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Original article

Anemia and Related Factors in Preschool Children in the Southern Rural Lao People's Democratic Republic

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Abstract: Anemia is a severe public health problem in the Lao People's Democratic Republic (PDR). Consequently, a new control strategy to reduce the burden of anemia has been introduced for preschool children (aged 6–52 months). The objective of this study was to assess the current prevalence of anemia and related factors in preschool children in southern rural Lao PDR. A population-based cross-sectional study was carried out in six communities in Songkhone district, Savannakheth province, in February 2009. As a result, the prevalence of anemia was found to be 48.9% (95% confidence interval (CI), 43.5–54.3), although most cases were mild. A multiple logistic regression analysis indicated that there was no protective effect of breastfeeding against anemia. The anemia prevalence was higher in 1) children aged 6–23 months (Odds Ratio (OR) = 1.73, 95% CI, 1.02–2.90) than in older children, 2) children in large families (6 or more members) (OR = 1.96, 95% CI, 1.17–3.29), and 3) children in three remote villages with relatively difficult access to markets (OR = 3.01, 95% CI, 1.25–7.47).
In Lao PDR, improvement of food practices and home-fortified food supplementation interventions are essential. High-risk groups should be targeted and a long-term health education program that aims to modify food habits implemented. Furthermore, in settings where iron deficiency is not the only cause of anemia, combining an iron supplement with other measures is necessary.
Key words: Anemia, prevalence, potential factors, preschool children, Lao PDR

INTRODUCTION

Globally, 1.62 billion people and an estimated 293 million children of preschool age are affected by anemia. Anemia is mainly found in Southeast Asia [1].

Although anemia has a variety of causes, it is generally assumed that 50% of cases are caused by iron deficiency [2]. The main risk factors for iron deficiency among young children are low intake and the high requirement of iron during child growth. The adverse effects of iron deficiency anemia (IDA) in children as well as adults include poor growth and development [3, 4], and mental and neuromotor malfunction [5, 6]. In resource-poor areas, the effects of IDA are frequently exacerbated by infectious diseases [7–12].

In addition to nutritional factors, several studies have shown that socioeconomic factors such as low parental education levels, low household incomes [13–15], and demographic factors including age, sex, and family size [16, 17] affect anemia.

In the Lao People's Democratic Republic (PDR), the national prevalence of anemia among children aged 6–59 months was 40.9% in 2006. One-tenth (10.8%) of these cases were IDA. The prevalence of IDA was even higher (25.2–30.9%) among children aged 6–23 months [18]. We analyzed data from a baseline survey of the randomized community-based trial, the primary aim of which was to assess the effect of daily and twice weekly supplementation using multivitamins and minerals sprinkled on rice on hemoglobin level in young children. The main purpose of this analysis is to identify the contributing factors affecting anemia that we could address in parallel with the home-fortified food supplementation.

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MATERIALS AND METHODS

A cross-sectional survey was conducted in six rural communities in the Songkhone district of Savannakheth province, and the prevalence of anemia and its related factors were assessed. A capillary blood sample was obtained from each child by a finger prick to examine the hemoglobin concentration, and the parents or legal caregivers were interviewed regarding the presence of potential risk factors.

Study area

Savannakheth province is located in the southern part of Lao PDR. Songkhone district was selected for this study because a research field study there the National Institute of Public Health (NIOPH) conduct and maintain a health and demographic surveillance system (HDSS). The HDSS is comprised of six villages (Bengkhamlai, Lahanam, Thakhamlian, Lahakhok, Kouthi, and Muangkhai) in Lahanam zone and covers 1,529 households with 7,120 people. All 438 children aged under five years of age were registered.

These areas are rural communities with moderate to poor socioeconomic conditions and a high prevalence of malnutrition and parasitic infections. Most of the villagers are subsistence farmers, migrant workers, or textile workers. The region has a relatively high rice production, and most villagers can obtain an adequate amount of rice by their own means. However, the production of other foodstuffs is not sufficient to meet the villagers' needs. Thakhamlian and Lahanam villagers have relatively good

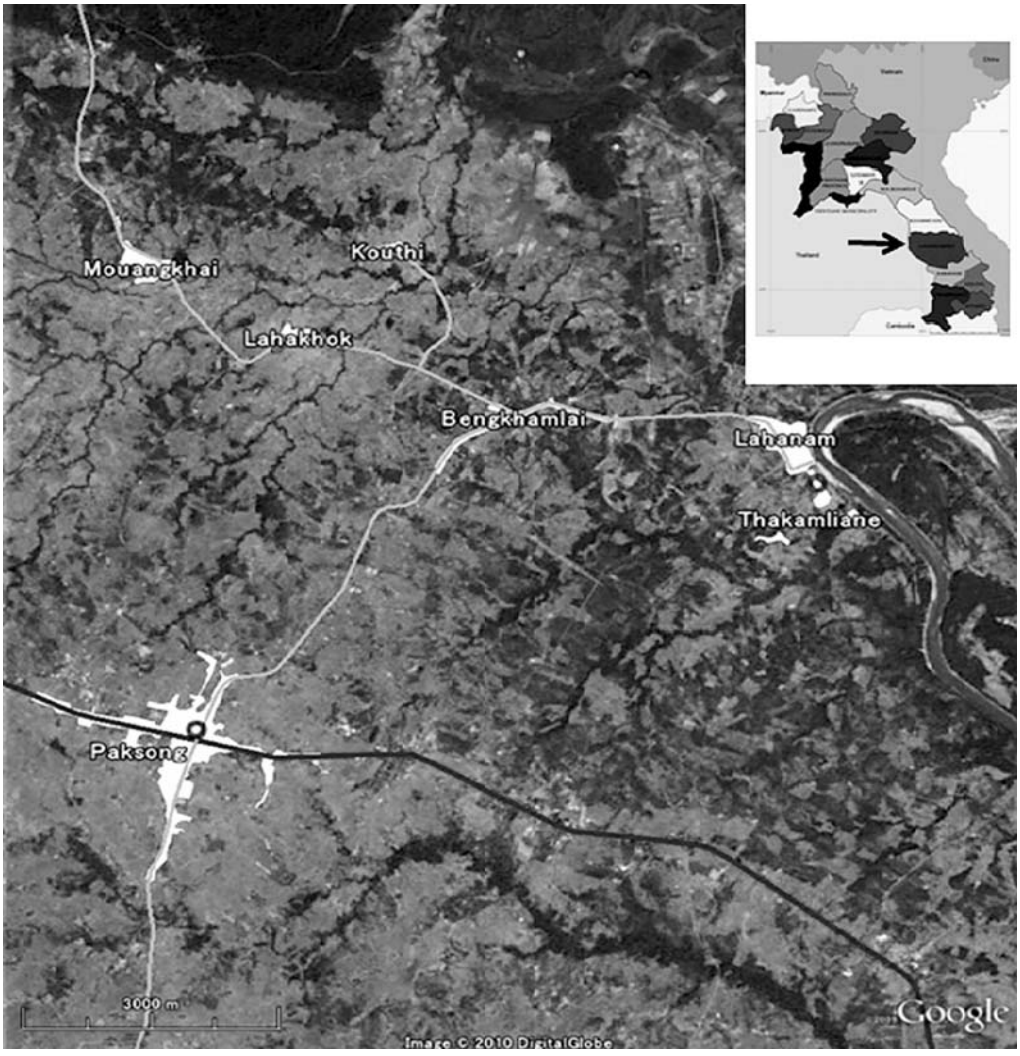

Fig. 1. Map of the study area. The thick and thin orange lines indicate paved and unpaved roads, respectively. The red circles indicate markets.

access to the market in Thakhamlian, which is open every morning. Bengkhamlai is approximately 2 km from Thakhamlian and is nearest (ca. 8 km) to the district capital, Paksong, where a permanent market is open every day. Lahakhok, Kouthi, and Muangkhai villagers have limited access to both markets. Public taxis are the main form of transportation in the study area. A typical journey from a study village to Paksong takes approximately 20–40 minutes by taxi in the dry season and longer in the rainy season (Figure 1).

Study subjects

This study describes a baseline assessment of randomized trials to determine the effectiveness of home-fortified food supplementation. A total of 367 eligible preschool children were identified in the HDSS database of the NIOPH, The inclusion criteria were: 1) age 6 to 53 months at the time of recruitment; 2) willingness to participate; 3) receiving complementary food in addition to breast milk; and 4) apparently healthy. The exclusion criteria were: 1) having fever or any other illnes on the day of enrolment; and 2) currently receiving iron supplementation. Of the original 367 eligible children, 17 were absent at the time of enrolment and 14 were excluded because they had infections with fever on the day of enrolment. Therefore, a total of 336 children were enrolled in the study and 331 were included in the analysis.

Data collection

This study was carried out in February 2009. A series of meetings with local authorities (heads of villages), parents, village health volunteers, and health centre staff were held beforehand to explain the study objectives and to promote community participation. A questionnaire was filled out by the parents or legal guardians of the children who had given individual written informed consent prior to enrolment. Ethical approval for the study was obtained from Nagasaki University as well as the National Ethics Committee for Health Research of the Ministry of Health, Lao PDR.

Assessment of related factors

Socioeconomic and demographic information as well as information on feeding practices were collected. The related factors evaluated were: age; sex; mother's educational level; working status; availability of, access to, and affordability of food sources; and child feeding practices (duration of breastfeeding, currently breastfeeding, age of starting complementary foods, type of complementary foods, and number of meals consumed per day). The parents were asked to report both the ill health of the child (occurrence of diarrhea or cough) within the previous two weeks and whether they had received routine deworming treatment.

Proxy markers of household socioeconomic status (SES) were 1) the presence of household-owned latrines and 2) access to electricity and safe water.

Blood sample collection and analysis

Capillary blood samples were obtained from a finger prick using an aseptic technique. The hemoglobin concentrations were measured immediately with a portable battery-operated HemoCue B-Hemoglobin Photometer (HemoCue Inc., Angelholm, Sweden) by trained technicians using standardized techniques [19]. In accordance with the World Health Organization (WHO) guidelines, preschool children with hemoglobin concentrations of <110 g/L were defined as anemic.

Anthropometric measurement

A calibrated seca weighting scale (www.seca.com) with intervals of 0.1 kg was used to measure body weight. An infant length board with a sliding foot board to the nearest 0.1 cm was used to measure the recumbent length of children aged less than 24 months, and a wooden scale with a sliding head piece was used to measure the standing height of children aged 24 months and older. Two field workers completed the measurements twice using standardized WHO procedures [20]. Height for age (stunting), weight for age (underweight), and weight for height (wasting) Z-scores were calculated using WHO Anthro software (version 3.01) [21]. Children with Z-scores below –2 SD of the reference population of the WHO child growth standard 2005 were defined as malnourished.

Data analysis

PASW statistical package version 18.0 (SPSS Inc., Chicago, IL, USA) was used for data analysis. The sociodemographic, health, and nutrition characteristics of the study population were summarized as the mean and SD for continuous variables and as the frequency for categorical variables. The chi-square (χ^2) test and Fisher's exact test were used to compare categorical variables between groups.

Bivariate analysis of the association between anemia and potential risk factors was conducted using logistic regression. Variables associated with anemia at $P<0.2$ were incorporated in multiple regression models. The results were expressed as the odds ratio (OR) and 95% confidence interval (95% CI). The significance level was set at $P<0.05$ for all tests.

For this study, "high" SES was defined as a household with a latrine and access to both electricity and safe water, while "low SES" was defined as a household with only one

or two of these three items. Based on the average household size at the national level [22], a family size of six was used as a cut-off. Six years was used as the cut-off value for the level of mothers' education. According to the previous study, the prevalence of anemia was high among young children, the age of the children being categorized as younger children 6–23 mo and older children 24–59 mo.

Ethical approval

Ethical approval for this study was obtained from the Nagasaki University Ethical Review Board (Japan) and the National Ethics Committee for Health Research of the Ministry of Health (Lao PDR).

RESULTS

A total of 331 preschool children (137 boys and 194 girls) aged 6–52 months with a mean (SD) age of 31.7 (14.1) months participated in the study. Table 1 summarizes the general sociodemographic and health characteristics of the study subjects in the six villages. Nearly two-thirds of the mothers had completed less than six years of formal education. One-third of the mothers were working outside the home. Overall, the results showed heterogeneity among the six villages in terms of sex, mothers' education, mothers' working status, and access to affordable commercial baby food. In addition, 40% of the study subjects suffered from stunting and 7.3% from wasting. Almost all of the mothers

Table 1. General characteristics of the children in the six study villages (n = 331)

Characteristics		Muangkhai No. (%)	Kouthi No. (%)	Lahakhok No. (%)	Lahanam No. (%)	Thakhamlian No. (%)	Bengkhamlai No. (%)	Total No. (%)	P[a]
Sex	Girls	22 (45.8)	21 (48.8)	33 (84.6)	60 (57.1)	29 (54.7)	29 (67.4)	194 (58.6)	0.003
	Boys	26 (54.2)	22 (51.2)	6 (15.4)	45 (42.9)	24 (45.3)	14 (32.6)	137 (41.4)	
Age	6–23 mo	18 (37.5)	15 (34.9)	14 (35.9)	33 (31.4)	13 (24.5)	21 (48.8)	114 (34.4)	0.227
	>23 mo	30 (62.5)	28 (85.1)	25 (64.1)	72 (68.6)	40 (75.5)	22 (51.2)	217 (65.6)	
Sociodemographic									
Mother's education	<6 years	29 (60.4)	38 (88.4)	24 (61.5)	48 (45.7)	35 (66.0)	40 (93.0)	214 (64.7)	<0.001
	>6 years	19 (39.6)	5 (11.6)	15 (38.5)	57 (54.3)	18 (34.0)	3 (7.0)	117 (35.3)	
Mother's working status	Home	1 (2.1)	1 (2.3)	3 (7.7)	20 (19.0)	8 (15.1)	1 (2.3)	34(10.3)	0.002[b]
	Out	47 (97.9)	42 (97.7)	36 (92.3)	85 (81.0)	45 (84.9)	42 (97.7)	297 (89.7)	
Family size	1–6 members	24 (50.0)	17 (39.5)	26 (66.7)	35 (33.3)	26 (49.1)	20 (46.5)	158 (47.7)	0.002
	>6 members	24 (50.0)	26 (60.5)	13 (33.3)	70 (66.7)	27 (50.9)	23 (53.5)	173 (52.3)	
SES	Low	48 (100.0)	37 (86.0)	35 (89.7)	41 (39.0)	38 (70.7)	28 (65.1)	227 (68.6)	<0.001
	High	0 (0.0)	6 (14.0)	4 (10.3)	64 (61.0)	15 (28.3)	15 (34.9)	104 (31.4)	
Feeding practices									
	Never breastfed	34 (70.8)	34 (79.1)	30 (76.9)	81 (77.1)	41 (77.4)	25 (58.1)	245 (74.0)	0.188
	Currently breastfed	14 (29.2)	9 (20.9)	9 (23.1)	24 (22.9)	12 (22.6)	18 (41.9)	86 (26.0)	
Afford baby food	No	39 (81.3)	43 (100.0)	39 (100.0)	96 (91.4)	53 (100.0)	17 (39.5)	287 (86.7)	<0.001
	Yes	9 (18.8)	0 (0.0)	0 (0.0)	9 (8.6)	0 (0.0)	26 (60.5)	44 (13.3)	
Health status									
Deworming	No	12 (25.0)	13 (30.2)	8 (20.5)	31 (29.5)	17 (25.0)	11 (25.6)	92 (27.8)	0.837
	Yes	36 (75.0)	30 (69.8)	31 (79.5)	74 (70.5)	36 (75.0)	32 (74.4)	239 (72.2)	
Diarrhoea or cough	No	24 (50.0)	24 (55.8)	30 (76.9)	69 (65.7)	36 (67.9)	31 (72.1)	214 (64.7)	0.078
	Yes	24 (50.0)	19 (44.2)	9 (23.1)	36 (34.3)	17 (32.1)	12 (27.9)	117 (35.3)	
Wasting	No	46 (95.8)	40 (93.1)	37 (94.8)	95 (90.4)	47 (88.6)	42 (97.6)	307 (92.7)	0.292[b]
	Yes	2 (4.2)	3 (6.9)	2 (5.2)	10 (9.6)	6 (11.4)	1 (2.3)	24 (7.3)	
Stunting	No	23 (48.9)	30 (69.8)	23 (58.9)	58 (55.2)	38 (71.7)	26 (60.5)	198 (59.8)	0.124
	Yes	25 (52.1)	13 (30.2)	16 (41.0)	47 (44.8)	15 (28.3)	17 (39.5)	133 (40.2)	
Underweight	No	29 (60.4)	33 (76.7)	27 (69.2)	73 (69.5)	44 (83.0)	37 (86.0)	243 (73.4)	0.041
	Yes	19 (39.5)	10 (23.3)	12 (30.7)	32 (30.4)	9 (16.9)	6 (13.9)	88 (26.6)	

[a] For comparison across villages (Pearson Chi-square test, df = 5)

[b] Villages were pooled into two groups (Muangkhai+ Kouthi + Lahakhok vs. Lahanam + Thakhamlian + Bengkhamlai) because of the small expected number for some table cells (df = 1)

had introduced an early food supplement in the form of chewed glutinous rice to the study subjects. It was noteworthy that none of the study subjects was exclusively breastfed. Of the children aged above 24 months, 72.2% had received routine deworming treatment within the two months prior to the study.

The mean (SD) hemoglobin concentration of the 331 children was 108.8 (14.3) g/L (Figure 1), 48.9% of the population showing values below the anemia cut-off point. Most cases were mild anemia; no severely anemic children were found in this study. Table 2 shows the hemoglobin concentration and prevalence of anemia based on the subjects' general sociodemographic, health, and nutrition characteristics. The association between anemia and each potential risk factor was determined using univariate logistic regression analysis. There was no difference in the prevalence of anemia between boys and girls. The prevalence of anemia was significantly higher in children aged less than 23 months compared with children in the older age group (crude OR = 1.92, 95% CI, 1.22–3.13).

Table 2. Mean haemoglobin level (SD) and unadjusted and adjusted odds ratios (and 95% CI) for the association between anemia and socioeconomic, health, and nutritional risk factors (n = 331)

Characteristics		Hemoglobin concentration (g/L) [mean (SD)]	N (%)	Anemia Odds Ratio (95% CI)	
				Unadjusted	Adjusted[a]
Sex	Girls	108.8 (14.7)	94 (48.5)	0.95 (0.62, 1.47)	
	Boys	108.9 (14.0)	68 (49.6)	1.00	
Age	6–23 mo	105.2 (15.7)	68 (59.7)	1.92 (1.22, 3.13)	1.90 (1.10, 3.30)
	>24 mo	110.8 (13.2)	94 (43.3)	1.00	1.00
Village	Muangkhai	107.0 (13.1)	28 (58.3)	2.61 (1.13, 6.23)	3.01 (1.25, 7.47)
	Kouthi	104.0 (11.8)	26 (60.5)	2.85 (1.20, 6.99)	3.64 (1.47, 9.36)
	Lahakhok	107.5 (18.5)	23 (59.0)	2.68 (1.11, 6.70)	3.94 (1.56, 10.39)
	Lahanam	109.4 (12.6)	50 (47.6)	1.70 (0.82, 3.60)	1.99 (0.93, 4.40)
	Thakhamlian	111.6 (15.9)	20 (37.7)	1.13 (0.49, 2.64)	1.42 (0.60, 3.45)
	Bengkhamlai	112.5 (15.0)	15 (34.9)	1.00	1.00
Education	<6 years	109.0 (14.9)	101 (47.2)	0.82 (0.52, 1.28)	
	>6 years	108.7 (13.4)	61 (52.1)	1.00	
Working status	Out	108.6 (14.5)	147 (49.5)	1.24 (0.61, 2.57)	
	Home	111.6 (12.7)	15 (44.1)	1.00	
SES*	Low	108.6 (14.3)	114 (50.2)	1.05 (0.60, 1.85)	
	High	109.4 (14.6)	48 (46.2)	1.00	
Family size	>6 members	108.0 (14.4)	95 (54.9)	1.97 (1.67, 3.33)	1.96 (1.17, 3.29)
	1–6 members	109.8 (13.7)	67 (42.4)	1.00	1.00
Breastfed	Never breastfed	110.1 (13.5)	111 (45.3)	0.57 (0.34, 0.93)	0.70 (0.39, 1.25)
	Currently breastfed	105.4 (16.1)	51 (59.3)	1.00	1.00
Afford baby food	No	108.5 (14.3)	144 (50.2)	1.18 (0.51, 2.76)	
	Yes	111.4 (14.6)	18 (40.9)	1.00	
Deworming	No	106.4 (15.6)	51 (55.4)	1.43 (0.88, 2.33)	
	Yes	109.8 (13.8)	111 (46.4)	1.00	
Diarrhea/Cough	Yes	105.9 (14.4)	64 (54.7)	1.42 (0.86, 2.34)	1.37 (0.84, 2.23)
	No	110.5 (14.5)	98 (45.8)	1.00	1.00
Wasting	No	108.8 (14.5)	151 (49.2)	1.14 (0.5, 2.68)	
	Yes	109.8 (12.4)	11 (45.8)	1.00	
Stunting	No	109.7 (14.9)	93 (47.0)	0.82 (0.53, 1.28)	
	Yes	107.6 (13.5)	69 (51.9)	1.00	
Underweight	No	109.5 (14.9)	114 (46.9)	0.74 (0.45, 1.20)	
	Yes	107.1 (12.6)	48 (54.6)	1.00	

[a] Adjusted for covariates that have a P value less than 0.2 (age, family size, illness, breastfeeding status, and location) using multiple logistic regression

The prevalence of anemia was significantly higher in the villages that had poor access to the markets (Kouthi: 60.5%; Lahakhok: 59.0%; and Muangkhai: 58.3%) compared with the villages that had relatively good access to the markets (Bengkhamlai: 39.4%; Lahanam: 47.6%; and Thakhamlian: 34.9%). While the mothers' education, mothers' working status, and household SES were statistically insignificant, large family size was identified as a related factor for anemia. Breastfeeding at the time of the interview also showed a positive correlation with anemia in univariate analysis. The other variables (affordable baby foods, deworming status, diarrhea or cough within two weeks, wasting, stunting, and underweight) showed no significant relationship with anemia.

After adjustment for other variables, the effects of age, village, and family size remained significant. On the other hand, the effect of breastfeeding was attenuated by the adjustment and became statistically insignificant.

DISCUSSION

This cross-sectional study included 331 preschool children (aged 6–52 months) living in six rural communities in Songkhone district, Savannakheth province, Lao PDR. The result showed that the prevalence of anemia among preschool children in this area (48.9%) was higher than both the national prevalence (40.9%) [18] and the estimated global anemia prevalence among preschool children (47.4%) [1]. The prevalence of anemia reported from several developing countries [17], [23] varied from 16.1% in the Philippines [24] to 92% in Kenya [25]. The prevalence in the present study was moderate compared with those countries [2]. Our study also demonstrated that particular high-risk groups existed among children within the study area.

Several studies have reported a sex-related difference in anemia prevalence. Studies on preschool children in Kenya and Zanzibar found that the prevalence of anemia was higher in males than in females [26, 27], whereas a study in the Philippines reported a higher prevalence of anemia in female preschool children [24]. In the present study, however, we found no significant sex-related difference in anemia prevalence.

The prevalence of anemia in the present study was high in younger children (56.9%) and decreased significantly with age, a finding consistent with an earlier study [17]. IDA commonly develops at six months of age, when nutrition needs must be met with both breast milk and complementary foods [28]. This increased risk has been attributed to a relatively large iron requirement owing to high growth rates during the first two years of life in combination with a rapidly expanding blood volume [29]. In addition, the typical rice-based complementary weaning foods in Lao PDR have a low iron content (1 mg of iron per 100 g of rice) [30]. The choice of complementary foods at this age can markedly influence the risk of iron deficiency, and thus anemia. The dramatic decrease in the prevalence of anemia among children aged above 23 months may be attributable to lower iron requirements associated with decreasing growth rate and the shift in diet from complementary foods to table foods.

Breastfeeding is generally recommended for young children. However, our results indicated no protective effect of breastfeeding against anemia. The significant positive association between breastfeeding and anemia detected in the univariate analysis can be partially explained by the age effect, since the OR of breastfeeding was attenuated in the multiple regression model adjusted for age and other variables. Nonetheless, however insignificant, the adjusted OR of breastfeeding was still higher than 1. This result may be attributable to insufficient breastfeeding and nutrient-poor complementary foods [31]. None of the 331 children aged 6–52 months in the present study were exclusively breastfed. Mothers traditionally introduced nutrient-poor rice-based complementary foods at an early age [32]. It is possible that children who can eat solid foods receive better nutrition than those who depend on breast milk and complementary foods in this study area.

The present results showed that the prevalence of anemia can vary among different villages within a small area. The six villages differed in several socioeconomic variables (Table 1). However, none of these socioeconomic variables were identified as related factors for anemia in the logistic regression analysis. Therefore, the difference in anemia prevalence cannot be attributed to these variables. A possible factor causing the high prevalence in three villages (Lahakhok, Kouthi, and Muangkhai) is the poor access to markets. Although the study area is thought to have adequate rice production [33], the low availability of iron-rich foods might contribute to the high prevalence of anemia. In Lao PDR, as in other countries in Southeast Asia, predominantly cereal-based complementary foods are generally poor in nutritional quality, and anemia is often caused by inadequate intake of animal-based foods.

Another factor that was significantly associated with a high prevalence of anemia was large family size (>6 members). Half of the anemic subjects had siblings of similar age in the same household. Although food distribution within the household seemed to be equal, rice was the predominant staple food in the rural diets, while legumes and meat products, which have higher levels of bioavailable iron [34], were commonly consumed in very small quantities and enriched foods were typically unavailable. Moreover, even if

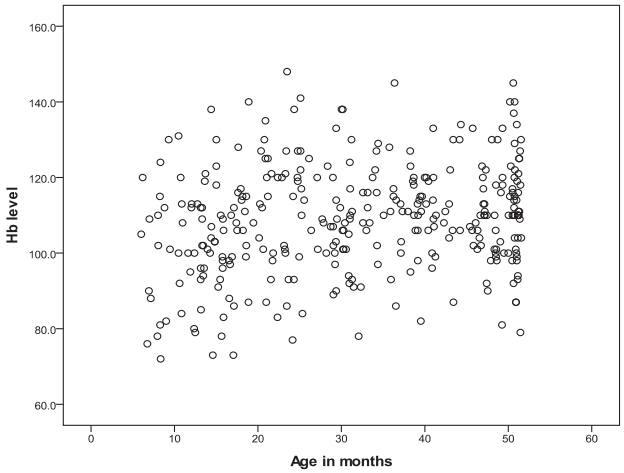

Fig. 2. Distribution of hemoglobin level by age of children (in months), (n = 331).
Mean: 108.8 g/L (SD 14.3 g/L, Max: 148.0 g/L, Min: 72.0 g/L); Median: 110.0 g/L, Mode: 110.0 g/L

these foods are available in a household, the adult males of the family tend to derive more benefit from them than children because of cultural norms. Villagers regarded food items other than rice as side dishes, and they did not consider a certain amount necessary for each family member. The rice-meat ratio might be correlated with the family size.

Many studies have reported that mothers' educational level plays an important role in the anemia status of school children [15, 17, 24, 35]. However, the present study found no significant correlation between mothers' education and anemia prevalence in children. This may be due to the small variation in the mothers' educational levels in our sample, since most of the mothers in the study area had a low literacy rate (64.7%), similar to that seen in Malaysia [36].

Previous studies identified parasitic infections, especially hookworm infection, as an important predictor of anemia among children [26, 27]. Stool examinations were not included in the present study because routine deworming had been administered to all children aged two years and older and almost all of the study subjects aged 24 months and above (72.2%) had received deworming within the two months prior to the study. It is noted that the lack of significant effects of the deworming treatment might be caused by the low prevalence of hookworm infection among the preschool children. Indeed, in a recent study conducted on preschool children in neighboring districts such as Sepol, Nong, and Vilabury in Savannakheth province, a lower prevalence of hookworm infections (10.9%) was identified and no heavy infection intensities were recorded [37].

Measures to correct anemia often require an integrated approach, owing to the multifactorial nature of the disease [1]. Additional health promotion and appropriate feeding practices are essential to ensure long-term benefits. In Lao PDR, where iron deficiency is the most frequent cause of anemia, additional iron intake is usually provided through iron supplements to vulnerable groups, especially pregnant women and young children. A food-based approach to increase iron intake through home-fortification using multivitamins and mineral condiments sprinkled on rice is an important way to prevent IDA in young children, in addition to a routine deworming strategy with two treatment rounds per year [37].

In conclusion, the present study confirmed a high prevalence of anemia, especially among young children, children in large families, and children in remote villages, where we found a high prevalence of stunting, poor socioeconomic conditions, poor access to enriched foods, and poor knowledge of enriched food sources. These findings underline the importance of food practices and home-fortified food supplementation interventions. Wherever resources are limited, high-risk groups should be targeted and a long-term health education program promoted to modify food habits, promote healthy weaning practices, and encourage consumption of nutritious foods. In settings where iron deficiency is not the only cause of anemia, approaches that combine iron interventions with other measures are needed. Strategies should also address other possible causes of anemia [38]. The challenge ahead is how best to reach preschool children in rural communities.

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SK conceived the study; SK, TS, MH, TY, KM, BB designed the study; SK carried out the field work; SK & TS analyzed and interpreted the data; and SK &TS drafted the manuscript. MH, JO, TY, KM, & BB revised the manuscript. All authors read and approved the final manuscript.

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CONFLICTS OF INTEREST

None declared

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