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Received: 18 October 2023 | Revised: 9 January 2024 | Accepted: 18 May 2024

DOI: 10.1002/rfc2.92

REPRODUCTIVE, FEMALE AND CHILD HEALTH

ORIGINAL ARTICLE

Association between children's feeding practices and the nutritional status of children 6–23 months in Lao PDR: Evidence from the Provincial Household Survey 2022

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Funding information

United Nations Children's Fund (UNICEF)

Abstract

Purpose: To investigate the association between children's feeding practices and the nutritional status of children 6–23 months in Lao PDR.

Method: The study is based on the latest Provincial Household Survey 2022 (PHS 2022). The WHO's guidelines were used to define nutritional status. If height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) *z*-scores were below −2, children were considered stunted, wasted and underweight, respectively. Minimum meal frequency (MMF) was considered if breastfeeding children consumed soft foods two times per day for infants 6–8 months and three times for children 9–23 months, and that nonbreastfeeding children consumed solid, semisolid, soft foods or milk feeds four times for children aged 6–23 months the previous day. A child was regarded to have a minimum dietary diversity (MDD) if they had consumed foods from at least five of the eight main groups the previous day. Minimum acceptable diet (MAD) was considered if children aged 6–23 months had at least the MMF and the MDD indicators in the previous 24 h.

Results: There was a significant ($p < 0.05$) positive relationship between MAD and stunting among children aged 6–23 months. Regarding the predictors of MMF, MDD and MAD, the probability of MDD and MAD increased with the child's age, whereas MMF decreased. We found that the higher the mother's education, the probability of their children attaining MDD, MMF and MAD increased. A significant negative relationship was observed among children living in rural areas with MMF, MDD and MAD. Our analysis also found that children who were not currently breastfed were less likely to meet MMF, MDD and MAD compared with children who were currently breastfed.

Conclusion: Interventions for infant and young child feeding (IYFC) in Lao PDR, with a particular emphasis on rural households, mothers with little to no education, and new parents, should be targeted for future nutrition interventions to increase optimal feeding practices among the children.

KEYWORDS

children, dietary diversity, IYCF, Lao PDR, malnutrition

Abbreviations: aOR, adjusted odd ratio; cOR, crude odd ratio; DDS, Dietary Diversity Score; DHS, Demographic and Health Survey; HAZ, height-for-age *z* scores; IYCF, infant and young child feeding; LASES, Lao Academy of Social and Economic Sciences; LSB, Lao Statistics Bureau; LSIS, Lao Social Indicator Survey; MAD, minimum acceptable diet; MDD, minimum dietary diversity; MMF, minimum meal frequency; PHS, Provincial Household Survey; SD, standard deviations; SDGs, sustainable development goals; SES, socioeconomic status; SPRI, Social Economic Policy Research Institute; UNICEF, United Nations Children's Fund; WAZ, weight-for-age *z* scores; WHO, World Health Organization; WHZ, weight-for-height *z* scores.

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INTRODUCTION

Children's malnutrition is a key barrier to reaching the Sustainable Development Goals (SDGs) and a global public health issue. High socioeconomic costs result from its detrimental impacts on children's educational attainment, lifetime earnings and long-term health. It is estimated that approximately 481 million USD annually, or 2.66% of GDP, is lost due to undernutrition in Lao PDR National Information Platforms for Nutrition Lao PDR.[1]

According to the latest Lao Social Indicator Survey II 2017, around 33% of under-5 children were too short for their age (stunted), 9% were too thin for their height (wasted), and 21% were underweight in Lao PDR.[2] The reasons a child is malnourished are complex and multi-dimensional, representing interactions between individual, household, community and regional-level factors related to biological, behavioural, socioeconomic and environmental conditions.

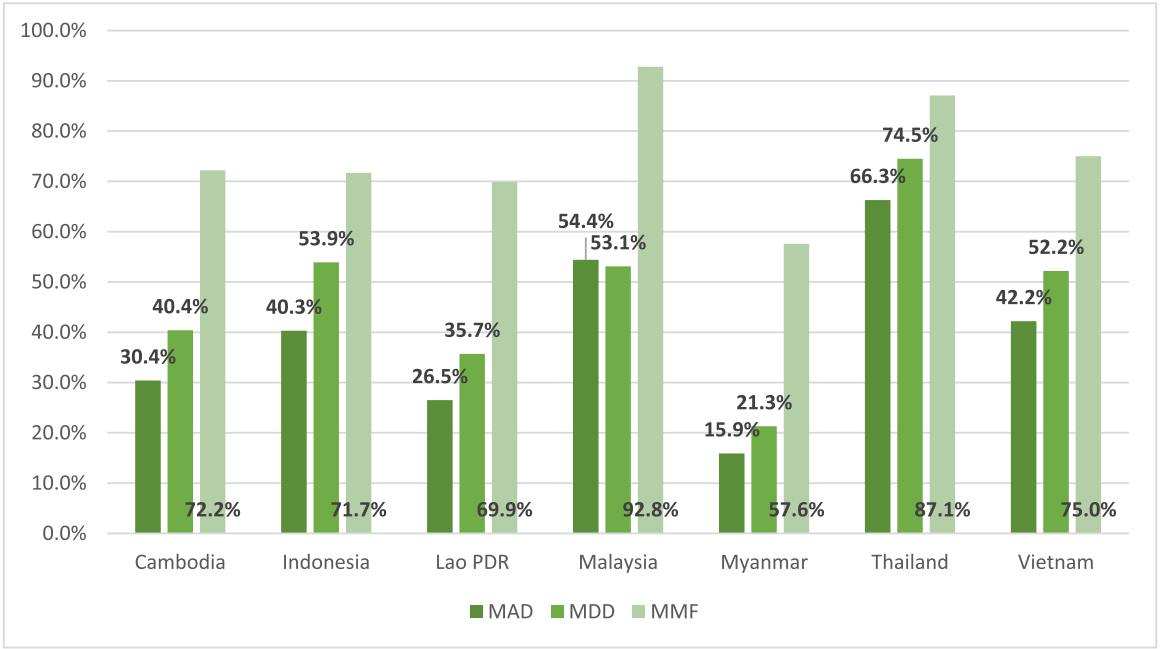
A child's growth and development require optimal nutrition, especially throughout the first 1000 days of life, from conception to the second birthday. Given its importance, this time frame is frequently referred to as the 'Window of Opportunity'. Lack of nourishment at this time can result in stunted growth, subpar cognitive development, an increase in the frequency and severity of illness and child mortality.[3]

According to the UNICEF Nutrition Strategy, 2020–2030, nutritious diets, practices and services are critical for the optimal growth and development of children.[4] Up until the age of 6 months, the World Health Organization (WHO) advises that infants should exclusively be fed breast milk. After 6 months, breast milk is unable to provide all the nutrients that a child needs, and regular consumption of a variety of foods is crucial to promoting their growth and development.[5]

To guarantee a child's growth and development and ensure additional nutrient requirements are being met, it suggests that breastfeeding children consume soft foods two times per day for infants 6–8 months and three times for children 9–23 months, and that nonbreastfeeding children consume solid, semisolid, soft foods or milk feeds four times for children aged 6–23 months.[5] This is known as minimum meal frequency (MMF). It also recommends that a child consume foods from at least five of eight main groups, also known as minimum dietary diversity (MDD).[6] Combined, these two measures make up the minimum acceptable diet (MAD); children aged 6–23 months had at least the MMF and the MDD the previous day.[6] In Lao PDR, only one in four (26.5%) children are benefiting from MAD practice and is the second lowest among Association of Southeast Asian Nations (ASEAN) member states (Figure 1).[7]

Considering the significance of diversified diets and feeding practices in ensuring a child's optimal growth and development, it is essential to investigate further the association between children's feeding practices and malnutrition among children using the most recent subnational-level data.

To inform or update nutrition policies and programme decisions in Lao PDR, a greater understanding of the role of infant feeding practices and diets on children's nutritional status is crucial. Therefore, this study aimed to assess the



Source: ASEAN, UNICEF, and WFP, 2022.

FIGURE 1 Feeding practices in children 6–23 months of age, ASEAN. *Source*: ASEAN, UNICEF, WFP.[7]

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association between feeding practices and the nutritional status of children 6–23 months In Lao PDR.

OBJECTIVES OF THE STUDY

To investigate the association between children's feeding practices and the nutritional status of children 6–23 months in Lao PDR. The parameters connected to MMF, MDD and MAD were also investigated in this study.

METHODS

Data source

The study is based on the latest Provincial Household Survey 2022 (PHS 2022). This survey was conducted by the Lao Statistics Bureau (LSB) and UNICEF to understand further the underlying causes of malnutrition in four provinces: Bokeo, Houaphanh, Phongsaly and Saravane. The shares of mothers and children who suffered from malnutrition in the four targeted provinces were relatively high compared to other provinces in Lao PDR. Data were collected from April to May 2022. Survey questionnaires for the Lao Social Indicator Surveys II conducted in 2017 were used to develop the Provincial Household Survey questionnaire. LSIS questionnaires were based on the UNICEF Multiple Indicator Cluster Survey (MICS) 4 model questionnaires with components added from the Demographic and Health Surveys (DHS). A total of 10 731 households were surveyed across the four provinces. In this study, we analysed the children's data and included those who were aged 6–23 months, totalling 4598 children aged 6–23 months before cleaning. A total of 4184 children's data were analysed after cleaning the data set and removing the data of children with missing cases (e.g., incomplete anthropometric measures, MMF, MDD, MAD, demographic and socioeconomic status variables).

Nutritional status of the children

Children's age, weight and length measurements were used to categorise their nutritional status, which was directly measured during data collection. Three widely recognised indicators of a child's nutritional status are stunting, wasting and underweight. Each indicator specifies a distinctive form of malnutrition; for example, stunting is the result to long-term nutritional deprivation (chronic), wasting is a consequence of insufficient food intake or high incidence of infectious disease especially diarrhoea (acute) and underweight is usually a combination of acute and chronic malnutrition. Stunting, wasting and underweight were determined using height-for-age (HAZ), weight-for-height (WHZ) and weight-for-age (WAZ) *z*-scores in accordance with 2007 WHO criteria. Children were deemed stunted, wasting, and underweight if their HAZ, WHZ or WAZ were more than two standard deviations (SD) below the reference population's median.

Meal frequency

Another important indicator to assess children's feeding practices is the MMF. This indicator assesses the minimum number of times children between 6 and 23 months ate solid, semisolid or soft foods during the previous day. The minimum number of times is defined as follows:

- Breastfed children between 6 and 8 months: eat two feedings of solid, semisolid or soft foods
- Breastfed children between 9 and 23 months: eat three feedings of solid, semisolid or soft foods
- Nonbreastfed children between 6 and 23 months: eat four feedings of solid, semisolid or soft foods or milk-based foods. At least one feeding should be a solid, semisolid or soft food.

Dietary diversity

The MDD for children between 6 and 23 months is an indicator of diet diversity per WHO recommendations.[6] High diet diversity is associated with improvements in a child's growth and development. MDD indicates whether children have eaten food and beverages from at least five out of eight defined groups during the previous day. The eight main groups are below:

1. Breast milk
2. Grains, roots, tubers and plantains
3. Pulses (beans, peas, lentils), nuts and seeds
4. Dairy products (milk, infant formula, yoghurt, cheese)
5. Flesh foods (meat, fish, poultry, organ meats)
6. Eggs
7. Vitamin-A rich fruits and vegetables
8. Other fruits and vegetables

A score of 1 or 0 was given to children who consumed at least one food item from each main group. By summing the values from each major food group consumed, which ranged from 0 to 8, a total Dietary Diversity Score (DDS) was calculated. If a child received five or more (≥5), that is, eaten foods from at least five different main groups the day before, MDD was considered attained.

Acceptable diet

The MAD measures whether children between 6 and 23 months are being fed a diverse diet at an appropriate frequency. MAD is a combination of the MMF and MDD indicators, with additional requirements for nonbreastfed children, explained below:

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TABLE 1 Prevalence of minimum meal frequency and demographic and socioeconomic characteristics of the children aged 6–23 months (PHS 2022).

Demographic and socioeconomic characteristics	Frequency (%)	Minimum meal frequency %, (95% CI)	*p* Value[a]
Total	4184 (100)	64.8 (63.4–66.3)	
Age in months			
6–11	1567 (37.5)	77.1 (74.9–79.1)	<0.001
12–17	1503 (35.9)	66.3 (63.9–68.7)	
18–23	1114 (26.6)	45.5 (42.6–48.4)	
Sex			
Male	2140 (51.1)	65.3 (63.3–67.3)	0.50
Female	2044 (48.9)	64.3 (62.2–66.3)	
Area			
Urban	386 (9.2)	69.9 (65.2–74.3)	0.03
Rural with road	2947 (70.4)	64.9 (63.2–66.6)	
Rural without road	851 (20.3)	62.2 (58.9–65.4)	
Ethnicity			
Lao-Tai	1819 (43.5)	63.9 (61.7–66.1)	0.07
Mon-Khmer	978 (23.4)	64.5 (61.5–67.5)	
Hmong-Mien	801 (19.1)	67.3 (64–70.5)	
Chinese-Tibetan	383 (9.2)	68.1 (63.3–72.6)	
Other	203 (4.9)	58.1 (51.3–64.7)	
Province			
Phongsaly	614 (14.7)	61.7 (57.8–65.5)	<0.001
Bokeo	512 (12.2)	76.8 (72.9–80.2)	
Houaphanh	2100 (50.2)	62.8 (60.7–64.8)	
Saravanne	958 (22.9)	64.9 (61.9–67.9)	
Maternal education			
Primary or less	2151 (51.4)	64.7 (62.6–66.7)	0.78
Secondary	1689 (40.4)	64.7 (62.3–66.9)	
Postsecondary or more	344 (8.2)	66.6 (61.4–71.3)	
Currently breastfed			
Yes	2614 (62.5)	87.1 (85.8–88.4)	<0.001
No	1570 (37.5)	27.6 (25.5–29.9)	
Stunted			
Yes	1622 (38.8)	63.6 (61.2–65.9)	0.19
No	2562 (61.2)	65.5 (63.7–67.4)	
Wasting			
Yes	328 (7.8)	65.2 (59.9–70.2)	0.91
No	3856 (92.2)	64.8 (63.3–66.3)	
Underweight			
Yes	874 (20.9)	66.2 (63–69.3)	0.34
No	3310 (79.1)	64.4 (62.8–66.1)	

[a]χ^2 test statistics.

Source: PHS 2022. Authors' calculations.

- Breastfed children: receive the MMF and MDD during the previous day
- Nonbreastfed children: receive the MMF and MDD during the previous day and at least two milk feedings.

Demography and socioeconomic status (SES)

Variables included (i) age in months: 6–11/12–23, (ii) sex: male/female, (iii) area: urban/rural with road access/rural without road access), (iv) ethnicity: Lao-Tai/Hmong-Mien/Mon-Khmer/Chinese-Tibetan/Other, (v) province: name of province (vi) maternal education: institutional form of education and (vii) still being breastfed: yes/no.

Statistical analysis

Inferential statistics as well as descriptive statistics were utilized to summarize the study's findings. The frequency and percentages were first calculated using descriptive statistics. Then, the association between the prevalence of MMF, MDD and MAD, across various demographic and socio-economic variables and children's nutritional status was determined using χ^2 tests. Finally, we carried out both univariate and multivariate logistic regression models to estimate the crude odd ratio (cOR) and adjusted odd ratio (aOR), respectively, with a 95% confidence interval (CI), to determine the impact of feeding practices on nutritional status and predictors of MMF, MDD and MAD. The relevant variables of the bivariate analyses were modified for the multivariate models. Data were analysed using RStudio® software. All statistical tests were considered significant at $p < 0.05$.

RESULT

Demographic and socioeconomic characteristics

The prevalence of MMF, MDD and MAD and the demographic and socioeconomic characteristics of the children are presented in Tables 1–3. Table 1 shows that of 4184 children aged 6–23 months, most of them (70.4%) were living in rural areas with

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TABLE 2 Prevalence of minimum dietary diversity and demographic and socioeconomic characteristics of the children aged 6–23 months (PHS 2022).

Demographic and socioeconomic Characteristics	Frequency (%)	Minimum dietary diversity %, (95% CI)	*p* Value[a]
Total	4184 (100)	58.4 (56.9–59.9)	
Age in months			
6–11	1567 (37.5)	52 (49.5–54.5)	<0.001
12–17	1503 (35.9)	61.9 (59.5–64.4)	
18–23	1114 (26.6)	62.7 (59.8–65.4)	
Sex			
Male	2140 (51.1)	58.8 (56.7–60.9)	0.60
Female	2044 (48.9)	58 (55.8–60.1)	
Area			
Urban	386 (9.2)	67.9 (63.1–72.3)	<0.001
Rural with road	2947 (70.4)	55.5 (53.7–57.3)	
Rural without road	851 (20.3)	64.3 (61–67.4)	
Ethnicity			
Lao-Tai	1819 (43.5)	58.9 (56.7–61.2)	<0.001
Mon-Khmer	978 (23.4)	43 (40–46.2)	
Hmong-Mien	801 (19.1)	71.4 (68.2–74.4)	
Chinese-Tibetan	383 (9.2)	61.4 (56.4–66.1)	
Other	203 (4.9)	70.9 (64.3–76.7)	
Province			
Phongsaly	614 (14.7)	61.7 (57.8–65.5)	<0.001
Bokeo	512 (12.2)	61.5 (57.2–65.6)	
Houaphanh	2100 (50.2)	71.8 (69.8–73.7)	
Saravanne	958 (22.9)	25.3 (22.6–28.1)	
Maternal education			
Primary or less	2151 (51.4)	52.2 (50–54.3)	<0.001
Secondary	1689 (40.4)	63.5 (61.2–65.8)	
Postsecondary or more	344 (8.2)	72.4 (67.4–76.8)	
Currently breastfed			
Yes	2614 (62.5)	59 (57.1–60.9)	0.31
No	1570 (37.5)	68.2 (65.9–70.5)	
Stunted			
Yes	1622 (38.8)	58.9 (56.5–61.2)	0.65
No	2562 (61.2)	58.1 (56.1–59.9)	
Wasting			
Yes	328 (7.8)	52.1 (46.7–57.5)	0.02
No	3856 (92.2)	58.9 (57.4–60.5)	
Underweight			
Yes	874 (20.9)	56.1 (52.8–59.3)	0.12
No	3310 (79.1)	59 (57.3–60.7)	

[a]χ^2 test statistics.

Source: PHS 2022. Authors' calculations.

road access, in Houaphanh Province (50.2%), were aged between 6 and 11 months (37.5%), and currently breastfed (62.5%). From the anthropometric measurements, almost two-fifths of them were stunted (38.8%), and one in every five children (20.9%) was identified as underweight.

Meal frequency, dietary diversity and acceptable diets of the children

The prevalence of MMF was found to be 64.8% (95% CI: 63.4–66.3). The prevalence was significantly higher among children living in Bokeo Province (76.8%), in urbans areas (69.9%) and in the younger age group (6–11 months), as well as among those who were currently breastfeeding (87.1%) (Table 2). There were also positive associations between the area of residence and MMF ($p = 0.03$), and the ethnicity of children and MMF ($p = 0.07$). No significant variation between male and female was observed in the prevalence of MMF. There was no variation between maternal education and the prevalence of MMF, as well as no statistically significant differences among the anthropometric measurements (i.e., stunted, wasting and underweight).

Prevalence of MDD was found 58.4% (95% CI: 56.9–59.9) with an average DDS of 4.8 (SD = 1.8). Approximately 12.83% of children consumed two food groups or less, and 28.78% consumed between three and four food groups during the last 24-h (Figure 2).

The prevalence was significantly higher among children living in Houaphanh Province (71.8%), in urban areas (67.9%) and in the older age group (18–23 months) (Table 1). There were also positive associations between ethnicity and MDD ($p < 0.001$), mother's educational attainment and MDD ($p < 0.001$), as well as wasting and MDD ($p = 0.02$). There was a weak positive association between underweight children and MDD ($p = 0.12$). No significant variation between male and female was observed in the prevalence of MDD. There was no variation in the prevalence of MDD among currently breastfed and non-breastfed children.

Most children (83.5%) at least consumed one food from flesh foods (meat, fish, poultry, organ meats). This is followed by Vitamin-A rich fruits and vegetables (80.7%),

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TABLE 3 Prevalence of minimum acceptable diet and demographic and socioeconomic characteristics of the children aged 6–23 months (PHS 2022).

Demographic and socioeconomic Characteristics	Frequency (%)	Minimum acceptable diet %, (95% CI)	*p* Value[a]
Total	4184 (100)	41.4 (39.9–42.9)	
Age in months			
6–11	1567 (37.5)	42.6 (40.1–45)	<0.001
12–17	1503 (35.9)	45.8 (43.3–48.4)	
18–23	1114 (26.6)	33.7 (30.9–36.5)	
Sex			
Male	2140 (51.1)	41.9 (39.8–44)	0.52
Female	2044 (48.9)	40.9 (38.7–43)	
Area			
Urban	386 (9.2)	52.1 (47.1–57)	<0.001
Rural with road	2947 (70.4)	39.3 (37.5–41.1)	
Rural without road	851 (20.3)	43.7 (40.4–47.1)	
Ethnicity			
Lao-Tai	1819 (43.5)	41.2 (38.9–43.5)	<0.001
Mon-Khmer	978 (23.4)	30.9 (28.1–33.8)	
Hmong-Mien	801 (19.1)	52.3 (48.8–55.7)	
Chinese-Tibetan	383 (9.2)	44.9 (40–49.9)	
Other	203 (4.9)	43.8 (37.2–50.7)	
Province			
Phongsaly	614 (14.7)	41.9 (38–45.8)	<0.001
Bokeo	512 (12.2)	50.2 (45.9–54.5)	
Houaphanh	2100 (50.2)	48.6 (46.4–50.7)	
Saravanne	958 (22.9)	20.6 (18.1–23.2)	
Maternal education			
Primary or less	2151 (51.4)	37.5 (35.4–39.5)	<0.001
Secondary	1689 (40.4)	44.5 (42.1–46.8)	
Postsecondary or more	344 (8.2)	50.6 (45.3–55.8)	
Currently breastfed			
Yes	2614 (62.5)	53.9 (51.9–55.8)	<0.001
No	1570 (37.5)	20.6 (18.6–22.6)	
Stunted			
Yes	1622 (38.8)	40.8 (38.4–43.2)	0.58
No	2562 (61.2)	37.4 (35.6–39.3)	
Wasting			
Yes	328 (7.8)	38.7 (33.6–44.1)	0.34
No	3856 (92.2)	41.6 (40.1–43.2)	
Underweight			
Yes	874 (20.9)	39.8 (36.6–43.1)	0.31
No	3310 (79.1)	41.8 (40.1–43.5)	

[a]χ^2 test statistics.

Source: PHS 2022. Authors' calculations.

grains, roots, tubers, and plantains (78.7%), breast milk (62.5%) and other fruits and vegetables (61.3%). On the other hand, pulses (beans, peas, lentils), nuts and seeds (28.1%) and dairy products (milk, infant formula, yoghurt, cheese) (27.7%) were the least consumed food groups. More than half (59.3%) consumed eggs during the last 24-h (Figure 3).

The prevalence of MAD was found to be 41.4% (95% CI: 39.9–42.9). Prevalence was significantly higher among children living in Bokeo Province (50.2%), in urban areas (52.1%) and in the middle age group (12–17 months) (Table 3). There were also positive associations between ethnicity and MAD ($p < 0.001$), mother's educational attainment and MAD ($p < 0.001$), as well as currently breastfed and MDD ($p < 0.001$). No significant variation male and female was observed in the prevalence of MAD. In addition, there was no variation in the prevalence of MAD among currently breastfed and nonbreastfed children. There were also no statistically significant differences among the anthropometric measurements (i.e., stunted, wasting and underweight).

Association between children's feeding practices and nutritional status

Table 4 shows the results of a regression analysis between MMF, MDD, MAD with the children's nutritional status. There was a significant ($p < 0.05$) positive relationship between MAD and stunting among children aged 6–23 months. The likelihood of stunting was 17% higher for children who did not meet the MAD [AOR = 1.17, 95% *CI: 1.01–1.37*].

There was a significant ($p < 0.05$) positive relationship between MDD and wasting among children aged 6–23 months. The likelihood of wasting was 32% higher for children who did not meet MDD [COR = 1.32, 95% *CI: 1.05–1.65*]. However, it was no longer significant after correcting for age in months, area, ethnicity, province, maternal education and currently breastfed [AOR = 1.03, 95% *CI: 0.79–1.33*].

Predictors of adequate feeding practices

MMF, MDD and MAD were independently predicted by age in months, area, ethnicity, province, maternal

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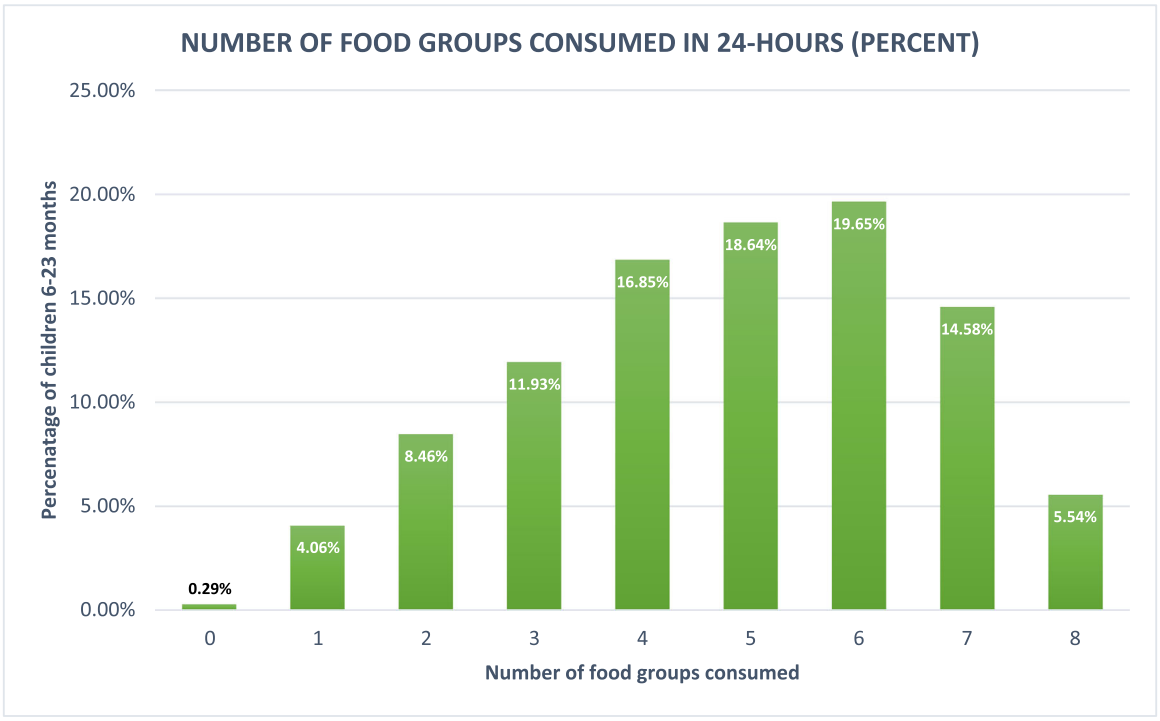
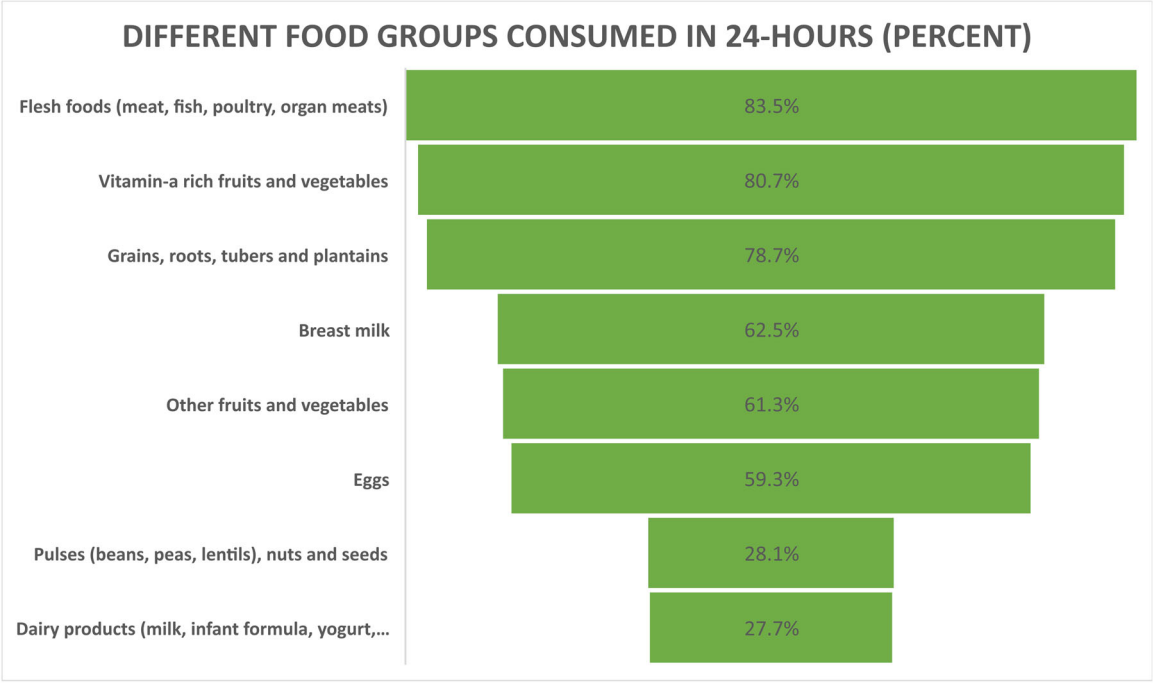


Source: PHS 2022. Authors' calculations.

FIGURE 2 Distribution of MDD among children aged 6–23 months, PHS 2022. *Source*: PHS 2022. Authors' calculations.



Source: PHS 2022. Authors' calculations.

FIGURE 3 Different food groups consumed by the children 6–23 months, PHS 2022. *Source*: PHS 2022. Authors' calculations.

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TABLE 4 Association between children's feeding practices and nutritional status of the children.

	Stunting		Wasting		Underweight	
	COR (95% CI)	AOR[a] (95% CI)	COR (95% CI)	AOR[a] (95% CI)	COR (95% CI)	AOR[a] (95% CI)
Minimum acceptable diet (MAD)						
Yes	Ref.		Ref.		Ref.	
No	1.04 (0.92–1.18)	1.17 (1.01–1.37)*	1.13 (0.90–1.42)	1.05 (0.81–1.37)	1.08 (0.93–1.26)	1.16 (0.97–1.39)
Minimum meal frequency (MMF)						
Yes	Ref.		Ref.		Ref.	
No	1.09 (0.96–1.25)	1.04 (0.87–1.25)	0.98 (0.77–1.24)	1.30 (0.97–1.75)	0.92 (0.79–1.08)	1.15 (0.94–1.42)
Minimum dietary diversity (MDD)						
Yes	Ref.		Ref.		Ref.	
No	0.97 (0.85–1.10)	1.15 (0.99–1.34)	1.32 (1.05–1.65)*	1.03 (0.79–1.33)	1.13 (0.97–1.31)	1.03 (0.87–1.23)

Note: Asterisks mark estimated coefficients which are statistically significant at level less than or equal to 5% (*).

Abbreviations: AOR, adjusted odd ratio; COR, crude odd ratio; Ref, reference group.

[a]Adjusted with age in months, area, ethnicity, province, maternal education and currently breastfed.

Source: PHS 2022. Authors' calculations.

education and currently breastfed (Table 5). Maternal education had the highest influence on MMF. Children whose mothers had secondary education and postsecondary education or more had a 1.4- and 2.4-times higher odds for MMF compared with children whose mothers had primary education or less, respectively. A significant negative association was observed among children living in rural areas with MMF. Children who lived in rural areas with road access had a 46% less chance for MMF compared with children living in urban areas, and children who lived in rural areas without road access had a 58% less chance for MMF compared with children living in urban areas. Children who were ethnically Mon-Khmer had a 32% less chance for MMF than children who were Lao-Tai. The children living in Bokeo Province had nearly 1.9-times higher odds for MMF compared with children from Phongsaly Province. Children who were not currently breastfed had a 96% less chance for MMF compared with children who were currently breastfed.

The children's age had the highest influence on MDD. When compared to children aged 6–11 months, children aged 12–17 months and 18–23 months had odds of meeting MDD that were 1.9- and 2.3-times greater, respectively. A significant negative association was observed among children living in rural areas with MDD. Compared to children living in urban areas, children who lived in rural areas with access to roads had a 33% chance for MDD. There was a significant positive association between maternal education and MDD. Mothers who had a postsecondary education or higher, there children had nearly a 2.0-times possibility of meeting MDD. Children who were ethnically Mon-Khmer had a 52% less chance for MDD than children who were Lao-Tai. Compared to children from Phongsaly Province, children from Houaphanh Province had nearly 1.5-times higher odds for MDD. In contrast, compared to children from Phongsaly Province, children in Saravanne Province had approximately 81% lower chance for MDD. Children who were not currently breastfed had a 47% less chance for MDD than those who were currently breastfed.

The children's age had the highest influence on MAD. When compared to children aged 6–11 months, aged 12–17 months and 18–23 months had odds of meeting MDD that were 2.0-times greater. There was a significant positive association between maternal education and MAD. Among mothers had a postsecondary education or higher, their children had nearly 2.2-times higher possibility for MAD. A significant negative association was observed among children living in rural areas with MAD. Compared to children living in urban areas, children who lived in rural areas had an average 49% lower chance for MAD. Children who were ethnically Mon-Khmer had a 49% less chance for MAD than children who were Lao-Tai. Children who were ethnically Tibetan-Chinese had a 31% less chance for MAD than children who were Lao-Tai. The children living in Saravanne Province had a 75% less chance for MAD compared with children from Phongsaly Province. Children who were not currently breastfed had an 89% less chance for MAD compared with children who were currently breastfed.

DISCUSSION

This study investigated the association between children's feeding practices and the nutritional status of children 6–23 months and to identify the risk factors related to MMF, MDD and MAD among Lao children aged 6–23 months. Our adjusted model found a significant positive relationship between MAD and stunting. Despite the fact that our final models did not show any correlation between MMF and MDD and nutritional status, the crude model did show a positive correlation between MDD and wasting. Children's

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TABLE 5 Predictors of MMF, MDD and MAD among the children.

	MMF		MDD		MAD	
	COR (95% CI)	AOR[a] (95% CI)	COR (95% CI)	AOR[a] (95% CI)	COR (95% CI)	AOR[a] (95% CI)
Age in months						
6–11	Ref.		Ref.		Ref.	
12–17	0.59 (0.50–0.69)*	1.26 (1.03–1.54)*	1.50 (1.30–1.73)*	1.91 (1.62–2.26)*	1.14 (0.99–1.32)	1.96 (1.66–2.32)*
18–23	0.25 (0.21–0.29)*	1.02 (0.82–1.28)	1.55 (1.32–1.81)*	2.28 (1.88–2.77)*	0.68 (0.58–0.80)*	2.00 (1.63–2.45)*
Area						
Urban	Ref.		Ref.		Ref.	
Rural with road access	0.79 (0.63–1.00)	0.54 (0.40–0.72)*	0.59 (0.47–0.74)*	0.67 (0.51–0.86)*	0.60 (0.48–0.74)*	0.51 (0.39–0.66)*
Rural without road access	0.71 (0.54–0.91)*	0.42 (0.30–0.60)*	0.85 (0.66–1.10)	0.77 (0.57–1.04)	0.71 (0.56–0.91)*	0.51 (0.38–0.70)*
Ethnicity						
Lao-Tai	Ref.		Ref.		Ref.	
Mon-Khmer	1.03 (0.87–1.21)	0.68 (0.55–0.85)*	0.53 (0.45–0.62)*	0.48 (0.40–0.57)*	0.64 (0.54–0.75)*	0.51 (0.42–0.62*
Hmong-Mien	1.16 (0.97–1.38)	0.88 (0.69–1.14)	1.74 (1.46–2.09)*	0.87 (0.70–1.07)	1.57 (1.33–1.85)*	0.95 (0.77–1.17)
Chinese-Tibetan	1.21 (0.96–1.53)	0.75 (0.50–1.13)	1.11 (0.88–1.39)	0.75 (0.55–1.04)	1.16 (0.93–1.45)	0.69 (0.49–0.96)*
Other	0.78 (0.58–1.05)	0.69 (0.45–1.05)	1.70 (1.25–2.35)*	1.03 (0.72–1.49)	1.12 (0.83–1.49)	0.80 (0.56–0.14)
Province						
Phongsaly	Ref.		Ref.		Ref.	
Bokeo	2.05 (1.58–2.67)*	1.91 (1.31–2.80)*	0.99 (0.78–1.26)	1.03 (0.77–1.38)	1.40 (1.11–1.77)*	1.17 (0.87–1.59)
Houaphanh	1.05 (0.87–1.26)	1.01 (0.73–1.40)	1.58 (1.31–1.91)*	1.48 (1.14–1.94)*	1.31 (1.09–1.57)*	1.19 (0.90–1.57)
Saravanne	1.15 (0.93–1.42)	0.80 (0.56–1.15)	0.21 (0.17–0.26)*	0.19 (0.14–0.26)*	0.36 (0.29–0.45)*	0.25 (0.19–0.35)*
Maternal education						
Primary or less	Ref.		Ref.		Ref.	
Secondary	1.00 (0.87–1.14)	1.37 (1.14–1.65)*	1.60 (1.40–1.82)*	1.26 (1.08–1.46)*	1.34 (1.17–1.52)*	1.31 (1.13–1.53)*
Postsecondary or more	1.08 (0.86–1.39)	2.40 (1.75–3.30)*	2.40 (1.88–3.10)*	1.98 (1.48–2.65)*	1.71 (1.36–2.15)*	2.18 (1.65–2.89)*
Currently breastfed						
Yes	Ref.		Ref.		Ref.	
No	0.06 (0.05–0.07)*	0.04 (0.03–0.05)*	0.93 (0.82–1.06)	0.53 (0.45–0.62)*	0.22 (0.19–0.26)*	0.11 (0.9–0.14)*

Note: Asterisks mark estimated coefficients which are statistically significant at level less than or equal to 5% (*).

Abbreviations: AOR, adjusted odd ratio; COR, crude odd ratio; Ref, reference group.

[a]Adjusted for all variables in the table.

age, place of residence, mother education level, province, ethnicity and whether a child is breastfed were also found to be independent predictors of MDD, MMF and MAD in this analysis.

The positive relationship between MAD and stunting (in the adjusted model) are incongruent with findings from Bangladesh, Ethiopia, India and Zambia, which found that attaining the MAD indicator was associated with stunting.[8] The difference in the findings could be due to the different methods used to calculate MMF and MDD. The study by Jones and colleagues followed the previous WHO Infant and Young Child Feeding (IYCF) guidelines, whereas this study followed the guidelines that were updated in 2021.

As childhood stunting indicates a chronic form of malnutrition, this study contends that malnutrition among children can be minimised by expanding the coverage of

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meal frequencies and dietary diversity throughout Lao PDR. This claim is reinforced on the grounds that meal frequencies and dietary diversity promote the timely and appropriate consumption of key nutrients.

The positive relationship between MDD and wasting (in the crude model) are in line with findings from sub-Saharan Africa.[9] An analysis of 32 sub-Saharan African countries in 2021 found that MDD was associated with a 13% reduced risk of wasting among children.[9]

Children who are wasted require an increased intake of energy and essential nutrients. As wasting indicates acute malnutrition, this study suggests that access to nutrient-rich foods, improved nutrition and health knowledge and practices and the promotion of exclusive breastfeeding and improved complementary feeding practices are preventative actions to address wasting.

The prevalence of MMF was found to be 54.8%, MDD at 58.4% and MAD at 41.4%. The findings suggest that a sizable number of Lao children are at risk of inadequate physical growth and cognitive development. Among the eight main groups, foods from flesh foods (83.5%), Vitamin-A rich fruits and vegetables (80.7%), and grains roots, tubers and plantains (78.7%) were highly consumed by the children. Pulse, nuts and seeds (28.1%) and dairy products (27.7%) were the least consumed food groups among the Lao children.

Regarding the predictors of adequate feeding practices, the probability of meeting MDD and MAD increased with the child's age. This finding could be explained by the fact that younger children may not be able to digest or consume all types of food, as opposed to older children.

The analysis found that a mother's education was significantly associated with MMF, MDD and MAD. Educated mothers may be higher income earners and, therefore, can spend more money on healthier and more diversified foods from a wide range of sources.

The importance of meal frequency and diverse diets to support children's optimal growth and development, the negative effects of poor feeding practices, and nutrition education may also be better known to or understood by educated mothers, leading them to feed their children more frequently and diversified foods. Educational interventions, especially at the community level, could improve the feeding practices of children among mothers who do not have formal education.

There were significant disparities among the provices. Compared with children from Phongsaly Province, the children living in Houaphanh Province had nearly 1.5-times higher chance for MDD. Conversely, compared with children from Phongsaly, the children living in Saravanne Province had approximately 81% lower odds for MDD. The children living in Bokeo Province had nearly 1.9-times higher odds for MMF compared with children from Phongsaly Province. There was also a negative association between children living in Saravanne Province with MAD. This would imply that there is a vacuum in the province-wide public health programmes already in place that focus on child feeding.

Disparities were also observed among urban and rural divisions. Children who lived in rural areas with road access had 33% lower odds for MDD compared with children living in urban areas.

In relation to MMF, children who lived in rural areas with road access had a 46% less chance for MMF compared with children living in urban areas, and children who lived in rural areas without road access had a 58% less chance for MMF compared with children living in urban areas. Additionally, Compared with children living in urban areas, children who lived in rural areas had an average 49% lower odds for MAD.

Disparities were also observed among ethnic groups. Children whose mothers were ethnically Mon-Khmer had a 32%, 52% and 49% less chance for MMF, MDD and MAD, respectively. There was also a negative association between children whose mothers were Chinese-Tibetan with MAD. Effectively addressing disparities in the quality of care for ethnic minorities requires improved data systems and new initiatives to appropriately train health professionals and recruit more providers from ethnic minority backgrounds. Identifying and implementing effective strategies to eliminate ethnic inequities in nutrition education should be prioritised.

Our analysis also found that children who were not currently breastfed had a less chance for MMF, MDD and MAD compared with children who were currently breastfed. Children who were not currently breastfed had a 96%, 47% and 89% less chance for MMF, MDD and MAD, respectively.

This study has several limitations. First, it should be noted that data on meal frequency and food variety consumed was based on a mother's 24-h recall, which may not accurately reflect the children's feeding frequency and dietary habits. This raises the possibility of underestimating food intake. Second, there might be recall biases and a potential that mothers might have overreported meal frequency and food variety consumed by their children. An additional limitation of the data on food variety consumed is that it does not consider the food quantity, cooking methods and seasonal variation.

The WHO feeding practices indicators (MMF, MDD and MAD) were intended as straightforward indicators that could be used in large-scale surveys. Although these indicators may not be very sensitive or specific measures of dietary quality in the analysis of the causal pathways to nutrition status, they are particularly well suited for tracking trends in diet quality in large-scale data sets where precise dietary data cannot be acquired.

CONCLUSION

This study found a significant positive relationship between MAD and stunting in our adjusted model. MMF and MDD did not significantly correlate with nutritional status in our final models, but in the crude model, we saw a correlation between wasting and MDD. Children's age, area of residence, maternal education status, province, ethnicity and

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whether a child is breastfed were the predictors of MMF, MDD and MAD. IYCF interventions in Lao PDR, particularly focusing on rural households, mothers with little to no education, and new parents, should be targeted for future nutrition interventions to increase optimal feeding practices among the children.

Stronger proxies of dietary quality may be required to identify these links in future research that examines how the quality of a child's diet influences nutrition status (e.g., feeding scores or measures based on 7-day meal frequency recall data). For programme planners, researchers and policymakers to decide how to best use these indicators and apply them in diverse and specific contexts, further research Is warranted to examine the relationships between these indicators and other food quality measures and child nutritional status.

AUTHOR CONTRIBUTIONS

Kyle Taylor: Conceptualisation; data curation; data analysis; writing original draft; review and editing; and validation. **Pany Sananikhom**: Writing original draft; review and editing. **Ousavanh Thiengthepvongsa**: Writing original draft; review and editing. **Janneke Hartvig Blomberg**: Writing original draft; review and editing. **Prosper Dakurah**: Writing original draft; review and editing. **Vilon Viphongxay**: Writing original draft; review and editing.

ACKNOWLEDGEMENTS

The authors sincerely acknowledge the United Nations Children's Fund (UNICEF) and the Lao Statistics Bureau (LSB) for providing access to the data set. The authors would like to express gratitude to the Socio-Economic Policy Research Institute (SPRI) at the Lao Academy of Social and Economic Sciences (LASES) for initiating the research activity under the National Information Platforms for Nutrition (NIPN) initiative.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are publicly available here. Data described in the manuscript, code book and analytical code will be made available from the corresponding author upon reasonable request.

ETHICS STATEMENT

No ethical review was necessary for this paper. The authors received authorisation from UNICEF and Lao Statistics Bureau to use the data set for analysis. However, the survey protocol for the Provincial Household Survey 2022 was approved by the Lao Statistics Bureau. In addition, written informed consent was obtained by the participants before data collection.

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How to cite this article: Taylor K, Sananikhom P, Thiengthepvongsa O, Blomberg JH, Dakurah P, Viphongxay V. Association between children's feeding practices and the nutritional status of children 6–23 months in Lao PDR: evidence from the Provincial Household Survey 2022. *Reprod Female Child Health*. 2024;3:e92. doi:10.1002/rfc2.92

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