CHAPTER V

DISCUSSION

Intestinal parasitic infections (IPI) remain major public health problems worldwide particularly among rural children in developing countries. In Malaysia, previous studies carried out among rural communities showed that soil-transmitted helminthiases or STH infections namely trichuriasis, ascariasis and hookworm infections are highly prevalent (Norhayati *et al.,* 1997a; Al-Mekhlafi *et al.,* 2007; Ahmed *et al.,* 2011; Ngui *et al.,* 2011; Anuar *et al.,* 2012; Nasr *et al.,* 2013a). These infections have been considered as the most common infections of humankind and classified among the most prevalent neglected tropical diseases (NTDs) as they persist exclusively in the underprivileged communities in remote, rural areas, urban slums or in conflict zones and refugees, and have been largely eliminated elsewhere and thus are often forgotten (Hotez *et al.,* 2009a).

5.1 PREVALENCE AND DISTRIBUTION OF STH

The baseline findings of the present study showed that almost all (490/498) of the children who participated were positive for at least one parasite species with *Trichuris* infection being the most common IPI in these children followed by *Ascaris* and *Giardia* infections. The overall prevalence of trichuriasis, ascariasis and hookworm infections were 95.6%, 47.8% and 27.9%, respectively. These findings are in agreement with

many previous studies conducted among Orang Asli children. Several studies conducted among Orang Asli demonstrated high prevalence rates of ascariasis, trichuriasis and hookworm infections, where the prevalence ranges between 30.2 – 69.0%, 15.8 – 100% and 6 – 51.0%, respectively (Sinniah *et al.*, 1978; Kan, 1982; Norhayati *et al.*, 1997a; Al-Mekhlafi *et al.*, 2006; Al-Mekhlafi *et al.*, 2007; Ahmed *et al.*, 2011; Ngui *et al.*, 2011; Nasr *et al.*, 2013a). The findings of the present study also showed that 28.3%, 14.1% and 5.2% of the children were infected with *Giardia*, *Entamoeba* and *Cryptosporidium* which are consistent with the findings of previous reports (Anuar *et al.*, 2012; Al-Mekhlafi *et al.*, 2010; Al-Mekhlafi *et al.*, 2013).

The present study also showed that almost two-thirds and half of the trichuriasis, and ascariasis, respectively, were of moderate-to-heavy intensities and this level of worm burden is associated with the negative consequences by these infections (Ahmed *et al.*, 2011; WHO, 2006). Since 1920s, the high prevalence of these infections remained largely unchanged among Orang Asli and rural populations in Malaysia (Lim *et al.*, 2009). However, a great reduction of these infections was reported in urban areas (Jamaiah and Rohela, 2005). This unchanged trend was found to be closely associated with contaminated environment and poor personal hygiene practices. Moreover, the re-infection rate of STH after effective treatment was found to be very high and occurs rapidly, and this reveals continuous exposure to the sources of infections in these communities (Norhayati *et al.*, 1997b; Al-Mekhlafi *et al.*, 2008b).

Among Orang Asli school children, moderate-to-heavy STH infections have been found to be associated significantly with malnutrition, IDA, VAD, poor cognitive functions, high rate of school absenteeism and poor school performance (Al-Mekhlafi *et al.*, 2005a; Lim *et al.*, 2009; Al-Mekhlafi *et al.*, 2010; Ahmed *et al.*, 2012; Ngui *et al.*, 2012; Al-Mekhlafi *et al.*, 2013). Thereby, this high rate of STH infections will increase the burden of these negative consequences contributing to the overall backwardness,

poverty and low productivity of Orang Asli population. It has been reported that heavy ascariasis are often associated with kwashiorkor, stunting growth and a hypovitaminoses (Neva and Brown, 1996). Similarly, heavy infection of hookworms particularly by *A. duodenale* is known to drain nearly 50 ml of blood per day thereby decreasing the blood cell count, hemoglobin and serum proteins (Nallam and Gnanamani, 1998). Moreover, *T. trichiura* invades the mucosa of the colon, causing bleeding and dysentery and may cause rectal prolapsed in chronic cases (Stephenson *et al.*, 2000).

According to the WHO, endemic communities for STH infections are classified into three transmission categories (I: high, II: medium and III: low) for the adoption of treatment strategy in preventive chemotherapy (WHO, 2012; Hotez *et al.*, 2008). The findings of the present study showed that this area and most probably all Orang Asli areas in Peninsular Malaysia fall within the first category (high risk), with STH prevalence of more than 50% and more than 10% of the infections being of heavy intensity. Hence, these findings call for urgent integrated interventions to protect Orang Asli children from the negative consequences of STH infections.

With regard to the type of infections, the present study showed that the majority of the infected children had polyparasitism (71.4%) while only 28.6% had monoparasitism. The findings further revealed that almost half and a quarter of the polyparasitism were concurrent infections with 2 and 3 parasite species, respectively. These findings clearly revealed that the Orang Asli environment is heavily contaminated with the parasites. Interestingly, 5.4% of the polyparasitized children were infected by 5 different parasite species (mainly the 3 STH species, *Giardia* and *Entamoeba*). Similar findings were reported among Kenyan school children with the inclusion of *Schistosoma mansoni* infections (Brooker *et al.*, 2000). A much higher prevalence of polyparasitism was reported among 500 participants in western Côte

d'Ivoire (Raso *et al.,* 2004). The study revealed that three quarters of the studied population harbored at least three parasites concurrently, including high prevalence rate of many intestinal commensals such as *Entamoeba coli, Blastocystis hominis, Entamoeba hartmanni, Iodamoeba butschlii, Chilomastix mesnili* and *Endolimax nana* and this could explain the very high polyparasitism rate among this population. Investigating polyparasitism status including protozoan infections was done by this study in order to evaluate the general intestinal parasitic infections among the studied children which may indicate their hygiene and the surrounding environment.

In the present study, high prevalence of *Blastocystis sp.* and other intestinal commensals were reported. However, the pathogenicity of *Blastocystis* is still controversial and numerous clinical and epidemiological studies concluded that *Blastocystis* is a commensal organism and probably is not responsible for clinical symptoms (Scanlan and Stensvold, 2013; Tan *et al.*, 2010). Hence, only pathogenic parasites of public health significance were considered in the statistical analysis in order to conclude useful findings and important implications about the polyparasitism.

The findings of the current study showed that *Trichuris* and *Ascaris* co-infection was the highest (54.0%) and this could be attributed to their common transmission pattern (ingestion of infective eggs), and could be favored by behavioral factors. Similar findings were reported among Orang Asli in earlier studies (Al-Mekhlafi *et al.,* 2006). A previous study suggested a clustering of *Ascaris* and *Trichuris* infections within households in endemic areas (Forrester *et al.*, 1988). Similarly, co-infection with *Trichuris* and *Giardia* was reported among almost one quarter of the poliparasitized children. *Trichuris*, *Ascaris* and hookworm infections were the most common triple infections (18.6%) followed by *Trichuris*, *Ascaris* and *Giardia* infections (13.9%).

This is an important finding since it implies that individuals with polyparasitism may also suffer multiple morbidities due to each parasite species infection. It is also

suggested that individuals with multiple species infections are likely to be at highest risk of significant morbidity due to the number of parasite species they harbor and intensity of each infection (Booth *et al.,* 1998). Polyparasitism was found to be significantly associated with underweight and stunting among school-age children from rural communities in Honduras (Sanchez *et al.,* 2013). A previous study among children in Senegal reported that the number of severe malaria attacks was significantly higher in children when prevalence of *Ascaris* was high (Le Hesran *et al.,* 2004). Moreover, it was reported that cognitive functions and school performance among school children from South Africa are related to polyparasitism with children harboring multiple parasite species having poorer school performance than those uninfected or infected with a single species (Kvalsvig *et al.,* 1991).

The results also showed that *Ascaris* infection was significantly higher among children aged below 10 years compared to those aged ≥ 10 years and this could be attributed to the higher susceptibility of young children. Similar findings were reported among rural populations in Malaysia and elsewhere (Al-Mekhlafi *et al.,* 2007; Naish *et al.,* 2004; Raso *et al.,* 2004). Likewise, a recent study among Orang Asli found a higher prevalence of STH infections among participants aged less than 15 years compared to older participants (Anuar *et al.,* 2014). Similarly, the prevalence of intestinal parasitic infections was significantly higher among Orang Asli people aged below 13 years compared to those aged ≥ 13 years (Ngui *et al.,* 2011). Young children were always reported having poor personal hygiene including geophagia/pica (habit of eating soil/dirt) and these make them at higher exposure to the source of infections then elder children (Glickman *et al.,* 1999; Luoba *et al.,* 2005). The prevalence of hookworm was reported be increase over age (Chan *et al,* 1992; Bundy *et al,* 1988a). However, such finding was not reported by the present study. A previous study among Orang Asli children found that school-age children had significantly higher prevalence of

hookworm compared to preschool children (Nasr *et al.,* 2013a). On the other hand the prevalence of trichuriasis was found to be similar among both age groups. This is due to the very high prevalence of trichuriasis, almost all children were infected. Moreover, the results showed that the age-associated pattern of STH infections prevalence was almost similar among boys and girls. Similar findings were reported in all previous studies among Orang Asli children in Selangor and Pahang (Anuar *et al.,* 2014; Nasr *et al.,* 2013a; Ahmed *et al.,* 2011; Al-Mekhlafi *et al.,* 2006; Norhayati *et al.,* 1997a). This may indicate that both males and females are homogenous in terms of exposure to the source of infections. While aggregation of helminth infections was observed among these children, similar pattern was also noted with intestinal protozoa infections. With regard to all six infections reported by the present study, parasite aggregation (number of parasites species present in each individual) was higher among the 9-year-old children than among the older children. Similar findings were reported elsewhere (Matthys *et al.,* 2011; Naish *et al.,* 2004).

5.2 POTENTIAL RISK FACTORS OF STH INFECTIONS

Investigating the potential risk factors of STH infections among these children revealed significant associations between the high prevalence of STH infections and age of children (< 10 years), presence of infected family member, lacking proper toilets and/or safe water supplies in the households, washing hands before eating, washing vegetables before consumption, cutting nails periodically, and wearing shoes when going outside. These risk factors are discussed collectively as some of them were significantly associated with one or two species but not with the others and this was due to the different modes of transmission and different prevalence rates as well.

The findings of the present study showed that STH infections was more likely to occur in children living in houses without functioning toilets and/or safe piped water

supply. Recent studies among Orang Asli communities reported that absence of functioning toilet in the house and using untreated drinking water were significant risk factors of STH infections among Orang Asli children in Lipis and Raub districts, Pahang (Nasr *et al.,* 2013a; Ahmed *et al.,* 2011). Similarly, a recent study identified using unsafe drinking water as a significant risk factor of intestinal parasitic infections among Orang Asli and other rural populations in Malaysia (Ngui *et al.,* 2011). Moreover, *Giardia* infection was significantly higher among Orang Asli people who used unsafe drinking water (Anuar *et al.,* 2012). Similar findings were also reported by previous studies in different countries (Rai *et al.,* 2000; Belyhun *et al.,* 2010; Mahdy *et al.,* 2008; Gunawardena *et al.,* 2011). In Malaysia, Orang Asli people prefer to live close to rivers which are considered essential for Orang Asli life. They collect water from the rivers for different purposes including cooking and drinking. Moreover, rivers are also their preferred site for defecation especially among children (Al-Mekhlafi *et al.,* 2007). Thus, water collected from the rivers is always likely to be contaminated with different parasite species and considered a source of infection.

Lack of functioning toilets is the main cause of open defecation which is among the major factors for helminth transmission as this lead to environmental contamination with eggs of the helminths (Schmidlin *et al.,* 2013; Ngui *et al.,* 2011; Al-Mekhlafi *et al.,* 2008b). This coupled with lack of health education and poor personal hygiene aggravates the spread of infections (Schmidlin *et al.,* 2013; Bethony *et al.,* 2006; Chan, 1997). Hence, providing proper and adequate sanitation is crucial for any effective STH control programme. In the same vein, the findings of the present study also revealed significant association between the high prevalence of hookworm and moderate-to-heavy trichuriasis and the open or indiscriminate defecation practice among these children. Similar findings were reported among Orang Asli and other rural populations in Malaysia (Anuar *et al.,* 2014; Nasr *et al.,* 2013a; Ngui *et al.,* 2011). However, the

significant association was not retained by the multivariate analysis, and this could be attributed to the high percentage of children who practiced indiscriminate defecation (67.5%). During sampling and questionnaire survey, children observed defecating in the rivers, besides houses and at play grounds and this practice plays a crucial role in the persistence of STH infections in these communities. Although the government has provided new houses for many Orang Asli families in the study area with toilet facilities, but Orang Asli people use these toilets as store rooms and continue open defecation practices. During the questionnaire survey, it was found that these people did not have knowledge about the importance of using toilets and stop open defecation in controlling helminth infections. Moreover, many of them revealed that having the toilets inside the houses is against their cultural beliefs. Hence, this issue should receive proper attention from the policy makers and health authorities in order to provide alternative ways to install toilets in these communities. It is important that this is carried out according to the preference of the Orang Asli communities.

The present study also identified the presence of a family member infected with STH as a significant risk factor of STH infections. This may indicate the high transmission occurring within the family as any family member may contract the infection and then serve as a source of infection. Previous studies showed similar associations with *Giardia* and *Entamoeba* infections among Orang Asli people (Anuar *et al.*, 2012; Shahrul Anuar *et al.*, 2012). However, there has been no previous study in Malaysia which considered this variable when investigating the associated factors with STH infections. This point is of great importance as it supported the recent suggestion that school-based deworming is not effective to curtail the transmission and morbidity of STH infections in endemic communities (Truscott *et al.*, 2014**).** Hence, distribution of anthelmintic drugs should also be extended to cover the preschool children and adult

members or otherwise these infected members will continue their role as a source of re-infections to the previously treated children.

With regard to personal hygiene practices, the present study showed that not washing hands before eating, not cutting nails periodically, walking barefooted and not washing vegetables before consumption were the significant risk factors of STH infections among these children. Previous studies among Orang Asli population reported these poor personal hygiene variables as risk factors for STH (Nasr *et al.,* 2013a; Ahmed *et al.,* 2011; Ngui *et al.,* 2011; Al-Mekhlafi *et al.,* 2007). These findings are also consistent with previous reports among children from different countries (Schmidlin *et al.,* 2013; Knopp *et al.,* 2010; Fung and Cairncross, 2009; Ekpo *et al.,* 2008). The infective stages could be transmitted to humans by ingestion of the eggs/cysts/oocysts from contaminated food, hands or nails or skin penetration by the larvae. In the same vein, indiscriminate or open defecation around the house and play grounds, and using human/animal fecal materials as fertilizers in these communities may also enhance the contamination of the environment and the spread of the source of infection, thereby increase the chances of infection and re-infection with STH and other intestinal parasites. The eggs, larvae, cysts, and oocysts of intestinal parasites can remain viable and infective in the environment (soil/water) for a long period of time.

The present study also revealed a significant association between STH infections and not washing fruits and/or vegetables before eating. The multivariable logistic regression model confirmed that not washing vegetables before eating is a significant risk factor while the association with not washing fruits was not retained. The significant association by univariate analysis could be attributed to the effect of confounders which then was controlled in the multivariate analysis. These findings are in accordance with findings of some other studies from Tanzania and Kyrgyzstan (Knopp *et al.,* 2010; Steinmann *et al.,* 2010). A recent study among three different

Orang Asli tribes identified eating raw fruits as a significant risk factor of STH infections (Anuar *et al.,* 2014). Most of the fruits in these communities are tropical peeled fruits like rambutan (*Nephelium lappaceum*), langsat (*Lansium domesticum*), longan (*Dimocarpus longan*), mangosteen (*Garcinia mangostana*), and durian (*Bombaceae durio zibethinus*). However, it was noted that children collected the dropped fruits (rambutan, langsat, longan) from the ground and opened the soft shell with their teeth directly without washing or may even eat the fruits (durian) using their dirty hands. Thus, fruits could be contaminated with the parasites either from the contaminated ground or from the contaminated hands. Similarly, eating fresh fruits was found to be associated with a higher risk of giardiasis among Orang Asli children (Mohammed Mahdy *et al.,* 2009).

The findings of the present study showed that walking barefooted was a significant risk factor of STH infections (hookworm infection and trichuriasis) among the studied children. This is of direct explanation with hookworm infection as it occurs via skin penetration by hookworm filariform larvae. Eggs of *Trichuris* can remain infective in the environment for a very long period of time and could easily get picked-up on the children's feet when walking or playing barefooted in such heavily contaminated environment and carried these eggs into their houses. Similar significant associations were reported among Orang Asli children by earlier reports (Nasr *et al.,* 2013a; Ahmed *et al.,* 2011). Walking barefooted when outside the house has been identified in previous studies conducted in other countries (Heukelbach *et al.,* 2008; Pullan *et al.,* 2010; Luoba *et al.,* 2005; Rai *et al.,* 2000).

Based on the PARF results, the findings of the present study showed that more than half (54.5%) of the STH infections cases could be reduced through the children practicing good standards of personal hygiene, while providing toilet facilities and better provisions of safe drinking water will help to reduce infections by 26.1% of the

cases. Similarly, when the PARF was calculated for polyparasitism, the results showed that about half (50.3%) of the polyparasitism cases could be reduced if these children had good standards of personal hygiene while providing toilets and safe drinking water will help in reducing 13.5% and 12.1% of the cases, respectively.

The results of the present study also showed significant associations between STH infections and mothers' educational level, parents' employment status, household monthly income, washing hands after defecation among the children studied; however, these associations were not retained by the logistic regression model. Again this could be attributed to the effect of confounders which was controlled in the multivariate analysis. These factors have been identified as significant risk factors of STH and other intestinal parasites among children in different countries (Anuar *et al.,* 2014; Schmidlin *et al.,* 2013; Anuar *et al.,* 2012; Gunawardena *et al.,* 2011; Al-Mekhlafi *et al.,* 2007).

5.3 KAP ON STH INFECTIONS AT BASELINE

The present results show that knowledge about intestinal helminths among the participants was generally poor with low awareness about the symptoms, ways of transmission and preventive measures. The present study showed that 79.9% of the participants had prior knowledge on intestinal worms as they mentioned that they have heard about the intestinal worms. This is in accordance with the only previous study on the KAP of Orang Asli towards STH conducted in 2010 and found that 61.4% of the participants had heard about the intestinal worms (Nasr *et al.,* 2013b). Similar findings were reported in western Cote d'Ivoire as more than 50% of the respondents indicated being aware of the intestinal worms (Acka *et al.,* 2010). Moreover, the percentage of people with prior knowledge on intestinal worms was found to be higher among two communities in Rio de Janeiro, Brazil (de Moraes *et al.,* 2010). On the other hand, a previous study among Zimbabwean children showed that only a quarter (26.2%) of

them indicated a prior knowledge on intestinal helminthic infections (Midzi *et al.*, 2011).

This current study showed that almost one third of those who had heard about the intestinal worms did not remember the source of information whilst 27.6% indicated that the main source of their information about worms was the health clinics. On the other hand, only six participants (2.9%) heard about the worms from the school. These findings revealed the poor role of the school towards disseminating information of the most common health problem of these communities. With regard to the types of intestinal helminths they might know, 15.8% of the respondents mentioned pinworm and 11.3% mentioned roundworms. This could be attributed to the possibility of seeing the adult worms of these species as the pinworm is always reported among young children and its adult worms could be noticed on the perianal area. Moreover, *Ascaris* adult worm could be expelled out in the faeces of infected children. Interestingly, one of the respondents indicated the passing of the adult worm from the mouth as a sign of infection and this sign has been reported elsewhere in heavy ascariasis (Margery and Niang, 2011).

Lack of knowledge on the signs and symptoms of intestinal helminthic infections among these people was obvious. Only 47.2% of them were able to mention at least one symptom, mainly abdominal pain and diarrhea. These are in agreement with the recent results among Orang Asli people where only 29.3% of the respondents were able to mention at least one symptom of intestinal helminthic infections (Nasr *et al.*, 2013b). Usually these signs and symptoms are known by people and some can be identified by the naked eyes but the issue is to associate them to the helminth infections. However, complications such as poor educational performance, high poor cognitive functions, rectal prolapse, growth retardation, micronutrients deficiencies, and other symptoms are difficult to be recognized by the children or their parents.

The findings also showed poor knowledge on the transmission of intestinal worms as about one third (36.1%) of the respondents have knowledge about at least one way of transmission, mainly contaminated food and dirty hands. These are consistent with the earlier findings reported among Orang Asli communities and rural Bangladesh (Nasr *et al.,* 2013b; Mascie-Tylor *et al.,* 2003). With regard to preventive measures, only 39.5% of the respondents had knowledge about how to prevent themselves from intestinal helminth infections, mainly taking deworming drugs and washing hands before eating. However, a recent study in Zimbabwe showed that only 5.8% of the respondents knew the correct measures to prevent themselves from STH (Midzi *et al.,* 2011).

The present study showed that 53.3% of the respondents considered intestinal worms as harmful to people's health. This finding contradicts the finding reported in Brazil, where majority of respondents knew that intestinal helminths including STH have harmful effect on their health (de Moraes *et al.,* 2010). This controversy may be explained by the lack of health education intervention by the clinic and school in the Orang Asli areas. With regard to practices, the findings showed that indiscriminate defecation was common in these communities and only half of the children wear shoes when going outside the houses and wash vegetables/fruits before consumption. On the other hand, only about one third practiced hand washing before eating and after defecation with only 19.3% of them wash their hands with soap. These findings indicated that the personal hygiene practices are poor among this population. Similar findings were reported in Orang Asli communities and in other countries (Nasr *et al.,* 2013b; Midzi *et al.,* 2011). In general, these findings about poor knowledge and unhygienic practices can explain the alarmingly high prevalence of STH infections among Orang Asli children. Improving the awareness of the target population towards

SHT infections is fundamental in order to implement an effective control programme and to ensure community mobilization which is crucial to achieve the desired success.

5.4 DEVELOPMENT AND EVALUATION OF HELP

Health education that is effective, focused and simple is often recommended as a first option to create the enabling environment for other strategies to thrive, especially in disadvantaged and rural communities (Ekeh and Adeniyi, 1988). With regard to STH infections, periodic mass chemotherapy has successfully reduced the morbidity of infections, but the continued potentials for the emergence of anthelminthic drug resistance by STHs, coupled with high rates of re-infection and the declining effectiveness with repeated anthelmintic drugs further threatens the sustainability of mass chemotherapy as the main option of STH control (WHO, 2011; Hotez *et al.*, 2006a). Similarly, improved sanitation has significantly contributed to the elimination of these infections by reducing the environmental sources of infections. However, the high cost and slow impact of sanitation on STH infections have limited its implementation in many communities with limited resources (Asaolu and Ofoezie, 2003). Without health education on the good personal hygiene practices, STH infections will persist in the endemic areas. It was also concluded that health education and sanitation are the options of choice not only for justifying intestinal helminth infections but also for sustaining the control outcome of other intervention programmes (Esrey *et al.*, 1991).

Although the high prevalence of STH infections remained largely unchanged among Orang Asli communities, there have been no previous intervention studies against these infections. The government has done intensive efforts to improve the quality of life of Orang Asli population throughout Peninsular Malaysia. These efforts

include the relocation of these people to settlements at the towns' periphery and building new or restored houses to those who prefer and insist to live in jungles.

In the present study, a health education package was developed based on a few models and theories on health behavior and health promotion mainly the Health Belief Model and PRECEDE-PROCEED Model. The developed package focused on providing information about the hygienic practices related to intestinal parasitic infections including STH. Based on the process of risk factors investigation, it was found that most of the risk factors of STH infections among Orang Asli communities were related to the poor personal hygiene practices. Although new houses provided by the government to these people contain proper water flush toilets, Orang Asli people use toilets as store rooms and prefer to continue their open defecation practice. This is due to a cultural belief that toilets should not be inside the houses, and also the lack of knowledge about the importance of sanitation in diseases prevention. An important point that was considered by HELP was that besides provision of health messages on hygienic practices, an aid kit was distributed to each child. The kit consists of a pair of slippers, hand soap and nail clipper. This was to help the children and their families to practice what they have learned throughout the study activities.

It is well documented that the prevalence of STH infections are significantly higher among school children than other groups (Pullan *et al.*, 2014; Nasr *et al.*, 2013a). Hence, HELP was developed as a school-based package with special considerations for the role of children as "health agents" or "health educators" to their families and the entire community. The package was designed to provide information on the STH including types of helminths, transmission, signs and symptoms and prevention. This was done by different means and activities including workshop for teachers, posters, comic book, music videos, puppet show, drawing activity and aid kit with proper follow-ups. These activities covered nine important health messages on personal

hygiene practices. In general, providing information on specific diseases and the possible and applicable preventive measures usually results in an increase in knowledge and awareness of the targeted population towards these diseases (Gyorkos *et al.,* 2013). Health educational materials (posters, leaflets, puppets and theatre, radio and video music and messages) with some practical activities on good personal hygiene practices have been successfully used to provide and disseminate health-related messages (Gyorkos *et al.,* 2013; Mascarini-Serra, 2011; Albonico *et al.,* 1996).

This present study examined the impact of the developed package (HELP) on the incidence and intensity of STH infections, and on the STH-related knowledge of teachers and Orang Asli people. After complete deworming of infected children in both schools (intervention and control), HELP was introduced to children according to a previous working plan and the status of STH infections in both schools was followed up for 6 months. The package was well-received with effective contribution and interests from teachers, children and their parents. The findings of the present study showed that HELP significantly reduced the incidence of hookworm infections and this may be explained by the distribution of slippers to the targeted children. Previous studies have found minimal and no significant effect for health education components on hookworm infections (Gyorkos *et al.,* 2013; Brooker *et al.,* 2004). This failure by previous studies could be explained by the poverty factor which prevents the parents from buying shoes or suitable slippers for their children (especially among big families) and therefore could not protect them from acquiring hookworm infections (Bird *et al.,* 2014).

In the underprivileged communities, several barriers to wearing shoes include the limited financial resources that made people neither able to purchase more than one pair of shoes nor afford shoes to all family members which may constrain on anticipated benefit of health education interventions (Mascarini-Serra, 2011; Ayode *et al.,* 2013). Similarly, it was observed that most of Orang Asli children walked and played

barefooted. When investigated, it was found that most of these children had only school shoes and their parents did not allow them to use these shoes at villages. HELP's aid kit contained slippers, hand soap and nail clipper in order to help these people to practice what they have learned from HELP interventions. Although the prevalence of *Ascaris* (at 4 months onwards) and *Trichuris* infections were lower among children from the intervention school compared to those from the control school, the differences were not statistically significant. This could be due to the easier mode of transmission by these parasites (ingestion of infective eggs in contaminated food or water, or transmitted from contaminated fingers) when compared with hookworm. In such a heavily contaminated environment, it seemed that acquiring these infections can hardly be avoided. Interestingly, HELP was also found to be effective in reducing *Giardia* and *Entamoeba* infections and this indicated the importance of health education in improving the personal hygiene and therefore reducing intestinal parasitic infections.

With regard to the intensity of infection, the results of the present study revealed that HELP was successful at reducing the intensity of STH infections. After 6 months, the intensity of hookworm infection and ascariasis were reduced by 70.0% and 43.4%, respectively among intervention group compared to only 10.2% and 5.6%, respectively among control group. A smaller but significant reduction was reported with trichuriasis; 38.7% among intervention group compared to 19.3% among control group. Based on the population attributable risk fraction (PARF) calculated for these population, the findings of the present study showed that more than half (54.5%) of the STH infections cases could be reduced if these children had good standards of personal hygiene while providing toilet facilities and provision of safe drinking water will help in reducing 26.1% of the cases. Although HELP did not show significant impact on the incidence of trichuriasis, but its significant impact on the intensity is consistent with the control strategy of the WHO which aimed to curtail the transmission dynamics and reduce the

worm burden of these infections (elimination of morbidity not parasites) as the eradication of STH proved to be not possible in these communities (Ahmed *et al.,* 2011; WHO, 2012).

Hence, the third arm of the STH control programme, the sanitation, is crucial in this situation. As most STH endemic communities are from underprivileged areas with very poor sanitation, it is most likely that people cannot afford shoes to wear, do not have access to treated drinking water or clean water to wash their hands, and live in environments with inadequate sanitary facilities. Hence, education should address alternative feasible preventive measures that are sustainable in the context of resource-limited settings. The availability of water, sanitation, and hygiene (WASH) is essential for a long-term and sustained control and elimination of STH (Campbell *et al.,* 2014; Strunz *et al.,* 2014). WASH involves a safe water supply, proper and adequate sanitation infrastructure that ensures safe disposal of human excreta, and the promotion of good personal and household hygiene practices (such as hand washing before eating and/or after defecation, use of soap, wearing shoes when outside, washing vegetables/fruits before consumption, etc). Interventions that include WASH have been shown to be highly effective in reducing the environmental contamination and curtail the transmission of STH (Esrey *et al.,* 1991). However, many challenges limit the implementation of WASH especially in rural areas of developing countries. These challenges include the high cost, lack of local government involvement, lack of advocacy and lack of perception among rural populations of the importance of improved sanitation (Cairncross, 2003; Cairncross and Valdmanis, 2006).

Previous studies showed that sanitation, with or without health and hygiene education, reduces the prevalence and intensity of STH infections, the impact of which was further improved when combined with deworming (Asaolu and Ofoezie, 2003; Hawdon, 2014). However, improving sanitation in highly endemic communities may

not attain the desired impact without a parallel improvement in hygiene and health-related behaviors amongst the targeted population (Sow *et al.,* 2004). For instance, a previous study found that the introduction of latrines into a rural and underprivileged community only reduced the prevalence of hookworm infection by four percent (Huttly, 1990). Likewise, another study in Salvador, Brazil found that improved drainage and sewerage had only minimal impact on the prevalence and no impact at all on the intensity of hookworm infections (de Moraes *et al.,* 2004).

In Malaysia, the government has made intensive efforts to improve the quality of life of indigenous people throughout the country, with their main strategy being to relocate those living in remote areas to new settlements at the periphery of towns. This strategy proved successful among indigenous people in East Malaysia (Sabah and Sarawaka) while the adherence of the Orang Asli people in Peninsular Malaysia (West Malaysia) to their jungle habitats has constrained the efforts to improve their quality of life. According to the annual report of the Ministry of Rural and Regional Development, hundreds of houses were built or restored for Orang Asli people in Peninsular Malaysia, 759 households were provided with 24-hour electricity and 600 households were provided with treated water supply (MRRD, 2010). In the present study, it was observed that the new houses provided by the government to these people were not fully occupied. Upon investigation, it became apparent that people in these communities preferred to live in their old houses made of bamboo. Many of those who did move in to the new homes chose to use their toilets as storage rooms due to cultural beliefs that toilets should not be located inside the house and also the lack of knowledge about the impact of toilets (APPENDIX B). Moreover, many respondents mentioned the high temperature inside the new houses which were built of bricks and concrete compared to their old bamboo houses which are cooler. Furthermore, the new houses are built on the ground which is not suitable during rainy season while the old houses are raised on stilts

with wooden or bamboo walls and adapted to their own needs, culture and equatorial environment.

Few studies have previously investigated the impact of health education intervention on STH prevalence rates and intensities (Gyorkos *et al.*, 2013). A previous study among school children in rural China investigated the effectiveness of health education intervention for one year against helminth infections and revealed remarkable improvements in students' knowledge, behavior and skills of protective measures, in school physical environment and in school/community relationship among experiment schools compared to control schools (Long-Shan *et al.*, 2000).

Previously, a national project was carried out in Seychelles over a two year period with the aim being to increase public awareness and provide information about IPI control using printed materials (newspapers, posters, leaflets) and electronic media (radio, television, audiovisual aids) (Albonico *et al.*, 1996). These include a video film produced by the control programme and the WHO and a leaflet on the prevention and control of IPI. The project achieved a 44% reduction in the prevalence of IPI, whilst the intensity of *Trichuris* infection, the predominant parasite, was reduced by 50% (from 780 to 370 eggs per g of faeces). The Republic of Seychelles is a small country (459 km^2) with a population of 88,303, the smallest population of any African state and this is an advantage to implement such programme at the national level. Similarly, another study showed significant reduction in both the frequency and intensity of *Ascaris* and *Trichuris* infections among elementary school children in Central Java in which the children were dewormed and provided with 6-7 months of behavioral remedial instruction which involved community meetings, songs and posters (Albright and Basaric-Keys, 2006).

A recent study has evaluated the impact of a school-based health hygiene education on STH re-infection after four months of treatment among 18 primary schools

of the Peruvian Amazon (Gyorkos *et al.*, 2013). The study found that the intervention was effective and significantly increased the knowledge towards intestinal helminth and water treatment behaviors, but not in most other hygiene practices (e.g., handwashing). The study also showed a significant reduction in *Ascaris* infections intensity among children from intervention schools compared with children from control schools. However, the results also showed no significant difference in *Trichuris* and hookworm infections between both groups. The health education of this study consisted of two components; one-hour classroom activity to describe STH transmission and prevention with aid of a 32-page booklet on STH, and a half-day workshop for teachers and school principals on how to develop innovative ways to help children improve their personal hygiene and how to prevent STH infections. Subsequently, 30-minute refresher activities were conducted every two weeks over four months.

Interestingly, a recent study among Chinese children reported that the incidence of STH infections proved to be 50% lower in the intervention group than in the control group (Bieri *et al.*, 2013). The intervention group received a health education package which involved a teacher-training workshop, as well as a cartoon based video followed by a 10-15 minutes classroom discussion at which pamphlets and posters were handed out to the children, supplemented with drawing and essay competitions, compared to the control group who only received posters. However, the impact of this package on the incidence of hookworm infection was not evaluated due to the very low prevalence at the study area.

By contrast, a previous study in Jakarta, Indonesia found no significant difference in the prevalence of *Ascaris* infection between children who received health education intervention over the course of 5 months when compared to their counterparts in the control group (Hadidjaja *et al.*, 1998). Similarly, Aung *et al.*, (1988) found no significant impact for hand washing intervention among children in Rangoon, Burma.

This could be explained by the different health education packages used by these studies and also the lower prevalence rates of infections compared to the higher prevalence among Orang Asli and the comprehensive package used by the present study.

5.5 IMPACT OF HELP ON KNOWLEDGE ABOUT STH INFECTIONS

The present study further showed that HELP significantly improved the KAP of Orang Asli people towards STH infections. The distance between the 2 schools (SKKK and SKPB) is about 50 km; therefore, interactions between students and teachers were not possible. At the 3 months assessment point, a significant percentage of respondents mentioned hookworms, the effects of STH on school performance, the role of flies in transmission, and washing vegetables before consumption as a preventive measure compared to none at the baseline assessment. Moreover, significant improvements were also reported with other variables (e.g. roundworms as example of STH, transmission by contaminated hands and walking barefooted, and prevention by wearing shoes when outside the house and washing hands before eating). These findings were in agreement with previous studies elsewhere (Bieri *et al.,* 2013; Gyorkos *et al.*, 2013). Bieri *et al.,* (2013) study which showed a significant impact in increasing the KAP among the intervention group. For instance, the rate of hand washing increased from 46.0% to 98.9% among the intervention group whilst remaining unchanged in the control group (from 54.0% to 54.2%). Similarly, almost twice as many intervention children (63.3%*vs* 33.4%) reported washing their hands after defecating.

The present study showed that the rates of hand washing before eating and after defecation, wearing shoes when outside and hand washing with soap were almost doubled among the intervention group compared to unchanged rates among the control group. Distributing the aid kit (slippers, soap and nail clippers) supported HELP and encouraged these people to practice what they have learned about. It was observed that

children wore their slippers while they were playing or walking outside, with a smaller (yet still significant) percentage of participants making good use of the distributed nail clippers and soaps. The quality of slippers distributed in the present study was not "closed footwear" and the upper surfaces of the feet were still exposed. This was due to the cost constrain as the closed footwear was expensive. However, the distributed slippers might contribute to the lower incidence of hookworm among these children. Likewise, Chen and Xu (2005) assessed a randomized intervention that promoted hand washing with soap, both before eating and after defecation among 657 school children in 4 counties in Xiao-wu City, China. The children were asked to wash hands with soap before meals, after defecation, after exercise or when their hands get dirty, and to keep a record of their hand washing. At the 1-year follow-up, a significant reduction in the prevalence of *Ascaris* infection was reported among children in the intervention group (from 68.3% to 43.9%) compared with an increase in the control group (from 41.4% to 73.7%). Furthermore, the knowledge of the teachers in the intervention school was significantly improved compared to control school. This was imperative to ensure effective contribution of teachers to follow-up HELP activities with the children.

The present study also focused on the role of children as educators or health messengers to extend the health messages and facts about STH to their families. It was observed that the children took this responsibility with great seriousness. During the visits to their villages, the children have always showed their commitment in wearing shoes, clipping nails and having the posters in their houses. Peer education has been successfully utilized in many health programmes that aim to reduce the prevalence of specific health problems. Many previous studies revealed significant impacts for school-based health education interventions which empowered school children to extend health messages and hygiene practices to their community children and adults. Such intervention has significantly improved the knowledge about the cause of malaria,

prevention, and bed net practices among adults in Ghana and subsequently contributed to the reduction of malaria prevalence (Ayi *et al.,* 2010). Likewise, a combined school and community health education project conducted in Tanzania found that school children preferred "learning by doing" and favored an approach where they played an active role as health change agents or messengers for health educational messages (Mwanga *et al.,* 2008). For example, a child-to-child (CTC) approach empowered children as active participants in their own development and the development of other children; e.g. their young siblings (Webb, 1988).

In Malaysia, there has been no health education programme on intestinal helminthic infections. However, a school-based health promotion programme called Doktor Muda (Young Doctor) Programme (DMP) was introduced in primary schools in 1989; in which a group of school children are motivated, trained and empowered to act as health agents to promote healthy lifestyles to their peers, families and their local community (Yusof and Jaafar, 2013). These children help in distributing health pamphlets, fixing health posters and organizing hand washing and tooth brushing exercises. Moreover, they also give health talks on personal (hand/body/hair/nails hygiene) and environmental hygiene (school environment and toilets), oral health, prevention of certain diseases (such as dengue and malaria), first aid, healthy nutrition and diet (healthy eating/breakfast/food premises), and healthy lifestyles (do not start smoking/exercise/weight watch). By 2013, there were 1860 schools participating in the DMP, with 49,610 trained school children throughout the country (JDC, 2014). The programme has proved to be practicable, effective and sustainable; although unfortunately it has not managed to become established within Orang Asli and other indigenous communities (Jaafar eta l. 2006; Yusof and Jaafar, 2013).

The participation of the community represents one of the cardinal tools of control programmes as improvements in the awareness and understanding can greatly

increase the realization and sustainability of long-term control strategies. A good example is the community-led total sanitation (CLTS), an innovative communications-based approach for mobilising communities towards ending open defecation and creating a clean and hygienic environment has been implemented in many countries in South Asia, Africa and Latin America (Mara *et al.*, 2010). In November 2013, UNICEF launched a nationwide campaign "*Poo2Loo"* against public defecation in India where about 594 million which is 48 percent of population in India practices open defecation. *Poo2Loo* is a social media campaign with the goal of increasing awareness of the negative effects of defecating in public in order to reduce the environment contamination with intestinal parasites (UNICEF, 2013).

5.6 PROS AND CONS OF HELP

This health education learning package (HELP) was developed and introduced to Orang Asli schoolchildren as the first health education programme among these indigenous populations. The package proved effective among these children, particularly in terms of reducing the morbidity of STH infections. The package may also be useful in controlling other intestinal parasites, as the health messages cover preventative messages that can also apply to such parasites. HELP messages are restricted to helping improve personal hygiene practices, while the other factors such as poverty and low levels of education require more direct intervention by the government. It is recommended that interventions such as providing provision of safe drinking water and providing toilets within rural households should be seriously considered by the government.

That said, the target population should also find alternative ways to help themselves and care for the health of their children. Such methods could include boiling drinking water before consumption, not defecating openly in the vicinity of house or

village living areas instead defecating over a green leaf and then burying the stool. School-based programmes could prove to be particularly cost effective, as schools already have an available and sustained infrastructure with a skilled workforce that has a close relationship with the schoolchildren and the community. Due to the cost-effectiveness of school-based implementation, HELP should cost as little as RM5 (1.5 USD) per child including the slippers, hand soap and nail clipper. This cost could be further reduced with bigger wholesale orders for HELP items. The main components of the package (posters, comic book, video songs and the puppets and theatre) can be produced extremely cheap to be used at the schools.

Besides HELP, the recommendation would be that anthelmintic drugs (albendazole tablets) should be distributed twice a year, at the beginning of school semesters. Such drugs are affordable, costing just a few cents, and often provided for free from different agencies as a donation to rural populations. The involvement of teachers in such a programme is perceived as being crucial in order to achieve the sustainability and efficiency of the control programme. HELP is a school-based package, therefore its activities may disturb other forms of schooling and may add a burden to the teachers. However, this could be overcome by improving and integrating the package into the overall curriculum and normal school activities. The benefits of school-based periodic deworming programmes are likely to be enhanced when a sustained health hygiene education intervention programme is integrated into school curricula. Nevertheless, fusing or integrating health education with other subjects such as science requires careful planning across subjects and levels. A good option would be for HELP to be integrated with the existing Doktor Muda programme, which would then be fully implemented in schools serving Orang Asli and other indigenous communities.