RISK FACTORS OF HOOKWORM INFECTION AMONG ABORIGINES DURING DIFFERENT SEASONS IN MALAYSIA

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Abstract

Hookworm infection threatens millions of people especially in tropical areas and has been a major public health concern. In Malaysia, hookworm infection is still a burden to the aborigines despite modernization. The actual factor of the never-ending hookworm infection among the aborigines should be ruled out to overcome the problem. Therefore, this study was performed to determine the prevalence and risk factors in the acquisition of hookworm infection among the aboriginal community in Pahang, Malaysia during wet and dry seasons. Age less than or equal to 15 years old was found to be the most significant risk factor to acquire hookworm infection during both seasons. Usage of stored river water for daily activities was found to be the risk factor to contract hookworm infection during the wet season. This study highlighted that a child has higher risk to acquire hookworm infection regardless of the seasonal variation. This could be due to the involvement in outdoor activities, which exposed them to the soil that contain hookworm larva. Usage of untreated water for daily activities was another risk, which highlighted that provision of safe, treated and clean water supply is very crucial in reducing the number of hookworm infection among the aborigines. Health education and improved sanitation are also important for the prevention and control of hookworm infection among the aboriginal community.

Keywords: *Hookworm infection, aborigines, seasons, children, untreated water.*

INTRODUCTION

Hookworm is a soil-transmitted helminth most commonly prevalent in the tropics and subtropics. The infection is mostly predominant among the impoverished individuals. Hookworm infection is still a huge problem throughout many regions although the global target is to eliminate morbidity due to soil-transmitted helminths including hookworm in children by 2020 (Molla & Mamo, 2018).

Since 1970s, soil-transmitted helminth have been known as one of a major public health problems in Malaysia. Foci of endemicity of the infection still persists in rural communities with poor socoeconomic and environmental sanitation, particularly among the aborigines. Soil-transmitted helminth infection remains a malady to the aboriginal communities as re-infection usually occurs rapidly even after treatment (Mohd-Shaharuddin et al., 2018). Despite modernization and restructuring of the

aboriginal settlements in Malaysia, hookworm is still a common infection among the aborigines.

Although provided with facilities including transportation, water, electricity and others, hookworm and other soil-transmitted helminths infection are still prevalent even among the aboriginal population who live very close to the city (Omran & Kamel, 2020). The blood-feeding nematode causes millions of disability-adjusted life years (DALYs) and annual economic productivity losses annually. Hookworm sucks blood and causes iron deficiency anemia and malnutrition, especially among children (Abuzeid et al., 2020). It causes physical and cognitive growth retardation, which hinder the children from educational advancement.

Pre-school and school-aged children are particularly at risk to harbour high infection rate (Lim & Chua, 2016). Current hookworm control effort relies and focus on mass drug administration that cures the infection; however, it does not solve the problem with re-infection (Diemert et al. 2018). Therefore, on that basis, there is a need to identify the risk factors behind the chronic infection and re-infection among the high-risk group, especially the aboriginal community. It is hoped that this study will pave a way for the authorities to come out with better strategies to eliminate hookworm infection among the aborigines.

METHODOLOGY

A. Study area

A cross-sectional study was performed at three aboriginal villages in Kuala Krau, Temerloh, Pahang during two seasons: wet season (October to November 2014, n=256) and dry season (June 2015, n=217). The wet and dry seasons were identified based on the data from Malaysian Meteorological Department in 2010 to 2013 recorded at Temerloh station.

B. Ethical approval, informed consent, and questionnaires

The protocol of study was approved by Research and Ethical Committee, Faculty of Medicine, Universiti Kebangsaan Malaysia (FF-2014-219) prior to collection of faecal samples. Permission for field work was obtained from the Department of Orang Asli Development (JAKOA) (JAKOA/PP.30.032Jld29(04)). Objectives and the study protocol were explained to all study participants and informed consent was obtained prior to commencement of study. Adapted and structured questionnaires were used through an oral interview. Risk factors for hookworm infection were identified using data from the questionnaires, which includes participants profile, sanitation and source of water, hygiene, educational information of participants and parents and others.

C. Stool collection and examination

Participants were provided with labeled faecal containers a day prior to faecal collection. The collected faeces were examined macroscopically and microscopically. Faeces were subjected to culture using Harada Mori technique and 10 grams of the faeces were preserved in polyvinyl alcohol (PVA) followed by Trichrome staining.

D. Statistical analysis

Data obtained from the questionnaires and prevalence of hookworm infection were analysed using Statistical Package for Social Sciences software for Windows (SPSS Version 23, Chicago, IL, USA). Association between the prevalence of hookworm infection and the independent variables obtained from the questionnaires were analysed using Chi-square (χ^2) analysis. Significant risk factors from the univariate analysis were included in the multivariate analysis where the level of significance was deemed at $P<0.05$.

RESULTS AND DISCUSSION

Table 1. Prevalence of hookworm infection during wet (n=256) and dry (n=217) seasons

Number of infection		Prevalence		Significant difference between the two seasons	
Wet season	Dry season	Wet season	Dry season	Z-score	*p*-value
59/256	73/217	23.0%	33.6%	2.5595	0.011*

Table 2. Univariate analysis of the risk factors associated with hookworm infections in the aboriginal community during wet (n=256) and dry (n=217) seasons

Variables	OR (95% CI)		*p*-value	
	Wet season	Dry season	Wet	Dry
Age				
≤15	2.296 (1.153, 4.573)	2.661 (1.198, 3.661)	<0.001**	0.001**
>15	1	1		
Gender				
Female	1.700 (1.390, 2.254)	1.679 (1.385, 3.198)	0.229	0.181
Male	1	1		
Number of household members				
≥8	1.221 (1.630, 2.368)	1.024 (0.578, 1.814)		
<8	1	1	0.553	0.936
Monthly household income				
≤ RM500	1.998 (1.530, 1.876)	1.677 (1.380, 2.209)	0.994	0.186
> RM500	1	1		
Education level				
No formal education	1.660 (1.347, 4.257)	1.048 (1.566, 1.939)		
Primary and secondary education	1	1	0.204	0.882
Occupation				
Rubber tapper, farmer	1.895 (1.176, 4.558)	1.809 (0.972, 3.365)		

Professional, factory	1	1	0.894	0.060
Water supply				
Untreated tap water from river and wells	1.617 (1.851, 3.073)	1.656 (0.909, 3.016)		
Governmental tap water	1	1	0.140	0.098
Usage of stored river water				
Yes				
No	1.979 (1.093, 3.584)	2.081 (1.175, 3.687)	0.023*	0.011*
	1	1		
Latrine system/defecation				
No latrine system, river				
Flush toilet and pit latrine	1.975 (1.953, 5.997)	1.981 (1.083, 3.624)		
	1	1	0.217	0.025*
Wash hand after playing with soil				
No	1.337 (0.909, 2.154)	0.538 (0.171, 1.698)	0.071	0.284
Yes	1	1		
Wash hand after defecation				
No				
Yes	1.497 (1.109, 2.266)	0.236 (0.209, 1.925)	0.357	0.144
	1	1		
Educational status of father				
No formal education				
Primary and secondary education	2.261 (1.251, 4.084)	2.214 (1.218, 4.027)		
	1	1	0.006**	0.009**
Educational status of mother				
No formal education				
Primary and secondary education	2.355 (1.303, 4.254)	2.805 (1.518, 5.183)		
	1	1	0.004**	0.001**

* significant at $p<0.05$ ** significant at $p<0.01$

Table 3. Multivariate analysis of the risk factors of hookworm infections during wet (n=256) and dry (n=217) seasons.

Variables	**OR (95% CI)**		***p*-value**	
	Wet season	**Dry season**	**Wet**	**Dry**
Age				
≤15	2.356 (1.174, 3.729)	2.460 (1.245, 2.864)	0.005**	0.016*
Usage of stored river water	2.060 (1.109, 3.826)	1.733 (0.939, 3.198)	0.022*	0.079
Latrine system				
No latrine system, river	NA	1.513 (1.474, 4.834)	NA	0.485
Educational status of father	2.295 (1.356, 4.805)	1.132 (1.004, 2.213)	0.382	0.431
No formal education				
Educational status of mother	1.796 (1.120, 5.296)	2.413 (1.563, 3.398)	0.814	0.917
No formal education				

* significant at $p<0.05$ NA Not applicable

The findings of the present study indicated that hookworm infection still remains a major public health problem among the aboriginal community in Malaysia with prevalence of 23.0% (59/256) during the wet season and 33.6% (73/217) during the dry season with significantly higher prevalence during the dry season (Z = 2.5595,

p=0.011) (Table 1). Higher prevalence of hookworm infection during the dry season could be due to more outdoor activities during dry season as compared to the rainy or wet season, hence the exposure to soil contaminated with hookworm was higher.

Hookworm-host cycle is maintained by faecal deposit on the soil especially by open defaecation, which is a common practice among the aborigines. Under optimum, favorable condition in the environment, hookworm eggs in the faeces develop into infective larvae and awaiting for human host contact. Upon contact with bare skin, the infective filariform larvae will penetrate the skin or the larvae could gain entry through drinking contaminated water with infective larvae. The larvae will reach the intestine via bloodstream and mature into adults (Na-Ek et al. 2016).

In this study, children at the age of less or equal to 15 years old are at higher risk to contract hookworm infection in comparison to the individuals of more than 15 years old with the odds of 2.356 (1.174, 3.729) during the wet season and 2.460 (1.245, 2.864) during the dry season (Table 3). During the field work, it was observed that the children spent most of their time with outdoor activities by playing with friends and family members along river bench, nearby houses and at open space without wearing shoes or slippers. Most of the time, the children walked barefooted while they were outside their houses. Furthermore, children at the age of less than 5 years old were observed to play with soil with bare hands and foot. This might explain the reason why children in the present study are at higher risk to acquire hookworm infection. Filariform larvae of hookworm present in soil may directly penetrate the skin by direct contact with contaminated soil.

Wearing shoes has been proven to decrease the rate of hookworm infection since it prevents the entry of infective hookworm larvae to susceptible hosts (Mengistu et al. 2010; Feleke 2018). School children at the age of less than 13 years old was reported to have higher risk for hookworm infection by 56%. Hookworm infection among school children who wear shoes were 65% lower than the children who had the habit of not wearing shoes (Feleke 2018). The present finding is in agreement with the published data. Since chronic hookworm infection is known to cause anaemia, growth and cognitive delays with reduction in academic performance, school attendance and future wage earnings (Hotez et al. 2016), therefore infection in children should be notified and treated regularly. Children are future leaders, therefore any problems related to their physical as well as mental growth and performance should be properly addressed.

Besides lower age as risk factor for hookworm infection, usage of untreated water originated from river was another risk factor to contract hookworm infection during wet season [OR=2.060 (1.109, 3.826), *p*=0.022)] (Table 3). The study area

included three aboriginal villages. The village located at the downstream of the river was provided with safe, treated tap water supply. However, the other two villages located at the midstream and upstream of the river were not equipped with treated tap water, therefore villagers in these two villages built and used their tap water supply originated from untreated river water from the upstream of Sungai Krau.

Hookworm has been reported to be able to survive in water and once it becomes infective larva, it can penetrate exposed skin of man and reach the intestine through the bloodstream. Transmission of hookworm outside the body from egg to filariform larvae requires suitable environment. Hookworm eggs submerged under water from rainfall or latrines for extended period may recover their ability to develop into infective filarofirm larvae when they are exposed to atmospheric air (Na-Ek et al. 2016).

High frequency of open defaecation and untreated water usage were previously reported to be significantly associated with acquiring soil-transmitted helminths infection including hookworm (Molla & Mami 2018). As aforementioned, open defaecation is a common practice among the aborigines. The aboriginal community in the present study practised open defaecation in the bushes and open spaces, as well as in the river. During wet season, heavy rainfall may flushed away most of contaminants on the soil surface and finally accumulated in the river. The practice of collecting river water and stored in the house to be used later was a risk for the aborigines to acquire hookworm infection where viable infective larvae may penetrate the skin upon contact with the contaminated river water.

The aborigines who use untreated river water for daily activities has two times higher risk to contract hookworm infection in comparison to those who do not use untreated, stored river water for domestic activities during wet season. In Islam, cleanliness and purification are not only requirements for embracing Islam but also a part of Muslim's faith (Kiani et al., 2015). Protection of the environment against littering and poor sanitation should be performed to preserve the cleanliness of the environment and ecology (Mamat & Mahamood, 2017).

Therefore, living in unsanitary environmental condition is discouraged in Islam since it will bring harm and illness. Since Malaysia is moving forward to becoming a more structured and modernized country with healthy populations in future years, therefore cultural belief and customs among the aborigines who still engage with nature, especially river should be addressed. Effective strategies aimed at reducing the risk for hookworm infection should be implemented. Assesibility to safe, treated tap water supply and health education are hoped to pave a way for a better, healthy aboriginal community with reduction in hookworm infections.

CONCLUSION

This study highlighted that lower age and usage of untreated water for daily activities contributes to hookworm infection among the aboriginal community. Open defaecation plays an important role in sustaining the prevalence and endemicity of hookworm infection in the community. Islam encourages hygiene and cleanliness to avoid infection and illness, therefore the aboriginal community should be taught to avoid practices that could lead to hookworm transmission. Safe, treated water supply and health education regarding the transmission and mode of infections are required to prevent and control the infection especially among the children.

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