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Original Research

Factors Associated with Questionnaire-Based Enterobiasis Risk Indicators among Students at SDN Banjarsari 2

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ABSTRACT

Introduction: Enterobiasis remains common among school-aged children, particularly in developing countries. Personal hygiene, socioeconomic status, and preventive knowledge may influence enterobiasis risk.

Objective: To determine the associations between personal hygiene, socioeconomic status, preventive knowledge, and questionnaire-based enterobiasis risk among students at SDN Banjarsari 2.

Methods: This analytical observational study used a cross-sectional design and total sampling. Participants comprised 131 eligible students from classes 4B, 4C, 5A, 5B, and 5C. Students provided written assent, and informed consent was obtained before participation. Questionnaires assessed personal hygiene (Cronbach's alpha = 0.606), socioeconomic status using the Kuppuswamy Scale (0.716), preventive knowledge (0.723), and questionnaire-based enterobiasis risk indicators (0.649). Data were analyzed using Chi-square and Fisher's Exact tests, with statistical significance set at $p < 0.05$.

Results: Overall, 11.5% of students were classified as having high questionnaire-based enterobiasis risk. Most demonstrated good hand hygiene (98.5%), poor nail hygiene (63.4%), low socioeconomic status (64.1%), and low preventive knowledge (64.1%). Hand hygiene was significantly associated with risk classification (Fisher's Exact $p = 0.012$; OR = 9.923, 95% CI: 5.926–16.616). Preventive knowledge was also significantly associated ($p = 0.001$; OR = 0.821, 95% CI: 0.743–0.908). Nail hygiene ($p = 0.778$; OR = 1.178, 95% CI: 0.378–3.675) and socioeconomic status ($p = 0.429$; OR = 1.620, 95% CI: 0.486–5.404) showed no significant associations. Sparse categories and zero-cell counts may have produced unstable estimates.

Conclusion: Hand hygiene and preventive knowledge were associated with questionnaire-based enterobiasis risk classification. Laboratory-confirmed diagnosis is needed to validate these findings.

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INTRODUCTION

Enterobiasis is a common parasitic infection caused by Enterobius vermicularis and remains a public health concern, particularly in developing countries. The infection spreads through ingestion of infective eggs from contaminated hands, food, clothing, or environmental surfaces, making children the most vulnerable group due to inadequate hygiene behavior and frequent environmental exposure. Common symptoms include nocturnal perianal itching, sleep disturbance, irritability, and reduced concentration in school.[1–9]

Globally, enterobiasis remains one of the most common helminth infections among children. A recent systematic review estimated that more than 400 million people worldwide are affected, with prevalence varying considerably according to geographic region, study population, and diagnostic methods used. The pooled prevalence among children has been reported at approximately 12.9%, although estimates range widely across countries. The prevalence of enterobiasis is commonly determined using the perianal adhesive tape test, which is more sensitive than stool examination for detecting Enterobius vermicularis eggs.[10–14] In Asia, enterobiasis remains relatively common, particularly in areas with poor sanitation and limited socioeconomic resources. In Indonesia, helminth infections among school-aged children continue to be reported, although epidemiological data specifically on E. vermicularis remain limited. Previous local studies have reported enterobiasis prevalence ranging from 3% to 80%, depending on the study setting and diagnostic methods employed. Furthermore, reports from Banten Province indicate that helminth infections remain an important public health concern among school-aged children.[15]

Several studies have reported associations between personal hygiene, socioeconomic status, and knowledge with enterobiasis or enterobiasis-related risk factors.[11,16–18] However, these factors are often examined separately, whereas enterobiasis transmission is influenced by the interaction of behavioral, socioeconomic, and environmental determinants. Using a behavioral–environmental transmission framework, this study simultaneously assessed personal hygiene, socioeconomic status, and preventive knowledge in relation to questionnaire-based enterobiasis risk classification among elementary school students. Understanding these combined factors may help identify priority areas for school-based health promotion and prevention programs.

Therefore, this study aimed to analyze the associations between personal hygiene, socioeconomic status, and preventive knowledge with questionnaire-based enterobiasis risk classification among students at SDN Banjarsari 2, Serang City, Banten. Personal hygiene, socioeconomic status, and preventive knowledge were treated as exposure variables, while questionnaire-based enterobiasis risk classification was the outcome variable. Because laboratory confirmation was not performed, the outcome represents risk indicators rather than confirmed Enterobius vermicularis infection. The findings may contribute to the development of school-based enterobiasis prevention programs.

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METHOD

Research Type

This school-based cross-sectional study was conducted at SDN Banjarsari 2, Serang City, Banten, Indonesia, in March 2026. A total sampling method was employed, and all eligible students from classes 4B, 4C, 5A, 5B, and 5C were invited to participate. A total of 131 students met the eligibility criteria, all participated in the study, and all were included in the final analysis. The primary outcome was questionnaire-based enterobiasis risk classification, categorized as high risk or low risk using a validated risk-assessment questionnaire. The primary exposure variables were personal hygiene (hand hygiene and nail hygiene), socioeconomic status, and preventive knowledge. Data were collected using structured questionnaires and analyzed using descriptive statistics, Chi-square tests, and Fisher's Exact tests when expected cell counts were less than five. Statistical significance was set at $p < 0.05$. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for cross-sectional studies.

Population and Sample/Informants

The study population consisted of students at SDN Banjarsari 2, Serang City, Banten, Indonesia. The target population included students enrolled in classes 4B, 4C, 5A, 5B, and 5C during the study period. Grade 4 and Grade 5 classes were selected because students in these grades were considered capable of understanding and completing the questionnaires independently. Lower grades were not included due to limited ability to comprehend and complete self-administered questionnaires, whereas Grade 6 students were not included because of school academic activities during the study period.

The inclusion criteria were: (1) being an active student at SDN Banjarsari 2, Serang City, Banten; (2) willingness to participate in the study and provision of student assent; and (3) willingness to complete the questionnaire, including items related to personal hygiene, socioeconomic status, preventive knowledge, and questionnaire-based enterobiasis risk indicators. The exclusion criterion was inability to understand the questionnaire despite explanation by the researcher.

A total of 131 students from the selected classes were screened for eligibility. All 131 students met the inclusion criteria and none met the exclusion criterion. Written informed consent was obtained from the school representatives/class teachers, and written assent was obtained from all participating students prior to data collection. No students declined participation, were absent during data collection, or submitted incomplete questionnaires. Therefore, all 131 eligible students were included in the final analysis using a total sampling approach.

Research Location

The study was conducted at SDN Banjarsari 2, Kelurahan Banjarsari, Kecamatan Cipocok Jaya, Kota Serang, Banten.

Instrumentation or Tools

Data were collected using four questionnaires adapted from previously published studies. Prior to data collection, all instruments underwent content validation through expert review by academic experts in relevant fields to assess the clarity, relevance, and appropriateness of each item for the target population. Reliability testing demonstrated Cronbach's alpha coefficients of 0.606 for the personal hygiene questionnaire, 0.716 for the socioeconomic questionnaire, 0.723 for the prevention knowledge questionnaire, and 0.649 for the questionnaire-based enterobiasis risk indicator questionnaire.

Personal hygiene was assessed using a questionnaire adapted from Saddania (2019), consisting of seven hand-hygiene items and two nail-hygiene items. Hand-hygiene

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items were scored on a four-point Likert scale ranging from 1 (never) to 4 (always), resulting in total scores ranging from 7 to 28. Based on the scoring system used in the original instrument, scores ≥17 were categorized as good hand hygiene and scores ≤16 as poor hand hygiene. Nail hygiene was assessed using two items evaluating nail-cutting habits and nail cleanliness. Total scores ranged from 1 to 6 and were categorized as good (score = 6) and poor (score = 1–5).[19]

Socioeconomic status was assessed using the Kuppuswamy Socioeconomic Scale adapted from Wahyu (2021) and translated into Indonesian by Febriyani (2019). The instrument evaluates three domains: occupation of the head of household, educational attainment of the head of household, and monthly family income. For analytical purposes, socioeconomic status was categorized into upper-middle and lower-middle groups according to the scoring system used in the adapted instrument.[20]

Prevention knowledge was assessed using a questionnaire adapted from Sugiartini (2021), consisting of 20 items covering the definition, causes, symptoms, impacts, and prevention of helminth infections. Correct responses were summed and converted into percentage scores. Based on the categorization used in the original instrument, scores of 76–100% were classified as good knowledge, whereas scores below 76% were classified as poor knowledge.[21]

Questionnaire-based enterobiasis risk indicators were assessed using a questionnaire adapted from Valenza (2020), consisting of 10 Likert-scale items evaluating behaviors and attitudes related to helminth transmission. Total scores ranged from 10 to 40 and were categorized as high risk (≤25) and low risk (≥26) according to the original scoring system. Because laboratory confirmation, such as the perianal adhesive tape test, was not performed, this instrument was used solely to classify questionnaire-based risk levels and should not be interpreted as evidence of actual Enterobius vermicularis infection. Therefore, the outcome measured in this study reflects questionnaire-based enterobiasis risk indicators rather than laboratory-confirmed enterobiasis.[22]

Although the instruments demonstrated acceptable internal consistency and underwent expert content validation, the outcome questionnaire was intended to assess behavioral risk indicators rather than diagnose enterobiasis. Therefore, the findings should be interpreted as associations with questionnaire-based enterobiasis risk classification rather than laboratory-confirmed infection.

Data Collection Procedures

Data were collected in March 2026 through questionnaire administration in classrooms at SDN Banjarsari 2. Before data collection, students received an explanation of the study objectives, procedures, and instructions for completing the questionnaires. Written informed consent was obtained from the school representatives/class teachers, and written assent was obtained from all participating students prior to data collection.

The questionnaires were completed by students under the supervision of the researchers in a classroom setting. Researchers remained present during data collection to provide clarification when necessary and to ensure that all questionnaire items were completed appropriately. Personal hygiene, prevention knowledge, and questionnaire-based enterobiasis risk indicators were self-reported by the students.

Socioeconomic data were not self-reported by the students. Information regarding parental occupation, educational attainment, and household income was obtained from school administrative records to improve data accuracy and minimize reporting bias. After completion, all questionnaires were checked for completeness by the researchers. No questionnaires contained missing data, and all completed questionnaires were included in the final analysis.

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Data Analysis

Data were analyzed using IBM SPSS Statistics software. Descriptive statistics were used to summarize participant characteristics and study variables. Associations between personal hygiene, socioeconomic status, prevention knowledge, and questionnaire-based enterobiasis risk classification were analyzed using Pearson's Chi-Square test and Fisher's Exact test when expected cell counts were <5 or zero-frequency cells were present. Odds ratios (ORs) with 95% confidence intervals (95% CIs) were calculated to estimate the strength of associations. Statistical significance was set at $p < 0.05$. No missing data were identified, and all 131 respondents were included in the final analysis.

Ethical Approval

This study was approved by the Health Research Ethics Committee of FKIK Universitas Sultan Ageng Tirtayasa (Approval Number: 24/UN43.20/KEPK/2026). Permission to conduct the study was obtained from SDN Banjarsari 2 and the respective class teachers prior to data collection. Written assent was obtained from all participating students after they received an explanation of the study objectives and procedures. Participation was voluntary, and students could withdraw from the study at any time without consequences. To maintain confidentiality, each participant was assigned a unique study code, and no direct personal identifiers were included in the research dataset. Access to the data was restricted to the research team and stored securely in password-protected files. Results are reported in aggregate form to prevent identification of individual participants.

RESULTS

The study involved 131 students at SDN Banjarsari 2. The distribution of respondents showed that 50.4% were male and 49.6% were female. Most respondents were aged 9–10 years (51.1%), followed by 11–12 years (45.8%) and 13–14 years (3.1%). Based on class distribution, 21.4% of respondents were from class 5C, 20.6% from class 5A, 19.8% from class 4B, and 19.1% each from classes 4C and 5B (Table 1).

The questionnaire-based risk assessment classified 15 students (11.5%) as high risk and 116 students (88.5%) as low risk for Enterobius vermicularis infection based on the predefined questionnaire cutoff. Most students had good hand hygiene (98.5%), whereas poor nail hygiene was observed in 63.4% of respondents. The majority of respondents were categorized as having lower-middle socioeconomic status (64.1%) and poor prevention knowledge (64.1%) (Table 2).

Hand hygiene was significantly associated with questionnaire-based enterobiasis risk classification (Fisher's Exact test, $p = 0.012$). Students with poor hand hygiene showed a higher proportion of high-risk classification (100%) compared with those with good hand hygiene (10.1%). The estimated odds ratio was 9.923 (95% CI: 5.926–16.616). However, only two respondents were classified as having poor hand hygiene; therefore, this finding should be interpreted with caution because sparse data may have resulted in unstable effect estimates and limited precision of the observed association (Table 3).

No significant association was found between nail hygiene and questionnaire-based risk classification (Chi-Square test, $p = 0.778$), although the proportion of high-risk classification was slightly higher among students with poor nail hygiene (12.0%) than among those with good nail hygiene (10.4%) (Table 4).

Socioeconomic status was not significantly associated with questionnaire-based risk classification (Chi-Square test, $p = 0.429$). Nevertheless, the proportion of high-risk classification was higher among students from lower-middle socioeconomic backgrounds (13.1%) compared with those from upper-middle socioeconomic backgrounds (8.5%) (Table 5).

Prevention knowledge was significantly associated with questionnaire-based risk classification (Fisher's Exact test, $p = 0.001$). All students with good prevention knowledge

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were classified as low risk (100%), whereas high-risk classification was observed only among students with poor prevention knowledge (17.9%) (Table 6).

Table 1. Characteristics of Respondents (n = 131)

Variabels	Distribution		Total
	Frequency	Percentage (%)	
Gender			131 Responden
Male	66	50.4%	
Female	65	49.6%	
Age			131 Responden
9-10 years old	67	51.1%	
11-12 years old	60	45.8%	
13-14 years old	4	3.1%	
Class			131 Responden
4B	26	19.8%	
4C	25	19.1%	
5A	27	20.6%	
5B	25	19.1%	
5C	28	21.4%	

Table 2. Proportion of *E. vermicularis* Infection Risk at SDN Banjarsari 2

Characteristics	Distribution	
	Frequency	Percentage (%)
Risk of *E. vermicularis* Infection		
High	15	11,5%
Low	116	88,5%
Personal Hygiene: Hand Hygiene		
Poor	2	1,5%
Good	129	98,5%
Personal Hygiene: Nail Hygiene		
Poor	83	63,4%
Good	48	36,6%
Socioeconomic Status		
Lower Middle	84	64,1%
Upper Middle	47	35,9%
Student Prevention Knowledge Level		
Poor	84	64,1%
Good	47	35,9%

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Table 3. Association Between Hand Hygiene and Questionnaire-Based Enterobiasis Risk Classification

Hand Hygiene	Risk of *E. vermicularis* Infection				Total		p-value	OR (95% CI)
	High		Low		N	%		
	n	%	n	%				
Poor	2	100%	0	0%	2	100%	0,012	9,923 (5,926–16,616)
Good	13	10,1%	116	89,9%	129	100%		
Total	15	11,5%	116	88,5%	131	100%		

Table 4. Association Between Nail Hygiene and Questionnaire-Based Enterobiasis Risk Classification

Nail Hygiene	Risk of *E. vermicularis* Infection				Total		p-value	OR (95% CI)
	High		Low		N	%		
	n	%	n	%				
Poor	10	12%	73	88%	83	100%	0,778	1,178 (0,378–3,675)
Good	5	10,4%	43	89,6%	48	100%		
Total	15	11,5%	116	88,5%	131	100%		

Table 5. Association Between Socioeconomic Status and Questionnaire-Based Enterobiasis Risk Classification

Socioeconomic Status	Risk of *E. vermicularis* Infection				Total		p-value	OR (95% CI)
	High		Low		N	%		
	n	%	n	%				
Lower Middle	11	13,1%	73	86,9%	84	100%	0,429	1,620 (0,486–5,404)
Upper Middle	4	8,5%	43	91,5%	47	100%		
Total	15	11,5%	116	88,5%	131	100%		

Table 6. Association Between Prevention Knowledge and Questionnaire-Based Enterobiasis Risk Classification

Prevention Knowledge	Risk of *E. vermicularis* Infection				Total		p-value	OR (95% CI)
	High		Low		N	%		
	N	%	n	%				
Poor	15	17,9%	69	82,1%	84	100%	0,001	0,821 (0,743–0,908)
Good	0	0%	47	100%	47	100%		
Total	15	11,5%	116	88,5%	131	100%		

DISCUSSION

Interpretation of Key Findings

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Our findings showed that hand hygiene was significantly associated with questionnaire-based enterobiasis risk classification (OR = 9.923; 95% CI: 5.926–16.616; p = 0.012), while prevention knowledge was also significantly associated with risk classification (Fisher's Exact test, p = 0.001). In contrast, nail hygiene (OR = 1.178; 95% CI: 0.378–3.675; p = 0.778) and socioeconomic status (OR = 1.620; 95% CI: 0.486–5.404; p = 0.429) were not significantly associated with questionnaire-based enterobiasis risk classification. Overall, 11.5% of students were classified as high risk based on the questionnaire instrument. However, these findings should be interpreted cautiously because the outcome was derived from a questionnaire-based risk classification rather than laboratory-confirmed enterobiasis, the number of high-risk cases was limited, and no adjusted multivariable analysis was performed to account for potential confounding factors.[1,2,13,15,16]

It should be emphasized that this study assessed the risk of E. vermicularis infection based on a questionnaire-based risk classification and not laboratory-confirmed enterobiasis. Therefore, the findings should be interpreted as factors associated with infection risk rather than confirmed infection status.

Most respondents were children aged 9–12 years, an age group considered vulnerable to enterobiasis because hygiene habits are still developing and contact with potentially contaminated environments is frequent. Previous studies have also reported that infection risk among children is more strongly influenced by hygiene behavior and environmental factors than by demographic characteristics such as age and sex.[12,13]

The observed association between hand hygiene and questionnaire-based enterobiasis risk classification is biologically plausible and consistent with the known transmission cycle of Enterobius vermicularis. Previous studies have shown that infective eggs may be ingested after contact with contaminated surfaces or following perianal scratching, particularly when hand hygiene practices are inadequate. Repeated hand-to-mouth behavior among children may further facilitate this transmission pathway. In addition, autoinfection may occur when eggs deposited around the perianal region are transferred to the fingers through scratching and subsequently ingested. However, the cross-sectional design of the present study does not allow conclusions regarding causality or the direction of the observed association. Furthermore, the findings may be influenced by self-reported hygiene behaviors, social-desirability bias, differential reporting, and other unmeasured factors that were not assessed in this study.[1,11,23,24]

Comparison with Previous Studies

The findings of this study are consistent with those of Moussavi et al. (2023) and Lashaki et al. (2023), which reported an association between poor hand hygiene and enterobiasis-related outcomes among children. In the present study, all students classified as having poor hand hygiene were also classified in the high-risk category based on the questionnaire instrument. However, this finding should be interpreted cautiously because only two students were categorized as having poor hand hygiene, resulting in sparse data and potentially unstable effect estimates. Similar associations between hygiene-related behaviors and helminth-related outcomes have also been reported among Indonesian schoolchildren. Because of the cross-sectional design, questionnaire-based outcome measurement, and reliance on self-reported behaviors, the observed association should not be interpreted as evidence that poor hand hygiene causes enterobiasis or that improving hand hygiene would necessarily reduce transmission. Reverse causation, social-desirability bias, differential reporting, and unmeasured confounding factors may also have influenced the results.[2,15,18]

However, 13 students (10.1%) were classified as having a high risk despite having good hand hygiene. This finding indicates that hand hygiene is not the only factor influencing infection risk. Other factors such as poor nail hygiene, nail-biting habits, hand-to-mouth behavior, environmental contamination, and low prevention knowledge may also contribute to the transmission of E. vermicularis among school-aged children.[8] Furthermore, good prevention knowledge may encourage children to adopt proper

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handwashing practices, although adequate knowledge does not always guarantee consistent implementation of all personal hygiene behaviors, including nail hygiene.[10]

The findings regarding nail hygiene showed no statistically significant association with infection risk. Students with poor nail hygiene had a slightly higher proportion of high-risk classification (12%) than those with good nail hygiene (10.4%), but the difference was not statistically significant. Similar findings have been reported by Jin et al. (2025), who found that nail-related behaviors such as nail biting and hand-to-mouth contact may increase the risk of *E. vermicularis* infection but do not always remain significant when analyzed together with other behavioral and environmental factors.[11] Likewise, Mao et al. reported that contamination of fingernails may contribute to transmission, although its influence varies depending on accompanying hygiene practices.[25]

From a biological perspective, fingernails can serve as an important reservoir for *E. vermicularis* eggs. Eggs may accumulate beneath fingernails after scratching the perianal area, particularly at night when female worms lay eggs, and subsequently enter the body through hand-to-mouth contact, resulting in autoinfection.1 Despite this biologically plausible mechanism, no significant association was observed in the present study. Several explanations may account for this finding. First, other hygiene-related behaviors, particularly handwashing practices, may have a greater influence on questionnaire-based enterobiasis risk classification than nail hygiene alone. Second, nail hygiene was assessed through direct observation of visible nail cleanliness and length at a single point in time, which may not accurately reflect microscopic contamination by parasite eggs or habitual nail hygiene practices. Third, individual behavioral variations and unmeasured environmental factors may have influenced the observed association.[1,11,25]

Socio-economic status was also not significantly associated with infection risk. Although students from lower socio-economic backgrounds showed a higher proportion of high-risk classification (13.1%) than those from higher socio-economic backgrounds (8.5%), the difference was not statistically significant. Similar findings were reported by Khayyat et al. (2021), who found that parental occupation, educational level, and household income were not independently associated with *E. vermicularis* infection among children.[12]

Several explanations may account for this finding. Socio-economic status may influence infection risk indirectly through hygiene behavior rather than acting as a direct determinant. Children from higher socio-economic backgrounds may still be at risk if they practice poor hygiene, whereas children from lower socio-economic backgrounds may maintain low risk through good hygiene practices. In addition, most respondents shared relatively similar school environments, daily activities, and exposure patterns, which may have reduced the impact of socio-economic differences on transmission risk. Environmental sanitation and household crowding were not assessed in this study and may also have influenced the observed association. [8,12]

Prevention knowledge showed a significant association with questionnaire-based enterobiasis risk classification. All students with good prevention knowledge were classified in the low-risk category, whereas all high-risk classifications occurred among students with poor knowledge. Similar associations have been reported in previous studies showing that educational interventions can improve children's understanding of enterobiasis prevention and hygiene-related practices.[2,15,18,23] However, this finding should be interpreted cautiously. The complete separation observed in the present study may reflect sparse data, the selected classification thresholds, or potential common-method variance arising from the use of questionnaire-based measures for both knowledge and risk classification. In addition, conceptual overlap between knowledge-related items and components of the risk classification instrument cannot be entirely excluded. Therefore, the observed association should not be interpreted as evidence that higher knowledge directly reduces enterobiasis risk, but rather as an association that warrants further investigation using laboratory-confirmed outcomes and instruments with clearly independent constructs.[10]

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Limitations and Cautions

While this study provides meaningful contributions to understanding factors associated with questionnaire-based enterobiasis risk classification, several limitations should be acknowledged. First, the study did not include laboratory diagnostic methods, such as the perianal adhesive tape test, and therefore the outcome represented a questionnaire-based risk classification rather than laboratory-confirmed Enterobius vermicularis infection. The criterion validity of this instrument as a surrogate measure of infection remains uncertain. Second, the cross-sectional design limits the ability to establish causal relationships between variables.[15] Third, because both predictors and outcomes were assessed using questionnaire-based instruments, common-method bias may have occurred. Potential overlap between items included in the prevention knowledge questionnaire and components of the risk-classification instrument also cannot be completely excluded. Fourth, some instruments demonstrated only moderate reliability, which may have introduced measurement error.

Furthermore, sparse data were present in several exposure categories, particularly hand hygiene, and complete separation was observed for prevention knowledge, resulting in potentially unstable effect estimates.[16] The analysis was limited to bivariate statistical tests and did not include multivariable adjustment for potential confounding factors. Questionnaire scores were also dichotomized into categorical variables, which may have reduced information and statistical power. Data were collected using questionnaires and direct observation at a single point in time, which may introduce reporting bias, social-desirability bias, and observer-related measurement bias. Environmental sanitation, household crowding, nail-biting habits, and perianal scratching behaviors were not evaluated and may have influenced questionnaire-based risk classification. Finally, the study was conducted in a single school, which may limit the generalizability of the findings to broader populations.[17]

Therefore, the findings should be interpreted as associations with questionnaire-based enterobiasis risk classification rather than evidence of causal relationships or laboratory-confirmed enterobiasis.

Recommendations for Future Research

Future studies should involve larger sample sizes and include multiple schools or regions to improve generalizability. Additional variables such as nail-biting habits, perianal scratching, hand-to-mouth behavior, environmental sanitation, and household crowding should be included to better understand transmission pathways. Furthermore, combining questionnaire-based assessments with direct observation and laboratory examination is recommended to obtain more objective and accurate measurements of *E. vermicularis* infection risk and confirmed infection status.

CONCLUSION

This study examined the association between personal hygiene, socioeconomic status, prevention knowledge, and questionnaire-based enterobiasis risk classification among students at SDN Banjarsari 2. Hand hygiene and prevention knowledge were significantly associated with questionnaire-based risk classification, whereas nail hygiene and socioeconomic status were not significantly associated. However, these findings should be interpreted cautiously because the outcome was based on a questionnaire-derived risk classification rather than laboratory-confirmed Enterobius vermicularis infection, and some analyses were affected by sparse data and complete separation. Therefore, the observed associations should be considered exploratory and not interpreted as evidence of causal relationships or confirmed infection risk. Further studies using validated, non-overlapping

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measurement instruments, larger sample sizes, multivariable analyses, and laboratory-confirmed diagnostic methods are needed to verify these findings.

While the findings should be interpreted cautiously, they suggest that school-based hygiene education and preventive behavior programs may be relevant areas for further consideration and evaluation, particularly those addressing handwashing practices and awareness of helminth infection prevention.

This study has several limitations, including the use of questionnaire-based risk assessment, the inclusion of respondents from only one school, and the absence of laboratory-confirmed diagnosis. Further studies involving larger populations, broader study settings, additional behavioral and environmental variables, and laboratory-confirmed diagnostic methods are needed to validate and expand upon these findings.

AUTHOR'S CONTRIBUTION STATEMENT

T.N.E. contributed to the conceptualization and design of the study, data collection, data curation, formal analysis, interpretation of findings, and preparation of the original manuscript draft. T.R.F. contributed to the conceptualization and methodology of the study, provided supervision and methodological guidance from the initial research planning stage, participated in data interpretation and validation of the findings, and critically reviewed and revised the manuscript. I.N.B.U. contributed to the methodology of the study, provided supervision and methodological guidance, participated in data interpretation and validation of the findings, and critically reviewed the manuscript. All authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest related to this study.

DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

The authors used ChatGPT (OpenAI) as a language-support tool during manuscript preparation, specifically for language refinement, grammar correction, and improvement of sentence structure and readability. The AI tool was not used to generate research data, perform statistical analyses, interpret findings, formulate scientific conclusions, or select references. All content generated with AI assistance was carefully reviewed, verified, and edited by the authors. The authors take full responsibility for the accuracy, integrity, and originality of the final manuscript, including all factual statements, citations, analyses, and conclusions.

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