

THE RELATIONSHIP BETWEEN ANTHROPOMETRIC INDICATORS OF NUTRITIONAL STATUS AND MALARIA INFECTION AMONG YOUTHS IN KHAMMOUANE PROVINCE, LAO PDR

Minoru Takakura¹, Miyoko Uza², Yachiyo Sasaki², Naoki Nagahama², Samlane Phommpida³, Somboun Bounyadeth³, Jun Kobayashi⁴, Takako Toma⁵ and Ichiro Miyagi⁵

¹Department of School Health, School of Health Sciences, University of the Ryukyus, Japan; ²Department of Community Health Nursing, School of Health Sciences, University of the Ryukyus, Japan; ³Institute of Malariology, Parasitology and Entomology, Ministry of Health, Lao PDR; ⁴Department of Parasitology, School of Medicine, University of the Ryukyus, Japan; ⁵Department of Medical Zoology, School of Health Sciences, University of the Ryukyus, Japan

Abstract. We assessed anthropometric indicators of the nutritional status among children and adolescents in Khammouane Province in the Lao PDR and examined the relation between malnutrition and malaria infection. The survey was conducted from July to August 1999 using a sample of 309 youths aged 2 to 18 years. Malnutrition was categorized as stunting (below -2 Z scores height-for-age) and wasting (below -2 Z scores weight-for-height). The prevalence of stunting and wasting were 45.1% and 9.2%, respectively, which were classified by WHO as "very high" prevalence. Compared with the results of previous national surveys in Lao PDR, similar prevalence was shown. The prevalence of wasting in youths with *P. falciparum* infection was 17%, significantly higher than those of not infected (4%). On the other hand, *P. vivax* infection was not associated with any indicators of malnutrition. In conclusion, this study showed that the nutritional status in youths was poor and *P. falciparum* infection was associated with acute malnutrition.

INTRODUCTION

The nutritional status of a person is the most important determinant factor in health status of that individual, especially children and adolescents for a period of growth. The most common nutritional problems affecting the young population in a developing country is protein-energy malnutrition (Takyi, 1999). This nutritional problem may be the results of various factors, most of which relate to unsatisfactory food intake or severe and repeated infections or a combination of the two and have not yet been improved in the de-

veloping world (de Onis *et al.*, 1993).

The nutritional status of the youth population has been most frequently assessed by using anthropometric measures of height and weight. The World Health Organization (1986) recommended the use of height-for-age and weight-for-height as indicators of protein-energy malnutrition. These indicators are based on the international growth reference curves that have been developed by the National Center for Health Statistics (NCHS) (Hamill *et al.*, 1979; Dibley *et al.*, 1987). WHO shows that most developing countries in Asia have high or very high prevalence of protein-energy malnutrition (de Onis *et al.*, 1993).

The relationship between malnutrition and malaria is complex. Previous studies have found that malaria can interfere with growth and that malnutrition is likely to increase the

Correspondence: Dr Minoru Takakura, Department of School Health, School of Health Sciences, Faculty of Medicine, University of the Ryukyus, 207 Uehara, Nishihara, Okinawa 903-0215 Japan.
E-mail: minoru@med.u-ryukyu.ac.jp

risk of malaria (Rowland *et al*, 1977; El Samani *et al*, 1987). On the other hand, there is some evidence that malnutrition may protect against malaria (Murray *et al*, 1978). Furthermore, it was found that susceptibility to malaria was not associated with prior poor nutritional status (Snow *et al*, 1991). Therefore, there are great discrepancies in the findings of association between malnutrition and malaria.

In Lao PDR, which is a landlocked country in Southeast Asia, malnutrition is one of the major health problems, especially in the youth population. A national nutritional survey in 1993 reported that 48% of children were stunted, 10% were wasted, and 44% were underweight. All the indicators were classified by WHO as a "very high" prevalence and greater than the average of developing countries in the world and in Southeast Asia (Phimmasone *et al*, 1996). In addition, malaria infection is generally the most common endemic disease in this country. However, scientific information on the recent malaria situation is not sufficient (Kobayashi *et al*, 2000).

In this study, we assessed anthropometric indicators of the nutritional status among children and adolescents in Khammouane Province in the Lao PDR and examined the relation between malnutrition and malaria infection.

MATERIALS AND METHODS

Study area and population

We selected eight villages in Khammouane Province in Lao PDR for the study, where a malaria control project has been introduced by the Institute of Malariology, Parasitology and Entomology (IMPE) of the Ministry of Health, Lao PDR. The study area is typical of rural communities, which lie in the tropical-monsoon zone. Endemic malaria is the most serious public health problem in the region.

The population of the study villages was estimated to be 2,383, based on counting the

number of resident cards. The occupation was predominantly farmers who mainly grew rice. About half of the population were "Lao Loum" referred to as "lowlanders". The rest of the population were "midlanders" from the "Lao Theung" group.

Study design

The cross-sectional study was conducted in a rainy season, from July to August 1999. Anthropometric methods included the measure of weight using a platform scale and height with a tape measure fixed on the wall. A total number of 309 children and adolescents aged 2 to 18 years were assessed. We did not include infants in the analysis because the age was not recorded to a unit of a month. Although this makes little difference in older children and adolescents, it can have an effect on the anthropometric calculations for infants. In addition, blood samples were obtained from them in order to indicate malaria infection. The Giemsa staining method was applied for detection of malaria parasites, *Plasmodium falciparum* and *Plasmodium vivax*.

Data analysis

Anthropometry was analyzed with the NutStat software of Epi Info 2000 (Dean *et al*, 2000), which calculated height-for-age and weight-for-height scores for each individual to compare with the NCHS reference values. We applied 2 Z-scores (SD units) below the reference median for the indices to classify low anthropometric levels, which recommended by WHO (1986); Gorstein *et al* (1994). Low height-for-age is considered an indicator of stunting, which is frequently associated with poor overall economic conditions and/or repeated exposure to adverse conditions. Low weight-for-height is considered an indicator of wasting and generally associated with failure to gain weight or a loss weight (WHO, 1986). We did not use weight-for-age score because it fails to distinguish tall, thin children from those who are short with adequate weight (Gorstein *et al*, 1994). We excluded the subjects who had extreme values or some inconsistency in either indicator.

RESULTS

The means and standard deviations of height and weight for the subjects at various ages are shown in Fig 1 and Fig 2. There were no major gender differences in the mean height and weight among most of the age groups. Boys at 14, 17, and 18 years were signifi-

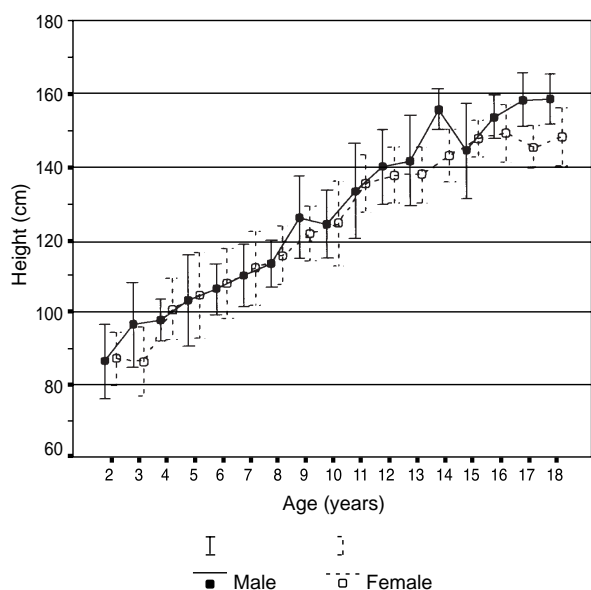


Fig 1—Mean and SD of height by age.

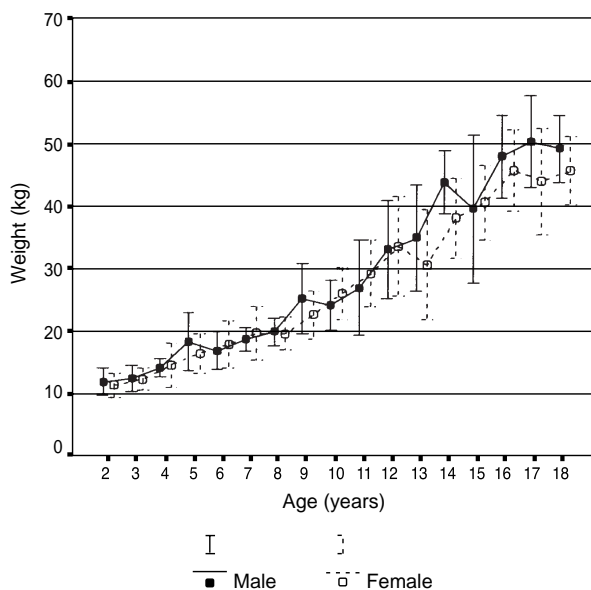


Fig 2—Mean and SD of weight by age.

cantly taller than girls ($p < 0.01$) and boys were significantly heavier than girls at 14 years old ($p = 0.019$).

Table 1 summarizes the prevalence and associations of malnutrition. Overall, the prevalence of stunting and wasting were 45.1% and 9.2%, respectively. When using -3 Z-scores as a cut-off point, severe stunting was found in 19.8% and severe wasting in 2.7%. Only the age groups were significantly associated with stunting and wasting. Stunting was more likely to increase with aging. The prevalence of wasting in the age group 5-9 years was less than other age groups. In addition, the prevalence of wasting in youths with *P. falciparum* infection was 17%, significantly higher than those not infected (4%). Gender, tribe, the number of family members, and *P. vivax* infection were not associated with any indicators of malnutrition ($p \geq 0.05$).

DISCUSSION

The most interesting finding of this study was the significant association between wasting and *P. falciparum* infection. Wasting indicates a deficit in tissue and fat mass compared with the amount expected in a child of the same height, and is commonly used to assess acute or recent malnutrition. It may be precipitated by infection or low food supply (WHO, 1986). *P. falciparum* is certainly malignant parasite, compared with the benign parasite *P. vivax*. Malaria infection frequently complicates anemia and hypoglycemia (Takyi, 1999; White *et al*, 1987). Additionally, severe symptoms of *P. falciparum* infection exhaust an individual and may lead to weight loss. Therefore, it seems reasonable to suppose that *P. falciparum* is one of the major causes of acute malnutrition in these communities. This finding was consistent with previous finding of El Samani *et al* (1987) who provided that malaria occurrence was positively associated with the degree of malnutrition in the Sudanese children. In that study, malaria occurrence was based on a history of clinical illness and microscopic diagnosis for malaria was not

Table 1
The prevalence and associations of malnutrition in children and adolescents.

Variable	Stunted (Height for age <-2SD)				Wasted (Weight for height <-2SD)			
	No. of sample	n	%	p ^a	No. of sample ^b	n	%	p ^a
Total	293	132	45.1		142	13	9.2	
Gender								
Male	131	51	38.9	0.060	77	8	10.4	0.772
Female	162	81	50.0		65	5	7.7	
Age (years)								
2-4	29	4	13.8	<0.001	29	5	17.2	0.032
5-9	93	39	41.9		91	4	4.4	
10-14	113	51	45.1		22	4	18.2	
15-18	58	38	65.5		-	-	-	
Tribe								
Lao Loum	148	59	39.9	0.079	77	8	10.4	0.772
Lao Theung	145	73	50.3		65	5	7.7	
No. of family members								
≤5	85	36	42.4	0.084	46	3	6.5	0.592
6-7	99	38	38.4		38	3	7.9	
≥8	109	58	53.2		58	7	12.1	
Malaria: <i>P. falciparum</i>								
-	159	74	46.5	0.515	75	3	4.0	0.041
+	49	20	40.8		30	5	16.7	
Malaria: <i>P. vivax</i>								
-	201	91	45.3	1.000	100	8	8.0	1.000
+	7	3	42.9		5	0	0.0	

^aFisher's exact tests except for age and the number of family members, which used χ^2 tests.

^bWasted indices are calculated for males to 11.5 years of age and less than 145 cm and for females to 10 years of age and less than 137 cm.

carried out. Meanwhile, in this study, it was not clear about how food intake affected the nutritional status because we did not obtain the dietary information.

Williams *et al* (1997) suggested that *P. vivax* infection was a major predictor of acute malnutrition in children on Espiritu Santo Island, Vanuatu. They showed that, apart from age, the only factor significantly associated with both underweight and wasting was clinical *P. vivax* malaria in the 6 months preceding nutritional assessment. The same analyses surprisingly provided no evidence that *P. falciparum* was a cause of acute malnutrition in this population. They explain that this may be a feature of the epidemiology of malaria

in this community, where *P. vivax* is the dominant parasite. On the other hand, in our study area, the predominant malaria species was *P. falciparum* (Kobayashi *et al*, 2000). Therefore, the association of wasting and *P. falciparum* in this study is likely to be derived from the dominant malaria species.

Stunting, an indicator of chronic malnutrition, was not associated with both *P. falciparum* and *P. vivax* infection. Some previous studies reported consistent findings (Snow *et al*, 1991; Williams *et al*, 1997). As a significant degree of stunting, representing the accumulated consequences of retarded growth, may not be evident for some years (WHO, 1986), we need further to examine the effects

of chronic or repeated malaria exposure on stunting in long-term prospective study.

Previous studies using a prospective study design showed no evidence that prior poor nutritional status either predisposed children to, or protected them from malaria infection (Snow *et al*, 1991; Williams *et al*, 1997), that is, these findings suggest that prior poor nutritional status does not alter vulnerability of malaria infection. However, we did not know whether malaria was a risk factor for malnutrition or malnutrition affected malaria infection, in our cross-sectional study design.

According to the worldwide distribution of malnutrition (de Onis *et al*, 1993), the prevalence of stunting and wasting in this study was categorized as "very high" prevalence. This finding was slightly worse than the average of developing countries in Southeast Asia, where the prevalence of stunting and wasting average 43% and 8%, respectively (de Onis *et al*, 1993). As for comparisons of sociodemographic variables, the prevalence of stunting and wasting was almost consistent except for age groups. In addition, a nationwide nutritional survey in Lao PDR has been conducted twice, in 1984 and 1993. Compared with the results of these surveys, similar findings were shown in this study. Therefore, it is likely that the nutritional status in Lao PDR has not been improved in the past 15 years. The children and adolescents in Khammouane, Lao PDR, still have acute and chronic malnutrition.

One limitation of this study was our study sample. According to the resident cards issued by local government office, the total population of the youths aged 2-18 years was estimated to be 1,136 individuals. We obtained the anthropometric data from only 27 % of them, although the village leaders and inhabitants were informed about this study before conducting the survey. However, it was supposed that a large proportion of the inhabitants might actually participate in this study because in most minority villages the numbers of the total population submitted to the local government offices are exaggerated.

Apparently, many inhabitants, especially the youth generation, have moved to big cities in Lao PDR or Thailand for economic reasons without informing the office (Kobayashi *et al*, 2000). Nevertheless, the results of this study must be interpreted cautiously and limited to generalize to inhabitants in Lao PDR as a whole.

Lack of improvement of the nutritional status in developing countries is due to many varied and complex factors that cannot be easily controlled, mainly adverse socioeconomic factors. However, because this study showed that malaria infection, especially *P. falciparum* infection was associated with acute malnutrition, malaria control may be one of the effective strategies to improve the nutritional status in Lao PDR and other areas where malaria infection is common.

ACKNOWLEDGEMENTS

This study was supported by Grant-in-Aid for Scientific Research (B) (11691217) from the Japanese Ministry of Education, Science, Sports, and Culture.

REFERENCES

- Dean AG, Arner TG, Sangam S, *et al*. Epi Info 2000, a database and statistics program for public health professionals for use on Windows 95, 98, NT, and 2000 computers. Atlanta, Georgia, USA: Center for Disease Control and Prevention, 2000.
- de Onis M, Monteiro C, Akre J, Clugston G. The worldwide magnitude of protein-energy malnutrition: an overview from the WHO Global Database on Child Growth. *Bull WHO* 1993; 71: 703-12.
- Dibley MJ, Goldsby JB, Staehling NW, Trowbridge FL. Development of normalized curves for the international growth reference: historical and technical considerations. *Am J Clin Nutr* 1987; 46: 736-48.
- El Samani FZ, Willett WC, Ware JH. Nutritional and socio-demographic risk indicators of malaria in children under five: a cross-sectional study in a

- Sudanese rural community. *J Trop Med Hyg* 1987; 90: 69-78.
- Gorstein J, Sullivan K, Yip R, *et al.* Issues in the assessment of nutritional status using anthropometry. *Bull WHO* 1994; 72: 273-83.
- Hamill PVV, Drizd TA, Johnson CL, Reed RB, Roche AF, Moore WM. Physical growth: National Center for Health Statistics percentiles. *Am J Clin Nutr* 1979; 32: 607-29.
- Kobayashi J, Somboon P, Keomanila H, *et al.* Malaria prevalence and a brief entomological survey in a village surrounded by rice fields in Khammouan Province, Lao PDR. *Trop Med Int Health* 2000; 5: 17-21.
- Murray MJ, Murray AB, Murray NJ, Murray MB. Diet and cerebral malaria: the effect of famine and refeeding. *Am J Clin Nutr* 1978; 31: 57-61.
- Phimmasone K, Douangpoutha I, Fauveau V, Pholsena P. Nutritional status of children in the Lao PDR. *J Trop Pediatr* 1996; 42: 5-11.
- Rowland MGM, Cole TJ, Whitehead RG. A quantitative study into the role of infection in determining nutritional status in Gambian village children. *Br J Nutr* 1977; 37: 441-50.
- Snow RW, Byass P, Shenton FC, Greenwood BM. The relationship between anthropometric measurements and iron status and susceptibility to malaria in Gambian children. *Trans R Soc Trop Med Hyg* 1991; 85: 584-9.
- Takyi EEK. Nutritional status and nutrient intake of preschool children in Northern Ghana. *East Afr Med J* 1999; 76: 510-5.
- White NJ, Miller KD, Marsh K, *et al.* Hypoglycaemia in African children with severe malaria. *Lancet* 1987; 1: 708-11.
- WHO Working Group. Use and interpretation of anthropometric indicators of nutritional status. *Bull WHO* 1986; 64: 929-41.
- Williams TN, Maitland K, Phelps L, *et al.* *Plasmodium vivax*: a cause of malnutrition in young children. *Q J Med* 1997; 90: 751-7.