Nutritional Status among Schoolchildren in the Risk Areas of Liver Fluke Infection, Surin Province, Thailand

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Background: *Opisthorchis viverrini is endemic in the Lower Mekong Basin, including Thailand, Lao People's Democratic Republic, Cambodia, and central Vietnam. This figure indicates that it is a serious public health problem in Thailand, particularly in northeastern and northern region.*
Objective: *To survey the nutritional status among schoolchildren including the association between nutritional status and related O. viverrini infection that is reported in their living areas.*
Material and Method: *A cross-sectional survey of nutritional status among schoolchildren was conducted in the rural communities of Surin province, Thailand, between September 2013 and July 2014. Nutritional evaluations, Socio-economic, and family information were collected through questionnaires. Four hundred sixty two children aged between 6 to 14 years were enrolled. Pearson correlation test and multiple logistic regression were used in this study.*
Results: *Most respondents who answered the questionnaire were mother (37.23%), and followed by children (34.41), female (51.73%), and age rank older than 9 to 12 years old (41.99%). Schoolchildren were evaluated for weigh for age, which resulted in normal weight (60.82%), wasting (8.01%), underweight (7.58%), obesity (2.38%), and overweight (1.95%). Height for age was divided into normal height (60.17%), stunting (0.74%), slightly short (4.76%), tall (3.46%), and slightly tall (2.6%). Weight for height was divided into appropriate (54.11%), thin (10.82%), slightly thin (8.02%), obesity (2.38%), and morbid obesity (1.73%). Children were not infected with O. viverrini in this study even if 15.8% of them consumed under-cooked particularly cyprinoid fish. Children with slightly underweight was statistically significant associated with O. viverrini infection (Adjust R square = 0.445, $p<0.05$). The equation for prediction of liver fluke infection among schoolchildren who had slightly underweight is $Y = -0.508 + 0.517\ X_{12}$ and $Z = 0.694\ X_{12}$.*
Conclusion: *The present study indicates that stunting, underweight and wasting children were found in high infectious areas of O. viverrini. Slightly underweight was associated with infection. Therefore, implementation of nutrient in this group is urgently required. Furthermore, health education for children and relative family should be encouraged for further campaign in this province.*

Keywords: *Nutrition, Schoolchildren, Liver fluke, Surin province, Thailand*

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The *Opisthorchis viverrini*, carcinogenic liver fluke, is endemic in the Lower Mekong Basin, including Thailand, Lao People's Democratic Republic (Lao PDR), Cambodia and central Vietnam[1]. This figure indicate that it is a serious public health problem in Thailand, particularly in northeastern and northern region[1-3]. Recently, a cross-sectional survey using multistage sampling was conducted from the rural communities of Surin province, Thailand, between September 2013 and July 2014. From the 510 participants, 32 (6.5%)

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participants were infected with *O. viverrini*. The distribution of high infection was found in Tha Tum (16.7%) and Sankha district (16.7%), followed by Samrong Thap (13.3%), Si Narong (13.3%), and Buachet district (13.3%). This finding confirmed that *O. viverrini* is still a problem in Surin province, Thailand[4]. Presently, a community-based cross-sectional study was conducted to determine the nutritional status in the risk areas of liver fluke among 405 people aged 60 years and above, between September 2013 and July 2014. The results reveal that increased consumption of carbohydrate (95.3%) was needed. The participants demonstrated under-nutrition (24.4%), over-nutrition (16.4%), and obesity (15.4%). Most had a high knowledge (43.0%), moderate attitude (44.4%), and moderate practice (46.2%) regarding food consumption related to liver fluke infection[5]. Nutritional status in the risk areas of liver fluke has been reported, however, current status in children particularly in schoolchildren has been so far. Therefore, this study is aimed to survey the nutritional status including the association between nutritional status and related *O. viverrini* infection that reported in their living areas.

Material and Method

Cross-sectional survey was conducted among schoolchildren in Surin province, northeastern Thailand between September 2013 and July 2014. Schoolchildren age between 6 and 14 years old were selected, and 400 participants were calculated by Taro Yamane equation[6] using a simple random sampling for participant included. Surin province is located in the northeast of Thailand with the distance of 450 kilometers from Bangkok (capital) by road and 420 kilometers by train. The province is subdivided into 17 districts. The districts are further subdivided into 158 sub-districts and 2,120 villages, 441,922 houses, and with a population of 1,381,761 (691,425 males and 690,226 females)[7].

Nutritional status, demographic data, and family information were collected by using predesigned questionnaires.

O. viverrini infection was determined using Kato thick smear and microscope[8]. Stools were collected among schoolchildren and kept in labeled plastic bags and then transported in an icebox to the laboratory at the Parasitic Disease Research Unit, Institute of Medicine, Suranaree University of Technology, Thailand, within a day after collection. The data were analyzed with descriptive statistics, and chi-square tests were used to investigate the associations between demographic and histories data with *O. viverrini* infection.

Descriptive statistics including frequencies and percentage were used to explain the demographic information. Pearson correlation test was employed for determining the correlation between consumption behavior and their relative areas with liver fluke infection. Multiple logistic regression was used for determining the influential factors with liver fluke infection (*O. viverrini* infection from the same areas[5]. Distribution of *O. viverrini* infection was identified into Tha Tum (16.67%), Sangkha (16.67%), Samrong Thap (13.33%), Buachet (13.33%), Si Narong (13.33%), Ratanaburi (10.00%), Chumphon Buri (6.67%), Non Narai (3.33%), Sanom (3.33%), Chom Phra (3.33%), Khwao Sinarin (3.33%), Muaeng Surin (3.33%), Lamduan (3.33%), and Phanom Dong Rak (3.33%). Meanwhile, the patient infected *O. viverrini* were not found in Kab Choeng, Prasat, and Sikhoraphum district. The study protocol was approved by Suranaree University Ethical Review Committee, EC55-57.

Definition

Nutrition classification: The classification of the z-score for the height for age (H/A), weight for age (W/A) and weight for height (W/H) scores was measured and evaluated according to the standards of the National Center for Health Statistics (NCHS, 1977) and Thailand weight for age z-score and height for age z-score criteria, Department of Health, Ministry of Public Health, Thailand (1999). Nutritional status was evaluated as follows; Height for Age: H/A (Tall, H/A >+2 SD, Slightly tall, H/A >+1.5 SD - +2 SD, Normal height, H/A -1.5 SD to +1.5 SD, Slightly short, H/A <-1.5 SD to -2 SD, and Stunting, H/A <-2 SD), Weight for Age: W/A (Obesity, W/A >+2 SD, Overweight, W/A >+1.5 SD to +2 SD, Normal weight, W/A -1.5 SD to +1.5 SD, Underweight, W/A <-1.5 SD to -2 SD, Wasting, W/A <-2 SD), Weight for Height: W/A (Morbid obesity, W/A >+3 SD, Obesity, W/A >+2 SD to +3 SD, Overweight, W/A >+1.5 SD to +2 SD, Appropriate, W/A -1.5 SD to +1.5 SD, Slightly thin, W/A <-1.5 SD to -2 SD, Thin, W/A <-2 SD).

Results

Four hundred sixty two children aged between 6 and 14 years were enrolled in this study. The respondents who answered the questionnaire were classified into mother (37.23%), children (34.41), cousin (11.47%), no answer (10.39%), father (3.25%), and teacher (3.25%), respectively. Most correspondents

were female (51.73%), age rank older than 9 to 12 years old (41.99%), without underlying disease (90.04%). The children were asked about the raw under-cooked consumption and it was found that 15.8% of them had eaten the raw under-cooked food. Demographic information of correspondents was shown in Table 1.

Nutritional status among schoolchildren of Surin province was analyzed and it was found that weigh for age, the percentage of wasting, underweight, obesity, and overweight was 8.01%, 7.58%, 2.38%, and 1.95%, respectively. Height for age, the percentage of stunting, slightly short, tall, and slightly tall was 0.74%, 4.76%, 3.46%, and 2.6%, respectively. Weight for height, the percentage of thin, slightly thin, obesity, and morbid obesity was 10.82%, 8.02%, 2.38%, and 1.73%, respectively. Nutritional status was shown in Table 2.

O. viverrini infection was examined and it was found that children were not infected in this study. However, at that times and the same place we had surveyed in the age rank older than 14 years old and found that 32 (6.47%) from 510 eligible participants were infected with *O. viverrini*. The highest of *O. viverrini* infection was found in Tha Tum, Sangkha, Samrong Thap, Buachet, Si Narong districts, respectively. Meanwhile, the participants in Kab Choeng, Prasat, and Sikhoraphum district were not infected with *O. viverrini*. Present data was used to analyze the factor related to children nutritional status. Children consummation behavior with under-cooked raw cyprinoid fish was 15.8%. In addition, family members that had consummation behavior of under-cooked ($r = 0.750$, $p<0.05$) and living near the natural water reservoirs ($r = 0.750$, $p<0.05$) were statistical significant associated with the areas where *O. viverrini* infection have been reported. Multiple logistic regression showed that children who were slightly underweight was statistically significant associated to the areas where *O. viverrini* infection have been reported (Adjust R square = 0.445, $p<0.05$). Moreover, children who were stunting, underweight, and wasting were found in the areas with high infection prevalence more than other areas where there are low or no infection (Table 3, 4). The equation for prediction of liver fluke infection among schoolchildren who were slightly underweight is $Y = -0.508 + 0.517 X_{12}$ and $Z = 0.694 X_{12}$.

Table 1. Demographic Information of participant

Information	Number (n = 462)	(%)
Respondents		
Children	159	34.41
Mother	172	37.23
Father	15	3.25
Cousin	53	11.47
Teacher	15	3.25
No answer	48	10.39
Sex		
Male	208	45.02
Female	239	51.73
No answer	15	3.25
Age		
6-9 years old	115	24.89
>9-12 years old	194	41.99
>12-14 years old	145	31.39
No answer	8	1.73
Address		
Kap Choeng	36	7.79
Khwao Sinarin	34	7.36
Chom Phra	23	4.98
Chumphon Buri	15	3.25
Tha Tum	39	8.44
Non Narai	14	3.03
Buachet	38	8.22
Prasat	40	8.66
Phanom Dong Rak	21	4.55
Mueang Surin	14	3.03
Rattanaburi	35	7.57
Lamduan	23	4.98
Si Narong	21	4.55
Sikhoraphum	20	4.33
Sanom	33	7.14
Sangkha	27	5.84
Samrong Thap	29	6.28
Children with Underlying diseases		
No	416	90.04
Yes	20	4.33
Congenital disorder	2	0.43
No answer	24	5.20
Raw under-cooked consumption (394)		
Yes	73	15.80
No	321	69.50

Discussion

This cross-sectional study was conducted among 462 children between the age of 6 and 14 years in Surin province. They had a nutritional status as a good level approximately 60%, however, the percentage of wasting, underweight, obesity, and overweight was 8.01%, 7.58%, 2.38%, and 1.95%, respectively. In addition, stunting, slightly short, tall, and slightly tall was 0.74%, 4.76%, 3.46%, and 2.6%, respectively. Weight for height, the percentage of thin, slightly thin,

obesity, and morbid obesity was 10.82%, 8.02%, 2.38%, and 1.73%, respectively. These results indicate that schoolchildren still need an implementation of nutrient in the underweight group and health promotion in obesity and overweight group. In this study, the parasitic infection was not found. This finding is as same as those from the other studies indicating that *O. viverrini* infection in children was not found. However, the detection of the others parasitic infection can be found. As in Damanhur City, the Capital of El-Behera, cross sectional study in five hundred children aged between 2 and 6 years revealed that 51.8% preschool children were infected with Cysts of *Entamoeba histolytica* and *Giardia lamblia* in 16.8% and 14.8% respectively[9]. Schoolchildren had a history with under-cooked consumption particularly raw cyprinoid fish (the second intermediate host of *O. viverrini*), 15.8%. Moreover, children' family members also had the histories with this cyprinoid fish and living near natural water reservoirs. Furthermore, family members had a consummation behavior with under-cooked (r = 0.750, $p<0.05$) and living near natural water reservoirs (r = 0.750, $p<0.05$). They were statistically significant associated with the areas where *O. viverrini* infection have been reported. Previous reports suggested that under-cooked behavior was related to infection[2,10].

In previous studies, schoolchildren who were slightly underweight were statistically significant associated to the areas where *O. viverrini* infection have been reported (Adjust R square = 0.44, 5 $p<0.05$). Moreover, children who were stunting, underweight and wasting were found in the areas with high infected prevalence. The nutritional status found in this study is similar to what had been found in the previous reports. The studies in children found significantly lower weight for age z-score (W/A) and weight for height z-score (W/H) were found among infested children compared to non-infested ones ($p<0.05$)[9], especially parasitic infestations among labor working children was significantly higher than the students[11].

A community-based cross-sectional study was conducted to determine the nutritional status in the risk areas of liver fluke among 405 people aged 60 years and above. The participants demonstrated under-nutrition (24.4%), over-nutrition (16.4%), and obesity (15.4%). The majority of them had a high knowledge (43.0%), moderate attitude (44.4%), and moderate practice (46.2%) regarding food consumption related to liver fluke infection. Some elderly show behavior regarding food consumption that is related to liver fluke infection[5]. This result indicates that children have a chance to be infected by the *O. viverrini* particularly in the high-risk areas of this disease.

Table 2. Nutritional status of schoolchildren in Surin province, Thailand

Nutritional status	n (462)	(%)
Weight for age		
Wasting	37	8.01
Underweight	35	7.58
Normal weight	281	60.82
Overweight	9	1.95
Obesity	11	2.38
No data	89	19.26
Height for Age		
Stunting	45	9.74
Slightly short	22	4.76
Normal height	278	60.17
Slightly tall	12	2.60
Tall	16	3.46
No data	89	19.27
Weight for Height		
Thin	50	10.82
Slightly thin	37	8.01
Appropriate	250	54.11
Overweight	13	2.82
Obesity	11	2.38
Morbid obesity	8	1.73
No data	93	20.13

Additionally, we should be aware of the coincidental decrease in trace elements and multivitamin deficiency. This is the important aspect for growth and development for children with parasitic infection[12]. Moreover, children may further waste and be underweight after *O. viverrini* infection.

In conclusion, this study indicates that there are many children stunting, underweight, and wasting found in area infected with *O. viverrini*. Therefore, implementation of nutrient in this group is urgently required. Furthermore, health education for children and relative family should be encouraged for further campaign in this province.

What is already known on this topic?

O. viverrini is a problem in Surin province, Thailand. Presently, a community-based cross-sectional study was conducted to determine the nutritional status in the risk areas of liver fluke.

What this study adds?

Children who had slightly underweight was statistical significant associated to the areas where have

Table 3. Association between nutritional status among schoolchildren and *O. viverrini* infection in the risk areas

Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	Y
X_1	1	0.538*	0.052	0.331	-0.13	0.701**	0.318	0.068	0.05	0.367	0.233	0.216	0.215	0.111	0.249	0.488	0.459
X_2		1	0.227	0.081	-0.004	0.031	0.493	0.453	0.148	-0.431	0.394	0.306	0.403	-0.11	0.262	-0.172	0.295
X_3			1	0.122	-0.17	-0.109	0.620*	0.925**	0.256	-0.255	0.082	0.665**	0.900**	-0.004	0.253	-0.205	0.347
X_4				1	-0.022	0.284	-0.086	0.197	-0.066	0.401	0.183	-0.037	0.153	0.336	0.49	0.28	0.11
X_5					1	0.153	-0.009	-0.099	-0.432	0	-0.229	-0.492	0.03	0.298	0.369	0.065	-0.039
X_6						1	0.014	-0.092	-0.074	0.738**	-0.022	-0.053	0.184	0.283	0.308	0.615**	0.223
X_7							1	0.644**	0.128	-0.271	0.131	0.545*	0.682**	-0.203	0.417	-0.023	0.533*
X_8								1	0.211	-0.252	0.269	0.669**	0.915**	0.223	0.32	-0.15	0.336
X_9									1	0.14	0.555*	0.401	0.142	-0.427	-0.23	-0.251	0.218
X_{10}										1	0.112	-0.116	-0.094	0.201	0.179	0.471	0.037
X_{11}											1	0.079	0.015	0.062	0.035	0.147	-0.202
X_{12}												1	0.655**	-0.117	0.032	-0.35	0.694**
X_{13}													1	0.162	0.364	-0.078	0.479
X_{14}														1	0.134	0.509*	-0.101
X_{15}															1	0.064	0.25
X_{16}																1	-0.078
Y																	1

X_1 = wasting (weight for age), X_2 = underweight (weight for age), X_3 = normal weight (weight for age), X_4 = overweight (weight for age), X_5 = obesity (weight for age), X_6 = stunting (height for age), X_7 = slightly short (height for age), X_8 = appropriate (height for age), X_9 = slightly tall (height for age), X_{10} = tall (height for age), X_{11} = thin (weight for height), X_{12} = slightly thin (weight for height), X_{13} = appropriate (weight for height), X_{14} = plump (weight for height), X_{15} = overweight (weight for height), X_{16} = obesity (weight for height), Y = *O. viverrini* infection in their areas.

* Statistical significant, *p*-value <0.05, ** Statistical significant, *p*-value <0.05

Table 4. Nutritional status among schoolchildren affected to *O. viverrini* infection in the risk areas using multiple logistic regression analysis

Factor	B	Std. error	β	t	*p*-value
Slightly underweight (X_{12})	0.517	0.143	0.694	3.607*	0.003
Constant	-0.508	0.416		3.607	0.242

X_{12} = slightly thin (weight for height), R square = 0.482 Adjust R square = 0.445 Std. error of the estimate = 1.008

been reported *O. viverrini* infection. Children who were stunting, underweight and wasting, was found in the areas with high infected prevalence area more than other areas where are the low or none of infection. The equation for prediction of liver fluke infection among schoolchildren who had slightly underweight, $Y = -0.508 + 0.517 X_{12}$ and $Z = 0.694 X_{12}$.

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Potential conflicts of interest

None.

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ภาวะโภชนาการของเด็กวัยเรียนในพื้นที่ระบาดการติดเชื้อพยาธิใบไม้ตับ จังหวัดสุรินทร์ ประเทศไทย

นพร อึ้งอาภรณ์, ลิขิต มาตระกูล, สรญา แก้วพิทูลย์, รัตนา รุจิรกุล, สีขาว เชื้อปรุง, ณัฏฐวุฒิ แก้วพิทูลย์

ภูมิหลัง: *พยาธิใบไม้ตับออร์พิสทอร์คิส วิเวอร์รินิมีการระบาดในพื้นที่ลุ่มแม่น้ำโขงตอนล่าง รวมถึงประเทศไทย ลาว กัมพูชา และเวียดนามตอนกลาง การระบาดนี้เป็นปัญหาที่สำคัญในประเทศไทยโดยเฉพาะภาคตะวันออกเฉียงเหนือและภาคเหนือ*

วัตถุประสงค์: *เพื่อสำรวจภาวะโภชนาการและความสัมพันธ์กับการติดเชื้อพยาธิใบไม้ตับในพื้นที่ๆ อาศัยของเด็ก วัยเรียน*

วัสดุและวิธีการ: *การสำรวจภาวะโภชนาการของเด็กวัยเรียนในชนบทจังหวัดสุรินทร์ ประเทศไทยแบบภาคตัดขวาง ระหว่างเดือนกันยายน พ.ศ. 2556 ถึงเดือนกรกฎาคม พ.ศ. 2557 เก็บข้อมูลโภชนาการ เศรษฐกิจและสังคม และข้อมูลครอบครัวด้วยแบบสัมภาษณ์ในเด็กวัยเรียนอายุระหว่าง 6-14 ปี จำนวน 462 ราย การทดสอบสหสัมพันธ์เพียร์สัน และการถดถอยพหุคูณนำมาใช้ในการศึกษานี้*

ผลการศึกษา: *ผู้สัมภาษณ์ส่วนใหญ่เป็นมารดา (37.23%), และตามมาด้วยเด็กวัยเรียน (34.41), เป็นเพศหญิง (51.73%), อายุช่วงระหว่าง >9-12 ปี (41.99%) เด็กวัยเรียนมีน้ำหนักตามเกณฑ์อายุ คือ ปกติ (60.82%), น้ำหนักค่อนข้างน้อย (8.01%), ต่ำกว่าเกณฑ์ (7.58%), อ้วน (2.38%) และน้ำหนักเกิน (1.95%) ส่วนสูงตามเกณฑ์อายุ คือ ปกติ (60.17%), เตี้ย (0.74%), ค่อนข้างเตี้ย (4.76%), สูง (3.46%), และค่อนข้างสูง (2.6%) น้ำหนักตามเกณฑ์ส่วนสูง คือ เหมาะสม (54.11%), ผอม (10.82%), ค่อนข้างผอม (8.02%), อ้วน (2.38%), อ้วนมาก (1.73%), ตามลำดับ ผลการตรวจอุจจาระไม่พบเด็กวัยเรียนติดพยาธิใบไม้ตับ จากการสัมภาษณ์พบว่าเด็กวัยเรียนมีพฤติกรรม รับประทานปลาดิบ เด็กวัยเรียนที่มีน้ำหนักค่อนข้างน้อยมีความสัมพันธ์กับพื้นที่มีรายงานการระบาดของพยาธิใบไม้ตับ (Adjust R square = 0.445, $p<0.05$) สมการทำนายการติดเชื้อพยาธิใบไม้ตับในเด็กวัยเรียนที่มีน้ำหนักน้อยได้ดังนี้ $Y = -0.508 + 0.517\ X_{12}$ และ $Z = 0.694\ X_{12}$*

สรุป: *การศึกษานี้ชี้ให้เห็นว่าเด็กวัยเรียนที่เตี้ย น้ำหนักต่ำกว่าเกณฑ์ มีน้ำหนักค่อนข้างน้อย พบในพื้นที่ๆ มีรายงานการระบาดของพยาธิใบไม้ตับ น้ำหนักต่ำกว่าเกณฑ์มีความสัมพันธ์กับพื้นที่ๆ มีรายงานการติดเชื้อ ดังนั้นการให้ความรู้ด้านโภชนาการจึงมีความสำคัญในเด็กกลุ่มนี้การให้สุขศึกษาเป็นสิ่งจำเป็นแก่เด็กและญาติ*