

---

## PUBLIC HEALTH RESEARCH

---

# Helminthiasis among Indian Preschoolers from Urban Areas in Penang

Vikneswaran Sabramani<sup>1\*</sup>, Halim Ismail<sup>1</sup> and Asrul Abdul Wahab<sup>2</sup>

<sup>1</sup>Department of Community Health, Universiti Kebangsaan Malaysia Medical Centre,

<sup>2</sup>Department of Medical Microbiology and Immunology, Universiti Kebangsaan Malaysia Medical Centre

\*Address of the author for correspondence: Vikneswaran Sabramani, Department of Community Medicine, UKM Medical Centre, Universiti Kebangsaan Malaysia, Jalan Ya'acob Latif, Bandar Tun Razak, Cheras, 56000 Kuala Lumpur, Malaysia.

E-mail address: [drvikneswaran@yahoo.com](mailto:drvikneswaran@yahoo.com)

### ABSTRACT

---

**Received** 29 May 2015

**Accepted** 2 July 2015

**Introduction** Helminthiasis is a common parasitic condition particularly among children in rural areas in developing countries where poor hygiene standard is practiced. The study aimed to determine the prevalence of helminthiasis among Indian preschoolers in urban areas in Penang and its associated factors.

**Methods** A total of 194 urban Indian preschoolers aged 4 to 6 years old were selected randomly from 11 kindergartens in the state of Penang for this cross sectional study. Data collection was carried out in 2 phases. First, microscopic stool examinations were done to examine the presence of helminths. Second, self administered questionnaires which inquired about human, environment and socioeconomic factors were completed by the parents/guardians.

**Results** The overall prevalence of helminthiasis was 7.2% and the most frequently encountered infective agent was *Ascaris lumbricoides* (57.1%) and followed by the tapeworms (42.86%). The logistic regression indicated that habitual thumb sucking (AOR= 5.6, 95%CI: 1.73-18.39) and families owning domestic pets (AOR= 3.2; 95%CI: 1.03-10.14) were the significant contributing factors to helminthiasis among the Indian pre-schoolers in urban Penang. Although the prevalence of helminth infection among the urban Indian preschoolers is lower than rural area, it is still a public health concern. Children habitual thumb sucking and rearing domestic pets at home were the significant contributing factors in helminthiasis.

**Conclusion** Prevention strategy should focus on health education and promotion among adults and children, awareness on domestic animal hygiene and maintaining good environmental sanitation. Multi agency collaboration is clearly essential, especially between state health, education and veterinary departments in curbing this disease.

**Keywords** Helminthiasis- urban - Indian - preschool - Penang - Malaysia.

## INTRODUCTION

Intestinal parasitic infections, particularly helminthiasis, are still prevalent among children especially in the developing countries.<sup>1</sup> According to World Health Organization (WHO) around two billion people are being infected with any form of intestinal parasitic infections.<sup>2</sup> People at risk would be those who practice poor hygiene standards.

These human parasites can be classified into several groups including protozoa, nematodes (roundworms), cestodes (tapeworms), trematodes (flukes), pentastomida (tongue worms), acanthocephalans (thorny-headed worms) and arthropods<sup>3</sup>. The groups cestodes, trematodes and nematodes form a bigger group called the helminthes. Although repeated studies are done to identify its prevalence in the society, without serious consideration and implementation of health policies, these illnesses will not be eliminated and will continue to haunt our society.

In Malaysia, studies have shown that the most common intestinal parasites in humans are *Enterobius vermicularis*, *Ascaris lumbricoides*, *Trichuris trichiura* and *Necator americanus*.<sup>4</sup> Helminthiasis is mainly found in underprivileged people with poor socioeconomic background, such as the Malaysian aborigines (locally known as "Orang Asli"), and people who are living in overcrowded areas. High prevalence was also seen in patients who are practicing high risk behaviours such as intravenous drug users, especially those who are asymptomatic HIV positive carriers.<sup>5</sup>

Children are mostly affected by these helminths. Study has shown that children aged 4-15 years old have high prevalence to helminth infection and age was a significant associated factor.<sup>6</sup> Faecal oral route has been considered as the main mode of transmission.

Children infected with helminths are prone to develop multiple clinical conditions such as iron deficiency anaemia, failure to thrive and reduced cognitive functions. A standardized national policy in Malaysia to treat intestinal parasitic infection is still absent and it is difficult to monitor precisely the prevalence of this disease in children or other groups in society. Although the mortality and morbidity of these diseases are not high, constant improvement in lifestyle is crucial in safeguarding the health of this younger generation.

The risk factors for developing helminth infection among children are still being studied regularly. Certain developing countries have already implemented policies which are dedicated to eradicate this disease but it is yet to be considered in Malaysia. Children particularly are at higher risk of developing this disease as compared to the adults. Early screening and proper intervention strategies are clearly essential in protecting their health and to provide a more sustainable environment for them to grow.

This disease is strongly associated with poverty and Indians are the most affected among the main three races in Penang. Therefore, the objective of this study is to determine the prevalence of helminth infection among Indian pre-school children from urban areas in the state of Penang and factors associated with it especially human, environment and socioeconomic factors.

## MATERIALS AND METHOD

### *Study area and context*

This cross-sectional study was conducted in the urban area of Penang. In Malaysia, urban area is defined as gazette areas with their adjoining built-up areas that have a combined population of 10 000 or more and at least 60 per cent of their population aged 15 years, and over engaged in non-agricultural activities.<sup>7</sup>

The Penang state is located at the northwest part of Peninsula Malaysia and is divided into an island and the mainland. It is made up of five districts. They are northeast and southwest districts in the island and north, central and south Seberang Perai districts in the mainland. Penang has a population of over 1.53 million Malaysian citizen and foreigners amounting to more than 87 000 people in 2010. A total of 11 600 out of 111 310 are Indian children from the age of 0 to 4 years old and 13 000 out of 116 895 children are Indians from the age group of 5 to 9 years old.

The land area is estimated around 1048 square kilometres, making it the second most densely populated state in Malaysia, with 1536 persons per square kilometre. There are few areas in the state that are designated as township areas such as Georgetown, Gelugor, Air Itam and Bukit Bendera from the island and Butterworth, Perai and Bukit Mertajam from the mainland<sup>8</sup>. In this state, there are 6 government and 10 private hospitals and 33 government and 491 private health clinics which provide comprehensive health care services to the population. There are 628 kindergartens and out of this, 26 kindergartens are conducted in Tamil medium as their main language. Being heavily urbanized region, it made this state to be a favourable study area for this research.

### *Selection of study population*

From the Tamil medium kindergartens who agreed to take part in this study, simple random sampling method was used to select the children. As to get the appropriate size of participant required for this study, calculation was done using PS Power and Sample Size Calculations computer software. The power of the sample size was set at 80% with confidence level at 95%, thus a total of 175 sample size was required in order to conduct this study.

## Helminthiasis among preschool

### Data collection

The data for this research was collected in two phases. In the first phase, stool samples were collected for microscopic examination from the preschoolers. Their parents were supplied with labeled plastic containers, waterproof papers, and applicator stick, and instructed to bring proper stool samples according to their convenient of availability within the study period. All the specimens received were checked for their label and quantity. Collected stool samples were sent to an accredited private laboratory for further analysis. Direct microscopic method was used to identify the presence of ova or cyst and detection of helminths were reported by their scientific names.

The second phase of the research was filling-up self-administered questionnaire by the respective parents/guardians of the pre-school children from whom stool sample was collected. All data regarding the evaluation of the independent variables was gathered through these self administered questionnaires. These questionnaires consist of three parts: part A (Human Factor), part B (Environment Factor) and part C (Socioeconomic Factor). A pre-test among thirty parents was conducted before it was used for this research. Thirty parents were given the questionnaire prepared in Malay. They were asked to give comments on the questionnaire and to ensure they were able to comprehend the questions well which they did.

### Statistical analysis

Data analysis was done using 'Statistical Package for Social Sciences' (SPSS) Version 22.0. Descriptive and statistical analytical tests were computed using this software. Statistical significance level was taken at the  $p$  value  $< 0.05$ . For bivariate analysis, the data were analyzed by using Pearson Chi-Square test for statistical difference of the categorical variables. Finally, for multivariate analysis the simple and multiple

logistic regressions were used to predict the final model.

### Ethical consideration

The parents and teachers involved in this study were briefed regarding the purpose and manner of study. They were reassured that the procedures involved in this study were only questionnaires and non-invasive microscopic stool examination. Written consent from the parents was obtained prior to participating in this study. Pre-school children who found to be positive for helminth infection were referred to the nearest government health clinic for treatment. Further approval was also obtained from the Medical Research and Ethics Committee, Universiti Kebangsaan Malaysia (Ethical Number: FF-2014-264).

## RESULTS

### Characteristics of Respondents

A total of 255 parents/guardians were approached to become the respondents for this research. Among them, 55 of the parents/guardians either refused to participate or did not return the stool sample of their children or completed questionnaire. Finally, 194 pairs of pre-school children and their parents/guardians responded completely, giving a respond rate of 76.1%. The respected teacher of each kindergarten were encouraged to regularly conduct awareness program on helminth infestation among the parents which might improve the response rate further in future similar studies.

Table 1 shows the characteristics of the pre-school children and their parents/guardians. Most of the Indian pre-school children were 6 years old (42.8%) with the mean age of 5.3 years ( $SD \pm 0.731$ ). Total of 52.6% (102) of the pre-school children were boys and 47.4% (92) of them were girls.

**Table 1** Characteristics of pre-school children and parents/guardian (n=194)

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
4	33	17.0
5	78	40.2
6	83	42.8
Gender		
Male	102	52.6
Female	92	47.4
Non-vegetarian children		
Yes	150	77.3
No	44	22.7
Type of food consumed		
Home cooked	76	39.2
Non home cooked	118	60.8

Children hand wash before meal		
Yes	179	92.3
No	15	7.7
Children hand wash after defecation		
Yes	186	96.4
No	8	3.6
Habit of thumb sucking by children		
Yes	26	13.4
No	168	86.6
Family owns domestic pets		
Yes	58	29.9
No	136	70.1
Parents/guardians education level		
Low education	161	83.0
High education	33	17.0
Number of family occupancy		
Less than 4	54	27.8
More than 4	140	72.2
Parents/guardians occupation		
Professional	45	23.2
Non professional	149	76.8

A majority of the pre-school children were non-vegetarian (77.3%. n=150) and most of them consumed non-home cooked food regularly (60.8%. n=118). The proportion of children who practiced hand washing before every meal and after defecation was high, 92.3% (179) and 96.4% (186), respectively. Most of them did not have habitual thumb sucking (86.6%. n=168). Most of these children lived in a family occupancy exceeded four people and a majority of these families did not have any domestic pets at home (70.1%. n=136).

*Prevalence of Helminth Infection*

The overall infection rate was 7.2% (14 cases), as shown in Table 2. Among the 14 cases of helminth infection, 57.14% (8) of them were infected with *Ascaris lumbricoides* while the remaining 42.86% (6) were infected with tapeworms. All these cases were single infection with no evidence of polyparasitism. Both gender had equal infection rates. Highest age groups infected were four and six years old, with 5 cases each.

**Table 2** Types of helminth infestation (n=14)

Type of helminth infestation	Frequency (n)	Percentage (%)
<i>A. lumbricoides</i>	8	57.1
Tapeworms	6	42.9

*Analysis of helminth infection and its associated factors*

Table 3 shows the association between helminth infection and contributing factors being studied such as human, environment and socioeconomic factors. The results by Multiple

Logistic Regression showed that habitual thumb sucking (AOR= 5.64. 95%CI: 1.73-18.39) and owning domestic pets (AOR= 3.24. 95%CI: 1.03-10.14) were statistically significant. Both of these factors were also noted to be significant in bivariate analysis.

**Table 3** Association between helminth infestation among children with human, environment and socioeconomic factors

Variables	Helminth Infestation		$\chi^2$	B	S.E.	Adjusted OR	p value	95% CI for OR
	Positive n(%)	Negative n(%)						
<b>a. Human</b>								
Non-vegetarian								
Yes	12(8)	138(92)	0.200 <sup>b</sup>	-	0.951	1	0.200	0.05,1.91
No	2(4.5)	42(95.5)		1.219		0.30		

## Helminthiasis among preschool

Type of food consumed								
Home cooked	5(6.6)	71(93.4)	0.076 <sup>a</sup>	-	0.640	1	0.890	0.26,3.21
Non home cooked	9(7.6)	109(92.4)		0.088		0.92		
Hand wash before meal								
Yes	11(6.1)	168(93.9)	2.168 <sup>b</sup>	-	0.966	1	0.796	0.12,5.17
No	3(20)	12(80)		0.250		0.78		
Hand wash after defecation								
Yes	12(6.5)	174(93.5)	1.658 <sup>b</sup>	-	1.356	1	0.094	0.01,1.47
No	2(25)	6(75)		2.273		0.11		
Habit of thumb sucking								
Yes	6(23.1)	20(76.9)	8.710 <sup>b</sup>	1.729	0.603	5.64	0.004*	1.73,18.39
No	8(4.8)	160(95.2)				1		
<b>b. Environment</b>								
Owning domestic pets								
Yes	8(13.8)	50(86.2)	4.035 <sup>b</sup>	1.174	0.583	3.24	0.044*	1.03,10.14
No	6(4.4)	130(95.6)				1		
<b>c. Socioeconomic</b>								
Parents/guardians education level								
Low education	11(6.8)	150(93.2)	0.008 <sup>b</sup>	0.370	0.984	1.45	0.707	0.21,9.96
High education	3(9.1)	30(90.9)				1		
Number of family occupancy								
<4	5(9.3)	49(90.7)	0.139 <sup>b</sup>	-	0.685	1	0.253	0.12,1.75
>4	9(6.4)	131(93.6)		0.784		0.46		
Parents/guardians occupation								
Professional	2(4.4)	49(95.6)	0.241 <sup>b</sup>	-	1.033	1	0.431	0.06,3.36
Non-professional	12(8.1)	137(91.9)		0.814		0.44		
Constant				-	0.479	0.031	<0.001	
				3.742				

Statistical test: <sup>a</sup> = Pearson Chi-Square Test, <sup>b</sup> = Chi-Square with Yates Correction Test, Multiple Logistic Regression. \*Significant values at p<0.05

## DISCUSSIONS

The prevalence of helminthiasis and their association with human, environment and socioeconomic factor among urban Indian preschool children in Penang were studied. Several previous studies were done in Malaysia<sup>6,9,10,11</sup> but this is the first study to investigate such situation in Penang as it closely fitted the definition of urban area, as mentioned in United Nation Demographic Yearbook<sup>7</sup>.

In this study, the overall prevalence of helminth infection in an urban setting was found to be 7.2%. This is lower compared to studies done in rural areas<sup>12,13,14,15</sup> which could be attributed to better living conditions of people in urban settlements. In such community, the occurrence of helminth infection is lower due to better environmental sanitation, adequate clean water supply and good access to anti helminthic medication in government health care clinics. However, there are certain parts of urban areas, such as in slumps, where the prevalence is very high due to inadequate or poor access to basic

necessity resulting in poor health quality of its inhabitants<sup>16</sup>.

*Ascaris lumbricoides* was the main helminth found in our study. According to WHO 2005<sup>17</sup>, around 800 million people are infected with such roundworm. Helminthiasis occurs when children are exposed to human faeces due to poor hand hygiene practice or when food is prepared without careful washing to remove the eggs from vegetables and fruits. Even cooked food or food containers may be contaminated by infected handlers. Around 200 000 eggs are being laid each day by this pathogen and these eggs are extremely resistant to strong chemicals, desiccation and low temperatures and can remain in the soil from several months to years<sup>18</sup>. Major clinical complications such as bile duct or intestinal obstruction can occur if this infection in children prolongs to severe form.

Apart from *Ascaris lumbricoides*, tapeworms or also known as cestodes were isolated from this study. Species included in this group are *Taenia solium*, *Taenia saginata* and

*Diphyllobothrium* spp<sup>18</sup>. The source of this helminth is generally due to consumption of underprepared meat such as beef or fish. Evidence shows that marine products such as fishes have very high prevalence of parasites and all these marine products are widely sold in markets for local consumption and also exported overseas. This has prompted the authors to recommend an optimal processing of the fish products prior to consumption or storage purposes<sup>19, 20, 21</sup>.

This study was carried out among Indian children in the preschool ages of 4 to 6 years old. Epidemiological study of helminthiasis showed that the prevalence and intensity of infections are significantly associated with age, from 4 to 15 years old and reaching its maximum values at 5 to 7 years of age and remains constant thereafter<sup>4</sup>. Most of the children at this age are in pre-school and usually are not well trained in hygiene practice such as hand hygiene after toilet usage or before meal, and cross contamination among their friends which eventually increase the risk of infection. This could also be due to poor handling by their parents or caretakers at the kindergarten<sup>9</sup>.

Habitual thumb sucking proves to have significant association with helminth infection among the pre-school children. The finding in this study is similar to studies carried out by<sup>22</sup>. The eggs of certain helminths especially *Ascaris lumbricoides* are usually localized at the dirty and uncut fingernail bed of these children and frequent thumb sucking increases the risk of these eggs to be ingested. Due to the high rate of eggs being laid per day, the chances of them being infected is inevitable.

Living environment is commonly shared between human and animal. In an urban area, it is quite evident as due to space constraint, domestic pets such as dogs' lives very closely with their masters, to the extent of sharing the same space in the house. Whether their pets are kept outside in the kennel or in their house, the risk of infection among the children is high due to cross contamination as they are the closest to their pets. This view is similarly shared by<sup>23</sup>, who reported that presence of pets such as dogs and cats in certain areas has provided direct evidence of zoonotic transmission of intestinal parasites.

This supports the significant association between helminthiasis and children whose families own pets at home. The odds were higher compared to those families who do not own domestic pets. The prevalence of helminths in urban dog is 76.7% and urban soil shows a higher contamination rate of 26.7% compared to rural areas with 4.9%<sup>3</sup>. As an infected dog can pass up to thousands of eggs each day in its faeces, humans especially children are at high risk. This is because these dogs have access to roam around on the contaminated soil in the

neighbourhood and as children spend longer time to play with them in and outside their houses.

In this study, children who regularly consumed non-home cooked and non-vegetarian food and did not practice hand washing before meal and after defecation had higher rate of infection. Although these factors were not statistically significant, they are closely related to environmental cleanliness and personal hygiene of the susceptible individual<sup>9, 10</sup>. Other factors such as parents with low education and higher number of family occupancy showed no significant associations. On the contrary, according to<sup>24</sup>, the rate of infection was significantly higher among these groups.

Parents who are non-professionals usually earn low income which eventually contributes to low financial reserve. Therefore, they are more likely to spend less on health such as purchasing anti helminthic drug for their children. Although not statistically significant; this might be the explanation for the rate of infection being higher among children with parents in the non-professional category.

Besides the involvement of the Ministry of Health in managing the well being of children, active participation of non-governmental organizations as part of their community project in screening and treating affected children with anti helminthic drugs may reduce the burden among parents in the non-professional category. In contrast, according to<sup>24</sup>, family income showed minimal effect on the rate of intestinal parasitic infection.

There were a few limitations of this study. Only one stool sample was collected from each participating child for microscopic examination. Multiple stool sampling may enhance the sensitivity in detecting the helminths. Data obtained from the self administered questionnaire was solely based on understanding of the parents or guardians. Due to this, certain difficulties might have occurred in filling up the form which may have affected the data collection. In order to minimize such occurrence, the questionnaire was simplified and printed in Malay due to the limitation of hiring a good Tamil language interpreter. The teachers were also highly committed in assisting them and making sure the accuracy of all answers was well maintained. The tapeworm also was not identified up to their species.

## CONCLUSION

Although the prevalence of helminth infection among the urban Indian pre-school children is lower than rural area, it is still a public health concern. Children habitual thumb sucking and rearing domestic pets at home were the significant contributing factors in helminthiasis. Thus,

## Helminthiasis among preschool

prevention strategy should focus on health education and health promotion among adults and children, awareness on domestic animal hygiene and maintaining good environmental sanitation.

### ACKNOWLEDGEMENT

We express our gratitude to the Dean of Medical Faculty of Universiti Kebangsaan Malaysia Medical Centre (UKMMC), Professor Dato' Dr. Raymond Azman Ali, Head of Department of Community Medicine, UKMMC, Professor Dr. Mohd Rizal Abdul Manaf and Director of Pusat Jagaan Kamakshi Development Centre, Dr S. Karnaneedi for the support and opportunity to conduct this community study.

### REFERENCES

1. Curtale F, Pezzotti P, Sharbini a L, al Maadat H, Ingrosso P, Saad YS, et al. Knowledge, perceptions and behaviour of mothers toward intestinal helminths in Upper Egypt: implications for control. *Health Policy Plan.* 1998;13(4):423–32.
2. Tian L-G, Chen J-X, Wang T-P, Cheng G-J, Steinmann P, Wang F-F, et al. Co-infection of HIV and intestinal parasites in rural area of China. *Parasit Vectors.* BioMed Central Ltd; 2012;5(1):36.
3. S.Garcia L. Classification of Human Parasites , Vectors , and Similar Organisms. *Clin Infect Dis.* 1999;734–6.
4. Norhayati M, Fatmah MS, Tech DM, Yusof S, Edariah AB. Intestinal Parasitic Infections in Man. A Review. *Malaysia Med J.* 2003;58(2):296–306.
5. Kamel AG, Maning N, Arulmainathan S, Murad S, Nasuruddin A, Lai KP. Cryptosporidiosis among HIV positive intravenous drug users in Malaysia. *Southeast Asian J Trop Med Public Health.* 1995;25(4):650–3.
6. Norhayati M, Zainudin B, Mohammad CG, Oothuman P, Azizi O, Fatmah MS. The prevalence of Trichuris, Ascaris and hookworm infection in Orang Asli children. *Southeast Asian J Trop Med Public Health.* 1997;28(1):161–8.
7. United Nation Demographic Yearbook. 2012 p. 1–6.
8. Department of Statistics Malaysia. Population Distribution According to District and Local City Council in the State of Penang. 2010: 33–45.
9. Hakim SL, Gan CC, Malkit K, Azian MN, Chong CK, Shaari N, et al. Parasitic infections among Orang Asli (aborigine) in the Cameron Highlands, Malaysia. *Southeast Asian J Trop Med Public Health.* 2007;38(3):415–9.
10. Jamaiah I, Rohela M. Prevalence of intestinal parasites among members of the public in Kuala Lumpur, Malaysia. *Southeast Asian J Trop Med Public Heal.* 2005;36(1):68–71.
11. Rahmah N, Tariff RH, Abdullah B, Shariman MSM, Nazli MZM, Rizal MZM. Parasitic Infections among Aborigine Children at Post Brooke Kelantan Malaysia. *Med J Malaysia.* 1997;52(4):412–5.
12. Belo VS, Oliveira RB de, Fernandez PC, Nascimento BWL, Vitorino F, Fernandez, et al. Factors associated with intestinal parasitosis in a population of children and adolescents. *Rev Paul Pediatr.* 2012;30(2):195–201.
13. Escobar-pardo ML, Paula A, Godoy O De, Machado RS, Rodrigues D, Neto UF, et al. Prevalence of intestinal parasitoses in children at the Xingu Indian Reservation. *J Pediatr (Rio J).* 2010;86(6):493–6.
14. Gelaw A, Anagaw B, Nigusie B, Silesh B, Yirga A, Alem M. Prevalence of intestinal parasitic infections and risk factors among schoolchildren at the University of Gondar Community School, Northwest Ethiopia. A cross-sectional study. *BMC Public Health.* 2013;13(1):1.
15. Panda S, Rao UD, Sankaram KR. Prevalence of Intestinal Parasitic Infections among School Children in Rural Area of Vizianagaram . *IOSR J Pharm Biol Sci.* 2012;3(3):42–4.
16. Mehraj V, Hatcher J, Akhtar S, Rafique G, Beg MA. Prevalence and Factors Associated with Intestinal Parasitic Infection among Children in an Urban Slum of Karachi. *PLoS One.* 2008;3(11):1–6.
17. WHO, (2005). Technical Report Series. Research Priorities for Helminth Infections: 279–284.
18. Roberts, Larry S.; Janovy, John Jr. *Foundations of Parasitology*, Eight Edition. United States: McGraw-Hill, 2009.
19. Al Zubaidy AB, Mhaisen FT. Larval tapeworms (Cestoda:Trypanorhyncha) from some Red Sea fishes, Yemen. *Mesopot J Sci.* 2011;26(1):1–14.
20. Jakob E, Palm HW. Parasites of commercially important fish species from the southern Java coast , Indonesia , including the distribution pattern of trypanorhynch cestodes. *Verhandlungen der Gesellschaft fur Ichthyol.* 2006;5:165–91.
21. Sithithaworn P, Sukavat K, Vannachone B, Sophonphong K, Ben-Embarek P, Petney T, et al. Epidemiology of food-borne

- trematodes and other parasite infections in a fishing community on the Nam Ngum reservoir, Lao PDR. *Southeast Asian J Trop Med Public Health*. 2006;37(6):1083–90.
22. Sah RB, Paudel IS, Baral R, Paudel P, Jha N, Pokhrael PK. Prevalence of intestinal helminthic infection and associated risk factors. *Indian J Community Heal*. 2013;25(2):134–9.
23. Saksirisampant W, Prownebon J. The prevalence of intestinal parasitic infections among school children in the central region of Thailand. *J Med Assoc Thai*. 2006;89(11):1928–33.
24. Ibrahim H, Amin TT. Prevalence of intestinal parasitic infections and its relationship with socio-demographics and hygienic habits among male primary schoolchildren in Al - Ahsa, Saudi Arabia. *Asian Pac J Trop Med*. 2010;906–12.