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 2.1-98.2%. 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...
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 (Khairul et al, 1978; Kan, 1982; Hanjeet 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.
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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 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 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 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 uninfected 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 re-infections 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 (Khairul 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
<table>
<thead>
<tr>
<th>Year</th>
<th>Area/Setting</th>
<th>Sample size</th>
<th>Target group</th>
<th>Prevalence (%) of STH infections</th>
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<tbody>
<tr>
<td>1978</td>
<td>Rural</td>
<td>433</td>
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<td>67.2 55.4 12.2 76.2</td>
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<td>834</td>
<td>Children</td>
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<td>1980</td>
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<td>562</td>
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<td>7 37 5 41</td>
<td>Sagin et al, 2002</td>
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<tr>
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<td>Al-Mekhlafi et al, 2006</td>
</tr>
<tr>
<td>2007</td>
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<td>292</td>
<td>Children</td>
<td>67.8 95.5 13.4 100</td>
<td>Al-Mekhlafi et al, 2007</td>
</tr>
<tr>
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<td>Rural/aboriginal</td>
<td>74</td>
<td>All ages</td>
<td>25.7 31.1 8.1 59.5</td>
<td>Hakim et al, 2007</td>
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</table>
society, especially among the Orang Asli (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 underprivileged 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 (Khairul 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,
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 undernutrition 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 the 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
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a threat to the community (Rajeswari et al, 1994). Therefore, this problem 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 Organisation 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.
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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