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Prevalence and risk factors of soil transmitted helminth infections among school−aged children in Garut, Indonesia: Insights from a six−year deworming intervention

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ABSTRACT

Objective: To assess prevalence and factors associated with soil-transmitted helminth (STH) infections among rural school children.

Methods: This school-based survey applied a cross-sectional design which included children aged 6-14 years enrolled in 12 elementary schools in Banjarwangi, Garut, West Java Province. Stool and blood samples were collected from 388 randomly selected students to examine the STH infections and anemia status, respectively. Anthropometric assessment was performed to profile nutritional status. A structured questionnaire was employed to collect socio-demographic and school performance data. Multivariable logistic regression models were built to assess the factors associated with STH infections in school children.

Results: Among 386 schoolchildren, 9.8% children were positive for one or more STH infections, predominantly *Trichuris trichiura* (9.0%), with males (n=23),) significantly more infected than females (n=13) (5.9% *vs.* 3.4%, P=0.04). The most infected age group was 6-10 years (n=25, 6.5%). The prevalence of STH infection was significantly higher among students that practicing open defecation (n=22, 5.7%) (P=0.03). The odds risk of STH infections was associated with practicing open defecation (a*OR* 2.54, 95% *CI* 1.17-5.53, P=0.02).

Conclusions: The findings from this study demonstrate the persistent STH transmission among children underscoring the need for sustained post-MDA intervention strategies in resource-limited settings.

KEYWORDS: Soil-transmitted helminths; School-age children; Academic performance; Stunted; Open defecation

1. Introduction

Significance

The prevalence of soil-transmitted helminth (STH) infections in school children was evaluated after six-year deworming program to better guide post-MDA interventions. The study found that while the prevalence of STH was relatively low (9.8%), continuous interventions are highly needed to improve children and community's awareness on factors maintaining the transmission of STH. Strengthening health promotion and basic sanitation infrastructure to reduce open defecation practice in addition to improve nutritional profile in children is recommended.

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Soil transmitted helminths (STH) affect over 1.5 billion individuals globally, predominantly in subtropical and tropical regions. Caused mainly by *Ascaris (A.) lumbricoides*, *Trichuris (T.) trichiura*, and hookworms, these parasitic infections are commonly managed together due to similar diagnostic and treatment methods[1,2]. Most prevalent in underdeveloped nations with high poverty rates and limited access to clean water and sanitation, STH infections have a profound impact on children, with 270 million under the age of five and 600 million school-aged children affected worldwide[2], leading to anemia, iron deficiency, chronic malnutrition, stunting, and developmental delays[3,4].

Research consistently links Water, Sanitation, and Hygiene (WASH) practices, worm diseases, nutritional status, and academic performance, particularly among school-aged children[5-8]. Helminth infections are closely associated with environmental health and access to WASH[9]. Alongside regular medication, improving environmental quality and ensuring equal access to WASH facilities are crucial for children's growth and development[10,11]. Studies indicate that piped water availability, sanitation, and handwashing practices after defecation correlate with reduced *A. lumbricoides* and *T. trichiura* infections[9]. Despite intervention studies in endemic regions[9,10,12], such research remains scarce in Indonesia.

Anthelmintic Mass Drug Administration (MDA) programs effectively combat worm infections, significantly reducing anemia, stunted growth, impaired cognition, and absenteeism in children[11,13]. WHO targets 75% treatment coverage in preschoolers and school-aged children by 2020[14].

Given the significant impact of STH infections on children's health, particularly their nutritional status, targeted treatment and control efforts are crucial. In Indonesia's West Java Province, especially Kab. Garut, the stunting prevalence is high at 35.2% according to 2021 Indonesian Nutritional Status Study (SSGI) data, presenting considerable challenges. For instance, Banjarwangi District in Garut has over 500 stunted children[15] and several areas that are not yet open defecation free (ODF). Program interventions include providing complementary foods to children and improving maternal health. Additionally, biannual Mass Drug Administration (MDA) for worm treatment has been implemented for over six years.

Comprehensive epidemiological data on the prevalence, determinants, and risk distribution of STH infections are essential for strengthening surveillance and evaluating interventions such as Mass Drug Administration (MDA) and WASH programs. However, baseline data is limited, emphasizing the need for further studies in Garut District, which has been implementing MDA for over six years. This study aims to determine the prevalence and risk factors associated with STH infection among school-aged children. The results of the study will help local government in guiding post-MDA interventions to ensure the maintainance of STH control within children population.

2. Subjects and methods

2.1. Study design and study area

A school-based cross-sectional survey was conducted in Banjarwangi, Garut, West Java, from April to July 2023. The study site is characterised as rural area with 11 villages and a population of 66 954 over 12 479 hectares (Figure 1). Geographically, it spans 7 ° 44' E – 107 ° 90' N latitude and longitude, with an altitude of 654 to 1 295 meters above sea level, experiencing a tropical climate with 2 029 mm rainfall and temperatures from 23.8 ℃ to 26.1 ℃[16]. Residents typically have elementary education and work in labor or farming.

2.2. Study population, sample size calculation and sampling technique

In 2022, there were 5 323 students enrolled across 34 primary schools in the Banjarwangi subdistrict, spanning grades 1 to 6. Our sample selection targeted villages along the Cikaengan river, encompassing 8 villages with higher weighting in our sampling units (schools). Employing a sample size calculation formula, with a confidence level of 95% and a margin of error of 5%, we determined a minimum sample of 10 schools and 385 students, assuming a helminth infection prevalence of 50%. Schools were chosen randomly from a list provided by the local education agency, comprising 50% of the student population. Within each selected school, 40 students (20 girls and 20 boys) were systematically and randomly chosen from each grade (grades 1–6), ensuring proportional representation based on the school's overall student distribution.

2.3. Sociodemographic, behavior, and school performance survey

A structured electronic-based questionnaire was developed using EpiCollect 5 platform (in local language, Bahasa Indonesia). Trained enumerators collected data on sociodemographic profiles (*e.g.*, age, sex), behavior (*e.g.*, open defecation practice, sanitation, hygiene), and school performance indicators (*e.g.*, attendance, average score last semester for all subjects) among participated children. These data were collected according to previous studies[5,6,11,13].

2.4. Stool collection and parasitological analysis

Participants were provided with sterile plastic containers equipped with screw covers to collect approximately 5 grams of fecal samples. Single stool samples were collected the following morning from selected children according to the survey team's schedule for each school. Each container was labelled with a unique identity corresponding to the participant. The fecal samples were then placed

in a box and promptly transferred to the local laboratory within 2-3 hours of sampling. As recommended by WHO, Kato-Katz technique was performed to detect STH infection and intensity for each STH species[17]. This method focused on identifying eggs of STHs such as *A. lumbricoides*, *T. trichiura*, and hookworms, as well as non-STH eggs [*e.g.*, *Enterobius (E.) vermicularis*, *Hymenolepis nana*, *Taenia* spp., *Giardia intestinalis*] in stool samples.

Two laboratory technicians prepared a single slide for each sample, while the remaining two technicians independently evaluated the samples under a light microscope. Egg counts were utilized to determine the prevalence and intensity of STH infections, with infection intensity defined in eggs per gram of feces (EPG). According to WHO guidelines, infection intensity was categorized as light, moderate, or heavy for each type of STH infection based on specific EPG ranges[2].

2.5. Hemoglobin and anthropometric evaluation

Hemoglobin (Hb) level, height (cm), and weight (kg) measurement was assessed by trained personnel. Hb measurement was conducted by using HemoCue Hb 201 (HemoCue AB, Ängelholm, Sweden). Hemoglobin levels (g/dL) were categorized according to WHO guidelines, distinguishing between non-anaemic, mild, moderate, and severe anaemia based on age-specific thresholds[18]. Anemia was defined by hemoglobin level less than 11 g/dL in children.

For anthropometric measurements, body weight was measured using a standardized digital weighing scale (GEA EB1653). Physical indicators, including height-for-age Z-score (HAZ) for stunting, body mass index (BMI)-for-age Z-score (BAZ) for wasting, and weight-for-age Z-score (WAZ) for underweight (applicable to children aged 10 years only), were assessed using WHO AnthroPlus Software 2007[19,20]. These indicators were categorized to identify individuals as stunted (<-2SD HAZ), underweight (<-2SD WAZ), overweight (BMI-age ≥ + 1SD), or obese (BMI-age ≥ + 2SD)[19].

2.6. Statistical analysis

The data were entered into Microsoft Excel, cleaned, and imported to STATA version 17.0 MP (StataCorp, College Station, TX, USA) for statistical analysis. Descriptive statistic analysis were applied to calculate the frequency and percentage of categorical variables (sex, age groups, health and antihelminthic treatment history, sanitation and hygiene practices STH infection status) and mean and standard deviation (SD) for continuous variables (age, Hb level, anthropometric parameters and school performances). Differences in demographic characteristics, health and antihelminthic treatment history, sanitation and hygiene practices among STH-infected and uninfected children were tested either using Spearman's *Chi*-squared tests (for categorical variables) or Mann-Whitney *U* test (for continuous variables). Levels of significance were set at 5%.

Further, the associations between factors including age, sex, history of anti-helminthic medication, history of diarrhea, sanitation and

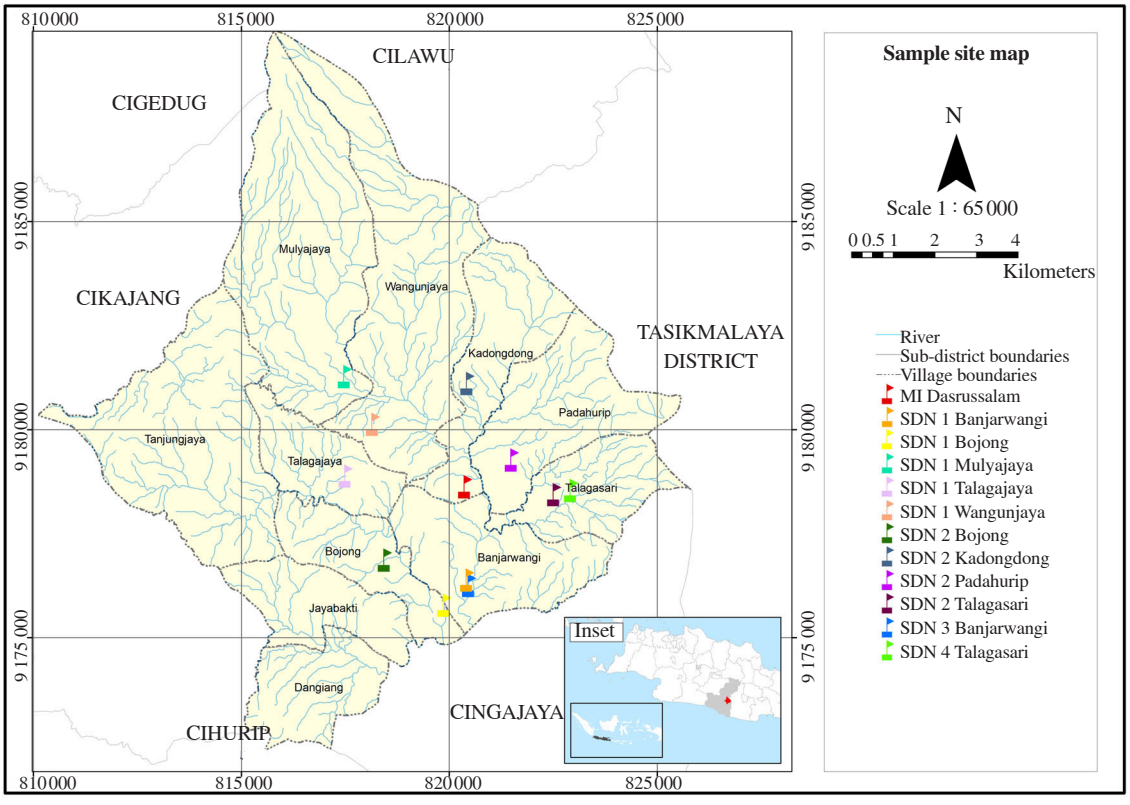

Figure 1. Map showing the geographical situation of Banjarwangi sub-district, Garut where the study was conducted. (https://tanahair.indonesia.go.id/portal-web).

Table 1. Summary of the socio-demographic and other characteristics of the study participants [*n* (%)].

Characteristics	Total (*n*=386)	STH infection		*P*-value
		Positive with any STH species (*n*=36)	Negative (*n*=350)	
Age, years*	9 (3)	9 (3)	9 (3)	0.76
Age groups, years				
>10	109 (28.2)	11 (2.8)	98 (25.4)	
6 to10	277 (71.8)	25 (6.5)	252 (65.3)	0.75
Sex				
Male	184 (47.7)	23 (5.9)	161 (41.7)	
Female	202 (52.3)	13 (3.4)	189 (49.0)	0.04
Received antihelminthic in ≥12 months				
No	233 (60.4)	20 (5.2)	213 (55.2)	
Yes	153 (39.6)	16 (4.1)	137 (35.5)	0.54
Received antihelminthic in ≥3 months				
No	126 (32.6)	12 (3.1)	114 (29.5)	
Yes	260 (67.4)	24 (6.2)	236 (61.2)	0.93
Had diarrhea in ≤ 30 days				
Yes	131 (33.9)	9 (2.3)	122 (31.6)	
No	255 (66.1)	27 (7.0)	228 (59.1)	0.23
Owned latrine				
No	155 (40.2)	15 (3.9)	140 (36.3)	
Yes	231 (59.8)	21 (5.4)	210 (54.4)	0.85
Practicing open defecation				
No	217 (56.2)	14 (3.6)	203 (52.6)	
Yes	169 (43.8)	22 (5.7)	147 (38.1)	0.03
Washed hand after defecating				
Unfrequent	186 (48.2)	16 (4.1)	170 (44.1)	
Frequent	200 (51.8)	20 (5.2)	180 (46.6)	0.64
Washed hand before eating				
Unfrequent	239 (61.9)	21 (5.4)	218 (56.5)	
Frequent	147 (38.1)	15 (3.9)	132 (34.2)	0.64
Washed fruits/vegetables				
Unfrequent	217 (56.2)	24 (6.2)	193 (50.0)	
Frequent	169 (43.8)	12 (3.1)	157 (40.7)	0.18
Putting on shoes/slippers				
Unfrequent	96 (24.9)	8 (2.1)	88 (22.8)	
Frequent	290 (75.1)	28 (7.2)	262 (67.9)	0.7
Putting slippers to the toilet				
Unfrequent	226 (58.5)	16 (4.1)	210 (54.4)	
Frequent	160 (41.5)	20 (5.2)	140 (36.3)	0.07
Haemoglobin level (g/dL)#	13.0±1.1	13.2±1.1	12.9±1.1	0.16
BMI-for-age#	-0.4±1.2	-0.3±1.2	-0.4±1.2	0.45
Height-for-age#	-1.6±1.0	-1.6±1.1	-1.6±1.0	0.75
Weight-for-age#	-1.2 (1.1)	-1.2 (1.5)	-1.2±1.1	0.99
Academic score of last semester#	80.1±5.2	78.1±5.2	80.3±5.1	0.01
Days absence due to illness#	1.6±1.5	1.8±1.7	1.5±1.4	0.36

STH: soil transmitted helminth; BMI: body mass index; *: data were expressed as median (IQR), # data were expresed as mean±SD.

hygiene practices, anemia status, nutritional status, and school performance with STH infection were analyzed by univariate and multivariate logistic regression models (backward stepwise). Variables with *P*-value ≤ 0.20 in the univariate analysis were included for multivariate logistic regression[21]. Additionally, variables identified as being associated with STH infection were further analyzed in the multivariate model. Results of univariate and multivariate was reported as crude odds ratio (*OR*) and adjusted odds ratio (a*OR*) with 95% confidence interval (*CI*), respectively. A *P*-value of less than 0.05 ($P \leq 0.05$) was considered significant. Variables showing statistical significance at a threshold of α=0.05 were included in the multivariable model.

2.7. Ethical approval and consent to participate

Prior to the study, written approval was obtained from all participants' parents or guardians. Confidentiality of participants' information is strictly maintained. The Health Research Ethics Committee of the National Research and Innovation Agency (BRIN) reviewed and approved the study (Approval number: 030/KE.03/SK/4/2023) on 4 April 2023.

3. Results

3.1. Socio–demographic characteristics of study participants

A total of 388 school children from 12 schools provided stool and blood samples (response rate: 388/400, 97.0%) and completed questionnaires. Yet, two students found infected with non-STH parasites (*E. vermicularis*). Therefore, a total of 386 children were included in the final analysis. Sociodemographic and other characteristics are presented in Table 1. The median age of children was 9 years (IQR=3). Of 277 (71.8%) children aged between 6 to 10 years and more than a half (*n*=202/386, 52.3%) participants were girls.

3.2. Antihelminthic treatment history and hygiene practice

Of the children, 60.4% (*n*=233/386) did not received anthelminthic drugs in the past year, while 66.7% (*n*=260/386) reported taking drug within three months prior to the study. Despite this, 6.2% (*n*=24/386) were still infected with STH. Although 59.8% (*n*=231/386) of households had septic tank latrines, many lacked proper waste disposal, with 43.8% (*n*=169/386) of students practicing open defecation (22 students, 5.7%) of whom were infected with STH.

Hygiene practices were lacking, with only 34.2% (*n*=132/386) washing hands before eating, while 46.6% (*n*=180/386) washed hands after defecating and 67.9% (*n*=25) wore shoes outdoors, boys and children aged 6–10 were most affected by STH. Surprisingly, STH infections were more prevalent among those who received antithelminthic, owned toilets, and practiced good hygiene.

3.3. STH infections, anemia, and nutritional status

The prevalence of soil-transmitted helminth (STH) infections among students was 9.8% (*n*=38/388), with *T. trichiura* being the most common (9.0%), followed by *A. lumbricoides* co-infection with *T. trichiura* (0.3%) and *E. vermicularis* (0.5%). Most *T. trichiura* infections were light, while *A. lumbricoides* infections were mainly moderate to heavy. Two samples tested positive for *E. vermicularis*, one with 82 eggs and the other with more than 500. Anemia affected 8.0% of students (*n*=31), with 5.9% having mild anemia and 2.1% moderate. Anthropometric measurements showed 134 students were stunted, and 7.7% (*n*=30) were wasting (Table 2).

Table 2. Intestinal parasitic infection, anemia, nutrition status and school performance of school-age children in Banjarwangi, Garut, West Java [*n* (%)].

Intestinal parasitic infection	*n* (%)
Any STH infection	38 (9.8)
Single STH infection (*Trichuris trichiura*)	35 (9.0)
Light intensity	32 (91.4)
Moderate to heavy intensity	3 (8.6)
Double STH infection (*Ascaris lumbricoides* & *Trichuris trichiura*)	1 (0.3)
Light intensity	0 (0.0)
Moderate to heavy intensity	1 (100.0)
Other intestinal parasites (*Enterobius vermicularis*)	2 (0.5)
Haemoglobin level*, g/dL	12.96±1.07
Normal haemoglobin level	357 (92.0)
Mild anemia	23 (5.9)
Moderate anemia	8 (2.1)
Height-for-age (HAZ)*/stunting	-1.599±0.985
Normal	254 (65.5)
Stunted	134 (34.5)
Weight-for-age (WAZ)/underweight*	-1.244±1.11
Normal	157 (40.5)
Underweight	55 (14.2)
Uncategorized (>10 years)	176 (45.3)
BMI-for-age (BAZ)*	-0.401±1.16
Normal	315 (81.2)
Overweight/Obese	43 (11.1)
Underweight	30 (7.7)

*Data were expressed as mean±SD.

3.4. Determinants of STH infection among school–aged children

In the univariable analysis, three factors were identified as being associated with the incidence of STH infection in children: gender, open defecation, and student academic performance. These variables, along with others linked to STH infection—such as hygiene practices (handwashing, washing fruits and vegetables, and wearing slippers or shoes), health indicators (anemia status, BMI, and height index), and school attendance were included in the multivariable model. The analysis revealed that male students had a higher risk of STH infection compared to females (crude *OR* 2.07, 95% *CI* 1.01-4.23, *P*=0.04), but multivariate analysis showed no significant association. Students who regularly practiced open defecation were found to have approximately 2.5 times higher odds of contracting STH infection (Crude *OR* 2.17, 95% *CI* 1.07-4.38, *P*=0.031; a*OR* 2.54, 95% *CI* 1.17-5.53, *P*= 0.02). The univariate analysis also revealed an association between students' academic performance and the incidence of STH infection. Children with an average academic score below 80 were twice as likely to be infected with STH compared to those with a score above 80 (Crude *OR* 2.23, 95% *CI* 1.11-4.47, *P*=0.024). However, this relationship was not significant in the multivariate analysis (a*OR* 2.1, 95% *CI* 0.98-4.53, *P* =0.06). Detailed results of the risk factor analysis for STH infection are presented in Table 3.

4. Discussion

This study examined the prevalence of soil-transmitted helminths (STH) in underserved rural areas of the Garut district, particularly focus on the Banjarwangi sub-district. Despite having access to springs for water supply, the area faces challenges in sanitation, particularly the lack of improved latrines, posing a risk for STH

Table 3. Univariate and multivariate logistic regression for estimating the risk factors with STH infection in school-aged children [*n*(%)].

Characteristic	*n*=386	Univariate		Multivariate	
		Crude *OR* (95%*CI*)	*P*-value	Adjusted *OR* (95% *CI*)	*P*-value
Age, years					
> 10	109 (28.2)	Reference		Reference	
6 to 10	277 (71.8)	0.88 (0.418-1.86)	0.75	1.19 (0.51-2.73)	0.68
Sex					
Female	202 (52.3)	Reference		Reference	
Male	184 (47.7)	2.07 (1.01-4.23)	0.04	2.16 (1.00-4.68)	0.05
Received antihelminthic in the past 3 months					
Yes	260 (67.4)	Reference		Reference	
No	126 (32.6)	1.03 (0.499-2.14)	0.93	1.16 (0.53-2.54)	>0.05
Had diarrhea in the past 30 days					
No	255 (66.1)	Reference		Reference	
Yes	131 (33.9)	0.62 (0.284-1.37)	0.24	0.52 (0.82-4.23)	0.14
Owned latrine					
Yes	231 (59.8)	Reference		Reference	
No	155 (40.2)	1.07 (0.534-2.15)	0.85	0.64 (0.32-1.27)	>0.05
Practicing open defecation					
No	217 (56.2)	Reference		Reference	
Yes	169 (43.8)	2.17 (1.074-4.38)	0.03	2.54 (1.17-5.53)	0.02
Washed hand after defecating					
Frequent	200 (51.8)	Reference		Reference	
Unfrequent	186 (48.2)	0.847 (0.637-0.425)	0.64	0.71 (0.28-1.80)	0.47
Washed hand before eating					
Frequent	147 (38.1)	Reference		Reference	
Unfrequent	239 (61.9)	0.847 (0.422-1.702)	0.64	0.70 (0.26-1.89)	0.49
Washed fruits/vegetables					
Frequent	169 (43.8)	Reference		Reference	
Unfrequent	217 (56.2)	1.627 (0.788-3.36)	0.19	1.87 (0.82-4.23)	0.14
Putting on shoes/slippers					
Frequent	290 (75.1)	Reference		Reference	
Unfrequent	96 (24.9)	0.85 (0.374-1.94)	0.70	0.67 (0.25-1.80)	>0.05
Putting slippers to the toilet					
Frequent	160 (41.5)	Reference		Reference	
Unfrequent	226 (58.5)	0.53 (0.267-1.006)	0.08	0.53 (0.24-1.17)	0.11
Haemoglobin level (anemia status)					
Normal	355 (91.97)	Reference		Reference	
Mild-moderate	31 (8.03)	0.304 (0.04-2.3)	0.20	0.32 (0.07-1.54)	0.16
BMI-for-age (BMI Index)					
Normal	313 (81.09)	Reference		Reference	
Thinnes/overweight/obesitas	73 (11.14)	1.05 (0.93-1.205)	0.39	1.52 (0.93-2.50)	0.10
Height-for-age (Height index)					
Normal	252 (65.28)	Reference		Reference	
Stunted	134 (34.72)	1.069 (0.523-2.186)	0.85	1.03 (0.46-2.33)	0.94
School attendance					
Present	120 (31.09)	Reference		Reference	
Absence	266 (68.91)	1.02 (0.488-2.16)	0.07	1.16 (0.52-2.62)	0.71
Academic score of last semester					
≥ 80	230 (59.6)	Reference		Reference	
< 80	156 (40.4)	2.23 (1.11-4.47)	0.02	2.09 (0.97-4.49)	0.06

transmission. Mass deworming efforts targeting children have been conducted according to government guidelines.

This research focused on STH prevalence in school-age children after six years of mass drug administration (MDA) in Garut. Stool samples from 388 children in eight villages were analyzed, revealing a 9.8% overall parasitic intestinal infection rate, with 0.5% non-STH and 9.3% STH infection. One case of double infection (*A. lumbricoides* and *T. trichiura*) was found, with the majority having single *T. trichiura* infection. Hookworms were not detected.

This observed prevalence contrasts with earlier research in a nearby rural-urban settings, which found higher prevalence of hookworms, Ascaris and *T. trichiura*[22]. The current prevalence

aligns closely with the national worm control objective of 10%. Although 90% of infections were categorized as low intensity, the presence of moderate to high intensity infections raises concerns and underscores the need for continued vigilance. Previous studies in Indonesia has reported higher prevalence rates[23-25], highlighting the necessity for continued monitoring and intervention efforts. The efficacy of single-dose treatment with Albendazole currently contributes to the persistence of *T. trichiura* infections, as the drug's effectiveness against this particular helminth is limited[26]. In response, researchers have explored combination therapies, such as albendazole-ivermectin, aiming to enhance treatment outcomes[27].

Furthermore, the study highlights a noteworthy contrast: despite the majority of worm-infected children utilizing home latrines and practicing proper individual hygiene, previous research linked soil-transmitted helminth (STH) infections with inadequate hygiene practices and lack of sanitation facilities[6,28]. Bivariate analysis in this study identified only sex (male) and open defecation as factors associated with STH incidence, consistent with prior findings even across different populations where males tend to have higher infection rates[29,30]. Multiple studies have highlighted the association between open defecation and STH infections, reflecting varied odds ratios[30,31].

Moreover, research has shown that poor environmental sanitation, lack of personal hygiene, and the use of contaminated water significantly affect the geospatial distribution of STH[6,32]. Improved sanitation facilities are crucial in reducing the prevalence of STH infections by ensuring the safe containment and disposal of feces (latrine access and use)[6]. Proper disposal of feces reduces the concentration of STH eggs in the environment, thereby decreasing the likelihood of exposure to infectious STH eggs.

The assessment of nutritional status and anemia among school-aged children in this study revealed that anemia rates were generally low but notably higher in stunted and underweight children. This finding aligns with previous research that has linked the prevalence of soil-transmitted helminth (STH) infections with stunting in children under five years old[8,33]. Although no significant direct relationship between anemia and STH infection was observed, it is important to consider STH infection due to its potential to cause low nutrient absorption and occult gastrointestinal bleeding, which can lead to anemia[34]. Moreover, STH infections have been associated with stunting, wasting, and underweight in children, negatively impacting their anthropometric parameters[35]. Consistent evidence indicates that STH infections contribute to anemia, growth retardation, protein-calorie malnutrition, and fatigue[36].

Although, addressing malnutrition is crucial for long-term child development, some studies have found insufficient evidence linking stunting, wasting, and anemia status with STH infection[3,33,37], necessitating widespread health promotion efforts, especially in schools, possibly through engaging media platforms.

While mass drug administration (MDA) programs have effectively reduced STH prevalence, ongoing research on adult communities is crucial to prevent reinfection and maintain control[38,39]. Long-term MDA interventions have shown promising results, although the current prevalence of 9.8% at the study site warrants continued monitoring and emphasis on treatment coverage.

Notably, the majority of STH-infected children had previously received anti-helminthic medicine, highlighting the importance of treatment compliance. Supervised administration of medication is vital to increase coverage and reduce STH infections, emphasizing the need for comprehensive monitoring and implementation of hygiene, sanitation, and health promotion strategies, particularly in school-aged children.

However, the study has limitations, including reliance on self-reported sanitation data, single stool sample per participant, and the low sensitivity of the Kato-Katz method compared to molecular diagnostic approaches[40]. These limitations underscore the need for improved surveillance and intervention methods in combating STH infections.

Conflict of interest statment

The authors declare that they have no competing interests.

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Authors' contributions

EPA and PWD designed the study. EPA, JH, YY, RPS, TI collected the data. EPA analyzed and interpreted the data. IKM and PWD supervised the implementation of study and data analysis. EPA wrote the initial draft and finalized the manuscript. All authors wrote and reviewed the final manuscript.

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