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Worm Infection among Children in Malaysia

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ABSTRACT

Parasitic worm infections, particularly by soil-transmitted helminths (STHs), are considered a public health concern affecting millions of children in developing countries around the world. In Malaysia, various prevalence studies have been carried out since 1970s among children from diverse population ranging from the remote aboriginal communities in the Peninsular Malaysia to the rural interior tribes of Sarawak. However, the number of worm infection studies in Malaysia is still limited particularly in East Malaysia but overall, more studies should be conducted presently compared to 20 years ago. Focusing mainly on STHs, we reviewed the prevalence and intensity of worm infection among children between East Malaysia and West Malaysia, particularly from rural and urban settings.

Keywords: worm infection, children, Peninsular Malaysia, Sabah, Sarawak

INTRODUCTION

Worm infection, also known as helminthiases, is a serious public health concern in either underdeveloped or developing countries. There are two major phyla of parasite worms – the nematodes (or roundworms) which include the major importance soil-transmitted helminths (STHs) as well as filarial worms; and platyhelminths (or flatworms) which comprise of flukes (or trematodes) including schistosomes and tapeworms (or cestodes) [1] (Table 1). Worm infections, particularly among children, are considered a major concern causing physical and cognitive growth retardation, hindering them from educational advancement and economic development [2]. Both pre-school and school-aged children tend to harbour high infection rate of the three main types of STHs and schistosomes [1].

Worldwide, it has been estimated that more than two billion individuals are infected with the four species of STHs [3]. Hence, making STH the most common cause of helminthiases, followed by schistosomes and filarial worms [1]. The tropical and subtropical countries have widespread infection with *Ascaris lumbricoides*, hookworms *(Ancylostoma duodenale* and *Necator americanus)* and *Trichuris*

trichiura [4, 5] due to the suitable climate as well as adequate moisture and relative atmospheric humidity which are essential for larval and ova development in the soil [6]. World Health Organization estimates that more than 880 million children are in need of treatment for STH [7]. For Schistosomiasis, over 240 million people worldwide are affected and requiring treatment and out of this number, over 120 million were school-age children between 5 and 14 years of age [8].

Another two major intestinal worms affecting millions of people globally are *Enterobius vermicularis* (also known as pinworm) and *Strongyloides stercoralis* (also known as threadworm). *E. vermicularis* which induces symptoms of itchiness of the perianal area, infects millions of people globally, especially children [9, 10]. Bethony *et al.* (2006), estimated 4-28% of children of the world population are infected with *E. vermicularis* [5]. On the other hand, *S. stercoralis* infect between 30 to 100 million people [11, 12].

WHO also estimates that at least 56 million of people are infected with foodborne trematodiasis of which four main genera of flukes – *Clonorchis* spp.; *Opisthorchis* spp.; *Fasciola* spp. and *Paragonimus* spp are among the most common flukes affecting human worldwide [13]. Estimated population at risk of *Fasciolopsis buski* is unknown but this particular fluke species is commonly recorded in Malaysia [14]. As for tapeworm, the most significant public health importance is of Taeniasis which plays a crucial role in the transmission of another form of epilepsy-causing serious disease called cysticercosis caused by the larval stage of *Taenia solium.*

The objective of this review is to compare the worm infections, focuses mainly on STHs, between East Malaysia and West Malaysia, particularly among children from rural and urban settings. Whether there is any difference in the prevalence and intensity of worm infection based on the improvement in the development of health care and socioeconomic conditions 20 years then and at present in Malaysia will also be discussed.

EPIDEMIOLOGY OF WORM INFECTION IN MALAYSIA

Nematode worms especially *E. vermicularis* and STHs which collectively include *A. lumbricoides*, *T. trichiura* and *N. americanus* are mainly found in high prevalences in Malaysia. Compared to STH, there were only several studies on *E. vermicularis* infection which have a lower burden among the adults[15]. Several studies of enterobiasis in Malaysia found that *E. vermicularis* is higher among children of 5-7 years age group [16-18]. *S. stercoralis*, although present, is not considered endemic in Malaysia and usually occurs in sporadic cases [19]. Studies about helminthiasis, particularly of STHs, have already been carried out since 1969 in Malaysia [20-22]. A review by Ahmed *et al.* (2011) listed out several studies of STHs among children from both rural and urban settings in Peninsular Malaysia from 1979

until 2007 [23]. Nevertheless, emphasis was more on underprivileged rural and *Orang Asli* communities [24-29]. There were also filariasis cases reported including in rural district of Serian in Sarawak, East Malaysia where *B. malayi* was reported at a low prevalence rate of 5.1% [30].

Infection with trematodes and tapeworms were reported occasionally only in adults even though it is possible that these are present in children. For example, liver fluke infections by *C. sinensis* and *Opisthorchis spp* were found among the Chinese in Malaysia mainly due to their habit of eating raw fish dishes [31 32]. A 39-year old Sabahan was the first reported case of *F. buski* infection, had neither travelled overseas nor to any endemic areas for *F. buski* [33]. Previously, trematode eggs were already discovered and reported in Sabah in 1978 [34]. Sinniah *et al.* (1978) reported about infection by tapeworms of *Hymenolepis spp* in adults working at the oil-palm plantation (0.7%) in Peninsular Malaysia and not in children [35]. The first case of *T. saginata* or beef tapeworm was detected by PCR in the stool specimen of a 56-year old man also hailed from Sabah (Chua, *et al.*, unpublished data) .

More than 207 million people are infected with human *Schistosoma* spp, including several cases discovered since 1975 in Malaysia [36]. Reported human schistosomiasis cases diagnosed histologically was attained among the rural aborigine communities in Pahang and Perak in the 1970s [37, 38] prior to serological surveys for schistosomiasis which showed prevalence of 4%-25% [39]. The autopsy cases were patients aged between 11-68 years old which disclosed occurrence of *Shistosomiasis* in Malaysian children [36]. Based on these findings, *S. malayensis* resembling those of *S. japonicum* was described in 1988 [40]. In 1985, schistosome eggs were found in stool samples of children aged between 2 months-18 years old in *Orang Asli* villages in Ulu Kelantan (1.8%) dan Selangor (1.9%) [41].

DISCUSSION

Worm infections, particularly the medically important STHs, have been well-studied in Peninsular Malaysia compared to the only several reports from East Malaysia [42]. The studies in Peninsular Malaysia covered wider areas which include the aboriginal populations, estates and even plantations, squatters' dwellers and in hospitals [31, 43-45] while selectively covered only certain interior tribal communities in East Malaysia, such as the Kayans, Kenyahs and Penan in Sarawak [46]. Study in Peninsular Malaysia covers most states such as Kelantan, Perak, Pahang, Penang, Selangor and of course, the Federal Territories of Kuala Lumpur [22, 25, 47-52]. However, data were limited only to the three main ethnicities in Malaysia (Malay, Chinese and Indian) [53-56]. This is mainly because Malay makes up the majority of the population in Peninsular Malaysia, followed by Chinese and Indian while population in Sabah and Sarawak are very diverse and unique with different ethnic and subethnic groups. There were also studies conducted in island population in Peninsular Malaysia, such as Pulau Ketam, where there were low prevalence of STH infection of only 8.4% among children aged between 5-12 years old in 1987

[57]. However, Oothuman *et al.* (1989) found high prevalence of *E. vermicularis* at 56.88% among 6-12 years old school-children from three National Chinese Primary Schools in the same island in 1988 [17].

Table 1: Major human worm infection

Species of worms	Disease	Estimated world prevalence (millions)	Recorded in Malaysia
Nematodes			
Ascaris lumbricoides	Ascariasis	807 – 1221	Yes
Trichuris trichiura	Trichuriasis	604 – 795	Yes
Necator Americanus & *Ancylostoma duodenale*	Hookworm infection	576 – 740	Yes
Strongyloides stercoralis	Strongyloidiasis		
Enterobius vermicularis	Pinworm infection	30 – 100	Yes
		4-28% of children	Yes
Filarial nematodes			
Wuchereria bancrofti & *Brugia Malayi*	Lymphatic filariasis	120	Yes
Onchocerca volvulus	Onchocerciasis	37	No
Trematodes			
Schistosomes sp	Schistosomiasis	> 207	Yes for *S. malayensis*
Liver Fluke			
Clonorchis sinensis	Food-borne trematodiasis	>56	Yes
Opithorchis spp			No
Fasciola hepatica			Yes
Lung Fluke			
Paragonimus spp	Food-borne trematodiasis		No
			Yes
Intestinal Fluke	Food-borne trematodiasis		
Fasciolopsis buski			

Cestodes			
Taenia spp	Taeniasis/ Cysticercosis	80% of the world's 50 million people affected by epilepsy	Yes

In East Malaysia, studies and documented data on worm infections were limited. Most of the studies were conducted in rural areas in several districts in both states where children were likely to be infected with intestinal parasitic worms. Kan *et al*. (1987) carried out a study among indigenous Penan children at Upper Baram in Sarawak whereby one-third of the respondents were found to be infected with STH [58]. Another study reported that the number of STH ova found in children from rural primary school outside Serian town is higher than those found in older age rural secondary school children from rural secondary school which indicates that younger children are prone to infection than older children [59]. Sagin *et al*. (2002) revealed that children less than 14 years old have higher parasitic intestinal infection rate at 68% in a study conducted in seven rural villages in Bakun Valley upper Rejang River involving several tribes[46]. These two studies reported *T. trichiura* infection as the most common worm infection in Sarawak but at a lower infection rate compared to Peninsular Malaysia. Overall, the infection rate of STH in Sarawak remained at a lower rate of less than 50% than in Peninsular Malaysia. Besides STH infection, *S. malayensis*-like schistosomiasis was detected among the indigenous tribe in all age group at similar study site at 6.8% seroprevalence but the highest rate were those above 60 years of age instead of children[60].

Similar to Sarawak, there were scarce amount of data of worm infection among children in Sabah. Therefore, it is difficult to estimate the overall rate of worm infection in Sabah and whether the prevalence is higher than Peninsular Malaysia or Sarawak remains unclear. Nor Aza *et al.* (2003) conducted a study in seven villages from the districts of Tambunan, Keningau and Tenom, Sabah to determine the infection of these parasites among the communities living on the fringes of the Crocker Range Park [61]. The prevalence rate of STH was relatively low with *T. trichiura, A. lumbricoides* and hookworm at 10%, 8.7% and 3.3% respectively. Low seroprevalence of 2.2% for cysticercosis was reported in a rural village in Ranau, Sabah but there is no indication whether children were included in this study [62].

Worm infection, particularly by STH, are usually prevalently high in impoverished areas where communities are living in poor environment with inadequate water and lack of sanitation facilities which are common in rural areas [53, 63]. It is considered a disease of poverty since parental socio-economic status correlates with helminthiases in children [19, 23, 64]. Urban population, on the other hand, lives in environment with better sanitation and adequate facilities to live with such as in the city of Kuala Lumpur. Comparable data of worm infection between urban and rural settings are few but it is always assume that

hookworm is more prevalent in rural areas whereas *A. lumbricoides* and *T. trichiura* are more prevalent in urban area [65]. However, based on the prevalence data of STH in Malaysia, there is no significant difference between rural and urban children whereby both *A. lumbricoides* and *T. trichiura* are high in prevalence rate even though there are contrast environmental conditions between the two different settings (Table 2).

For example, a study by Kan (1984) showed high prevalences of *T. trichiura* among primary school-children in urban and rural areas of Kuala Lumpur at 90.7% and 92.7% respectively but infection by hookworm is higher (42.4%) than *A. lumbricoides* in rural setting [54]. Rajeswari *et al.* (1994) also reported *T. trichiura* with the highest prevalence rate at 47.1% among children of Gombak [52] . A study by Lo *et al.* (1979) showed that *A. lumbricoides* is the dominant species of STH affecting the lives of rural school-children at a rate of 86.7%, followed by *T. trichiura* at 84.5% [44]. Sinniah *et al.* (2014) also found that *T. trichiura* is the most common helminth among children from different areas at 20.2% followed by *A. lumbricoides* (10.5%) and even though hookworm has a low prevalence rate of 6.7%, there is no case reported in urban children [55]. More than 40 years ago, hookworm was found to be as high as 95% [20 44] but as socio-economic development has improved, the infection rate tend to decrease even among the indigenous communities. Plus, unlike *T. trichiura* and *A. lumbricoides*, hookworm infection predominantly affects adults which may contribute to the decreasing rate of infection among children. According to Hanjeet *et al.* (1991), the general unsuitable soil which is needed for development and maturation purposes may contribute to the low prevalence of of hookworm in many parts of Malaysia [66].

Hence, the most prevalent STH in this region is *T. trichiura*, even though mix-infection is common, particularly with *A. lumbricoides* [24]. This species of STH is partly responsible for the high prevalence of infection in various communities ranging from the remote indigenous aborigine as well as urban dwellers. This may be due to relatively long life span and higher resistance to many anthelminthic drugs [23]. Urban population near squatter areas had high infection of the so-called whipworm as well due to poverty, cultural factors, environmental sanitations with the highest prevalence rate among the primary six school children [67]. This is evident in several reports among children of urban slums, particularly in the federal territory of Kuala Lumpur [42, 64, 66, 67]. Until present, this particular species still continues to show its dominancy as the most prevalent worm infection in Malaysia [68, 69]. However, published information and comparable data of STH and other worm infections between urban and rural settings in East Malaysia is still very scarce or possibly none since most of the studies conducted and published were from rural communities.

Several studies in 1990s showed a high prevalence of either one or more STH infections in among the children of aboriginal communities in Malaysia [47, 50, 70-73]. The rate of infection was reportedly reduced

over the years but studies still reveal high prevalence of STH infection among the indigenous minority people [74]. Hartini et al. (2013) indicated that overall prevalence for STH infection among aborigine children in Pos Sungai Rual, Kelantan was considerably high at 87.4% [28]. Studies by Al-Mekhlafi et al (2005-2007) showed among the highest prevalence of STH at 98.2% - 100% among Orang Asli children since 1970. This showed that despite comprehensive development towards health care and socioeconomic improvements in Malaysia, STH infection, particularly *T. trichiura*, remain a burden to the country that needs further effective intervention program and strategies for many generations to come.

Worm infection is the most common parasitic disease in the world and prevalence varies greatly depending on the endemicity and different regions of developing countries across the globe as well as the age which predominantly affecting the youngest generation of human being. Worm infection among children is a public health concern due to the negative consequences to a child's health and development both mentally and physically as infection is associated with a range of significant growth impairment. In contrast to other developing countries however, the condition and quality of life of children in Malaysia have improved as this country is progressing and moving forward towards a developed nation. Malaysian government continue its effort to reduce poverty and improve the well-being of the people by providing education compulsory for children, safe and treated drinking water, latrine facility, as well as primary healthcare services that provide periodic deworming treatment in local clinics and hospitals. Nevertheless, despite all these effort, there are still many populations especially the *Orang Asli*, rural and remote communities plagued with STH infection and other helminthiasis due to their lifestyle, involvement with agricultural sectors and industrialization which has resulted in undergoing rapid urbanization and change in land-use.

Morbidity and mortality is considered very low in Malaysia, hence parasitic worm infection is usually neglected and considered not important. Statistical of parasitological data and information in hospitals are limited too. Therefore, Malaysian government should encourage and provide more funds to assist Malaysian researchers in related field to conduct more studies to further assess STH prevalence in school-age population as well as investigating the risk factors of infection as there are still other remote and rural communities who are considered hard-core poor such as in Sabah and Sarawak. Follow-up studies should also be conducted to help distinguish clearly whether there is any decrease or increase in the prevalence rate among the school-aged children who were examined since 1970.

Table 2: Studies of worm infection among children in Malaysia (1970-2014)

Area	Sample size	*A. lumbricoides* (%)	***T. trichiura*** **(%)**	**Hookworms** **(%)**	Other helminths (%)	Overall worm infection in children (%)	Reference
Aboriginal	110	48	81	95	NA	87.3	Bisseru and Aziz, 1970 [20]
Aboriginal	231	NA			*S.japonicum*-type ova in 9 autopsy cases (aged 11-68) with 3.9% overall prevalence		Leong *et al.*, 1975 [38]
Rural	834	86.7	84.5	43.2	NA	95	Lo *et al.*, 1979 [44]
Urban	7,682	21.9	44.5	4.6		50	George and OwYang, 1982 [67]
Urban	305	17.4	14.8	2.9		39	Hamimah *et al.*, 1982 [45]
Rural	271	41.2	74.2	28.0		86.3	Sinniah, 1984 [53]
Urban	389	37.5	53.7	5.4	1 case of Strongyloides; 2 cases of *H. nana*; cases of *E.vermicularis*	64	Sinniah, 1984 [48]
Rural	342	36.9	92.7	42.4	NA	38.9	Kan, 1984 [54]
Urban	688	75.6	90.7	2.9		75.6	
Aboriginal	618	NA			*Schistosomes* ova found in stool of children aged 2 months-18 years old		Lai *et al.*, 1986 [41]
Rural and urban slum	11,874	19.3	36.2	3.3	NA	41.1	Kan and Poon, 1987 [42]
Island	1,286	4.0	4.7	0.2		8.4 (very low)	Kan *et al.*, 1987 [57]
Urban slum	1,574	49.6	62.8	5.3		66.7	Bundy *et al.*, 1988 [64]
Island	1,352	NA			*E. vermicularis* – 56.9%	56.9	Oothuman *et al.*, 1989 [17]
Estate	1,203	71.6	82.8	14	NA	83.2	Li, 1990 [76]
Urban slums	9,863	33	49	6		58	Hanjeet et al., 1991 [66]
Rural	363	29.2	16.5	NA	NA	38.8	Hidayah *et al.*, 1997 [77]

Aboriginal	205	63	92	29		92	Norhayati *et al.*, 1997 [71]
Aboriginal	84	59.5	41.7	6.0	*S. stercoralis* (1.2%)	79.8	Rahmah *et al.*, 1997 [47]
Aboriginal	259	47.5	33.9	6.2		56.0	Zulkifli *et al.*, 1999 [50]
Rural	183	62.8	38.9	12.6		69.4	Zulkifli *et al.*, 2000 [51]
Aboriginal	368	61.9	98.2	37.0		98.2	Al-Mekhlafi *et al.*, 2005 [27]
Aboriginal	292	67.8	95.5	13.4		100	Al-Mekhlafi *et al.*, 2007 [25]
Rural	550	41.6	71.5	13.5		76.5	Ngui *et al.*, 2012 [78]
Aboriginal	254	47.6	84.6	3.9	NA	93.7	Ahmed *et al.*, 2012 [73]
Aboriginal	111	40.5	65.8	25.2		87.4	Hartini *et al.*, 2013 [28]
Aboriginal and Rural	189	12.7	28.0	12.2		32.3	Sinniah *et al.*, 2014 [55]
Urban Slum	97	12.4	13.4	NA		20.6	
Urban (Flats)	56	3.6	3.6	NA		5.4	
EAST MALAYSIA							
Rural	120	STH infections recorded exactly 1/3rd				40	Kan *et al*., 1987 [58]
Rural	264	12.8	25.4	7.2		33.6	Lee *et al.*, 1999 [59]
Rural	NA	NA			Schistosomiasis	6.8 (seroprevalence)	Sagin *et al.*, 2001 [60]
Rural	355	7.0	37	5	NA	41	Sagin *et al.*, 2002 [46]
Rural	150	8.7	10	3.3	NA		NorAza *et al.*, 2003 [61]
Rural	135	NA			Cysticercosis	2.2 (seroprevalence)	Noor Azian *et al.*, 2006 [62]

Furthermore, education is also very important not only school-based but also community-based with the participation of the community themselves as well as government and other agencies. Literacy in parents and children, public awareness about personal hygiene, proper nutrition and environmental sanitation are crucial in improving the living status and well-being of the population, especially children at risk. It is definitely the right time now to embark on intensified community-based programmes and empowerment to effectively eradicate worms in the country. It is also not possible for the local community of a particular population who have succeeded in bring down the infection rate to help to implement the same programme to other improved population in the neighbouring countries such as in South-east Asia region.

Besides conducting studies, improvements in sanitation and education, regular treatment of anti-helminthic drugs for school-aged children prone to worm infection should be sustained and the progress be monitored to effectively control worms and eventually be eliminated. Treatment for worm infection is appropriate at a tender age of 7-12 years old child [75] and regular treatment is fundamental since re-infection may occur even after treatment. Failure in a treatment programme will hamper not only the children development but also compromises the economic development of the nation. Hence periodic deworming and chemotherapy through school should continue to be incorporated into existing worm control programs, especially among primary school children.

CONCLUSION

Comparing the studies reported 20 years ago and 20 years later of the epidemiology of worm infection in Malaysia, particularly STH infection, still persist among the children of diverse background ranging from the *Orang Asli,* rural, urban slums and urban population. Hence, associated risk factors to the promotion in the spread and transmission of worm infection need to be focused with great attention and identified sustainably. More studies, including follow-up studies, should be conducted to assess and monitor the prevalence rates of worm infection not only in Peninsular Malaysia but also East Malaysia. Furthermore, Malaysian government should put more emphasis on the worm infection studies in Sabah and Sarawak, not only limited to data collection of the prevalence rate but also the implementation of strategies to control and eradicate the burden of STH and other helminths including *Schistosomiasis* among the children at risk in Malaysia.

CONFLICT OF INTEREST: None

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