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Research Article

Status of Soil-transmitted Helminth after Implementation of School-based Deworming Programmes in Five Districts, South Kalimantan Province, Indonesia

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I N F O

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A B S T R A C T

Background: South Kalimantan Province, Indonesia, has endemic soil-transmitted helminth (STH) infections. Nationally and globally, this parasitic disease is treated periodically, and its recommended impacts have been assessed over five years.

Method: This study examined STH prevalence and risk factors in the school-going children of South Kalimantan. This cross-sectional study was conducted from July to October 2019. Stool samples from primary school children in five South Kalimantan districts were processed using the Kato Katz helminth egg detection method. Individual interviews were used to assess STH and hygiene knowledge, attitude, and behaviour. We used both univariate and bivariate analyses to show how helminthiasis had spread and to find out how school-going children's knowledge, attitudes, and practice (KAP) were linked to helminthiasis.

Results: STH infections were detected in less than 5% of five districts. *E. vermicularis* (8 out of 21 positive samples) and *Trichuris trichiura* (5 out of 21 positive samples) were the two most frequent infections. We only found one youngster with a mixed disease, a combination of *E. vermicularis* and *T. trichiura*. A KAP statistics analysis revealed a significant relationship between behaviour and the frequency of infection cases in Balangan. However, in four districts, knowledge, attitude, and behaviour were not significantly associated with helminthiasis.

Conclusions: Students have low STH infection rates following regular deworming. Interestingly, children are infected with enterobiasis. We found hymenolepiasis in many children. Hence a comprehensive intestinal parasite control strategy must incorporate more than soil-transmitted helminths.

Keywords: Helminthiasis, School-going Children, South Kalimantan

Introduction

Soil-transmitted helminths (STHs) represent some of the greatest numbers of commonly neglected tropical illnesses worldwide, notably affecting children in impoverished communities.[1] The four most frequently detected species that infect people are *Ascaris lumbricoides* (roundworms), *Trichuris trichiura* (whipworms), and hookworms (*Ancylostoma duodenale* and *Necator americanus*).[1]

An estimated 820 million people worldwide are afflicted by roundworms, 460 million by whipworms, and 440 million by hookworms.[1] Infections from roundworms have contributed to around one million disability-adjusted life-years (DALYs), while infections from whipworms and hookworms have contributed to half a million and four million DALYs, respectively.[2]

STH affects 24% (more than 1.5 billion) of the world's population. It is extensively dispersed in tropical and subtropical countries, affecting the poorest and most deprived communities. It is passed on by eggs in human stool that contaminate soil in areas with a lack of proper sanitation. As preschool and school-age children reside in STH-endemic areas, prevention as well as treatment are required.[1]

Infections caused by STH in Indonesia are one of the nation's most critical health problems, with prevalence rates ranging from 45% to 65%. In areas with poor sanitation, the frequency might reach as high as 80%.[3] Banten, South Sulawesi, DKI Jakarta, Bali, Papua, as well as Nusa Tenggara are the most endemic provinces in Indonesia.[1] In East Nusa Tenggara, around 66% of adults are afflicted with STH, with hookworm infections being the most common (51.7%).[4] South Kalimantan is considered endemic for STH and other zoonotic helminths. Although the deworming programme is administered at the district level, due to limited resources, the programme has yet to conduct regular STH assessments. The prevalence of intestinal worms in Indonesia was reported to have decreased significantly between 1990 (47.2%) and 2010 (24.6%).[5] Although some cross-sectional findings indicate the estimated prevalence at the district levels as well as analyse the relationship between helminth infections and relevant risk factors, the prevalence data are required to evaluate the implementation of the mass deworming programme. The purpose of the research was to compile the latest data on helminthiasis prevalence among students in primary schools in five districts in South Kalimantan. With the belief that understanding the relationship between risk factors and infection rates would allow us to determine which aspects of the control strategy should be improved, we conducted research in five districts/ municipalities of the South Kalimantan province: Banjarbaru and Banjar represented urban areas; while Balangan, Tapin, and Tanah Laut represented remote communities or rural areas.

Subjects and Methods

Participant Recruitment and Sample Demographics

The population in this study included primary school students who had received deworming treatment in the five districts selected for the survey in the province of South Kalimantan: Balangan, Tapin, Banjarbaru, Banjar, and Tanah (Figure 1). The sample population consisted of 1st to 5th-grade elementary school students from the five different districts. Using the probability proportionate to size technique, thirty elementary schools were chosen in each district, with 7–22 children chosen as samples from each, implying that at least 210 students would have been sampled from each area. The total number of samples was 1050.

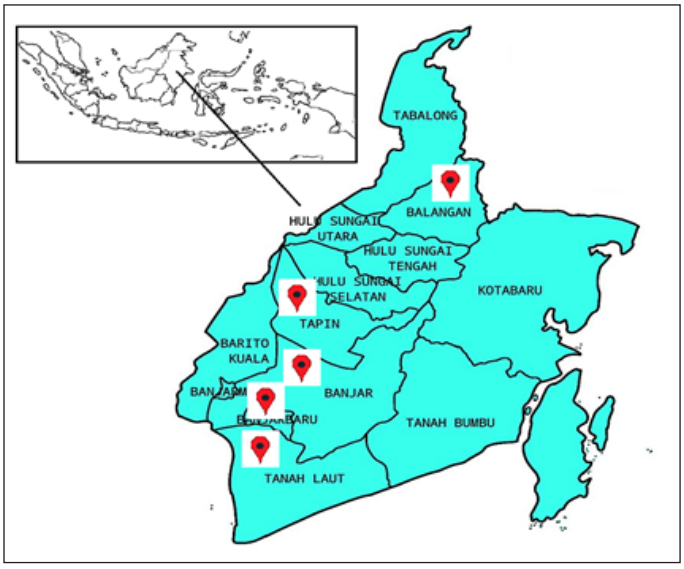

Figure 1.A Map Depicting the Research Locations at the Five Districts[6]

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Study Design

The study used a cross-sectional design and was conducted between July and October of 2019. Besides the faecal specimen, interviews on students' knowledge, attitude, and practice regarding intestinal parasitic infections were also carried out.

Stool Examination

The Kato-Katz thick smears method was used to examine the faecal specimens collected from the selected students. The hole-punched template was placed at the centre of a microscope slide. Subsequently, the upper surface was scraped with a flat spatula to collect the filtered faeces after pressing the mash screen on top to allow some of the faeces to filter through, leaving only the debris. The gathered faeces were subsequently placed into the template's hole (which held roughly 41.7 mg). The template was removed with care, leaving the faeces cylinder on the slide. The faeces were subsequently wrapped in a pre-soaked cellophane strip. The microscope slide was flipped over, and the faecal sample was tightly compressed against the cellophane strip on a smooth and hard surface, like a tile. The material was distributed evenly. The slide was gently removed by moving it sideways to prevent splitting the cellophane strip. The slide was positioned such that the cellophane was pointing up. The smear was examined methodically, and the eggs of each species were recorded. The number of eggs per gram of faeces was then multiplied by the appropriate number (24 for 41.7 mg template).[7]

Measurement of Knowledge, Attitude, and Behaviour

Structured questionnaires were distributed to 2005 consenting school-going children to collect information on knowledge, attitudes, and practices of STH infection. For the knowledge assessment, the subjects had to answer three questions concerning the definition, symptoms, and spread of STH. Knowledge of the respondents was categorised as low, medium, and high for one, two, and three correct answers respectively. Elementary school children's attitudes and behaviour towards the prevention of worm infection were categorised into positive and negative. Those who agreed with at least 50% of the statements in each section belonged to the positive category, while the rest were categorised as negative.[8]

Statistical Analysis

The gathered data were input and categorised in Microsoft Excel™ (version 2010) before being analysed in SPSS version 15 software (SPSS Inc., Chicago, Illinois, USA). To determine the significance of the variation in prevalence, a test called the chi-square test was applied. The association of the prevalence of infection with knowledge, attitudes, and behaviour of school-going children about STH infection was analysed using bivariate analysis.

Ethical Approval

The Ethical Committee of the National Institute of Health Research and Development granted approval for this study under the number LB.02.01/2/KE.332/2018.

Results

The total number of samples in Balangan, Banjar, Banjarbaru, Tapin, and Tanah Laut together reached the required minimum sample size. The study comprised a total of 2005 children, with nearly equal percentages of boys and girls in each district (Table 1).

Table 1.Characteristics of the Sample in Each District

District	Characteristics		n (%)
Tanah Laut	Gender	Male	233 (52.83)
		Female	208 (47.17)
		Overall	441 (100.00)
	Age (years)	5–10	433 (98.18)
		> 10	8 (1.82)
	Grade	1st	86 (19.50)
		2nd	110 (24.94)
		3rd	81 (18.37)
		4th	82 (18.59)
		5th	82 (18.59)

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District	Characteristics		n (%)
Tapin	Gender	Male	220 (50.34)
		Female	217 (49.66)
		Overall	437 (100.00)
	Age (years)	5–10	415 (94.97)
		> 10	22 (5.03)
	Grade	1st	94 (21.51)
		2nd	91 (20.82)
		3rd	90 (20.59)
		4th	84 (19.22)
		5th	78 (17.85)
Balangan	Gender	Male	256 (51.00)
		Female	246 (49.00)
		Overall	502 (100.00)
	Age (years)	5–10	485 (96.61)
		> 10	17 (3.39)
	Grade	1st	108 (21.51)
		2nd	127 (25.30)
		3rd	95 (18.92)
		4th	92 (18.33)
		5th	80 (15.94)
Banjar	Gender	Male	187 (50.00)
		Female	187 (50.00)
		Overall	374 (100.00)
	Age (years)	5–10	348 (93.05)
		> 10	26 (6.95)
	Grade	1st	86 (22.99)
		2nd	88 (23.53)
		3rd	63 (16.84)
		4th	81 (21.66)
		5th	56 (14.97)
Banjarbaru	Gender	Male	118 (47.01)
		Female	133 (52.99)
		Overall	251 (100.00)
	Age (years)	5–10	242 (96.40)
		> 10	9 (3.60)
	Grade	1st	88 (35.06)
		2nd	73 (29.08)
		3rd	22 (8.76)
		4th	38 (15.14)
		5th	30 (11.95)

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In Tanah Laut, boys (52.83%) outnumbered girls (47.17%), most of the participants (98.18%) belonged to the age group of 5–10 years, and the majority (24.94%) were in 2nd grade. Tapin had a total sample size of 437 students. The majority were 5–10 years old (94.97%), boys (50.34%), and the majority of respondents who returned stool containers were from 1st grade (21.51%). A similar result was discovered in the Balangan where the majority of the 502 surveyed school-going children were 5–10 years old (96.61%) and boys (51.00%), and it was seen that 2nd-grade students mostly returned the stool containers (25.30%).

Banjar and Banjarbaru districts are urban, and compliance with returning stool containers is lower here than in rural areas. The parents assumed that deworming pills would be sufficient to protect them from the infection. The district of Banjar and Banjarbaru collected 374 and 251 samples, respectively. The proportion of boys and girls was equal where most of the participants were from 2nd grade in Banjar, and 1st grade in Banjarbaru.

Prevalence of STH Infections

The prevalence of infections in the districts is shown in Table 2. The prevalence of STH varied significantly (0.45%–1.59%) in the districts.

In general, 1.05% of the children (21 out of 2005) were detected for helminthiasis. Among them, infection from *Enterobius vermicularis* was the most prevalent, where eight (14.29%) children in total were infected by this species. That is still not including one child from Tanah Laut District who got a mixed infection from *Enterobius vermicularis* and *Trichuris trichiura.*

Balangan and Banjarbaru had the highest helminthiasis prevalence (1.6%) out of the five districts studied. However, the prevalence remains relatively low in the STH infection category.

The distributions of STH infection varied across the surveyed districts. *T. trichiura* was the most common infection in three districts. There was one Ascaris infection in Banjar and two in Banjarbaru. While hookworm infection was discovered in one child in Tapin and one in Banjarbaru, Balangan and Banjarbaru are the districts with the highest prevalence of STH, each presenting 1.59%. *Enterobius vermicularis* was also discovered in Tapin, Balangan, and Banjar. *H. nana* was found only in Banjar, specifically in two children. Figure 2 shows the various STH eggs found in children in South Kalimantan provinces.

Table 2.Number of Children Infected with Helminths in Each District

Districts	Total Samples n (%)	Infected Samples n (%)	Infection by STH Species				Infection by Non-STH Species	
			Al (n)	Tt (n)	H (n)	Mix (n)	Ev (n)	Hn (n)
Tanah Laut	441 (22.00)	2 (0.45)	-	1	-	1	-	-
Tapin	437 (21.80)	3 (0.68)	-	-	1	-	2	-
Balangan	502 (25.00)	8 (1.59)	-	3	-	-	5	-
Banjar	374 (18.70)	4 (1.06)	1	-	-	-	1	2
Banjarbaru	251 (12.50)	4 (1.59)	2	1	1	-	-	-

Al: *Ascaris lumbricoides*; Tt: *Trichiuris trichiura*; H: Hookworm; Ev: *Enterobius vermicularis*; Hn: *Hymenolepis nana*

Figure 2.STH Eggs Found in Children in South Kalimantan Provinces: A) *Ascaris* sp.; B) Hookworm; C) *Trichuris* sp.; D) *E. vermicularis*; E) *H. nana*[9]

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Table 3.Knowledge, Attitude, and Behaviour of Study Subjects regarding Helminthiasis

S. No	Questions	Banjarbaru		Banjar		Tapin		Tanah Laut		Balangan	
		n	%	n	%	n	%	n	%	n	%
Knowledge											
1	Do you know about helminthiasis?	79	31.47	153	40.91	179	40.96	178	40.36	160	31.87
2	Knowledge regarding the symptoms	-	-	-	-	-	-	-	-	-	-
	Stomach ache/ diarrhoea	62	24.70	91	24.33	93	21.28	273	61.90	239	47.61
	No appetite	9	3.59	19	5.08	25	5.72	188	42.63	161	32.07
	Pale/ weak	7	2.79	19	5.08	22	5.03	174	39.46	141	28.09
	Distended stomach	5	1.99	18	4.81	30	6.86	165	37.41	127	25.30
	Do not know/ not answered	158	62.95	219	58.56	312	71.40	74	16.78	139	27.69
3	Knowledge regarding the cause of transmission	-	-	-	-	-	-	-	-	-	-
	Playing with soil	53	21.12	112	29.95	96	21.97	286	64.85	251	50.00
	Not washing hands	33	13.15	38	10.16	59	13.50	256	58.05	242	48.21
	Careless eating/ drinking (not paying attention to the hygiene and nutrition aspects)	138	54.98	189	50.53	292	66.82	67	15.19	153	30.48
	Do not know/ not answered	138	54.98	189	50.53	292	66.82	67	15.19	153	30.48
Attitude											
1	Attitude regarding the prevention	-	-	-	-	-	-	-	-	-	-
	Not playing with soil	29	11.55	44	11.76	59	13.50	257	58.28	233	46.41
	Handwashing	58	23.11	101	27.01	99	22.65	296	67.12	257	51.20
	Keeping nails short and clean	14	5.58	22	5.88	44	10.07	266	60.32	223	44.42
	Using footwear outside	3	1.20	7	1.87	34	7.78	248	56.24	196	39.04
	Taking deworming pill	45	17.93	63	16.84	118	27.00	354	80.27	302	60.16
	Do not know/ not answered	111	44.22	132	35.29	196	44.85	34	7.71	89	17.73

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S. No	Questions	Banjarbaru		Banjar		Tapin		Tanah Laut		Balangan	
		n	%	n	%	n	%	n	%	n	%
Behaviour											
1	Handwashing before eating and after defecating	238	94.82	366	97.86	430	98.40	433	98.19	496	98.80
2	Handwashing with soap	224	89.24	330	88.24	368	84.21	404	91.61	435	86.65
3	Handwashing after playing with soil	231	92.03	316	84.49	391	89.47	414	93.88	478	95.22
4	Handwashing with soap after playing with soil	205	81.67	262	70.05	311	71.17	371	84.13	356	70.92
5	Using footwear every time going outside	230	91.63	322	86.10	380	86.96	427	96.83	475	94.62
6	Using shoes during school break time	228	90.84	332	88.77	415	94.97	405	91.84	452	90.04
7	Defecating in toilet/ water closet	242	96.41	340	90.91	416	95.19	435	98.64	495	98.61
8	Having short nails	111	44.22	166	44.39	189	43.25	178	40.36	188	37.45
9	Having clean nails	169	67.33	213	56.95	238	54.46	254	57.60	290	57.77

Table 4.Cross-tabulation of Knowledge, Attitude, and Behavior and Their Relationship with the Incidence of Helminthiasis

		Tanah Laut		Tapin		Balangan		Banjar		Banjarbaru	
		Positive n (%)	Negative n (%)	Positive n (%)	Negative n (%)	Positive n (%)	Negative n (%)	Positive n (%)	Negative n (%)	Positive n (%)	Negative n (%)
Knowledge	Low	114 (25.85)	1 (0.22)	410 (93.83)	2 (0.46)	198 (39.45)	5 (0.99)	320 (85.56)	4 (1.07)	26 (10.36)	0 (0.00)
	Medium	248 (56.24)	1 (0.22)	23 (5.27)	1 (0.22)	202 (40.24)	3 (0.59)	50 (13.37)	0 (0.00)	221 (88.04)	4 (1.60)
	High	77 (17.47)	0 (0.00)	1 (0.22)	0 (0.00)	94 (18.73)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
	p value[Ü]	0.668		0.105		0.283		0.430		0.493	
Attitude	Negative	113 (25.62)	0 (0.00)	317 (72.54)	2 (0.46)	206 (41.03)	4 (0.80)	255 (68.18)	3 (0.80)	193 (76.90)	3 (1.20)
	Positive	326 (73.92)	2 (0.46)	117 (26.77)	1 (0.23)	288 (57.37)	4 (0.80)	115 (30.75)	1 (0.27)	54 (21.51)	1 (0.39)
	p value[Ü]	0.405		0.804		0.637		0.794		0.880	
Behaviour	Negative	1 (0.23)	0 (0.00)	1 (0.23)	0 (0.00)	34 (6.77)	2 (0.40)	6 (1.61)	0 (0.00)	6 (2.40)	0 (0.00)
	Positive	438 (99.32)	2 (0.45)	433 (99.08)	3 (0.69)	460 (91.63)	6 (1.20)	364 (97.33)	4 (1.06)	241 (96.01)	4 (1.59)
	p value[Ü]	0.946		0.934		0.049		0.797		0.752	

Statistically significant at $p < 0.05$

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Table 3 shows that a significant proportion (> 30%) of children in every district showed knowledge of the phrase "helminthiasis. Regarding the symptoms of helminthiasis, the percentage of students in five districts who were unaware of them varied from 16% to 71%. The majority of students residing in the Banjarbaru and Tapin districts lacked knowledge regarding the symptoms of helminthiasis. Attitudes towards prevention: Students in Balangan and Tanah Laut exhibited a favourable disposition, which encompassed refraining from engaging in activities involving soil, washing hands and keeping short and tidy nails, wearing shoes outside and ingesting deworming pills. almost all responders (99%) from all survey areas had good helminthiasis prevention practices. This was shown by their responses on handwashing, footwear, and direct inspection of their nails.

As shown in Table 4, practically all respondents in Tapin (93.83%) and Banjar (85.56%) had limited knowledge about helminthiasis. Also, most respondents (88.04%) in Banjarbaru, just over half (56.24%) in Tanah Laut, and less than half (40.24%) in Balangan had a medium understanding of helminthiasis.

A majority (76.9%) of respondents in Banjarbaru had a negative attitude in which they did not agree with the statements of cutting nails once a week, taking deworming pills once every 6 months, and handwashing before and after meals to prevent helminthiasis. Most of the respondents from Tapin (72.54%) and Banjar (68.18%) also had a negative attitude. Meanwhile, 73.92% and 57.37% of respondents from Tanah Laut and Balangan, respectively, had a positive attitude.

The statistical analysis revealed no association between children's knowledge, attitude, and behaviour and the incidence of helminthiasis. In contrast, in Balangan District, the behaviour was found to be associated with helminthiasis incidence (p value = 0.049). There was no correlation between gender, grade, or age and the incidence of helminthiasis. According to direct observation in Balangan, school-going children wore flip-flops instead of shoes and were poor economically. Furthermore, the community had a practice of defecating in the river. More than 70% of children had long and unclean nails. Additional information was that the area had three primary schools and was a sentinel lymphatic filariasis village. Observations and investigations indicated that there was a risk of STH transmission.

The univariable analysis of risk factors for STH infections is shown in Table 5. Females were shown to be 0.066 times less likely than males to be infected with STH (OR = 0.066; 95% CI: -0.022–0.004). It was revealed that there was a substantial relationship between the presence of STH and the age group. There was also a correlation found between STH infections and gender.

Table 5.Prevalence of STH Infections as per Gender, Age Group, and District

Variable	No. of Individuals Examined		STH Infection		p Value	OR	95% CI
	N	%	Positive n (%)	Negative n (%)			
Tanah Laut	-	-	-	-	-	-	-
Gender	-	-	-	-	-	-	-
Male	233	52.83	2 (0.45)	231 (52.38)	0.500	0.066	-0.022–0.004
Female	208	47.17	0 (0.00)	208 (47.17)			
Age group (years)	441	100.00	-	-	-	-	-
5–10	433	98.18	2 (0.45)	431 (97.73)	0.999	0.215	-0.005–0.030
> 10	8	1.82	0 (0.00)	8 (1.82)			
Grade	-	-	-	-	-	-	-
1st	86	19.50	0 (0.00)	86 (19.50)	1.000	0.202	-0.024–0.005
2nd	110	24.95	1 (0.22)	109 (24.73)			
3rd	81	18.37	0 (0.00)	81 (18.37)			
4th	82	18.59	1 (0.22)	81 (18.37)			
5th	82	18.59	0 (0.00)	82 (18.59)			
Tapin	-						-

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Variable	No. of Individuals Examined		STH Infection		p Value	OR	95% CI
	N	%	Positive n (%)	Negative n (%)			
Gender	-	-	-	-	-	-	- -
Male	220	50.34	3 (0.68)	217 (49.66)	0.252	0.072	-0.028-0.004
Female	217	49.66	0 (0.00)	217 (49.66)			
Age group (years)	437	100.00	-	-	-	-	-
5-10	415	94.97	3 (0.68)	412 (94.29)	0.709	0.020	-0.008-0.006
> 10	22	5.03	0 (0.00)	22 (5.03)			
Grade							
1st	94	21.51	0 (0.00)	94 (21.51)	0.183	0.072	-0.003-0.012
2nd	91	20.82	0 (0.00)	91 (20.82)			
3rd	90	20.59	0 (0.00)	90 (20.59)			
4th	84	19.22	3 (0.68)	81 (18.55)			
5th	78	17.85	0 (0.00)	78 (17.85)			
Balangan	-	-	- - -	- - -	- -	- -	- -
Gender	-	-	-	-	-	-	- -
Male	256	51.00	5 (1.00)	251 (50.00)	0.512	0.610	0.142–2.610
Female	246	49.00	3 (0.60)	243 (48.40)			
Age group (years)	-	-	-	-	-	-	- -
5–10	485	96.61	8 (1.60)	477 (95.01)	0.834	0.370	0.070–1.943
> 10	17	3.39	0 (0.00)	17 (3.39)			
Grade	-	-	-	-	-	-	- -
1st	108	21.51	1 (0.20)	107 (21.31)	0.536	2.603	0.722–9.390
2nd	127	25.30	1 (0.20)	126 (25.10)			
3rd	95	18.92	1 (0.20)	94 (18.72)			
4th	92	18.33	5 (1.00)	87 (17.33)			
5th	80	15.94	0 (0.00)	80 (15.94)			
Banjar	-	-	- - -	- - -	- -	- -	- -
Gender	-	-	-	-	-	-	- -
Male	187	50.00	2 (0.53)	185 (49.47)	0.966	0.016	-0.017–0.024
Female	187	50.00	2 (0.53)	185 (49.47)			
Age group (years)	374	100.00	-	-	-	-	- -
5–10	348	93.05	3 (0.80)	345 (92.25)	0.659	0.356	0.010–0.037
> 10	26	6.95	1 (0.27)	25 (6.68)			
Grade	-	-	-	-	-	-	- -
1st	86	22.99	0 (0.00)	86 (22.99)	0.983	0.257	-0.034–0.004
2nd	88	23.53	1 (0.27)	87 (23.27)			
3rd	63	16.84	1 (0.27)	62 (16.57)			
4th	81	21.66	1 (0.27)	80 (21.39)			
5th	56	14.97	1 (0.27)	55 (14.70)			
Banjarbaru	-	-	- - -	- - -	- -	- -	- -
Gender	-	-	- - -	- - -	- -	- -	- -

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Variable	No. of Individuals Examined		STH Infection		p Value	OR	95% CI
	N	%	Positive n (%)	Negative n (%)			
Male	118	47.01	2 (0.80)	116 (46.21)	0.853	0.008	-0.029–0.034
Female	133	52.99	2 (0.80)	131 (52.19)			
Age group (years)	251	100.00	-	- - -	- -	-	-
5–10	242	96.40	4 (1.60)	238 (94.80)	0.989	0.125	-0.034–0.013
> 10	9	3.60	0 (0.00)	9 (3.60)			
Grade	-	-	-	- -	- -	- -	-
1st	88	35.06	1 (0.40)	87 (34.66)	0.562	0.189	-0.008–0.42
2nd	73	29.08	0 (0.00)	73 (29.08)			
3rd	22	8.76	1 (0.40)	21 (8.36)			
4th	38	15.14	1 (0.40)	37 (14.74)			
5th	30	11.95	1 (0.40)	29 (11.55)			

Statistically significant at $p < 0.0$

Discussion

The Ministry of Health, Indonesia is aiming at reducing the prevalence of helminthiasis to less than 10% in every city and district. According to our findings, five districts have a prevalence of less than 2%.

The Indonesian government combats helminthiasis according to the the World Health Organization's recommendations, focusing on three species of STH, *Ascaris lumbricoides, Trichiuris trichiura,* and hookworm. Although the frequency is still modest, pinworm infections were shown to be more common than other helminth infections. These findings suggest that health education, in the context of worm control, should include information regarding the transmission of STH and other helminthic infections that pose a risk to children, such as pinworms.

The prevalence of STH in Hulu Sungai Utara, in 2012, was 12.7%. The prevalence decreased significantly below 3% in 2015. This area is co-endemic for lymphatic filariasis and was administered a two-drug regimen of diethylcarbamazine citrate (DEC) and albendazole (ALB).[10]

Based on the survey conducted in 2010–2011, *Hymenolepis* and *Enterobius* were found more frequently among children in South Kalimantan; the prevalence was reported to be lower than 3%. *E. vermicular* is infection was also found to have the same prevalence.[11] Eggs of *E. vermicularis* were rarely found in stool.[12] Interestingly, our 2019 survey indicated that the proportion of *E. vermicularis* infection was greater than that of STH. This may suggest that the infection intensity was quite high. Meanwhile, we found that the proportion of children infected with *H. nana* was similar to those having STH infection. These cosmopolitan helminths are more prevalent in a warmer climate, making Indonesia one of the countries suitable for their growth. This study also discovered enterobiasis and hymenolepiasis (Table 2). The transmission of this nematode is relatively fast and easy. Unlike STHs, the transmission of *Enterobius* eggs does not necessarily need contact with soil. Humans can get infected by it just by inhaling the eggs.[12] Contaminated foods and household items are also common sources of transmission.

T. trichiura, also known as whipworms, tend to live in hot and humid areas,[13] which makes Indonesia a very convenient place for them to live. Trichuriasis was discovered in three districts with a prevalence of less than 5% in this study. This is particularly observable in trichuriasis, where over 90% of the population may be infected, yet only 10% develop severe and symptomatic infections.[14] The most common infection in the Balangan district was trichuriasis. Whipworm infection is mainly caused by ingesting faeces or water infected with whipworm parasites or their eggs. If faecal contamination is utilised in fertilizers or infected humans or animals defecate outdoors, whipworm eggs may penetrate the soil.[15] Since children are more likely to have direct physical contact with contaminated soil, they are more likely to be infected with trichuriasis than adults. The level of acquired immunity may also play a role.[16] According to genetic research in the Nepalese population, genetic variables account for around 25% of the diversity in susceptibility to *T. trichiura* infection.[17]

Routine deworming using albendazole or mebendazole for at-risk populations, as well as enhancements in sanitation,

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hygiene, and access to water, comprise every part of the programme's control strategy. The efficacy of the regimen against *A. lumbricoides* infections is very high; however, *T. trichiura* infections have a low cure rate.[18] The geographical distribution of whipworms is like those of *Ascaris* worms and their presence is more common among people with low socioeconomic status. Whipworms can infect people of any age and gender. Also, like *Ascaris*, whipworms can be transmitted through meals that have been contaminated with their eggs, with the same risk factors.[18] Albendazole is a commonly used and efficient anthelmintic drug for the treatment of STH; however, it is ineffective against *T. trichiura* and its efficiency varies between populations. Albendazole and mebendazole are both very effective against *A. lumbricoides* in single doses; albendazole is preferable to mebendazole for curing hookworm, and mebendazole marginally outperforms albendazole in curing *T. trichiura*.[19]

According to a study by Weatherhead et al., behaviour affects the occurrence of soil-transmitted helminthiasis. The information, attitudes, beliefs, as well as traditions of an individual and society, determine their health behaviour. Furthermore, restricted facilities, attitudes, and conduct of health practitioners toward health will encourage and promote behavioural formation. Change of knowledge and attitude do not guarantee behavioural change. It is relatively easier to make behavioural changes through education in children than in adults.[20] However, from our survey, the statistical analysis of knowledge, attitude, and behaviour in all the surveyed districts shows no significant relationship with the rate of helminthiasis, except in the district of Balangan. We also found no relationship between gender, grade, and age of the children with helminthiasis incidence.

According to the results of this study, *E. vermicularis* and *H. nana* are among the most prevalent causal agents of intestinal parasite infestations in children. The findings revealed that even after mass drug administration (MDA), some children still had *T. trichiura* infestations, followed by *E. vermicularis* infection, which primarily affects children due to its quick and easy transmission. Two out of 441 children (0.45%) were found to be infected. Factors impacting the occurrence include the absence of children's deworming treatment pills in school. Several sources confirmed this information. While we did not investigate children's hand-washing habits, in a particular study, it was seen that children had inadequate hand-washing practices, making them highly susceptible to parasite infestation.[21]

According to the KAP survey, less than half of the children were unaware of helminthiasis. The intention of frequent deworming is to prevent morbidity caused by the disease as well as the development of severe consequences. MDA utilising school platforms may reduce the cost of distribution while effectively reaching both enrolled and unenrolled school-age children.[22]

Open defecation such as in the farm, forests, and rivers, risks contaminating the surrounding environment and causing communicable diseases. Open defecation-free is the first pillar of Community-based Total Sanitation (STBM) in Indonesia. The rising Indonesian population contributes to the problem of open defecation. Indonesia has the second most prevalent open defecation after India.[23]

As we mentioned, in Balangan, the community has a habit of defecating in the river, and children go to school wearing flip-flops. A study in Northwest Ethiopia revealed that open defecation practices are associated with STH prevalence. More importantly, wearing open shoes, wearing shoes occasionally, and playing with soil were all related to STH infections ($p < 0.01$).[24] These factors may be associated with STH infections among children.

Indonesia has been implementing the deworming programme using albendazole since 2010, however, the scale increased in 2016. MDA distributes albendazole to school-age and preschool children. The regimen of albendazole (ALB) and mebendazole (MBZ) is recommended for soil-transmitted helminths for four major species. These multiple-dosing regimens are more efficacious. A recent study found that when mean faecal egg counts (FECs) increased, the efficiency of a single dose of 400 mg ALB against *T. trichiura* decreased dramatically. Therefore, infection intensity should be considered a vital indicator of treatment efficacy.[25] In another study carried out in Sri Lanka, after combining treatments, the cure rate in children reached 79%, and this combination was almost two times as effective as albendazole alone.[26]

We realised that numerous factors, including limitations, could have moulded the result of our study. More research is required in this field, for instance, Water, Sanitation and Hygiene (WASH) aspects and its consequences for STH-endemic areas. This will support the programme in promoting national targets and determining when to end MDA, as well as the phase of maintenance.

Conclusion

This study discovered that MDA dramatically reduced STH infections in children. The most frequent infection observed in the five districts was trichuriasis. *H. nana* and *E. vermicularis* were found to exist among children. Based on the findings, it is suggested that the national programme should provide praziquantel and mebendazole to health centres to anticipate various helminth infections that pose a risk to children.

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