REVIEW

EPIDEMIOLOGY OF SOIL-TRANSMITTED HELMINTHIASES IN MALAYSIA

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Abstract. We reviewed the epidemiology of STH in Malaysia from the 1970s to 2009. High prevalence rates persist among the rural Aborigines, estate workers and in urban slums and squatter areas. *Trichuris trichiura* is the most prevalent helminth in Malaysia ranging from 2.1% to 98.2%. *Ascaris lumbricoides* follows closely with a prevalence rate of 4.6-86.7%, while hookworm is the least prevalent (0-37.0%). A countrywide control program with special emphasis on school-based intervention is highly recommended among aboriginal people.

Keywords: soil-transmitted helminths, deworming, school-based intervention, Malaysia

INTRODUCTION

Soil-transmitted helminths (STH) are a group of parasitic nematode worms that afflict humans through the ingestion of infective eggs or contact with larvae. The three main STH which cause common clinical disorders in man are *Ascaris lumbricoides, Trichuris trichiura* and hookworms (*Ancylostoma duodenale* and *Necator americanus*). The morbidity caused by STH is most commonly associated with infections of moderate to heavy intensity (Neva and Brown, 1994; Nokes and Bundy, 1994). STH live for years as adult worms in the human gastrointestinal tract. Recent estimates of global prevalence suggest *A. lumbricoides* infects 800 million people and *T. trichiura* and hookworms infect 600 million each (Hotez *et al*, 2009a,b). The infections are associated with poverty, poor sanitation, inadequate hygiene, illiteracy, ecosystem differences and overcrowding (Crompton, 1999).

STH, traditionally endemic in rural areas, are increasingly becoming a public health concern in urban slums of cities in tropical and subtropical developing countries of the world (Bundy *et al*, 1988). The major endemic regions include southern and southwestern China, southern India, Southeast Asia, Sub-Saharan Africa and Central and South America (de Silva *et al*, 2003). Schoolchildren are more vulnerable to infection because of their hygiene and play habits (Savioli *et al*, 2002). In 2006, it was estimated there were 181 million school-aged children in Sub-Saharan Africa of whom 89 million were infected

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with one or more parasitic worms (Hotez and Kamath, 2009).

Infections with STH among schoolchildren cause malnutrition, intellectual retardation and cognitive and educational deficits (WHO, 2005). Studies have shown such infections have a profound effect on school performance and attendance and future economic productivity (Bleakly, 2003; Miguel and Kremer 2003). Recent studies have shown infection with STH may increase the host's susceptibility to other important illnesses, such as malaria, tuberculosis and HIV infection (Fincham *et al*, 2003; Le Hesran *et al*, 2004). Hookworm infections cause pathological blood loss leading pregnant women and their children to a higher risk of death during pregnancy and delivery (Drake and Bundy, 2001).

In most areas where STH infections are endemic, school-aged children suffer the greatest burden; hence, attention is focused on the health of schoolchildren (WHO, 1995). Infections with STH can thwart the effort of a country to provide basic education for its children (Partnership for Child Development, 1997a). School-based health programs, including mass deworming exercises, can be delivered at low cost (PCD, 1997b; Savioli *et al*, 2002) and can ultimately contribute to improvement in child growth, well being, nutritional status, cognitive ability and school attendance (Miguel and Kremer, 2003).

As a result of the growing worldwide concern about STH infections, more organizations and countries throughout the world are committing substantial resources to helminth control strategies in order to reduce the burden caused by STH (Fenwick *et al*, 2003). Attainment of effective helminth control is possible through simple intervention strategies which can be achieved at low cost. School-based interventions offered to school-aged children are an example of effective low cost worm control strategies (Bundy and Guyatt, 1996).

EPIDEMIOLOGY OF STH IN MALAYSIA

Malaysia is a developing country with a range of parasitic diseases. Several studies have been carried out regarding the prevalence, intensity and clinical manifestations of intestinal parasitic infections in Malaysia since the 1970s (Anuar *et al*, 1978; Kan, 1982; Hanjeet *et al*, 1991; Norhayati *et al*, 1997; Al-Mekhlafi *et al*, 2007). The Malaysian Government has embarked on a comprehensive socioeconomic development program in order to improve living conditions since 1978. Despite improvements in health care and socioeconomic conditions, STH infections remain a major public concern especially among the aboriginal populations in Malaysia. A recent study of the prevalence and intensity of STH among Orang Asli children revealed 100% of the sampled population were infected by at least one or more STH (Al-Mekhlafi *et al*, 2006).

The epidemiological patterns of STH infections and their prevalence in Malaysia are similar to other regions of the world. The majority of infected people fall within the school going age range (3-14 years), mainly due to the fact that these children are the most active but least careful about their personal hygiene, hence the high risk for exposure to sources of infection. The eggs of the worms or their larvae enter humans through oral ingestion (*Ascaris* and *Trichuris)* or by skin penetration (hookworm). The eggs of *Ascaris* and *Trichuris* can remain viable in the soil for several months, while the larvae of the hookworm can remain viable for several weeks depending on the prevailing environmental conditions (Booker *et al,* 2006).

Prevalence of STH in Malaysia

Table 1 shows a summary of several prevalence studies cited. Helminthic infections are a leading public health problem in the Western Pacific, affecting millions of children (WHO, 2010). It is common to find up to 90% of children living in poor communities with inadequate hygiene and sanitation who are infected with at least one STH (WHO, 2010). Reports of prevalence studies obtained for the period since the 1970s in Malaysia indicate *A. lumbricoides, T. trichiura* and hookworm (*Necator americanus*) are the common STH infections in Malaysia (Table 1). Cases of mixed infection have been reported by many authors (Lo, *et al,* 1979; Hanjeet *et al,* 1991; Rajeswari *et al,* 1994; Norhayati *et al,* 1997; Rahmah *et al,* 1997, Al-Mekhlafi *et al,* 2005, 2007).

As seen in Table 1, *Trichuris trichiura* is the most prevalent STH in Malaysia, while hookworm infection remains low in all the studies cited. The high prevalence of *Trichuris* represents cumulative reinfection in the host. Its relatively long life span and higher resistance to many anthelmintic drugs compared to the other STH may be the reason for this higher prevalence (Hanjeet *et al,* 1991; Norhayati *et al,* 1997). The low prevalence of hookworm may be related to the generally unsuitable soil for hookworm egg development and maturation in many parts of Malaysia, being relatively heavy, rather than the sandy porous soil which is more favorable (Hanjeet *et al,* 1991).

The lower prevalence of *Trichuris trichiura* reported by some authors (Table 1) may be attributed to the role of time in reducing the infectiveness of this helminth, since infective stages become un-infective with time. Density dependent processes regulate parasite populations; at endemic equilibrium, the effective reproductive ratio equals unity, that is, each female replaces herself (Anderson and May, 1991).

Associated risk factors

Soil-transmitted helminths are important causes of chronic human infections in the world. Infections are common among rural and squatter populations. The main risk factors for infection include houses without cement floors, lack of health and hygiene education, lack of potable drinking water, poor latrines and children walking barefooted. Other factors including overcrowding and poor sanitation in urban centers (Harhay *et al,* 2010). Helminths do not reproduce within human hosts, therefore, high worm burdens are the result of frequent infections and reinfections acquired through contact with or ingestion of infected matter (Miguel and Kremer, 2003).

In Malaysia, risk factors associated with infection, reported by previous studies, include poor household hygiene, large family size in the household, poor socioeconomic status, cultural factors, lack of proper environmental sanitation, poor water supply, maternal employment status and illiteracy (Anuar *et al,* 1978; Bundy *et al,* 1988; Kan, 1989; Rajeswari *et al,* 1994; Norhayati *et al,* 1997; Al-Mekhlafi *et al,* 2006, 2007).

Malaysia is a developing nation in the process of becoming a developed country. An important aspect of this vision is improving the quality of life of people. Although these efforts have been successful in most communities, it has not been very successful among lower classes in society, especially among the Orang Asli

Table1
Prevalence of soil-transmitted helminthiases in Malaysia.

Year	Area/Setting	Sample size	Target group	Prevalence (%) of STH infections				Reference
				Ascaris	*Trichuris*	Hookworm	Total	
1978	Rural	433	Adults	67.2	55.4	12.2	76.2	Anuar *et al*, 1978
1978	Estate	150	Adults	52	56	28	82.7	Sinniah *et al*, 1978
1979	Rural	834	Children	86.7	84.5	43.2	95	Lo *et al*, 1979
1980	Estate	562	Adults	14.9	18.5	27.8	36.3	Zahedi *et al*, 1980
1982	Urban	305	Children	17.4	14.8	2.9	39	Hamimah *et al*, 1982
1982	Urban	7,682	Children	21.9	44.5	4.6	50	George and OwYang, 1982
1982	Urban slums	25,246	All ages	18.8	33	7.1	39.6	Kan, 1982
1984	Rural	271	Children	41.7	74.2	28	86.3	Sinniah, 1984
1987	Urban slums and rural	11,874	Children	19.3	36.2	3.3	41.1	Kan and Poon, 1987
1988	Urban slums	1,574	Children	49.6	62.8	5.3	66.7	Bundy *et al*, 1988
1989	Estate	819	All ages	33.9	36.4	15.6	51	Kan, 1989
1990	Estate	1,203	Children	71.6	82.8	14	83.2	Li, 1990
1991	Urban slums	9,863	Children	33	49	6	58	Hanjeet *et al*, 1991
1994	Urban slums	456	Children	7.1	47.1	2.9	79.5	Rajeswari *et al*, 1994
1997	Rural	363	Children	29.2	16.5	-	38.8	Hidayah *et al*, 1997
1997	Peripheral/aboriginal	205	Children	62.9	91.7	28.8	92	Norhayati *et al*, 1997
1997	Aboriginal	78	Children	59.5	41.7	6	79.8	Rahmah *et al*, 1997
1997	Urban and rural	249	Children	31.8	43.8	8.5	76.6	Mahendra *et al*, 1997
2000	Rural/ aboriginal	183	Children	62.8	38.9	12.6	69.4	Zulkifli *et al*, 2000
2002	Urban	111	Children	4.6	2.1	-	51	Mahmood *et al*, 2002
2002	Rural	355	All ages	7	37	5	41	Sagin *et al*, 2002
2006	Peripheral/aboriginal	281	Children	61.9	98.2	37	98.2	Al-Mekhlafi *et al*, 2006
2007	Rural/aboriginal	292	Children	67.8	95.5	13.4	100	Al-Mekhlafi *et al*, 2007
2007	Rural/aboriginal	74	All ages	25.7	31.1	8.1	59.5	Hakim *et al*, 2007

(Aborigines) who comprise about 5% of the country's population (Rajeswari *et al,* 1994). Several studies have demonstrated a high prevalence of *A. lumbricoides, T. trichiura* and *N. americanus* infections among underpriviledged communities, such as the Aborigines (Norhayati *et al,* 1995, 2003; Al-Mekhlafi *et al,* 2005, 2006, 2007), estate workers (Sinniah *et al,* 1978; Kan, 1989; Li, 1990), poor Malay villagers (Anuar *et al,* 1978; Rahmah *et al,* 1997; Zulkifli *et al,* 2000) and squatter areas/urban slums (Bundy *et al,* 1988; Hanjeet *et al,* 1991). In urban areas with better standards of living, recent studies indicate lower prevalence rates (Mahmood *et al,* 2002; Jamaiah and Rohela, 2005). In Malaysia, as in other developing countries of the world, helminthiasis has remained a disease of poverty, since there is a strong correlation between parental socio-economic status and helminthiases in children (Bundy *et al,* 1988; Norhayati *et al,* 2003; Al-Mekhlafi *et al,* 2006).

Some authors have reported traditional or cultural foods and eating habits exhibited by various races in Malaysia may contribute to helminthiases. For instance, Kan (1982), Bundy *et al* (1988) and Hanjeet *et al* (1991) found higher prevalences of STH infections among Indians and Malays compared to Chinese in Malaysia, possibly due to traditional practices of food preparation and eating with fingers practised by these groups, since these habits usually increase the chances of exposure to infection.

Most studies report a higher prevalence of infection among schoolchildren 6 – 15 years old (Rajeswari *et al,* 1994; Mahmood *et al,* 2002; Norhayati *et al,* 2003). However, infection rates have also been reported in adult populations, such as plantation workers (Sinniah *et al,* 1978; Zahedi *et al,* 1980). The higher rate of infection among school-aged children makes a strong case for control programs to target children in particular and the community in general (Drake and Bundy, 2001). The Partnership for Child Development (1997b) strongly recommends the use of schools as venues for implementation of worm control programs.

EFFECTS OF STH ON CHILDREN

Infection with STH is a major source of disease and malnutrition in schoolchildren. Infected children tend to be physically unfit, underweight and are as much as four times more likely to be stunted than their healthy counterparts. They also suffer from learning disabilities and have academic problems (WHO, 2010). Many children in low income groups underachieve and may never realize their full potential (Drake and Bundy, 2001) since STH may have a detrimental effect on both the physical and intellectual development (Drake and Bundy, 2001; Norhayati *et al,* 2003). The most common effect on health is a subtle constraint on normal physical development, resulting in children failing to achieve their potential for growth and suffering from the clinical consequences of iron deficiency anemia and other nutritional deficiencies (Drake and Bundy, 2001).

Heavy burdens of both *Ascaris lumbricoides* and *Trichuris trichiura* are associated with protein energy malnutrition (Stephenson *et al,* 1993; Al-Mekhlafi *et al,* 2005). Intense trichuriasis in children results in *Trichuris* dysentery syndrome, which causes growth retardation and anemia (Bundy and Cooper, 1989; Li, 1990). Moderate to heavy hookworm burdens are a major cause of iron deficiency anemia (Nokes *et al,* 1992; Al-Mekhlafi *et al,* 2007). Ascariasis is associated with deficits in growth among primary schoolchildren (Mahendra *et al*, 1997). There is increasing evidence these infections can have a detrimental effect on cognition and educational achievement in children (Nokes *et al*, 1992; Sternberg *et al*, 1997; Ahmed *et al*, 2003). Helminthiasis in children causes under nutrition which is associated with low scores on achievement and intelligent tests (Lozoff *et al*, 1998). In another cross-sectional study (Nokes and Bundy, 1993), more heavily infected individuals were absent from school twice as often as their un-infected counterparts, missing the opportunity to benefit fully from the education offered at schools.

The disability adjusted life years (DALYs) lost to STH are enormous in comparison with other infections (Chan, 1997). Such high DALYs are attributed to link between ascariasis and stunting and wasting, between hookworm infection and anemia and between trichuriasis and poor school performance (Li, 1990; Nokes *et al*, 1992; Savioli *et al*, 2004). Another important aspect of helminthiasis is predisposition to re-infection following treatment is common (Chan *et al*, 1992). In highly endemic areas, re-infection can occur as early as two months post-treatment and by four months nearly half the treated population becomes re-infected (Norhayati *et al*, 1997). A growing body of evidence suggests that the effects of infection due to STH is underestimated (Drake and Bundy, 2001). Clinical consequences of infection can manifest themselves at much lower worm burdens than previously thought (Nokes *et al*, 1992). Since children suffer at an age when they are both growing and learning, the entire developmental process is placed in jeopardy (Drake and Bundy, 2001). However, the effect of STH infection can be reversed through chemotherapy using cheap and safe drugs (Stephenson *et al*, 1993).

THE NEED FOR SCHOOL-BASED INTERVENTION IN MALAYSIA

Intestinal helminthiases are a public health concern in Malaysia, especially in the rural and aboriginal communities (Al-Mekhlafi *et al*, 2006, 2007; WHO, 2008). Efforts made to control STH infections are minimal compared to other health activities (Norhayati *et al*, 2003). There is no national policy in Malaysia for the prevention and control of these infections. Instead, their control is integrated into the national environmental sanitation program, with a view to educating the public on personal hygiene, environmental sanitation and to give anthelminthic treatment to children (Norhayati *et al*, 2003). According to the Ministry of Health (MOH) Malaysia (2008), the problem is well controlled and localized in specific areas and populations, such as the Aborigines and those living in remote areas. An ongoing deworming program has been carried out in maternal and child clinics, mobile clinics provided in rural areas, aboriginal settlements and school health programs (MOH, 2008).

However, some studies conducted recently indicate high prevalence rates of STH (Sagin *et al*, 2002; Al-Mekhlafi *et al*, 2006, 2007, 2008). Many studies still advocate continued health education, sanitation improvement and periodic deworming in order to achieve worm reduction and curtail transmission (Norhayati *et al*, 1995; Rahmah *et al*, 1997; Al-Mekhlafi *et al*, 2007). These can be effectively achieved by school-based intervention programs. Children below age 15 years constitute 40% of the population of Malaysia, most of them are prone to infections which pose a threat to the community (Rajeswari *et al*, 1994). Therefore, this problems needs focused attention by the government. Regular treatment of school-aged children and other groups at risk (such as pregnant women, pre-school children and special occupation groups) will help to avoid the worst effects of infection even if there is no improvement in safe water supply or sanitation (Savioli *et al,* 2002).

The World Health Organization proposes preventive chemotherapy as a measure for reducing morbidity due to STH infections. They state early and regular administration of anthelminthic drugs recommended by the WHO, contribute to a sustained reduction in transmission, reduce occurrence, severity, extent and long term consequences of morbidity due to STH (WHO, 2006). In the year 2001, the World Health Assembly passed a resolution urging all member states to provide and ensure access to essential drugs against STH in all endemic areas, for the treatment of clinical cases and groups at risk, such as children and women (WHO, 2001). It set a global target to offer regular deworming (single dose of albendazole, 400 mg, twice a year) to at least 75% of all school aged children at risk for STH infections by the year 2010 (WHO, 2001).

In 2004, Cambodia was the first country in the southwestern Pacific region to reach the WHO target by regularly providing anthelminthic drugs to 84% of its school-aged children (WHO, 2010). School-based deworming programs were also introduced in Kiribati, Tonga, Tuvalu, Fiji and Vanuatu (WHO, 2010). Treatment with any of the anthelminthic drugs on the WHO essential drugs list (albendazole, levamisole, mebendazole or pyrantel) is safe, even when given to an uninfected person, and thus there is no need for individual screening (de Silva *et al,* 2003). Since re-infection can occur as early as two months after treatment (Norhayati *et al,* 1995), repeated chemotherapy may be conducted at least once every three months to cover the whole of the vulnerable population (Thien *et al*, 1987).

A countrywide, school-based helminth control program has not been implemented in Malaysia. It is time for the country to embark on such a laudable program for effective worm eradication in the country. A helminth control program using chemotherapy can be introduced at a relatively low cost into established health care programs since the drugs are cheap and available (de Silva, 2003). The estimated cost per treatment, as evidenced by programs in Tanzania and Nigeria, ranges from USD0.21 to USD0.51 per child (WHO, 2002). By training teachers and other school officials to administer anthelmintic drugs, the system could achieve even lower costs. In Ghana and Tanzania, it was reported the delivery of school-based targeted anthelmintic single treatment with albendazole or mebendazole, costs as little as USD 0.05 per child (WHO, 2002).

The lymphatic filariasis elimination program has been carried out for years in filariasis endemic areas of Malaysia. Albendazole is used as the drug of choice for the filariasis elimination program and in the treatment of soil transmitted helminth infections (Sunish *et al,* 2006). It is readily available, cheap, effective and safe to use by all people. The countrywide helminth control program can be combined with the filariasis program by the government. The treatment regimens can be increased from once yearly treatment to twice or thrice yearly to cover the whole of the vulnerable population. When the programs are conducted concurrently, even greater cost effectiveness can be achieved in addition to the positive impact on the population (Ottesen *et al,* 1999).

School-based deworming programs are cost effective in boosting school participation. In Kenya, one such program reduced absenteeism by 25% among schoolchildren (Miguel and Kremer, 2003). In Tanzania, the program reaches 98% of enrolled schoolchildren and 60% of non-enrolled school - aged children by simply inviting their siblings and friends to the deworming day at school (Montressor *et al,* 2001). Mass deworming programs have also been successful in the Republic of Korea with the aid of a NGO, the Korea Association for Parasite Eradication, which was supported by the government to screen and administer anthelminthic drugs to schoolchildren throughout the country from 1969 to 1995. School-based programs offer the opportunity to deliver public health intervention to a great number of beneficiaries at a relatively low cost.

Where the prevalence of STH infection among schoolchildren is >20%, the program may be better achieved by mass drug administration (WHO, 2006). Where the prevalence is <20%, it can be managed by targeted chemotherapy. Some problems that hinder the full realization of this program, such as parental consent and child compliance, may be addressed by organized public enlightenment campaigns in public places and through mass media.

Since the program also targets non-school-going children, who are usually the most affected group (Beasley *et al,* 2000), it serves as a major step towards complete worm eradication in a population. Failure to treat school-aged children hampers child development, yields a generation of adults disadvantaged by the consequences of infection and compromises the economic development of their communities and nation (Partnership for Child Development, 1997a)

CONCLUSION

Malaysia is striving to become a developed nation. Efforts are being made to improve the quality of the lives of people. However, the prevalence of soil-transmitted helminthiases has remained high, especially among underprivileged citizens with poor socio-economic levels, poor literacy levels, poor personal and environmental hygiene and poverty. The climatic conditions of the country also favor parasite development.

Infections with STH cause malnutrition, intellectual retardation, cognitive deficits, poor school performance, absenteeism, poor economic productivity and increased susceptibility to other deadly diseases. Meaningful and proper economic and social development can only be achieved by a healthy society, hence the need for a countrywide worm eradication program through periodic deworming and chemotherapy. Effective worm control could be accomplished at a low cost to cover the whole vulnerable population through school-based intervention programs, since even non-target individuals can be reached by this program. The program can be incorporated into an existing national health care scheme, such as the filariasis control program. To achieve desired development, we need to boost health of our citizens through school-based STH intervention programs.

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