예방의학회지 제41권 제4호(2008년 7월)
J Prev Med Public Health 2008;41(4):232-240
DOI: 10.3961/jpmph.2008.41.4.232

Nutritional Status and the Characteristics Related to Malnutrition in Children Under Five Years of Age in Nghean, Vietnam

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Objectives : This study was conducted to assess the nutritional status and characteristics related to malnutrition in children less than five years of age in Nghean, Vietnam.

Methods : In this study, which was conducted in November 2007, 650 child-mother pairs were selected using a two-stage cluster sampling methodology. A structured questionnaire was then administered to the mothers in their home settings. Anthropometric measurement was then used to determine if children were underweight (weight-for-age), wasting (weight-for-height) and stunting (height-for-age) based on reference data from the National Center for Health Statistics (NCHS)/World Health Organization (WHO). Logistic regression analysis was then used to describe the hierarchical relationships between potential risk factors and malnutrition.

Results : The mean Z-scores for weight-for-age, height-for-age and weight-for-height were -1.46 (95% CI=-1.57, -1.35), -1.44 (95% CI=-1.56, -1.32) and -0.71 (95% CI=-0.82, -0.60), respectively. Of the children included in this study, 193 (31.8%) were underweight, 269 (44.3%) were stunting and 72 (11.9%) were wasting. Region of residence, the mother's level of education and occupation, household size, number of children in the family, weight at birth and duration of exclusive breastfeeding were found to be significantly related to malnutrition.

Conclusions : The findings of this study indicate that malnutrition is still an important problem among children less than five years of age in Nghean, Vietnam. In addition, maternal, socio-economic and environment factors were found to be significant factors for malnutrition among children under five.

J Prev Med Public Health 2008;41(4):232-240

Key words : Child, Malnutrition, Vietnam

INTRODUCTION

Worldwide, over 10 million children under the age of 5 years die every year from preventable and treatable illnesses despite effective health interventions [1,2]. At least half of these deaths are caused by malnutrition [3,4]. Malnourished children have lowered resistance to infection; therefore, they are more likely to die from common childhood ailments such as diarrheal diseases and respiratory infections. In addition, malnourished children that survive are likely to suffer from frequent illness, which adversely affects their nutritional status and locks them into a vicious cycle of recurring sickness, faltering growth and diminished learning ability [5]. In developing countries, malnutrition is a major health problem [4].

Child malnutrition is one of the most serious health issues in Vietnam. The 2000 Mother and Child Nutrition Survey conducted by the Vietnam National Institute of Nutrition (NIN) found that 16 million people, or 22 % of the population, were malnourished. In addition, that study found that a greater portion of the population in mountainous areas and the countryside were malnourished than in urban areas. In addition, children accounted for 2.5 million of the 16 million malnourished individuals [6]. Of the malnourished children, 34 % were less than five years old, 44 % lived in the mountainous areas, 37 % lived in rural areas, and 19 % lived in cities and towns. The prevalence of underweight children under five years old was 33 % from 1995-2002; however, this value was reduced to 28.4 % in 2003. The stunting prevalence for children under five years old was 36 % for the same period.

Nghean, which is one of the poorest provinces in Vietnam, is located in the Northern Centre Coast of Vietnam. This area has a poor economy and has recently suffered numerous natural disasters such as drought and flood. According to the annual data generated by the national surveillance system (NIN), the prevalence of underweight and stunting in children in Nghean was approximately 41.1% and 47.2%, respectively, in 2000 [7,8], giving Nghean one of the highest malnutrition rates in Vietnam.

The nutritional status of children has an impact on their health and development. Therefore, the physical, mental, and social and nutritional status of children, as well as other characteristics related to malnutrition should be evaluated periodically to monitor malnutrition, thereby enabling appropriate measures that can prevent it to be implemented [9,10].

Received : 17 April 2008, Accepted : 11 June 2008
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Arcordingly, this study was conducted to assess the nutritional status and examine the characteristics related to malnutrition in children less than five years of age in Nghean, Vietnam.

SUBJECTS AND METHODS

I. Research Design

This study was a cross-sectional descriptive survey that was conducted using a structured questionnaire and measurements of weight and length/height to determine the nutritional status of children aged 0 to 59 months. The impact of child feeding practice, as well as socioeconomic and demographic factors on the nutritional status of children were then evaluated. This study was conducted in November 2007 in Nghean province, one of the poorest provinces in Vietnam.

The population of Nghean province in 2006 was 3,064,300, of which approximately 200,000 were children under five years old. Prior to conducting sampling, the required sample size was calculated using the formula shown below (formula 1) under the following assumptions: the population of interest contained approximately 200,000 children under the age of five and a 95% confidence level, a confidence interval of 4.0, and a power of 50% true positives (worst case) were desired.

Formula 1:

$$N = \frac{Z^2 * P * (1-P)}{C^2}$$

Z = Z value (e.g. 1.96 for 95% confidence level)

P = power desired, expressed as a decimal (e.g: a power of 50% true positives = 0.5)

C = confidence interval, expressed as a decimal.

The results of this calculation indicated that the minimum sample size required was approximately 598. Therefore, this study enrolled a total of 650 children under the age of 5 along with their mothers to take into account exclusion due to incomplete data, etc.

Subjects were selected using a two-stage cluster design. Nghean province is comprised of 18 districts; therefore, during the first stage of sampling we selected one to three villages in each district at random. This resulted in a total of 30 villages being selected. During the second stage, a total of 20-25 children were systematically sampled from each village selected during the first stage.

At the beginning of this study, 650 child/mother pairs were selected. However, 43 of these pairs were excluded due to incomplete data. Therefore, the final study population included of 607 child/mother pairs.

II. Materials and Data Collection

Data were gathered using a combination of a structured questionnaire and the collection of anthropometric data such as length/height and weight.

Anthropometric measurements: Field workers were trained to record the anthropometric measurements. All children were weighed and measured once while wearing light-weight clothing. Children aged less than 24 months of age were laid horizontally and weighed using a children's scale that had a precision of 0.05 kg. Their length were also measured using a measuring tape that had a precision of 0.01 m. Children aged 24 to 59 months were weighed barefoot using a digital scale with a precision of 0.5 kg. These children's height were also measured using a stadiometer with a precision of 0.01 m while standing straight on a horizontal surface with their heels together and eyes straight forward.

The National Center for Health Statistics (NCHS) and the WHO standards were used to determine the nutritional status of children (Appendix 1,2)[11]. To accomplish this, the standard deviation of scores (z-scores) of weight for age (WAZ), height for age (HAZ) and weight for height (WHZ) were calculated using the following calculation: Z-score = (individual value-median value of the reference population)/SD value of the reference population. For each of the anthropometric indicators of malnutrition, a cutoff point of -2 standard deviations (-2SD) below the median of that of the NCHS/WHO reference population was used. Accordingly, underweight, stunting and wasting were defined as WAZ<- 2, HAZ< - 2 and WHZ<- 2, respectively. Overweight children were defined as having a Z-score weight-for-length/height > 2 SD above the median of the NCHS/WHO reference population.

In addition, we considered mothers with a body mass index (BMI, kg/m^2) of <18.5 kg/m^2 to be underweight (WHO, 1995).

Sociodemographic and child development variables: Mothers of selected children who were willing to participate in the study were interviewed to collect the desired information. However, the causes of malnutrition in children are complex and include biological, social and environmental factors [12]. To handle the complex hierarchical inter-relationships between these variables Victora et al. proposed the use of frameworks and models to study and predict the risk factors of health outcomes [13]. Child health, particularly in less developed countries, is determined by a large number of factors. Ultimately, most ill health in such societies can be ascribed to poverty resulting from a lack of resources. To assess the levels of poverty or wealth, most studies use variables such as family income, parental education or the number and type of household appliances. Such factors, however, rarely cause ill-health directly and are therefore referred to as distal determinants. These factors are most likely to act through a number of inter-related proximate determinants, sometimes referred to as intermediate variables. These proximate determinants may be subdivided into groups which are inter-related in a hierarchical way [13].

Based on previous studies that have described risk factors of malnutrition, we constructed a conceptual framework. In our model, we divided the variables into three groups: (a)

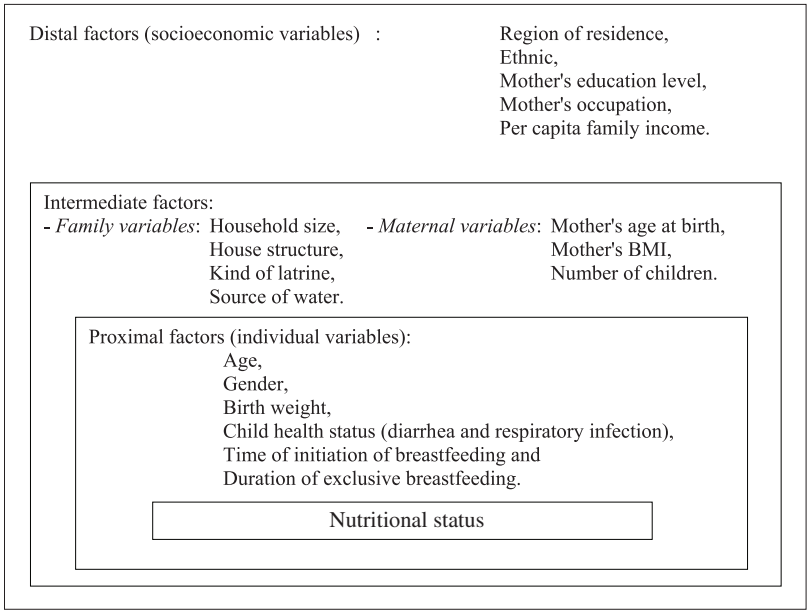

Figure 1. Conceptual hierarchical framework of the determinants of nutritional status.

Table 1. Summary of steps involved in analysis of the effects of socioeconomic, family and maternal variables, as well as individual variables on malnutrition

Model	Equation (explanatory variables)	Interpretation
1	Socioeconomic	Overall effect of socioeconomic variables; adjusted for all other variables in the model.
2	Socioeconomic + family and maternal	Effect of family and maternal variables; adjusted for all other family and maternal variables, and the confounding role of socioeconomic variables.
3	Socioeconomic + family and maternal + individual	Effect of individual variables; adjusted for all other individual variables and family and maternal variables, and the confounding roles of socioeconomic variables.

Table 2. Nutritional status (mean z-scores) of children under five years of age

Age group (months)	Mean Z-scores weight-for-age (95% CI)			Mean Z-scores height-for-age (95% CI)			Mean Z-scores weight-for-height (95% CI)		
	Girls	Boys	All	Girls	Boys	All	Girls	Boys	All
0 - 11	-0.20 (-0.49,0.08)	-0.45 (-0.81,-0.08)	-0.29 (-0.62,0.02)	-0.69 (-1.03,-0.35)	-1.10 (-1.53,-0.66)	-0.85 (-1.21,-0.48)	0.47 (0.19,0.76)	0.42 (0.05,0.78)	0.45 (0.17,0.73)
12 - 23	-1.48 (-1.78,-1.17)	-2.00 (-2.31,-1.68)	-1.73 (-1.95,-1.51)	-1.48 (-1.84,-1.12)	-1.97 (-2.34,-1.60)	-1.72 (-2.00,-1.43)	-0.76 (-1.07,-0.46)	-1.06 (-1.37,-0.76)	-0.91 (-1.20,-0.62)
24 - 35	-1.61 (-1.93,-1.30)	-1.94 (-2.23,-1.66)	-1.79 (-1.97,-1.62)	-1.53 (-1.91,-1.16)	-1.37 (-1.71,-1.03)	-1.45 (-1.65,-1.24)	-0.75 (-1.06,-0.44)	-1.33 (-1.61,-1.05)	-1.07 (-1.23,-0.91)
36 - 47	-1.79 (-2.09,-1.49)	-1.89 (-2.20,-1.58)	-1.84 (-2.01,-1.67)	-1.54 (-1.90,-1.19)	-1.76 (-2.13,-1.39)	-1.65 (-1.85,-1.44)	-1.03 (-1.33,-0.74)	-1.17 (-1.47,-0.86)	-1.10 (-1.25,-0.94)
48 +	-1.32 (-1.70,-0.94)	-1.83 (-2.20,-1.45)	-1.58 (-1.83,-1.33)	-1.38 (-1.83,-0.93)	-1.67 (-2.11,-1.23)	-1.53 (-1.80,-1.25)	-0.63 (-1.01,-0.26)	-1.15 (-1.52,-0.79)	-0.90 (-1.12,-0.68)
All	-1.25 (-1.41,-1.08)	-1.69 (-1.84,-1.54)	-1.46 (-1.57,-1.35)	-1.30 (-1.49,-1.12)	-1.59 (-1.75,-1.43)	-1.44 (-1.56,-1.32)	-0.51 (-0.67,-0.34)	-0.93 (-1.08,-0.79)	-0.71 (-0.82,-0.60)

distal factors indicated by socioeconomic variables (region of residence, ethnicity, mother's education, mother's occupation, and per capita family income); (b) intermediate factors including family variables (household size, house structure, type of latrine and source of water) and maternal variables (mother's age when the child was born, mother's BMI, number of children); and (c) proximal factors including age, gender, child's weight at birth, child health status (diarrhea and respiratory infection), time at which breastfeeding was initiated and the duration of exclusive breastfeeding (BF) (Figure 1)(Table 1).

Figure 1 shows a scheme of this conceptual framework in which variables near the top of the Figure influence those below them. Socioeconomic variables (the distal factors) may directly or indirectly affect all other groups, with the exception of sex and age. These variables may include family variables and maternal variables. These variables, in turn, may affect the child's birth weight and type of diet. They may also affect the health status of the child. Finally, all of the above factors may affect the risk of child malnutrition.

III. Statistical Analysis

Data were entered into a microcomputer and analyzed using Epi-Info version 3.4.1 and SPSS version 13.0 for windows. The Epi-Info 2000 NutStat program was used to analyze the anthropometric values. Weight, height, and age data were used to calculate the weight-for-age, height-for-age, and weight-for-height z-scores based on the National Center for Health Statistics/WHO reference data [14].

The SPSS program was used for descriptive statistics. Statistical significance was set at $p<0.05$. Hierarchical logistic regression analysis was used to analyze the effects of child feeding practice, as well as socioeconomic and demographic factors on the nutritional status of children (Table 1).

RESULTS

I. Nutritional Status

Table 2 present the nutritional status (mean Z-scores) of children under five years of age. The mean Z-score were -1.46 (95% CI=-1.57, -1.35) for weight-for-age, -1.44 (95% CI= -1.56, -1.32) for height-for-age and -0.71 (95% CI=-0.82, -0.60) for weight-for-height. The mean Z-score differences between boys and girls were statistically significant for weight-for-age ($p<0.001$), height-for-age ($p<0.05$) and weight-for-height ($p<0.001$). The lowest mean Z-score of weight-for-age, which was -1.84, was observed in children between 36 and 47 months of age. The lowest mean Z-score of height-for-age, which was -1.72, was observed

Table 3. The prevalence rate of underweight, stunting and wasting among children under five years of age

Categories of malnutrition	Girls (N=314)	Boys (N=293)	All (N=607)
Underweight	80 (25.5%)	113 (38.6%)	193 (31.8%)
Stunting	121 (38.5%)	148 (50.5%)	269 (44.3%)
Wasting	29 (9.2%)	43 (14.7%)	72 (11.9%)

Table 4. Socioeconomic variables and their odds ratios (95% confidence interval) for malnutrition in children under five years of age based on logistic regression analysis

Categorical variables	N=607	Malnutrition		
		Underweight†	*Stunting*†	*Wasting*†
Ethnic				
Kinh groups	481 (79.2%)	1.00	1.00	1.00
Minority ethnic groups	126 (20.8%)	1.27 (0.60- 2.66)	1.13 (0.55-2.35)	1.44 (0.57- 3.62)
Region of residence				
Urban area	147 (24.2%)	1.00	1.00	1.00
Rural area	290 (47.8%)	4.38 (1.92- 9.99)	2.21 (1.18-4.12)	3.84 (1.13-13.05)
Mountainous area	170 (28.0%)	5.10 (1.86-13.98)	1.93 (0.82-4.53)	7.10 (1.70-29.65)
Mother' s education level				
Primary school or lower	76 (12.5%)	1.56 (0.80- 3.05)	1.04 (0.55-1.95)	0.78 (0.25- 2.48)
Junior high school	285 (47.0%)	1.72 (1.05- 2.80)	0.97 (0.62-1.52)	2.69 (1.24- 5.83)
Senior high school or higher	246 (40.5%)	1.00	1.00	1.00
Mother' s occupation				
Officer	47 (7.7%)	1.00	1.00	1.00
Laborer	68 (11.2%)	5.53 (1.07-28.48)	0.90 (0.36-2.27)	6.77 (0.70-64.72)
Farmer	411 (67.7%)	5.59 (1.21-25.89)	2.11 (0.90-4.93)	2.20 (0.25-19.04)
Housewife	81 (13.3%)	4.93 (1.01-24.04)	1.38 (0.59-3.20)	3.10 (0.33-29.90)
Per capita family income				
500.000 - 1.000.000 VND†	105 (17.3%)	1.00	1.00	1.00
> 1.000.000 VND	30 (4.9%)	0.67 (0.19- 2.40)	1.61 (0.65-3.96)	1.61 (0.29- 8.73)
< 500.000 VND	472 (77.8%)	0.65 (0.35- 1.21)	1.13 (0.66-1.93)	0.75 (0.31- 1.77)

† Odds ratio adjusted for all the other variables in the table.
† Exchange rate as of October 2007: US$1 = VND 16,000.

Table 5. Family and maternal variables and their odds ratios (95% confidence interval) for malnutrition in children under five years of age based on logistic regression analysis

Categorical variables	N=607	Malnutrition		
		*Underweight**	*Stunting**	*Wasting**
Household size (people)				
≤ 4	55 (9.1%)	1.00	1.00	1.00
5 - 6	217 (35.7%)	0.25 (0.14-0.44)	0.69 (0.45-1.06)	0.40 (0.17- 0.92)
≥ 7	335 (55.2%)	0.36 (0.16-0.79)	0.58 (0.28-1.16)	0.27 (0.79- 0.91)
Type of house				
Permanent	152 (25.0%)	1.00	1.00	1.00
Semi-permanent	351 (75.8%)	1.01 (0.48-2.12)	1.42 (0.79-2.57)	1.54 (0.47- 4.98)
Wooden frame	104 (17.2%)	1.26 (0.50-3.16)	1.77 (0.80-3.93)	3.77 (0.97-14.61)
Kind of latrine				
Septic tank, pour flush latrine	250 (41.2%)	1.00	1.00	1.00
Other	357 (58.8%)	0.88 (0.48-1.61)	0.75 (0.43-1.31)	0.91 (0.37- 2.22)
Source of water				
Protected	437 (72.0%)	1.00	1.00	1.00
Unprotected	170 (28.0%)	1.03 (0.63-1.67)	0.81 (0.50-1.29)	0.88 (0.45- 1.69)
Mother' s age at birth (years)				
25 - 34	333 (54.9%)	1.00	1.00	1.00
≤ 24	220 (36.2%)	0.93 (0.61-1.44)	1.21 (0.82-1.77)	1.20 (0.65- 2.21)
≥ 35	54 (8.9%)	0.82 (0.41-1.65)	0.71 (0.37-1.38)	0.91 (0.36- 2.31)
Mother' s BMI				
Non underweight (BMI ≥ 18.5)	442 (72.8%)	1.00	1.00	1.00
Underweight (BMI < 18.5)	165 (27.2%)	1.44 (0.95-2.18)	1.27 (0.86-1.86)	1.32 (0.74- 2.35)
No of children				
1 - 2	487 (80.2%)	1.00	1.00	1.00
≥ 3	120 (19.8%)	4.24 (2.24-8.02)	3.16 (1.79-5.57)	5.46 (2.15-13.86)

* Odds ratio adjusted for all the other variables in the table, region of residence, level of mother' s education.

in children between 12 and 23 months of age. The lowest mean Z-score of weight-for-height, which was -1.10, was observed in children between 36 and 47 months of age.

Of the 607 children included in this study, only 21 (3.5%) were overweight. However, the prevalence of underweight, stunting and wasting were high, with 31.8% (193) being found to be underweight, 44.3% (269) being found to have stunting and 11.9% (72) showing signs of wasting (Table 3). The highest proportion of underweight children (44.3%) was observed in children between the ages of 36 and 47 months and the highest proportion of stunting (57.3%) was observed in children between the ages of 12-23 months, while the highest proportion of wasting (17.0%) was observed in children that were ≥ 48 months old.

II. Characteristics of the Study Population

Of the children evaluated in this study, 79.2% belonged to the Kinh ethnic group and 20.8% belonged to other ethnic groups. The regions of residence were distributed as follows: urban area, 24.2%; rural area, 47.8% and mountainous area was 28%. Additionally, 12.5% of the children' s mothers had only a primary school or lower education, while 47% had a junior high school education and 40.5% had a senior high school or higher education. Furthermore, 67.7% of the children' s mothers were farmers, while 11.2% were laborers, 7.7% were officers workers and 13.3% were housewives. The family income per capita was <500,000 VND, 500,000-1,000,000 VND and >1,000,000 VND for 77.8%, 17.3% and 4.9% of the subjects, respectively (Table 4).

The number of family members ranged from two to twelve (mean 4.6±1.4) and the average number of children in each family was 1.86 ± 0.82. The mother' s age at the time the child was born ranged from 16 to 43 years (mean 26.77 ± 5.2) (Table 5).

Of the children included in the study, 293 (48.3%) were boys and 314 (51.7%) were girls. The mean (± SD) age of the children was 29.37 months (±15.85) (Table 6).

III. Characteristics Related to the Child Malnutrition

Multiple logistic regression analysis was used to identify the characteristics that were related to malnutrition. The variables that were found to be significant factors of malnutrition are presented in Table 4, 5 and 6.

Table 4 shows the association between socioeconomic variables and the nutritional status of children. Multiple logistic regression analysis revealed that the region of residence, the level of the mother's education and the mother's occupation were significantly related to malnutrition of children. When compared with children in urban areas, children in rural areas and mountainous areas were 4.3 and 5.1 times more likely to be underweight, 2.2 and 1.9 times more likely to be stunted and 3.8 and 7.1 times more likely to be wasted, respectively. The education level of the mother was also found to be one of the most important factors of malnutrition. Children whose mothers have a junior high school education were found to be 1.7 times more likely to be underweight than children whose mothers have an education level of senior high school or higher. In addition, children whose mothers have an education level of junior high school were found to be 2.6 times more likely to show signs of wasting than children whose mothers have an education level of senior high school or higher. The likelihood of being underweight was also found to be 5.3 times higher among children whose mother's are laborers, 5.9 times higher among children whose mother's are farmers and 4.9 times higher among children whose mothers are housewives than children who have a mother who works in an office.

The results shown in Table 5 describe the association between family and maternal variables and the nutritional status of children. Multiple logistic regression analysis revealed that household size and number of children in the family had a significant effect on the nutritional status of children. Specifically, children from families that had ≥3 children were found to be 4.2 times, 3.1 times and 5.4 times more likely to be underweight, stunted and wasted, respectively, than children from families with <3 children. However, having a large number of individuals in the household was found to be a protective factor against underweight and wasting. Specifically, children from families with 5-6 members were found to be 0.2 times more likely to be underweight and 0.4 times more likely to be wasted than children from families with ≤4 members. In addition, children from families with ≥7 members were 0.3 times more likely to be underweight and 0.2 times more likely to be wasted than those from families with ≤4 members.

Table 6. Individual variables and their odds ratios (95% confidence interval) for malnutrition in children under five years of age as determined by logistic regression analysis

Categorical variables	N=607	Malnutrition		
		Underweight *	Stunting*	Wasting*
Gender				
Boy	293 (48.3%)	1.00	1.00	1.00
Girl	314 (51.7%)	0.49 (0.31- 0.78)	0.61 (0.42- 0.90)	0.54 (0.29- 1.00)
Age (months)				
0 - 11	120 (19.8%)	1.00	1.00	1.00
12 - 23	131 (21.6%)	2.40 (1.11- 5.19)	2.69 (1.49- 4.87)	1.98 (0.59- 6.65)
24 - 35	137 (22.6%)	5.06 (2.34-10.94)	2.10 (1.16- 3.79)	6.65 (2.07-21.35)
36 - 47	131 (21.6%)	10.24 (4.71-22.23)	2.20 (1.22- 3.99)	5.00 (1.52-16.38)
48 +	88 (14.5%)	7.70 (3.23-18.32)	1.58 (0.81- 3.11)	8.58 (2.42-30.46)
p trend		< 0.001	0.001	0. 017
Birth weight				
≥2500 g	544 (89.6%)	1.00	1.00	1.00
< 2500 g	63 (10.4%)	7.76 (3.71-16.24)	5.68 (2.84-11.33)	5.12 (2.38-11.00)
Initiation of BF				
Within 1 hour	506 (83.4%)	1.00	1.00	1.00
1-3 hours	39 (6.4%)	1.74 (0.70- 4.26)	0.68 (0.31- 1.48)	1.64 (0.61- 4.39)
After 3 hours	62 (10.2%)	1.87 (0.87- 4.03)	1.19 (0.63- 2.26)	0.83 (0.27- 2.52)
Duration of exclusive BF				
≥ 6 months	104 (17.1%)	1.00	1.00	1.00
< 6 months	503 (82.9%)	5.98 (2.57-13.91)	3.74 (2.09- 6.69)	3.92 (1.08-14.24)
Cough in last 8weeks				
Yes	346 (57.0%)	1.41 (0.89- 2.22)	0.94 (0.64- 1.38)	1.69 (0.90- 3.18)
No	261 (43.0%)	1.00	1.00	1.00
Diarrhea in last 2 weeks				
Yes	54 (8.9%)	2.33 (1.10- 4.90)	1.36 (0.70- 2.63)	1.37 (0.56- 3.33)
No	553 (91.1%)	1.00	1.00	1.00

* Odds ratio adjusted for all the other variables in the table, all the other variables in table 5, region of residence and level of mother's education.

Table 6 describes the association between a child's individual variables and the nutritional status of children. Multiple logistic regression analysis revealed that age, gender, weight at birth and duration of exclusive breastfeeding were important factors related to the nutritional status of children. In addition, the odds ratio of being underweight and stunting was lower among female children than among male children. Furthermore, children that were 0-11 months old were found to have a lower odds ratio of underweight, stunting, wasting than older children. Furthermore, low-birth-weight infants were 7.7 times, 5.6 times and 5.2 times more likely than normal-birth-weight infants to be underweight, stunting and wasting, respectively. Additionally, the risk of being underweight, stunted and wasted was 5.9 times, 3.7 times and 3.9 times higher for children who were exclusively BF for <6 months than for children who were exclusively BF for ≥6 months, respectively. Finally, the risk of being underweight was 2.3 times higher for children who had experienced diarrhea in the last 2 weeks than in children who had not. The odds ratios of all variables evaluated in the multiple logistic regression analysis are presented in Appendix 3.

DISCUSSION

In Vietnam, as in other developing countries, nutritional status of children is a major health problem [15,16]. The Child Nutrition Survey conducted by the Vietnam National Institute of

Nutrition (NIN) in 2004 estimated that 26.6%, 30.7%, and 7.7% of children in Vietnam showed signs of being underweight, stunting and wasting, respectively [17,18]. The same survey estimated that 31.7%, 36.4% and 8.4% of children in the Northern Centre Coast were underweight, were stunting and were wasting, respectively [17]. Furthermore, the Vietnam multiple indicator cluster survey 2006 [19] found the prevalence of underweight, stunting and wasting among children under five years of age in Vietnam to be 20.2%, 35.8% and 8.4%, respectively. In the current study, the prevalence of underweight, stunting and wasting in Nghean was found to be 31.8%, 44.3% and 11.9%, respectively. These findings indicate that chronic growth retardation is the major effect of malnutrition in Nghean province, Vietnam. With respect to underweight and stunting, the nutritional status of the study population was approximately the same as that of the population of the Northern Centre Coast results, but worse than that of the national population. This may be because the 6 provinces in the Northern Centre Coast are less developed than many of the other provinces in Vietnam. In addition, the prevalence of wasting observed in the study population was higher than that of the Northern Centre Coast. This may be because wasting, which is an indicator of acute nutritional deficiency, reportedly occurs due to recent illness (e.g. diarrhea, febrile sickness, etc.) or weight loss related to seasonal differences. The prevalence of 31.8% underweight, 44.3% stunting and 11.9% wasting are considered to be "very high level" by the WHO [8]. In a study conducted in the province of Quang Tri in the Northern Centre Coast of Vietnam in 2004 [20], the prevalence of underweight, stunting and wasting were reported to be 29.2%, 44.7% and 5.4%, respectively. Because Quang Tri is located in the same region as Nghean, we expected similar prevalence rates, however, the prevalence of wasting children was higher in Nghean. This may be because the study conducted in Quang Tri included only one rural area, whereas this study included subjects from urban, rural and mountainous areas throughout Nghean province. In this study, higher rates for wasting were reported for mountainous areas, which generally have poorer sociodemographic characteristics than other areas. This finding is consistent with those of the Child Nutrition Survey conducted by the Vietnam National Institute of Nutrition (NIN) [18]. Some other studies in Vietnam have reported different prevalence rates for nutritional disorders [21,22]. However, most of these studies were conducted in regions where the socioeconomic situation is better than area evaluated in the present study. So this study would be expected to contribute to regional statistics. Relative to other regions of southeast Asia, Nghean's children are lighter and shorter (mean Z-score WAZ: -1.46 vs. -1.01 and HAZ: -1.44 vs. -0.38) than those of Surabaya, Indonesia [23], but are heavier and taller (mean Z-score WAZ: -1.46 vs. -1.75 and HAZ: -1.44 vs. -1.89) than Lao children [24].

Multiple logistic regression analysis identified region of residence, education level of the mother and mother's occupation as factors significantly related to malnutrition. In this study, living in rural and mountainous areas were factors for malnutrition. This may have occurred due to differences in economic level, and cultural and social security which results in poor accessibility to education and health services. The results of a study conducted in Malaysia reported that the prevalence of underweight and stunting were high among children in poor rural areas [25]. In addition, several studies found that the mother's education level is associated with more efficient management of limited household resources, greater utilization of available health care services, better health promoting behaviors, lower fertility and more child-centered caring practices, all of which are associated with better child health and nutrition [26,27]. In the present study, having attended junior high school was the only education category found to be significantly associated with underweight and wasting. This may be because most mothers who only completed primary school or less were unemployed and therefore able stay home and care for their children, whereas mothers who had completed junior high school were more likely to be employed. Conversely, the number of children whose mother's highest education level was primary school or lower in this study was only 76 (12.5%), which may be too small of a sample size to allow an accurate analysis. However, the results do suggests that the mother's level of education played a significant role in reducing the prevalence of underweight and wasting. In the present study, although bivariate analysis indicated that the prevalence of underweight, stunting and wasting was significantly different between families with different per capita incomes, this difference was not observed when the hierarchical logistic regression model was used. This indicates that when important socioeconomic variables are evaluated, per capita family income alone does not have a significant effect on the nutritional status of children. This finding is in accordance with those of previous studies [28,29]. Finally, although the adjusted odds ratio of stunting and wasting was not significantly different between groups of mothers with different occupations, bivariate analysis indicated that the prevalence of underweight, stunting and wasting among children who had a morther who was a farmer was higher than that of children who had a mother who was an office worker or a housewife. This result is similar to the results of previously conducted studies [30,31].

Our analysis also showed that family and maternal factors were associated with the children's nutritional status. Specifically, the number of children in the family and household size were found to be important factors related to the nutritional status of children. For example, children from families

with three or more children were more likely to be underweight, stunted and wasted than children from families with two or less children. This may be because mothers with many children have less overall time to devote to child care than those who have two children or less. However, the results of this study also indicated that there was a relationship between low family income and a large number of children. This finding suggests that children of low-income families often only have a limited range of food sources, which results in there being more competition for available food when the family contains a high number of children. One difference between the results of this study and those of other studies [32,33] is that we found a large household size to be a protective factor against malnutrition in children. This may be because most of large households size is the extended family which is the basic family unit in Vietnam tradition. In such families the children were found to be well cared for. This also suggests that part of the positive effect of household size on nutritional status was mediated by the quality of the family. Another difference between the results of this study and those of other studies is that no association was found between underweight, stunting or wasting and the mother's age at birth in this study. Several previous studies have reported that the mother's age at birth being < 24 years or > 35 years is a risk factor. It has also been suggested that this increased risk in younger mothers (<24 years) is due to their not being ready to take care of a child, while the increased risk of malnutrition in older mothers (>35 years) is due to the increased likelihood of giving birth to babies with a low birth weight. However, in Vietnam, the children of young mothers are usually cared for by their grandmothers, which may explain why the results of this study differed from those of previously conducted studies.

Prior to 2001, the World Health Organization (WHO) recommended that infants be exclusively breastfed for the first 4-6 months of life, after which complementary foods (any fluid or food other than breast milk) should be introduced [34]. However, after a systematic review and expert consultation, it was recommended that exclusive breastfeeding be conducted for the first 6 months of life [35]. The results of the present study support these updated recommendations. The finding of this study indicated that the risk of malnutrition increases with age. Children in the youngest age group, 0-11 months, had a significantly lower risk of being underweight, stunting and wasting than children in the older age groups. This low risk may be due to the protective effect of breastfeeding, since almost all children in Vietnam are breastfed and most of them continue to be breastfed throughout the first year of their life. Consistent with other studies [36,37], the results of this study indicated that the highest risk of stunting was among children aged 12-23 months. The high rates of stunting observed after 12 months are linked to inappropriate food supplementation during the weaning period to stopping breast-feeding earlier than the suggested 24 months. However, low birth weight was found to be the most important factor related to malnutrition, which is consistent with the findings of other studies [29,38]. The results of the present study revealed a higher prevalence of malnutrition in boys than girls, which is similar to the results of other studies [12,39]. The cause of this discrepancy is not well established in the literature, but it is believed that boys are more influenced by environmental stress than girls [40,41].

In conclusion, the results of this study indicate that malnutrition is still an important problem among children under five years of age in Nghean, Vietnam. Furthermore, this malnutrition was found to be a result of maternal, socio-economic and environmental factors. These findings are of great importance because they identify potential actions that can be used to improve the nutritional status of children.

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Appendix 1. National Center for Health Statistics (NCHS) and WHO child growth standards (0-60 months): Weight-for-age (Z-scores)

Month	Z-scores (weight in kg) for girls					Z-scores (weight in kg) for boys				
	-2SD	-1SD	Median	1SD	2SD	-2SD	-1SD	Median	1SD	2SD
0	2.4	2.8	3.2	3.7	4.2	2.5	2.9	3.3	3.9	4.4
6	5.7	6.5	7.3	8.2	9.3	6.4	7.1	7.9	8.8	9.8
12	7	7.9	8.9	10.1	11.5	7.7	8.6	9.6	10.8	12
18	8.1	9.1	10.2	11.6	13.2	8.8	9.8	10.9	12.2	13.7
24	9	10.2	11.5	13	14.8	9.7	10.8	12.2	13.6	15.3
30	10	11.2	12.7	14.4	16.5	10.5	11.8	13.3	15	16.9
36	10.8	12.2	13.9	15.8	18.1	11.3	12.7	14.3	16.2	18.3
42	11.6	13.1	15	17.2	19.8	12	13.6	15.3	17.4	19.7
48	12.3	14	16.1	18.5	21.5	12.7	14.4	16.3	18.6	21.2
54	13	14.9	17.2	19.9	23.2	13.4	15.2	17.3	19.8	22.7
60	13.7	15.8	18.2	21.2	24.9	14.1	16	18.3	21	24.2

Appendix 2. National Center for Health Statistics (NCHS) and WHO child growth standards (0-60 months): Length/height-for-age (Z-scores)

Month	Z-scores (length/height in cm) for girls					Z-scores (length/height in cm) for boys				
	-2SD	-1SD	Median	1SD	2SD	-2SD	-1SD	Median	1SD	2SD
0	45.4	47.3	49.1	51	52.9	46.1	48	49.9	51.8	53.7
6	61.2	63.5	65.7	68	70.3	63.3	65.5	67.6	69.8	71.9
12	68.9	71.4	74	76.6	79.2	71	73.4	75.7	78.1	80.5
18	74.9	77.8	80.7	83.6	86.5	76.9	79.6	82.3	85	87.7
24	80	83.2	86.4	89.6	92.9	81.7	84.8	87.8	90.9	93.9
30	83.6	87.1	90.7	94.2	97.7	85.1	88.5	91.9	95.3	98.7
36	87.4	91.2	95.1	98.9	102.7	88.7	92.4	96.1	99.8	103.5
42	90.9	95	99	103.1	107.2	91.9	95.9	99.9	103.8	107.8
48	94.1	98.4	102.7	107	111.3	94.9	99.1	103.3	107.5	111.7
54	97.1	101.6	106.2	110.7	115.2	97.8	102.3	106.7	111.1	115.5
60	99.9	104.7	109.4	114.2	118.9	100.7	105.3	110	114.6	119.2

Appendix 3. The variables included at the 3rd step of the analysis and their odds ratios (95% confidence interval) for malnutrition in children under 5 years of age as determined by multiple logistic regression analysis

Variables	Categorical variables	Malnutrition		
		Underweight*	Stunted*	Wasted*
Gender	Boy	1.00	1.00	1.00
	Girl	0.49 (0.31- 0.78)	0.61 (0.42- 0.90)	0.54 (0.29- 1.00)
Age (months)	0 - 11	1.00	1.00	1.00
	12 - 23	2.40 (1.11- 5.19)	2.69 (1.49- 4.87)	1.98 (0.59- 6.65)
	24 - 35	5.06 (2.34-10.94)	2.10 (1.16- 3.79)	6.65 (2.07-21.35)
	36 - 47	10.24 (4.71-22.23)	2.20 (1.22- 3.99)	5.00 (1.52-16.38)
	48 +	7.70 (3.23-18.32)	1.58 (0.81- 3.11)	8.58 (2.42-30.46)
Birth weight	≥2500g	1.00	1.00	1.00
	<2500g	7.76 (3.71-16.24)	5.68 (2.84-11.33)	5.12 (2.38-11.00)
Initiation of BF	Within 1 hour	1.00	1.00	1.00
	1-3 hours	1.74 (0.70- 4.26)	0.68 (0.31- 1.48)	1.64 (0.61- 4.39)
	After 3 hours	1.87 (0.87- 4.03)	1.19 (0.63- 2.26)	0.83 (0.27- 2.52)
Duration of exclusive BF	≥ 6months	1.00	1.00	1.00
	< 6months	5.98 (2.57-13.91)	3.74 (2.09- 6.69)	3.92 (1.08-14.24)
Cough in last 8weeks	Yes	1.41 (0.89- 2.22)	0.94 (0.64- 1.38)	1.69 (0.90- 3.18)
	No	1.00	1.00	1.00
Diarrhea in last 2 week	Yes	2.33 (1.10- 4.90)	1.36 (0.70- 2.63)	1.37 (0.56- 3.33)
	No	1.00	1.00	1.00
Household size (people)	≤ 4	1.00	1.00	1.00
	5 - 6	0.21 (0.11- 0.39)	0.68 (0.43- 1.07)	0.43 (0.18- 1.04)
	≥ 7	0.49 (0.20- 1.22)	0.78 (0.36- 1.64)	0.35 (0.09- 1.30)
Type of house	Permanent	1.00	1.00	1.00
	Semi-permanent	1.10 (0.50- 2.43)	1.38 (0.74- 2.56)	1.49 (0.46- 4.81)
	Wooden frame	1.41 (0.51- 3.88)	1.89 (0.81- 4.41)	4.28 (1.07-17.13)
Kind of latrine	Septic tank, pour flush latrine	1.00	1.00	1.00
	Other	0.57 (0.32- 1.04)	0.56 (0.30- 1.01)	0.57 (0.21- 1.54)
Source of water	Protected	1.00	1.00	1.00
	Unprotected	1.26 (0.71- 2.26)	0.99 (0.59- 1.66)	0.98 (0.47- 2.04)
Mother' s age at birth (years)	25 - 34	1.00	1.00	1.00
	≤ 24	0.86 (0.53- 1.40)	1.07 (0.71- 1.62)	1.35 (0.68- 2.65)
	≥ 35	0.89 (0.38- 2.05)	0.74 (0.36- 1.50)	1.10 (0.38- 3.20)
Mother' s BMI	Non underweight (BMI ≥ 18.5)	1.00	1.00	1.00
	Underweight (BMI < 18.5)	1.59 (0.97- 2.61)	1.18 (0.78- 1.80)	1.37 (0.73- 2.60)
No of children:	1 - 2	1.00	1.00	1.00
	≥ 3	3.14 (1.52- 6.47)	2.42 (1.33- 4.42)	4.08 (1.50-11.11)
Region of residence	Urban area	1.00	1.00	1.00
	Rural area	9.91 (3.98-24.68)	3.23 (1.66- 6.27)	2.17 (0.59- 7.95)
	Mountainous area	11.42 (4.08-31.96)	2.93 (1.33- 6.46)	4.27 (1.05-17.26)
Mother' s education level	Primary school or lower	1.34 (0.60- 2.99)	1.42 (0.73- 2.77)	0.30 (0.08- 1.06)
	Junior high school	1.62 (0.93- 2.81)	1.19 (0.74- 1.90)	1.60 (0.72- 3.56)
	Senior high school or higher	1.00	1.00	1.00

* Odds ratio adjusted for all individual variables and all family and maternal variables and region of residence and level of mother' s education.