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EFFECT OF SOIL-TRANSMITTED HELMINTHS ON SCHOOLCHILDREN IN KOTA KINABALU, SABAH

Hairul Hafiz Mahsol[1] and Mohd. Zahedi Daud[2]

[1]School of Science & Technology, Universiti Malaysia Sabah
88999 Kota Kinabalu, Sabah, Malaysia
[2]School of Medicine, Universiti Malaysia Sabah
88999 Kota Kinabalu, Sabah, Malaysia

ABSTRACT. *The aim of this paper is to study the relationships between Soil-Transmitted Helminths (STH) infection and the academic performance and cognitive ability of schoolchildren. One thousand three hundred and fifteen (1,315) schoolchildren of age 7, 9 and 11 years old were studied. Three schools in Kota Kinabalu were selected i.e. SK Likas, SK Darau and SK Gentisan. Faeces were collected and examined using the direct smear, Kato-Katz and Harada-Mori techniques. Physical anthropometrics measurements were also taken and this include weight, height and mid arm circumference. Cognitive performances of these children were assessed based on their school examination marks, the result of TONI-3 test, and questionnaire survey among schoolchildren. The overall prevalence of children with STH infection was 27.4%, of which 77.2% were infected with Ascaris lumbricoides, Trichuris trichiura (50.3%) and hookworm (3.1%). There was no significant association between STH infection and gender ($P > 0.05$) but there was a low significant association between STH infection and age ($P < 0.05$). There were significant differences in the weight of children ($P < 0.01$), height of children ($P < 0.01$) and mid arm circumference ($P < 0.01$) associated with the type of STH infections, and followed by highly significant relationship between STH infection and nutrition status, weight for age ($P < 0.01$), height for age ($P < 0.01$), weight for height ($P < 0.01$) and mid arm circumference for age ($P < 0.01$). The study showed that there were significant differences in the marks of school examination ($P < 0.01$) and the result of TONI-3 ($P < 0.01$) associated with STH infections. Also there were significant relationship between socio-economic factors, citizenship ($P < 0.01$), educational background of parents ($P < 0.01$), family income per month ($P < 0.01$) and type of housing ($P < 0.01$) of the population with STH infection. The study demonstrated that the academic performance and cognitive ability of school children in Kota Kinabalu, Sabah were affected by STH infection.*

KEYWORDS. Soil-Transmitted Helminths, schoolchildren

INTRODUCTION

Soil-Transmitted Helminths (STH) infection due to *Ascaris lumbricoides*, *Trichuris trichiura, Strongyloides stercolaris* and hookworm is a common health problem in most rural areas of developed countries and squatter areas of developing countries where children are the greatest risk group. STH also are common in Malaysia and they pose a major health problem, especially among schoolchildren. Several surveys have been carried out among children and findings indicate that the problem is often polyparasitic in character.

In Malaysia, studies regarding the prevalence of STH have been mainly carried out among children in Peninsular Malaysia (Russel, 1934; Lie, 1964; Balasingam *et al.,* 1969; Zahedi *et al.,* 1980; Sinniah, 1984; Kan, 1988; Oothuman, 1992). Little or no work has been done among schoolchildren from East Malaysia such as Sabah and Sarawak. So far, there has been no report of STH survey in Kota Kinabalu or Sabah generally.

The main aim of the study was to measure the impact of STH infection on the academic performance and cognitive ability of schoolchildren. Other than that, a few factor to be considered as the variable to determine the effect of STH on schoolchildren such as the physical measurements (weight, height and mid arm circumference) and nutritional status (weight for age, height for age, weight for height and mid arm circumference for age).

MATERIAL AND METHOD

One thousand three hundred and fifteen (1,315) schoolchildren of age 7, 9 and 11 years old were investigated. Three schools in Kota Kinabalu were selected such as Sekolah Kebangsaan (SK) Likas, SK Darau and SK Gentisan. Faeces were collected and examined using the direct smear, Kato-Katz and Harada-Mori techniques to see any infection. Physical anthropometrics measurements were also taken including weight, height and mid arm circumference. Cognitive performances of these children were assessed based on their school examination marks, the result of Test of Nonverbal Intelligence 3 (TONI-3), and questionnaire survey among schoolchildren.

The independent sample t-test was used to examine differences between infected and uninfected group of schoolchildren. In addition to make association between any two types of variables in this study, chi-square test for independent and relatedness was used. All the data were analysed using SPSS for Windows (version 11.0) package.

RESULT

The overall prevalence of STH infection among schoolchildren was 27.4%, of which 77.2% were infected with *Ascaris lumbricoides*, *Trichuris trichiura* (50.3%) and hookworm (3.1%). *Strongyloides stercolaris* was not detected. The detailed numbers of STH infection among schoolchildren in Kota Kinabalu are shown in Table 1 below.

Table 1. The positive infection of STH among schoolchildren

	No. of positive infection	(%)
No. of sample	360	27.4
	No. of specific STH	
Ascaris	278	77.2
Trichuris	181	50.3
Hookworm	11	3.1

The relation between Gender and Age with STH infection

The distribution of STH infection between genders is tabulated in Table 2. The percentage of male positive infection was higher than female.

Table 2. The STH infection between gender

		STH Infection					
		Positive		Negative		Total	
		Count	Percentage	Count	Percentage	Count	Percentage
Gender	Male	182	29.8%	428	70.2%	610	100.0%
	Female	178	25.2%	527	74.8%	705	100.0%
Total		360	27.4%	955	72.6%	1315	100.0%

Table 3 shows the distribution of STH infection among age 7, 9 and 11. The percentage of schoolchildren with worm of age 9 and 11 was almost similar. Whereas the percentage positive infection of age 7 was a little bit higher than age 9 and 11.

Table 3. The STH infection among ages

		STH Infection					
		Positive		Negative		Total	
		Count	Percentage	Count	Percentage	Count	Percentage
Age	7	140	32.7%	288	67.3%	428	100.0%
	9	111	24.9%	335	75.1%	446	100.0%
	11	109	24.7%	332	75.3%	441	100.0%
Total		360	27.4%	955	72.6%	1315	100.0%

The statistical analysis result showed that there was no significant association between STH infection and gender (χ^2 = 3.462, df = 1, P > 0.05) but there was a significant association between STH infection and age (χ^2 = 9.083, df = 2, P < 0.05).

Effect of STH infection on physical anthropometrics

The physical anthropometrics measurements in this study involve weight, height and mid arm circumference. The descriptive statistics of STH infection between weight, height and mid arm circumference is tabulated in Table 4. The table shows that the means of negative infection was lower than positive infection in all of physical anthropometrics measurements.

Table 4. The STH infection on weight, height and mid arm circumference

	STH Infection	N	Mean	Std. Deviation	Std. Error Mean
Weight	Positive	360	21.486	5.907	.311
	Negative	955	26.075	7.525	.244
Height	Positive	360	122.306	11.040	.582
	Negative	955	128.568	11.197	.362
Mid arm circumference	Positive	360	17.047	2.053	.108
	Negative	955	18.413	2.710	8.771E-02

Consequently, the SPSS result showed that the significant differences were observed for the means of STH infections on weight of children (t = 11.611, df = 817.4, $P < 0.01$), height of children (t = 9.077, df = 1313, $P < 0.01$) and mid arm circumference (t = 9.803, df = 848.1, $P < 0.01$).

Relation between STH infection and nutritional status

Accordingly, from the three types of anthropometrics measurement before, the schoolchildren were classified into degree of nutritional status by weight for age, height for age, weight for height and mid arm circumference for age. Comparing these four factors with the National Centre for Health Statistics (NCHS) finally assessed the nutritional status standard.

The relationship between STH infection and nutritional status, such as weight for age (χ^2 = 497.843, df = 1, $P < 0.01$), height for age (χ^2 = 104.038, df = 1, $P < 0.01$) were highly significant. Similar results were obtained for weight for height (χ^2 = 44.568, df = 1, $P < 0.01$) and mid arm circumference for age (χ^2 = 21.868, df = 1, $P < 0.01$). The detail crosstabulation tables for all nutritional status factors are shown in Table 5 below.

Effect of STH infection on examination marks and TONI-3 result

Percentage marks obtained by schoolchildren in the semester examination for all subjects were used to measure academic performance. Whereas cognitive ability was measured using TONI-3 test in the classroom setting. The raw score was converted to quotient according to age group based on the standard table provided by the test publisher (Brown *et al.*, 1997). Quotient instead of percentile was used to measure problem-solving ability in this study. Table 6 shows the mean quotients of the TONI-3 test and marks of school examination for all schoolchildren at baseline.

Table 5: The crosstabulation tables of: a) Height for age, b) Weight for age, c) Weight for height and d) mid arm circumference, with STH infection

a) Height for age * STH Infection Crosstabulation

		STH Infection				Total	
		Positive		Negative			
		Count	Percentage	Count	Percentage	Count	Percentage
Height for age	Stunting	110	57.9%	80	42.1%	190	100.0%
	Normal height	250	22.2%	875	77.8%	1125	100.0%
Total		360	27.4%	955	72.6%	1315	100.0%

b) Weight for age * STH Infection Crosstabulation

		STH Infection				Total	
		Positive		Negative			
		Count	Percentage	Count	Percentage	Count	Percentage
Weight for age	Underweight	199	87.3%	29	12.7%	228	100.0%
	Normal weight	161	14.8%	926	85.2%	1087	100.0%
Total		360	27.4%	955	72.6%	1315	100.0%

c) Weight for height * STH Infection Crosstabulation

		STH Infection				Total	
		Positive		Negative			
		Count	Percentage	Count	Percentage	Count	Percentage
Weight for height	Wasting	60	54.5%	50	45.5%	110	100.0%
	Normal	300	24.9%	905	75.1%	1205	100.0%
Total		360	27.4%	955	72.6%	1315	100.0%

d) Mid arm circumference for age * STH Infection Crosstabulation

		STH Infection				Total	
		Positive		Negative			
		Count	Percentage	Count	Percentage	Count	Percentage
Mid arm circumference for age	Malnutrition	315	30.3%	723	69.7%	1038	100.0%
	Healthy	45	16.2%	232	83.8%	277	100.0%
Total		360	27.4%	955	72.6%	1315	100.0%

Table 6. The descriptive statistics of school examination marks and TONI-3 results for all schoolchildren

	N	Minimum	Maximum	Mean	Std. Deviation
Marks of school examination	1315	1.00	99.00	51.1943	20.9421
Result of TONI-3	1315	45.00	150.00	93.4061	17.8151

Table 7 shows the comparison between STH infection (infected & uninfected schoolchildren) on marks of school examination and Toni-3 results. It shows that the means of negative infection was lower than positive infection in school examination marks and TONI-3 result.

Table 7. The STH infection on examination marks and TONI-3 result

	STH Infection	N	Mean	Std. Deviation	Std. Error Mean
Marks of school examination	Positive	360	37.7113	22.0530	1.1623
	Negative	955	56.2768	18.0720	.5848
Result of TONI-3	Positive	360	83.9083	15.4653	.8151
	Negative	955	96.9864	17.3282	.5607

Finally, there were significant differences in the marks of school examination ($t = 14.269$, df = 550.5, $P < 0.01$) and the result of TONI-3 ($t = 12.558$, df = 1313, $P < 0.01$) with STH infections. It showed that there was a significant effect of STH infection on academic performance and cognitive ability among schoolchildren.

Relationships between STH infection and socio-economic factors

STH infection also had some association with socio-economic factors. In this study, there were significant relationship between socio-economic factors such as, citizenship ($\chi^2 = 49.4$, df = 1, $P < 0.01$) and educational background of parents ($\chi^2 = 544.8$, df = 4, $P < 0.01$) with STH infection. Similar results were obtained for family income per month ($\chi^2 = 194.4$, df = 3, $P < 0.01$) and type of housing ($\chi^2 = 254.7$, df = 1, $P < 0.01$) of the population with STH infection.

DISCUSSION

In theory, the potential effects of STH infection on mental function and academic achievement of schoolchildren can be through the following mechanism: (1) STH can cause abdominal pain, nausea, vomiting, fever and diarrhoea. (2) STH can cause malnutrition directly through competition for nutrients with the host. These two mechanisms may disturb sleep and concentration in class, which can adversely affect attention span and problem solving ability of schoolchildren (Che Ghani, 1995).

Based on this theoretical framework, the comparisons between infected and uninfected group schoolchildren were assessed on academic performance and cognitive ability, with independent sample t-test. In addition, the association between STH infection and nutritional status also had been done using chi square test to support the main aim of this study.

In this study, it was demonstrated the significant differences of STH infections on the weight of children ($P < 0.01$), height of children ($P < 0.01$) and mid arm circumference ($P < 0.01$). The result was also similar to Stephenson *et al.* (1993a, 1993b) and Adams *et al.* (1994) with the addition that the Kenyan schoolchildren weight gain is improved following once yearly treatment. These finding are major public health importance, because the schoolchildren in this study essentially all of them regularly attending school and were not selected for complaints of illness.

Then, the comparison also had been made that shown the significant effect of STH infection on academic performance ($t = -14.269$, $P < 0.01$). The other researcher such as Nokes *et al.* (1992) also had proved the significant effect on educational programme among children in Jamaica. This fact had also been strengthen by Che Ghani (1995) that shown the relationship between STH and examination results for certain subjects such as English, Bahasa Malaysia and Mathematics in Terengganu, Malaysia. The further study can be made to evaluate the STH effect on specific subject in Malaysian school.

Despite numerous intelligence tests available from various publishers, the TONI-3 was chosen because it is not culture-dependent and extremely objective (minimal instruction). In addition, Che Ghani (1995) had success applied the TONI-2 on his research in Kuala Berang, Terengganu. So, the recommendation of TONI-3 was a bright idea that can be made to improve the successful use of this tool.

The findings of this study expand the domains of cognitive process that can be impaired by STH infection. The study has shown that there was a significant effect of STH infection on cognitive ability among schoolchildren here in Kota Kinabalu ($t =$

12.558, $P < 0.01$). The earlier study (Che Ghani, 1995) also had shown the similar result where STH (*Ascaris* and Trichuris) adversely affected problem solving ability of children in Terengganu. There also a few studies used the different intelligent test to measure mental function of worm-infected children such as Nokes *et al.* (1992) used *IQ* (*Ravens*) *matrices* ($P < 0.05$) and Boivin *et al.* (1993) indicated the Kaufman-Assessment Battery for Children ($P < 0.05$).

CONCLUSION

As a conclusion, the study demonstrated that the academic performance and cognitive ability of school children in Kota Kinabalu were affected by STH infection.

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