < 0·05$).

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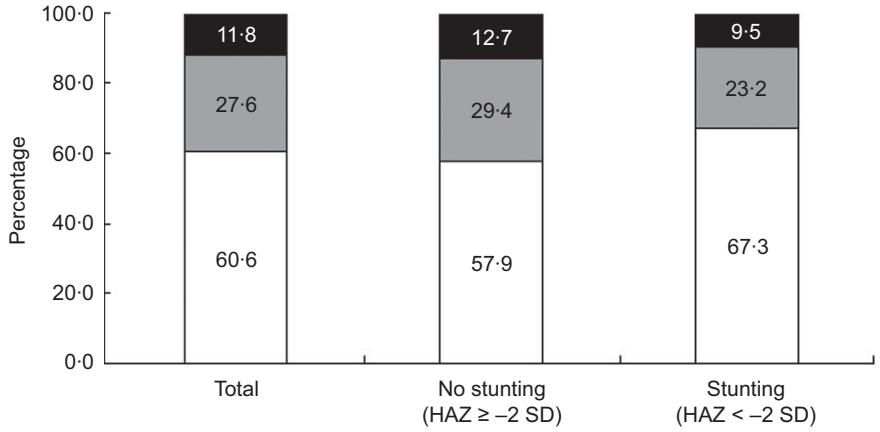

Fig. 1 Prevalence of maternal weight status by child's stunting status. □, Normal-weight mothers (<23·0); ▒, overweight mothers (23–27·4); ■, obese mothers (≥27·5). HAZ, height-for-age *Z* score

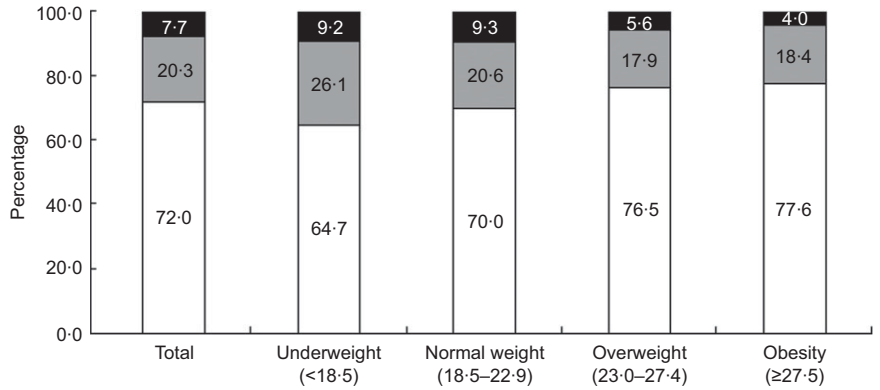

Fig. 2 Prevalence of child's stunting by maternal weight status. □, No stunting (height-for-age *Z* score (HAZ) ≥ –2 SD); ▒, moderate stunting (–3 SD ≤ HAZ < –2 SD); ■, severe stunting (HAZ < –3 SD)

mother–child dyads resided in rural areas (78·2 %) and spoke Myanmar as their first language (85·3 %) and had no formal education or primary education (63·8 %).

Figures 1 and 2 shows that the prevalence of childhood stunting and maternal overweight/obesity was relatively high (28·0 % and 39·4 %, respectively). When mothers were divided by child stunting status, 32·7 % of the mothers were overweight in the child stunting group, while 42·1 % were in the group of children without stunting (Fig. 1). When divided by maternal weight status (Fig. 2), the prevalence of stunting was higher in underweight mothers (35·3 %) and also relatively high in maternal overweight (23·5 %) and obese (22·4 %). In the eight possible combinations of maternal weight status with child stunting status (Fig. 3), only about 33·7 % of mother–child pairs had neither maternal overweight/underweight nor child stunting and the remaining 49·2 % of the dyads had either child stunting or maternal overweight/obesity.

In the four combinations of child stunting with maternal overweight/obesity, the prevalence of SCNOM, NSCOM and SCOM was 18·8 %, 30·3 % and 9·1 %, respectively (Table 1). Mother–child dyads with children aged 25–36 months had a higher prevalence of SCOM, while there was no difference in gender. Among maternal characteristics, the dyads with older maternal age (35–49 years), maternal age at first delivery <20 years, short mothers (<150 cm), mothers with primary education, non-Myanmar mothers, working mothers and mothers having only one child ever born had a higher prevalence of SCOM ($P < 0·01$). On family factors, those from middle or rich wealth index tertiles had a higher prevalence of SCOM ($P < 0·0001$). In addition, significant regional differences in SCOM among fifteen administrative regions of Myanmar were found ($P < 0·0001$) (Table 1 and Fig. 4). National prevalence of SCOM was 9·1 % (95 % CI 7·9, 10·4). When divided by fifteen administrative regions, the prevalence ranged from 3·6 % (95 % CI 0·9, 6·3) in Naypyitaw to 12 % in Kachin (12·0 % (95 % CI 7·0, 16·9)) and Mon (12·2 % (95 % CI 5·5, 18·9)) and 14·6 % (95 % CI 9·1, 20·1) in Kayah (Fig. 4).

Table 2 shows the adjusted OR with 95 % CI for SCOM, relative to NSCNOM by the covariates considered in the multivariate multinomial logistic regression analyses. Significant determinants for SCOM included children in

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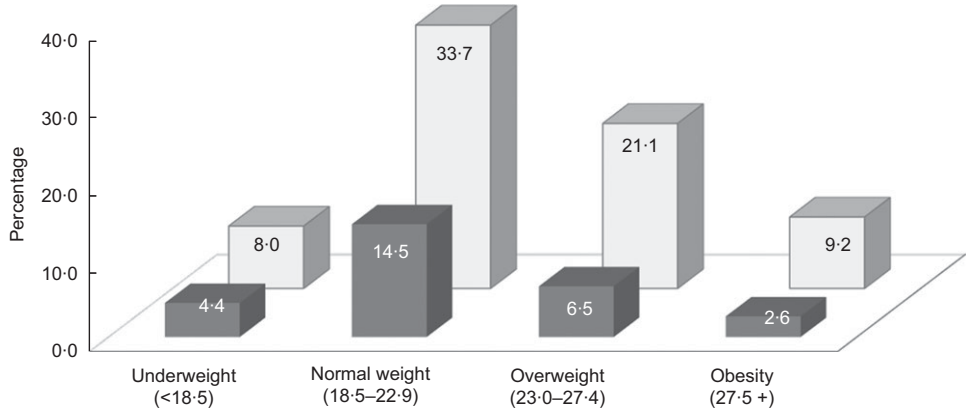

Fig. 3 Clustering of child stunting and mother's weight status. □, Not stunting (height-for-age *Z* score (HAZ) ≥ −2 SD); ■, stunting (HAZ < −2 SD)

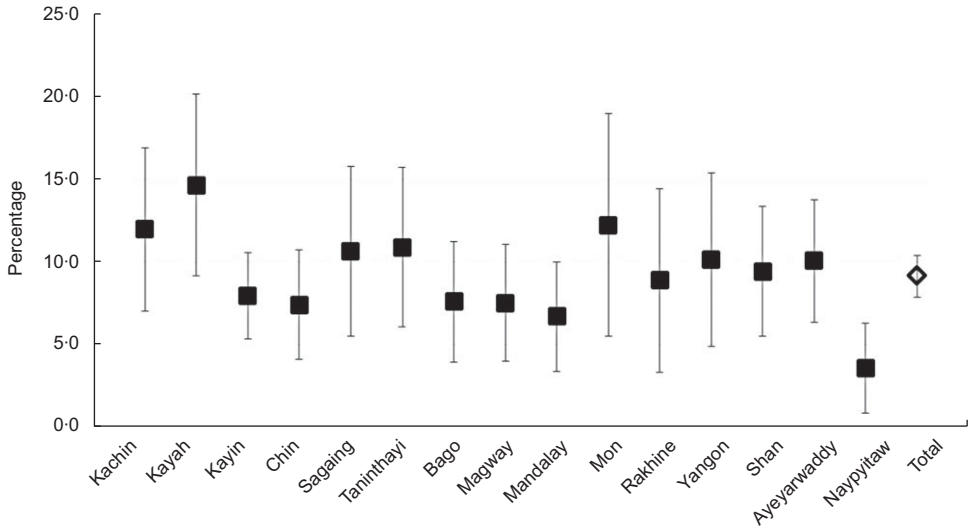

Fig. 4 Prevalence and 95 % CI of households with a stunted child and an overweight/obese mother by fifteen states and regions National prevalence (95 % CI) for SCOM is 9·1 (95 % CI 7·9, 10·4) and the prevalences for administrative regions are 12·0 (95 % CI 7·0, 16·9) for Kachin, 14·6 (95 % CI 9·1, 20·1) for Kayah, 7·9 (95 % CI 5·3, 10·6) for Kayin, 7·4 (95 % CI 4·1, 10·7) for Chin, 10·7 (95 % CI 5·5, 15·8) for Sagaing, 10·9 (95 % CI 6·1, 15·7) for Taninthayi, 7·6 (95 % CI 4·0, 11·2) for Bago, 7·5 (95 % CI 4·0, 11·0) for Magway, 6·7 (95 % CI 3·4, 10·0) for Mandalay, 12·2 (95 % CI 5·5, 18·9) for Mon, 8·9 (95 % CI 3·3, 14·4) for Rakhine, 10·1 (95 % CI 4·9, 15·3) for Yangon, 9·4 (95 % CI 5·5, 13·3) for Shan, 10·1 (95 % CI 6·4, 13·7) for Ayeyarwaddy and 3·6 (95 % CI 0·9, 6·3) for Naypyitaw

the age group of 13–59 months (adjusted OR = 2·89 (95 % CI 1·58, 5·30) for 13–24 months, 8·47 (95 % CI 4·82, 14·9) for 25–36 months, 6·45 (95 % CI 3·62, 11·5) for 37–48 months and 3·71 (95 % CI 2·12, 6·47) for 49–59 months), older mothers (1·62 (95 % CI 1·01, 2·61) for 25–35 years and 2·79 (95 % CI 1·68, 4·63) for 35–49 years)), mothers delivered the first baby under 20 years old (1·87 (95 % CI 1·27, 2·74)), short mothers (2·11 (95 % CI 1·51, 2·96)), mothers with primary education (1·62 (95 % CI 1·04, 2·52)) and those from middle or rich wealth index tertiles (1·92 (95 % CI 1·17, 3·15) and 1·71 (95 % CI 1·12, 2·63), respectively). In addition, compared with living in Naypyitaw (the capital of Myanmar), the dyads living in Shan (3·28 (95 % CI 1·11, 9·68)), Sagaing (3·56 (95 % CI 1·21, 10·5)), Taninthayi (4·22 (95 % CI 1·44, 12·3)), Ayeyarwaddy (4·56 (95 % CI 1·62, 12·8)), Yangon (4·83 (95 % CI 1·49, 15·6)), Mon (4·92 (95 % CI 1·65, 14·7)), Kachin (5·02 (95 % CI 1·76, 14·3)) and Kayah (5·56 (95 % CI 1·96, 15·8)) had greater odds of SCOM. Other factors (child's gender, marital status, native language of mother, working mother, number of children ever born and place of residence) were not statistically significantly associated with the likelihood of SCOM.

Discussion

Under-five stunting is still common in the Southeast Asian region[33], where on average 36 % of children are stunted compared with the global average of 26 %[34]. Myanmar made some progress in under-five stunting during the

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Table 2 Adjusted OR (AOR) and 95 % CI for double burden of malnutrition in mother–child pairs*†

	SCNOM		NSCOM		SCOM	
	AOR	95 % CI	AOR	95 % CI	AOR	95 % CI
Child characteristics						
Gender (boys)	**1·38**	**1·10, 1·73**	1·07	0·88, 1·30	1·19	0·91, 1·56
Age (months)						
13–24 *v.* 0–12	**3·76**	**2·43, 5·80**	**1·52**	**1·12, 2·05**	**2·89**	**1·58, 5·30**
25–36 *v.* 0–12	**7·51**	**4·97, 11·4**	**1·74**	**1·32, 2·30**	**8·47**	**4·82, 14·9**
37–48 *v.* 0–12	**5·09**	**3·36, 7·71**	**1·75**	**1·31, 2·34**	**6·45**	**3·62, 11·5**
49–59 *v.* 0–12	**4·98**	**3·24, 7·66**	**1·59**	**1·15, 2·20**	**3·71**	**2·12, 6·47**
Maternal characteristics						
Maternal current age (years)						
25–35 *v.* 18–24	1·24	0·87, 1·77	**1·85**	**1·34, 2·55**	**1·62**	**1·01, 2·61**
35–49 *v.* 18–24	**1·53**	**1·04, 2·26**	**2·77**	**1·93, 3·99**	**2·79**	**1·68, 4·63**
Maternal age at first delivery (<20 years)	**1·40**	**1·09, 1·79**	**1·52**	**1·15, 2·00**	**1·87**	**1·27, 2·74**
Short stature of mother (<150 cm)	**1·70**	**1·33, 2·17**	0·87	0·67, 1·15	**2·11**	**1·51, 2·96**
Mother's education levels						
Primary school *v.* no education	0·97	0·72, 1·32	**1·44**	**1·00, 2·08**	**1·62**	**1·04, 2·52**
Secondary or higher *v.* no education	0·89	0·60, 1·30	**1·53**	**1·02, 2·30**	1·34	0·72, 2·49
Marital status (living without partner)	0·96	0·60, 1·53	0·97	0·60, 1·58	1·03	0·47, 2·23
Native language of mother (non-Myanmar)	0·98	0·67, 1·43	0·86	0·47, 1·57	1·47	0·78, 2·75
Working mothers (yes)	1·25	0·97, 1·62	0·96	0·77, 1·18	1·08	0·75, 1·55
No. of children ever born (2+)	1·23	0·94, 1·60	0·80	0·64, 1·01	0·77	0·54, 1·10
Familial factors						
Residence (urban)	1·34	0·96, 1·86	0·92	0·66, 1·27	1·04	0·63, 1·71
Wealth index						
Rich *v.* poor	0·97	0·73, 1·29	**1·58**	**1·19, 2·09**	**1·71**	**1·12, 2·63**
Middle *v.* poor	**0·63**	**0·46, 0·86**	**2·36**	**1·72, 3·24**	**1·92**	**1·17, 3·15**
Region						
Kachin	**2·10**	**1·10, 4·01**	1·58	0·87, 2·86	**5·02**	**1·76, 14·3**
Kayah	**1·93**	**1·10, 3·39**	0·73	0·42, 1·28	**5·56**	**1·96, 15·8**
Kayin	1·18	0·64, 2·19	1·22	0·69, 2·16	2·62	0·89, 7·74
Chin	**2·16**	**1·24, 3·77**	0·99	0·50, 1·93	2·37	0·75, 7·45
Sagaing	1·08	0·62, 1·90	1·11	0·66, 1·87	**3·56**	**1·21, 10·5**
Taninthayi	0·97	0·56, 1·70	1·50	0·90, 2·52	**4·22**	**1·44, 12·3**
Bago	0·96	0·54, 1·70	0·91	0·54, 1·53	2·18	0·77, 6·21
Magway	1·03	0·58, 1·82	0·98	0·58, 1·67	2·39	0·88, 6·51
Mandalay	1·20	0·71, 2·01	0·87	0·50, 1·51	2·01	0·71, 5·67
Mon	1·14	0·67, 1·95	1·49	0·83, 2·66	**4·92**	**1·65, 14·7**
Rakhine	1·64	0·88, 3·05	1·30	0·60, 2·81	2·95	0·80, 10·9
Yangon	0·84	0·43, 1·66	**1·87**	**1·00, 3·50**	**4·83**	**1·49, 15·6**
Shan	1·68	0·97, 2·91	1·18	0·66, 2·10	**3·28**	**1·11, 9·68**
Ayeyarwaddy	1·74	0·99, 3·05	1·39	0·80, 2·41	**4·56**	**1·62, 12·8**
Naypyitaw	1·00		1·00		1·00	

NSCNOM, non-stunted child and non-overweight/obese mother; SCNOM, stunted child and non-overweight/obese mother; NSCOM, non-stunted child and overweight/obese mother; SCOM, stunted child and overweight/obese mother.
*Bold values indicate statistical significance ($P < 0·05$).
†Reference group = NSCNOM.

Millennium Development Goals era (28 % in the study), although it is still greater than the global average of 26 %[34]. The persistent high childhood stunting[17] and the rising prevalence of female overweight[17,35] may support previous studies, reporting that the DBMN in the same household is not an independent entity but is affected by the prevalence of both stunting and overweight[5,23]. According to a study by Garrett and Ruel[6], while countries like Latin America who are in the advanced stages of the nutrition transition have the higher prevalence of DBMN, those in the earlier stages of the transition like Asian countries have a lower prevalence, generally below 10 %. The current study showed the DBMN in Myanmar, which is in the early stage of the nutrition transition, was about 10 % (5·54 % when maternal overweight/obesity was defined as BMI 25 kg/m^2 or higher[19]).

A closer look at the SCOM prevalence in the current study revealed striking regional disparities within Myanmar, ranging from 3·6 % in Naypyitaw to 12 % in Kachin and Mon, and 14·6 % in Kayah. Prevalence of SCOM, compared with NSCNOM, was found to be higher in Kachin, Kayah, Mon, Yangon, Ayeyarwaddy, Taninthayi and Sagaing, after adjusting for the covariates. Some of the regions, such as Kachin, Kayah, Taninthayi, Shan and Sagaing, are bordered by the neighbouring countries. Yangon is Myanmar's most populous city and its most important commercial centre. The Myanmar's border regions and Yangon are notable for their high rates of

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population growth and urbanisation since there has been an influx of internal migrants in search of work who mostly originate from other regions. Rural–urban migrants experience environmental changes associated with urbanisation very rapidly over short time periods. Studies of rural–urban migrants in India showed that migration was associated with higher levels of obesity and diabetes[36], probably due to both an increased intake of fat[36], meat, sugar and dairy[37] and reduced physical activities[36], compared with rural dwellers. Similar findings for women were found despite weaker associations[36]. Thus, it may imply that the higher prevalence of SCOM in those regions may be explained partly by changes in lifestyle and dietary nutrient intake associated with increase in migration and urbanisation. In addition, Myanmar people consume a lot of edible oil, such as palm oil, sesame and ground nut. Large scale of oil palm plantations was developed in Taninthayi, Mon, Rakhine and Kachin[38]. Oil palm is one of the major commodity crops particularly in the southern Myanmar since the palm plantation has been expanded to meet the domestic demand for edible oil and with the aim of going into an export industry[39]. Thus, it may imply that people in the southern regions of Myanmar have higher consumption of oils that contributes to higher rates of overweight or obesity. Prevalence of overweight or obesity (BMI $\geq$ 23 kg/m^2) among women of reproductive age in the southern regions was high (42·9 % in Taninthayi and 40 % in Mon)[35]. Taken together, it is important to note that the large regional disparities may be due to differences in the socio-economic, demographic and cultural contexts and levels of urbanisation and migration. The current study warrants further research to understand the pathways to this familial coexistence of context-specific nutrition challenges.

The double-burden households seem not purely an urban phenomenon as the similar prevalence of SCOM between urban and rural areas (around 9·1 % for each) was shown to be consistent with the study of Garrett and Ruel[6]. Regarding the association with socio-economic status, this current study in a Myanmar population showed an inverse U-shaped relationship between SCOM and socio-economic status, measured with wealth index and maternal educational attainment. For example, the prevalence was higher in the middle levels of wealth and education. A study in Indonesia suggested that the coexistence of under-nourished and overweight individuals in the same household seems to be a transitory phenomenon[40]. For instance, the highest prevalence of dual burden households was observed in the richest, while observing the lowest prevalence in the poorest expenditure quintile in 1993. In 2007, the poorest expenditure quintile had the highest proportion and the richest quintile had the lowest proportion of dual burden households[40]. It was supported by a study in Brazil, which is in the advanced stage of the nutrition transition, showing the inverse association between education level of the head of the household and SCOM[27]. The transitions can be partly explained by the higher consumption of energy-dense foods and less physical activity leading to obesity no longer occurring in mothers/adults in high-income families, but in low-income families. It is supported by a study among US adults using nationally representative surveys which showed that those marginally food insecure or food insecure without hunger are associated with greater weight gain compared with being fully food secure[41]. Moreover, appropriate and sufficient nutrient-dense foods are less likely to be given to children, leading to under-nutrition, particularly in low-income families[23]. It may imply that the co-existence of malnutrition is associated with the nutrition transition and the double-burden transitions from high to low socio-economic families with the advancing nutritional transition.

Nutritional status of mothers, both under- and over-nutrition, have significant effects on the fetal growth and developmental restrictions in the child, such as low birth weight and poor nutritional status of children[42,43]. Along with a high prevalence of maternal overweight or obesity, underweight mothers also remain high in Myanmar (14·1 %). In addition, children with short stature mothers (31·4 %) and those born weighing <2500 g (8 %)[25] were also pretty high in Myanmar, and they were significantly associated with child stunting and double-burden households in this present study. Meanwhile, of interest in maternal overweight is age at first birth below 20 years. A multi-year US study using a nationally representative sample showed that women who gave birth in their teens were significantly more likely to be overweight or obese in later life than women without a teen birth[44]. This present study supports the previous studies by showing that experience of early motherhood was more likely to be associated with childhood stunting, maternal overweight/obesity and also DBMN, as compared with the non-stunted child and maternal overweight/obesity group. In this Myanmar population, about 20 % of mothers delivered a baby before 20 years of age. They were more prevalent in low wealth families (data not shown). It may imply that early sexual debut and childbearing may be related to unintended pregnancies and subsequent socio-economic disadvantage in adulthood[45,46], and it might further result in poor nutritional status of child and mother.

Although the prevalence of child stunting and the DBMN seems to decline after 36 months of age, children aged 25–36 months had the highest odds of DBMN as well as being stunted, compared with those aged under 12 months in the current study. Of indicators of infant and young children feeding practice, exclusive breast-feeding up to 6 months of age has improved health and nutritional outcomes of children[42] as well as reduction of postpartum weight retention[47–49]. Prevalence of exclusive breast-feeding under 6 months of age in Myanmar was pretty low at 10·5 % in 2000 and 23·6 % in 2009, although a recent estimate increased by 51·2 % in 2015–2016[50]. A recent

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analyses in children aged 6–23 months using the MDHS[51] showed that less than a quarter of children achieved minimum dietary diversity defined as at least four food groups (25 %) and a minimum acceptable diet (16 %), and only about 60 % met the minimum required meal frequency and iron-rich foods in the last 24 h. A recent study in Myanmar showed non-breast-feeding mothers showed a positive association with DBMN at household level than those continuously breastfed their children[19]. Enhancing optimal infant and young children feeding practices should be continued for children's appropriate growth and development and also for the prevention of maternal obesity. Thus, Myanmar government is encouraged to conduct comprehensive and integrated health literacy programmes to enhance maternal, infant and child health[52].

The current study acknowledge some limitations of the study. First, the cross-sectional study design restricts the drawing of causal inferences. However, the current study used a nationwide representative sample of Myanmar children with appropriate statistical analysis reflecting a complex sampling design. In addition, according to the objectives of the current study, the current study mainly dealt with maternal overweight and the DBMN, as characterised by child stunting with maternal overweight. The prevalence of maternal underweight in the mother–child dyads was relatively high (12·4 %). Children are at greater risk of under-nutrition if the mother was underweight. About 35 % of underweight mothers had stunted children in this present study. However, analyses excluding underweight mothers did not change the result.

The findings of the current study showed that the DBMN in mother–child pairs poses a challenge in Myanmar. These call for immediate concerted effort to avert the problem through delineating strategies that respond to the complexity of nutrition interventions, such as the differential needs of individuals within the household. Increased access to and consumption of energy-dense, nutrient-poor foods may be the primary constraints to good nutrition in LMIC like Myanmar. Myanmar government must tailor policies and programmes to deal with the conflicting demands of dietary excess and deprivation not only in the population but also in the same household. To deal with the challenges of the nutrition transition, further research may be needed to understand the real contributors to this DBMN in Myanmar, and to design and evaluate appropriate evidence-based nutrition interventions to avert the two extreme nutrition problems, both deficiency and overconsumption, at the same time. Policies and programmes targeting the food and nutritional needs of each age group rather than the household as a homogeneous unit should be considered[3].

The current study showed the DBMN in mother–child pairs appeared to be about 10 % in Myanmar and significant regional variations were found. There is a need for recent data to study the trends of childhood stunting, maternal overweight/obesity and DBMN, considering the rate of transitions occurring in LMIC. Overarching policies and programmes with culturally sensitive public health strategies and focusing on the different needs of individuals within households should be formulated and implemented.

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