FACTORS ASSOCIATED WITH THE PREVALENCE OF *ASCARIS LUMBRICOIDES* INFECTION AMONG PRESCHOOL CHILDREN IN A PLANTATION COMMUNITY, KANDY DISTRICT, SRI LANKA

Lahiru Galgamuwa[1], Devika Iddawela[1] and Samath D Dharmaratne[2]

[1]Department of Parasitology, Faculty of Medicine, University of Peradeniya, Sri Lanka; [2]Department of Community Medicine, Faculty of Medicine, University of Peradeniya, Sri Lanka and Institute for Health Metrics and Evaluation, University of Washington, Seattle, Washington, USA

Abstract. Plantation living conditions in Sri Lanka are often poor. *Ascaris lumbricoides* infections are common among those living in plantations. We conducted a cross sectional study of children aged 1 - 6 years living on a plantation to determine the prevalence of ascariasis and factors associated with it in order to educate on prevention and to implement treatment programs. A total of 258 preschool children selected using a simple random sampling was included in the study conducted during January - April, 2013. Data regarding socio-demographic and hygienic habits were collected from heads of households via an interviewer administered structured questionnaire. Wet mount preparation, formaldehyde-ether sedimentation and Kato-Katz techniques were used to evaluate stool samples for *Ascaris* eggs. The overall prevalence of *Ascaris* infection among study subjects was 37.8%. On multivariate logistic regression analysis, factors significantly associated with *Ascaris* infections were: living in attached houses (p=0.035), shared toilet facilities (p=0.001), de-worming period more than three months (p<0.001), maternal education level (p<0.001) and living in the "Top" government administrative division (p=0.028) in the study area. Poor sanitation facilities and poor health education were important factors associated with *Ascaris* infections. A health education program promoting improved sanitary facilities and good hygiene is needed to reduce the prevalence of *Ascaris* infection in the study population.

Keywords: *Ascaris lumbricoides* infection, preschool children, plantation community, Sri Lanka

INTRODUCTION

The intestinal nematode *Ascaris lumbricoides* is responsible for human helminth infections globally (Bethony *et al*, 2006). The highest prevalence of this infection occurs in tropical countries where warm, wet climate enhances the transmission of the infection (De Silva *et al*, 1997a). Recent estimates suggest over a billion humans are infected with *Ascaris* infections (WHO, 2010). *Ascaris* infection is common among children aged 3 - 8 years (Xu *et al*, 1995). They often become infected by playing in contaminated soil, eating raw

Correspondence: Lahiru Galgamuwa, Department of Parasitology, Faculty of Medicine, University of Peradeniya, Sri Lanka.
Tel: +9407 10574688
E-mail: lahiruahs@yahoo.com

food grown in contaminated soil or drinking inadequately treated water (De Silva *et al,* 1997b). Although most of these children are asymptomatic, some infected children may develop malnutrition, stunted growth (Taren *et al,* 1987) and impaired cognitive function with low educational achievement (Dickson *et al,* 2000). The prevalence of *Ascaris* infection varies by country and even by area within a country due to varying geographic and climatic factors, socioeconomic conditions and healthcare infrastructures (WHO, 1981).

Over a million people in Sri Lanka reside on plantations (tea and rubber), where socio-economic conditions, sanitary facilities and access to education are poorer than the rest of the country (Fernando, 2000; World Bank, 2007). Soil transmitted helminth infections are associated with poverty (Liese *et al,* 2010). A survey carried out on a tea plantation in Sri Lanka, reported the prevalence of soil transmitted helminthes infection among children aged 2-12 years to be 90% (Sorensen *et al,* 1994). Several other surveys carried out on tea plantations in Sri Lanka found *A. lumbricoides* to be the most common helminthes infection among children (Sorensen *et al,* 1996; Gunawardena *et al,* 2004). Therefore, we conducted the present study to determine the prevalence of and factors associated with *Ascaris* infection among preschool children living on a tea plantation in Kandy District, Sri Lanka.

MATERIALS AND METHODS

Study area and population

The study was conducted on the Uduwela tea plantation (7° 11′- 7° 15′N and 80° 38′- 80° 39′E), Kandy District, Central Province, Sri Lanka. The area is located about 600-1,100 meters above sea level and covers about 2,000 hectares with an estimated population of 10,000 people. The annual rainfall of this area has a range of 2,000-2,500 mm and the temperature has a range of 15-27°C. The majority of the inhabitants work on tea plantations. The socio-economic status and the average educational status of the adult population are poor (DHS, 2007). People live in poor sanitary conditions in crowded housing. The study area consists of seven administrative divisions; 3 were chosen for the study: Factory Division, West Division and Top Division. We studied children aged 1-6 years old, randomly sampled. The estimated minimum sample size needed for significance in this study was 258, calculated by the formula $n=Z_{1-\alpha/2}{}^2p(1-p/d^2)$ using a previous estimated prevalence of *Ascaris lumbricoides* infection among children on tea plantations in Kandy District of 21.4% (Gunawardena *et al,* 2011) with 5% absolute precision and a 95% confidence interval.

Data collection

Data were collected during January-April, 2013. Written informed consent for each studied child was obtained from the head of the household where the child resided. An interviewer administered structured questionnaire was completed based on an interview with the head of house. The questionnaire asked about socio-demographic data, availability of sanitary facilities, parental education level, history of worm treatment, personal health habits and hygienic practices. Stool samples were collected by the heads of households from each study subject and kept in a clean specimen container labeled with an identification number. The specimens were kept at 4°C until examined at the Parasitology Laboratory, Faculty of Medicine, University of Peradeniya, Sri Lanka.

Laboratory investigations

The stool samples were concentrated using the formaldehyde-ether sedimentation technique and examined for the presence of *Ascaris* ova by direct wet mount using normal saline and Lugol's iodine solutions. Positive samples were then examined using the Kato-Katz quantitative technique. The intensity of infection was expressed as eggs per gram (epg) of feces and classed into three categories: light (<5,000 epg), moderate (5,000-49,999 epg) and heavy infection (≥50,000 epg) according to World Health Organization criteria (WHO, 2002).

Statistical analysis

Data were entered into Excel 2007 (Microsoft) and analyzed using SPSS, version 17.0 (SPSS, Chicago, IL). The Descriptive data were reported as means ± standard deviations (SD). Univariate statistical analysis was used to identify associations between dependent (presence of *Ascaris* infection) and independent variables (socio-demographic factors, behavioral characteristics, anthelminthic treatments and sanitary and living conditions). All independent variables significantly associated on univariant analysis were included on multivariate logistic regression analysis using forward elimination to identify factors associated with *Ascaris* infection in this study cohort. Odds ratios (OR) and 95% confidence intervals (CI) were calculated for all factors. A p - value < 0.05 was considered statistically significant.

Ethical considerations

This study was approved by the Ethics Review Committee (ERC), Faculty of Allied Health Sciences, University of Peradeniya, Sri Lanka. Permission to conduct this study was obtained from the relevant administrative authorities of the tea plantations.

RESULTS

Prevalence and intensity of *A. lumbricoides* infection

Of the 258 children recruited, 254 (98.4%) provided a stool sample. Fifty-two point eight percent of study subjects were female. The mean age of study subjects was 3.2±1.3 years. Ninety-six subjects (37.8%) had a stool sample positive for *Ascaris*. Females (39.6%) showed as slightly higher infection rate than male (35.9%). With regards to age groups, children aged 4-6 years had higher prevalence (42.4%) compare to children aged 1-3 years (33.8%). The mean intensity of infections was 7,178.5 (±10,573.6) (range 0-82,326) epg stools. Of those infected, 74% had a low intensity, 19.8% had a moderate intensity and 6.2% had a heavy intensity of infection. Female children (75.4%) had a slightly higher prevalence of light infections than male (72.1%) while in moderate and heavy conditions, males showed the higher prevalence than females. When considering the age groups, equal prevalence of light infections was seen among both age groups while moderate infections were more common in the 4-6 years age group and heavy infections were greater in children aged 1-3 years (Table 1).

Risk factors for *Ascaris* infection

Univariate logistic regression was used to determine the risk factors associated with *Ascaris* infections in relation to socio-demographic and hygienic practices among this pre-school community. Nine factors were identified as associated with *Ascaris* infections: living in attached houses (OR = 3.13; 95% CI: 1.39-7.07, p = 0.006), shared toilet facilities (OR = 2.37; 95% CI: 1.41-3.99, p = 0.001), last de-worming date 2-3 months back (OR = 6.77; 95% CI: 1.80-25.45, p = 0.005), de-worming longer than

Table 1
Intensities of infection with *Ascaris lumbricoides* among study subjects by gender and age groups.

Variable	Intensity of infection		
	Light No. (%)	Moderate No. (%)	Heavy No. (%)
Gender			
Male	31 (72.1)	9 (20.9)	3 (7.0)
Female	40 (75.4)	10 (18.9)	3 (5.7)
Age (years)			
1-3	34 (73.9)	8 (17.4)	4 (8.7)
4-6	37 (74.0)	11 (22.0)	2 (4.0)
Total	71 (74.0)	19 (19.8)	6 (6.2)

3 months (OR = 15.93; 95% CI: 4.69-54.14, $p < 0.001$) and never de-worming (OR = 11.20; 95% CI: 2.51-49.97, $p = 0.002$) were identified as risks factors. In addition, Mothers education level up to Ordinary Level (OR = 0.14; 95% CI: 0.07 - 0.25, $p < 0.001$) and up to Advanced Level (OR = 0.13; 95% CI: 0.04-0.37, $p < 0.001$), living in the 'Top' Division (OR = 0.34; 95% CI: 0.16-0.69, $p = 0.003$), and eating washed fruits (OR = 0.45; 95% CI: 0.24-0.84, $p = 0.015$) were identified as protective factors for *Ascaris* infection among preschool children in this community (Table 2). In addition, being a child aged 4-6 years, being a female, drinking boiled water, not sucking fingers, overcrowding, not washing hands with soap before a meal and after defecation every time and the low level of paternal education were associated with high rate of infection. However, none of these factors were found to be statistically significant with *Ascaris* infections in this community (Table 2).

Multivariate regression model further confirmed, living in attached houses were 4.5 times (95% CI: 1.09-11.11, $p = 0.035$), shared toilet facilities were 3.4 times (95% CI: 1.63-7.26, $p = 0.001$), last de-worming date 2-3 months back was 6.9 times (95% CI: 1.50-31.37, $p = 0.013$) and last de-worming date longer than 3 months were 23.8 times (95% CI: 6.01-94.53, $p < 0.001$) were likely to be associated with *Ascaris* infections in this community. In addition, mothers education level up to Ordinary Level (95% CI: 0.05-0.22, $p < 0.001$), up to Advanced Level (95% CI: 0.02-0.32, $p < 0.001$) and living in the 'Top' Division (95% CI: 0.12-0.89, $p = 0.028$) were identified as protective factors for *Ascaris* infection among preschool children in this community (Table 3).

DISCUSSION

There was a high prevalence of *Ascaris* infection among our study subjects (37.8%), similar to reports revealed that 38% among dwellers in a tea-growing community of Assam, India (Traub *et al*, 2004), 38.5% among dwellers in a rural community of West Malaysia (Ngui *et al*, 2011), 40.5% among children aged <6 years in Cuba (Escobedo *et al*, 2008) and 36.5% among children in the highlands of rural Ecuador (Jacobsen *et al*, 2007) were infected with *A. lumbricoides*. A follow-up study 10 years after mass anthelmintic

Table 2
Univariate analysis of socio-demographic and hygienic factors associated with *Ascaris* infections.

Variable	Number examined (%)	Number positives (%)	OR	95% CI	*p*-value
Age (years)					
1-3[a]	136 (53.5)	46 (33.8)	1		
4-6	118 (46.5)	50 (42.4)	1.43	0.86 - 2.39	0.162
Sex					
Male[a]	120 (47.2)	43 (35.8)	1		
Female	134 (52.8)	53 (39.6)	1.17	0.70 - 1.94	0.542
Study site					
Factory Division[a]	111 (43.7)	46 (41.4)	1		
West Division	76 (29.9)	37 (48.9)	1.34	0.74 - 2.41	0.328
Top Division	67 (26.4)	13 (19.4)	0.34	0.16 - 0.69	0.003
No. of siblings					
0-1[a]	95 (37.4)	35 (36.8)	1		
2-3	96 (41.0)	39 (40.6)	1.17	0.65 - 2.10	0.592
≥4	63 (24.8)	22 (34.9)	0.92	0.47 - 1.78	0.805
Types of dwellings					
Separate houses[a]	43 (16.9)	8 (18.6)	1		
Attached houses	211 (83.1)	88 (81.4)	3.13	1.39 - 7.07	0.006
No. of rooms					
1[a]	138 (54.3)	57 (41.3)	1		
2	78 (30.7)	28 (35.9)	0.79	0.44 - 1.41	0.435
>3	35 (13.8)	11 (31.4)	0.65	0.29 - 1.43	0.287
Fathers' education level					
Grade 8[a]	139 (54.7)	51 (36.7)	1		
Ordinary Level	93 (36.6)	34 (36.6)	0.99	0.57 - 1.71	0.984
Advanced Level	22 (8.6)	11 (50.0)	1.72	0.69 - 4.26	0.237
Mothers' education level					
Grade 8[a]	101 (39.8)	65 (64.6)	1		
Ordinary Level	127 (50.0)	26 (20.5)	0.14	0.07 - 0.25	<0.001
Advanced Level	26 (10.2)	5 (19.2)	0.13	0.04 - 0.37	<0.001
Toilet facility					
Separate[a]	147 (57.9)	43 (29.3)	1		
Shared	107 (42.1)	53 (49.5)	2.37	1.41 - 3.99	0.001
Water source					
Spring water[a]	230 (90.6)	89 (38.7)	1		
Wells	20 (7.9)	7 (35.0)	0.85	0.32 - 2.20	0.745
Others	4 (1.6)	0	0	0	0
Boiling of drink water					
Yes[a]	101 (39.8)	35 (34.6)	1		
No	153 (60.2)	61 (39.9)	1.25	0.74 - 2.10	0.402
Hand washing with soap before a meal					
Everytime[a]	94 (37.0)	30 (31.9)	1		
Sometimes	54 (21.3)	22 (40.7)	1.46	0.73 - 2.93	0.280
Never	106 (41.7)	44 (41.5)	1.51	0.84 - 2.70	0.162

Table 2 (Continued).

Variable	Number examined (%)	Number positives (%)	OR	95% CI	*p*-value
Hand washing with soap after defecation					
Everytime[a]	227 (89.4)	82 (36.1)	1		
Sometimes	8 (3.1)	4 (50.0)	1.76	0.43 - 7.25	0.429
Never	19 (7.4)	10 (52.6)	1.96	0.76 - 5.03	0.159
Eating unwashed fruits					
Yes[a]	49 (19.3)	26 (53.1)	1		
No	205 (80.7)	70 (34.1)	0.45	0.24 - 0.84	0.015
Barefoot					
Yes[a]	180 (70.9)	72 (40.0)	1		
No	74 (29.1)	24 (32.4)	0.72	0.40 - 1.27	0.259
Sucking fingers					
Yes[a]	80 (31.5)	28 (35.0)	1		
No	174 (68.5)	68 (39.1)	1.19	0.68 - 2.06	0.534
De-worming					
<1 month[a]	45 (17.7)	3 (6.7)	1		
1-2 months	21 (8.3)	4 (19.0)	3.29	0.66 - 16.31	0.144
2-3 months	46 (18.1)	15 (32.6)	6.77	1.80 - 25.45	0.005
>3 months	124 (48.8)	66 (53.2)	15.93	4.69 - 54.14	0.001
Never	18 (7.1)	10 (55.6)	11.20	2.51 - 49.97	0.002

[a]Reference category; OR, Odds ratio; CI, Confidence interval.

treatment reported a lower prevalence of *A. lumbricoides* infection (24.4%) among children aged 3-12 years in Sri Lanka (Gunawardena *et al*, 2011). Several studies on tea plantations in Sri Lanka reported the prevalence of *Ascaris* infection among children to be 50-54% (Sorensen *et al*, 1996; Gunawardena *et al*, 2004).

Compared to tea plantations, children in rural areas and in urban slums in Sri Lanka had lower prevalence (range; 0-24.5%) of A*scaris* infections (De Silva *et al*, 1994; Amarasinghe and Weerasooriya, 1999; Fernando *et al*, 2001; Karunaithas *et al*, 2011). These variations in prevalences might be due to differences in climatic conditions, sanitary facilities, socio-economic conditions or the education level of the parents.

In Sri Lanka, very young children are better cared for and are generally looked after inside the house. Children aged 4-6 years often spend much of their time playing in the garden exposing them to infected soil. The *Ascaris* eggs can remain infective for years in the soil (Gilgen and Mascie-Taylor, 2001). Soil contamination with *Ascaris* eggs is a major factor associated with human ascariasis (Gyawali *et al*, 2009). This is a possible explanation for the highest prevalence and intensity of ascariasis in this age group in our study population.

In our study, there was a higher prevalence of *Ascaris* infection in the Factory Division (41.4%) and West Division (48.9%) than in the Top Division (19.4%). The Top Division is at a higher altitude than the Factory and West Divisions, suggesting the possibility of *A. lumbricoides* eggs washing

Table 3
Multivariate logistic regression model for risk factors of *Ascaris* infections.

Variables	OR	CI	*p*-value
Study site			
Factory Division[a]	1		
West Division	1.22	0.51 - 2.89	0.653
Top Division	0.32	0.12 - 0.89	0.028
Types of dwellings			
Separate houses[a]	1		
Attached houses	4.49	1.09 - 11.11	0.035
Mothers' education level			
Grade 8[a]	1		
Ordinary Level	0.10	0.05 - 0.22	<0.001
Advanced Level	0.07	0.02 - 0.32	<0.001
Toilet facility			
Separate[a]	1		
Shared	3.44	1.63 - 7.26	0.001
Eat unwashed fruits			
Yes[a]	1		
No	0.64	0.23 - 1.84	0.411
De-worming period			
<1 month[a]	1		
1-2 months	5.61	0.84 - 37.38	0.075
2-3 months	6.86	1.50 - 31.37	0.013
>3 months	23.84	6.01 - 94.53	<0.001
Never	6.51	0.98 - 43.80	0.054

[a]Reference category; OR, Odds ratio; CI, Confidence interval.

down to the other divisions during the rainy season since they are situated at lower altitudes. The Top Division has a smaller population and a larger number of detached houses. These factors might have contributed to the lower prevalence of infection in the Top Division than the other two studied divisions.

In our study, 83% of study subjects live in old long buildings called estate line houses which are attached to each other. Few of our study subjects lived in quarters and detached houses. *Ascaris* infections were significantly more common among subjects living in line houses than in detached houses. Most line houses had shared toilets and insufficient sanitary facilities. The soil and water around line houses are more contaminated with human feces.

Overcrowding is a known risk factor for *Ascaris* infection on plantations in Sri Lanka (Sorensen *et al*, 1996). In this study, majority of study subjects live in small houses containing one or two rooms with more than one sibling. High family clustering in a small household increases the risk of helminth infections. It is highly recommended that deworming treatments should be given to the entire family to prevent reinfection (Kliegman *et al*, 2007). However, no statistical significance was found with the number of rooms or siblings with *Ascaris* infections in our study.

Only 57.9% of the study subjects' houses had a toilet; the others had to share toilets among 3 to 4 families. All the toilets belonging to the study subjects' were pit latrines and not connected to a proper sewage system.

There was a statistically significant association between *Ascaris* infection and the use of shared toilets in our study. Younger children on the plantations defecated in and around the home garden. A similar observation was reported for the urban slums of Matara (Amarasinghe and Weerasooriya, 1999) and low country plantation areas in Sri Lanka (Gunawardena *et al*, 2004). In addition, studies from Ethiopia (Debalke *et al*, 2013) and Nigeria (Ogwurike *et al*, 2004) have documented a high prevalence of intestinal nematode infections (54.7% and 77.7%, respectively) among children who defecated in the open.

In our study, a higher prevalence of *Ascaris* infections was seen among children who did not wash their hands before a meal (41.5%) or after defecation (52.6%). Similarly, Debalke *et al* (2013) in Ethiopia reported that 48.9% and 47.9% of study subjects had no habits of washing hands before a meal or after defecation, respectively.

Picking up and eating fruits that have fallen to the ground is common among study subjects. The prevalence of *Ascaris* infection in our study was high among children who ate unwashed fruit (53.1%). Soil contamination with infected human feces is probably the main contributory factor in the transmission of *Ascaris* infection. A study carried out on a tea plantation in Kandy District found that 54% of soil samples examined were positive for *Ascaris* ova indicating a high level of soil contamination in and around the home gardens and the work areas on tea plantations (Edirisinghe and Weilgama, 1997). These eggs can be transferred to vegetables, fruits and to hands and then directly to mouth.

In our study, a higher maternal educational level was associated with a low prevalence of *Ascaris* infection among study subjects. Several studies have found similar results (Quihui *et al*, 2006; Ugbomoiko *et al*, 2009; Gunawardena *et al*, 2011). However, the paternal education level was not significantly associated with the prevalence of *Ascaris* infection. In this study area, the majority of men were daily paid laborers working mostly away from their homes. They had very little time to spend with their children.

The use of anthelmintics in the community was effective in reducing the prevalence of *Ascaris* infection. Multivariate logistic regression analysis in our study identified last date of deworming >3 months previously was associated with a higher prevalence *Ascaris* infection. Similar results were seen in rural communities from Malaysia where re-infection was observed as early as 2 months after de-worming and by 4 months half the treated population had been re-infected (Norhayati *et al*, 1998). Another study found re-infestation by 3 months post-de-worming (Al-Mekhlafi *et al*, 2008). In a study from Bangladesh, 66% of children aged <2 years became re-infected with *Ascaris* within 3 months of treatment (Roy *et al*, 2011). Our results confirm deworming alone cannot control *Ascaris* infections.

In conclusion, our study found a high prevalence of *Ascaris* infection despite anthelmintic treatment. This prevalence might be reduced by improving sanitary facilities and hygiene along with regular de-worming. Greater emphasis should be given to educating plantation workers about good hygienic practices.

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