

GEOGRAPHICAL Information System Spatial Mapping of *Enterobius vermicularis* among Children in Kidapawan CITY

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ABSTRACT

Enterobius vermicularis (pinworm) is a cosmopolitan infection. School children living in crowded environments are the most commonly infected group, with hygiene and exposure being essential factors. The study aimed to investigate the prevalence of *E. vermicularis* among children in Kidapawan City, Philippines, and explore its associations with socio-demographic factors and hygiene practices with its geographical distribution using spatial mapping. A total of 138 respondents were included in the study, and data were collected through the scotch tape technique and surveys and were analyzed using statistical methods, including the Pearson product-moment correlation coefficient. The majority of infected children were boys (52.9%), aged 1 to 3 years (52.2%), and from households with five or fewer family members (55.8%). The result showed a 15.21 percent prevalence of *E. vermicularis* infection. The age of children ($p=0.000$) and the mother's education level ($p=0.009$) are significant socio-demographic factors; washing of hands before eating ($p=0.001$) and after using the toilet ($p=0.006$), bathing without family members ($p=0.002$), sharing a bed ($p=0.001$), and type of bed ($p=0.042$) are significant risk factors.

KEYWORDS: *Medical Technology, prevalence, socio-demographic factors, hygiene practices, household conditions, epidemiology, public health, Philippines*

INTRODUCTION

Enterobius vermicularis, a cosmopolitan parasite, affects over 200 million people worldwide, with the highest vulnerability observed among individuals residing in tropical regions and school-aged children. Pinworm infections occur when individuals inadvertently ingest pinworm eggs that are

present on their fingers, clothing, bedding, or other surfaces that have been contaminated (Al-Warid et al., 2022). Many developing nations are still struggling with the infection known as enterobiasis.

A study conducted in 2020 in Southeast Asia found that the prevalence of *E. vermicularis* infection in Thailand ranges from 0% to 50.90%. School children living in overcrowded conditions and practicing poor personal hygiene were the most commonly affected group (Laoraksawong et al., 2020). In the Philippines, the prevalence of *E. vermicularis* infection is 30%. Furthermore, a significant proportion of school children, specifically 66% of those aged 5-14 years, were found to be infected with intestinal helminths. Within the province of Davao del Norte, a significant proportion of the indigenous population, specifically 46.2%, have been identified as having intestinal helminth infections. By contrast, a significant 62% of children residing in institutional facilities and street communities in Metro Manila were found to have tested positive for intestinal infections (Ordoñez et al., 2017).

Despite the existence of accessible tools for controlling and eradicating various neglected parasitic diseases, there is a need for greater public awareness and intervention. Moreover, while there are available studies on the precise characteristics of the research, local studies are scarce. Unlike previous studies, the current study employed multivariate analysis to investigate the relationship between demographic characteristics, personal hygiene factors, and sanitary household conditions and *E. vermicularis* infections in schoolchildren. Moreover, the utilization of geospatial mapping as a tool to visually represent the occurrence and spread of infection within a particular geographic region and associating it with variables that are factors that may affect the spread.

METHODS

Research design

This study employed a descriptive-correlational design. The researcher utilized a survey questionnaire to gather data on the sociodemographic profiles of participants. Data was then analyzed to explore the associations between these profiles and the prevalence, distribution, and risk factors of *E. vermicularis*.

Research locale and respondents

This study included 138 young children in Kidapawan city. Children under the age of ten who agreed to participate and whose parents or legal guardians consented are included. With a population size of 27,144 and a response

distribution of 90 percent, the margin of error is set at 5 percent with a 95 percent confidence level. The study utilized cluster sampling, which involved the random selection of children from the 40 barangays in the city. Children who did not live in Kidapawan City, did not complete the 3-day sampling, or bathed/had bowel movements before collection were not included.

Ethical considerations

UIC-REC granted ethical approval (Protocol Code: GS-41-01-23). Approval was obtained from the city health office and barangay offices in order to carry out the study and enlist participants. The parents of the 138 children who took part, all of whom were under the age of 10, gave their informed consent. The researcher ensured the provision of an assent form, which is intended for respondents who are not yet capable of giving informed consent due to their young age, but possess sufficient understanding of the proposed research, its anticipated risks and potential benefits, as well as the expected activities they will undertake as participants.

Research instrument

The questionnaire gathered demographic information, potential risk factors, hygiene practices, and sanitation conditions.

Data collection

The Scotch tape technique was used to diagnose children with *E. vermicularis* infection: perianal skin is pressed with transparent tape to collect possible pinworm eggs around the anus first thing in the morning. Two medical technologists performed microscopic examinations on a three-day adhesive cellophane perianal swab. The morning before defecation and bathing, samples was collected. This was used to qualitatively diagnose pinworm infection without providing a quantitative measure of the number of eggs present. The prevalence of *E. vermicularis* infection was assessed by using Pearson correlation (r) to associate sociodemographic and risk factors.

RESULTS

Table 1 presents the demographic composition of the study's respondents, including gender distribution, children's age range, family size, number of siblings, parental education levels, parental occupations, and household income. The data presented in Table 1 were drawn from a sample of 138 participants involved in the research. Notably, the gender distribution shows a slight majority of males (52.9%) compared with females (47.1%). The age

range of the children revealed that the majority fell within the 1–3 years bracket (52.2%), with a smaller proportion aged between 7 and 9 years (10.1%). Moreover, approximately 55.8% of households have five or fewer members, while the remainder have larger family units. Remarkably, a significant proportion of children have older siblings (66.7%), and a substantial portion lack younger siblings (60.1%). In addition, parental education levels vary, with a notable percentage completing secondary education while fewer have attained a bachelor's degree or higher. Both fathers (76.1%) and mothers (92.0%) are involved in diverse occupations. Income distribution highlights that a considerable number of fathers (41.3%) and most mothers (74.6%) earn less than PHP 5,000.

Table 1
Sociodemographic Profile of the Respondents

Factors		Frequency	Percentage (%)
Sex			
male		73	52.9
female		65	47.1
	Total	138	100.0
Age of the Children			
1–3 years old		72	52.2
4–6 years old		52	37.7
7–9 years old		14	10.1
	Total	138	100.0
Number of Family Members			
5 and less than 5		77	55.8
greater than five		61	44.2
	Total	138	100.0
With Older Brother/s or Sister/s			
Yes		92	66.7
No		46	33.3
	Total	138	100.0
With Younger Brothers or Sisters			
Yes		55	39.9

No		83	60.1
	Total	138	100.0
Father’s Education Level			
Primary School		51	37.0
Secondary School		62	44.9
Bachelor’s degree or higher		25	18.1
	Total	138	100.0
Mother’s Education Level			
Primary School		28	20.3
Secondary School		76	55.1
Bachelor’s degree or higher		34	24.6
	Total	138	100.0
Father’s Occupation			
Agricultural		15	10.9
Trade/Business owner		9	6.5
Government/Private officer		9	6.5
Others		105	76.1
	Total	138	100.0
Mother’s Occupation			
Agricultural		2	1.4
Trade/Business owner		6	4.3
Government/Private officer		3	2.2
Others		127	92.0
		138	100.0
Father’s Income			
< P 5,000		57	41.3
P 5,000 – P 9,999		57	41.3
P 10,000 –P14,999		18	13.0
P 15,000 – P19,000		3	2.2
> P 20,000		3	2.2
	Total	136	100.0
Mother’s Income			
< P 5,000		103	74.6
P 5,000 – P 9,999		16	11.6
P 10,000 –P14,999		9	6.5
P 15,000 – P19,000		6	4.3

> P 20,000		4	2.9
	Total	136	100.0

Table 2 shows that most of the children were doing the following practices: washing their hands before eating (97.8%) and after using toilet facilities (98.6%); keeping their fingernails short (97.8%); playing with others (94.9%); taking a bath before sleeping and after waking up (79.7%, and 88.4% respectively); and sharing a bed with family members (93.5%). Notably, many of the children sucked their fingers (79.7%), bathed with the assistance of family members (62.3%), and washed their underwear with the help of family members (93.5%). Meanwhile, a little more than half of them are sharing towels with others and having been dewormed, 60.1 percent and 58.0 percent, respectively.

Table 2
Status of Personal Hygiene of Children with E. vermicularis Infection

Personal Hygiene Possible Risk Factors	Yes		No	
	Freq.	%	Freq.	%
<i>Are children ...</i>				
1. Washing their hands before eating?	135	97.8	3	2.2
2. Washing their hands after using toilet facilities?	136	98.6	2	1.4
3. Keeping their fingernails short?	135	97.8	3	2.2
4. Sucking their fingers?	28	20.3	110	79.7
5. Playing with others?	131	94.9	7	5.1
6. Taking a bath before sleeping?	110	79.7	28	20.3
7. Taking a bath after waking up?	122	88.4	16	11.6
8. Bathing without the assistance of family members?	52	37.7	86	62.3
9. Washing their underwear without the help of family members?	9	6.5	129	93.5

10. Sharing a towel with others?	83	60.1	55	39.9
11. Sharing a bed with family members?	129	93.5	9	6.5
12. Having been dewormed for parasites?	80	58.0	58	42.0

Considering household sanitary conditions as a possible risk factor for children, table 3 presents that most children lived in a single-family detached home (94.9%), with many of them having homes made up of wood (68.8%). Regarding the type of bed of the children, most had wood or spring mattresses (81.9%), and most of the children's beddings were changed once a week (81.1%). Also, the houses of the children are mostly being cleaned every day (98.6%).

Table 3
Status of Household Sanitary Condition of Children Towards E. vermicularis Infection

Household Sanitary Conditions Risk Factors	Freq.	%
1. What is the style of the residence		
single-family detached home	131	94.9
apartment	7	5.1
2. What is the structure the residence made of		
concrete	43	31.2
wood	95	68.8
3. What type of bed the child has		
wood or spring mattress	113	81.9
floor mats	25	18.1
4. How often do you change the beddings		
once a week	112	81.1
once every two weeks	15	10.9
once a month or more	11	8.0
5. Do you clean the house everyday		
Yes	136	98.6
No	2	1.4

The prevalence of *E. vermicularis* is based on a population size of 27,144 and a response distribution of 90 percent; the margin of error is set at 5% with a 95% confidence level. Figure 1A shows the geographical distribution of *E. vermicularis* in Kidapawan. The result indicates that 29 of 138 respondents (15.21%) tested positive for *E. vermicularis*. Because of some circumstances that support the infection, this reflects a rather high prevalence despite the rigorous deworming effort of the local health office. Therefore, *E. vermicularis* is still a significant parasitic illness in Kidapawan City, Philippines.

Figure 1B-C shows the geographical distribution of significant sociodemographic factors. This shows that only two sociodemographic factors are significantly associated with the prevalence of *E. vermicularis*: the age of the children ($p=0.000$) and the mother's education level ($p=0.009$). This implies that behaviors among kids, such as playing outside, getting their hands dirty, going barefoot, and/or completely ignoring cleanliness, as most kids do, encourage *E. vermicularis* infection. Children between the ages of 3 and 6 years are most likely to contract *E. vermicularis*, which is consistent with the results of other studies.

Considering the association of personal hygiene as possible risk factors and the prevalence of *E. vermicularis*, Figure 1D-G shows the geographical distribution of significant risk factors: (D) washing their hands before eating ($p=0.001$), (E) washing their hands after using toilet facilities ($p=0.006$), (F) bathing without the assistance of family members ($p=0.002$), and (G) sharing a bed with family members ($p=0.001$). Additionally, the association between household sanitary conditions risk factors and the prevalence of *E. vermicularis*, only the type of bed children has a significant association.



Figure 1. (A) Heat map of *E. vermicularis* infection in Kidapawan City. Red spots indicate positivity and blue spots indicate negative results. Choropleth map of statistically significant ($p < 0.05$) socio-demographic factors: (B) Age of the children ($p = 0.000$), (C) mother's education level ($p = 0.009$). Choropleth map of statistically significant ($p < 0.05$) personal hygiene possible risk factors: (D) Washing their hands before eating ($p = 0.001$), (E) Washing their hands after using toilet facilities ($p = 0.006$), (F) bathing without the assistance of family members ($p = 0.002$), and (G) sharing a bed with family members ($p = 0.001$). QGIS Desktop 3.30.3-'s-Hertogenbosch.

DISCUSSION

The current study aligns with the research conducted by Laoraksawong et al. (2020), which demonstrated that certain factors such as gender, age group, mother's education level, having older or younger siblings, practicing hand hygiene after using toilet facilities, maintaining short fingernails, and finger sucking were identified as risk factors for *E. vermicularis* infections. Children at the primary school education level had an 11.22-fold higher likelihood of being infected compared to those with a higher level of education.

A study conducted by Forson et al. (2018) demonstrated a positive correlation between individuals with low socioeconomic status and a heightened susceptibility to intestinal parasitic infection. The relationship between socioeconomic status and the likelihood of parasitic infections is intricate. It can be ascribed to factors such as drinking water and food quality, hygiene practices, environmental conditions, educational opportunities, and individual living circumstances. Their research shows an opposite relationship between parent's education level and the infection rate in children.

The findings align with the research conducted by Al-Adhroey et al. (2022), in which a multivariate analysis confirmed the following variables as genuine independent risk factors for *E. vermicularis* infection among children in Dhamar Governorate: The factors significantly associated with the occurrence of the condition are as follows: the responsibility of child's care ($p = 0.001$), irregular handwashing before meals ($p = 0.003$), the habit of nail biting or cutting with teeth ($p = 0.002$), the habit of putting toys or pen in mouth ($p = 0.002$), frequent anal itching ($p = 0.016$), the use of anthelmintic medication in the last six months ($p = 0.011$), and parents' lack of knowledge on preventive measures ($p = 0.036$).

The data indicates that the prevalence of parasite infection is

significantly influenced by environmental, personal, and public hygiene practices, especially in certain populations like children and rural residents. The data indicates that hygiene practices have a significant impact on parasite infection rates. However, further investigation is needed to understand the role of environmental factors such as access to clean water and waste management. Research should focus on investigating the efficacy of particular handwashing methods and hygiene instruction in preventing the spread of parasites. Ultimately, it is necessary to assess the effectiveness of public health interventions such as sanitation campaigns and deworming programs. This research aims to develop effective interventions that promote healthy hygiene practices and reduce parasite infection rates by specifically targeting high-risk populations and considering cultural contexts.

The frequency of daily housekeeping did not have an impact on the rate of pinworm infection. However, children residing in townhouses or on the ground floor had a significantly higher infection rate compared to those living in apartments or single-family detached residences ($P < 0.001$). In addition, the study found that children who lived in houses with concrete floors or carpet (3-3 percent for concrete or carpet vs. 2-4 percent for wood, plastic, or stone), slept on beds with matting (30 percent for matting vs. 2-4 percent for wood or spring mattress), and shared a bedroom with family members (2-6 percent vs. 1-7 percent) had significantly higher rates of positive outcomes (Shin et al., 2021).

Increased rates of pinworm prevalence were observed in schoolchildren (ages 2-12) from Gaozhou City. Pinworm infection is strongly correlated with socioeconomic status, children's hygiene, and the hygienic standards of the environment (Fan et al., 2021). A prior study agrees that the initial stage in the transmission of intestinal parasites within a community is the existence of infected individuals. The second stage for species that transmit their parasites to humans through feces is characterized by inadequate sanitation. The socioeconomic and behavioral aspects of the population are also highly significant (Younes et al., 2021).

Based on a study, the only socio-demographic factors that have a notable impact are the age of the children and the educational attainment of the mother (refer to Figure 1 B-C). The relationship between socioeconomic status and the likelihood of parasitic infections is intricate and can be ascribed to factors such as the quality of drinking water and food, hygiene practices, environmental conditions, educational opportunities, and individual living circumstances

(Forson et al., 2018).

Likewise, there is a statistically significant correlation between being positive for intestinal parasites and having parents or guardians with a low level of education. Children whose parents or guardians had less than eight years of education were 2.4 times more likely to have intestinal parasites compared to those whose parents had nine or more years of education. An inverse relationship was observed between the level of education of parents and the occurrence of intestinal parasitosis, indicating a significant association. The study found that parents' limited formal education is a significant risk factor, showing that the frequency of parasitic infections decreases as parental education levels increase. Individuals with higher levels of education can improve their family members' health (Fantinatti & Da-Cruz, 2023).

It is crucial to understand that inadequate personal hygiene increases the risk of pinworm infection, and there is a strong correlation between personal hygiene standards and the prevalence of enterobiasis. Due to the greater impact of children's behaviors on the development of *E. vermicularis* infection compared to adults, children are generally considered the primary targets. Risk factors for contracting enterobiasis include children residing in non-apartment settings, engaging in floor play, nail biting, living in overcrowded environments, and having a lower likelihood of handwashing before meals. Children who reported having long fingernails, sucking their fingers, and sharing towels with others were found to have a significantly increased risk of pinworm infection. Additional studies have also demonstrated the correlation between pinworm infection and various risk factors such as age, hand washing before meals, bed linens, parents' occupation, and educational level (Amiri et al., 2016).

The combination of various factors, along with the possibility of reduced educational opportunities that impact knowledge and practices related to hygiene, can lead to the development of an environment favorable to the spread of parasitic infections. Additional investigation should examine these interrelated factors in order to provide a more distinct representation. This may entail examining the impact of socioeconomic status (SES) indicators such as income, healthcare accessibility, and housing quality on hygiene practices, environmental exposure, and, consequently, the prevalence of parasite infections in children from various socioeconomic backgrounds.

In comparison to the study conducted by Chen et al. (2018), a

single-variable analysis of household sanitary conditions linked to *E. vermicularis* infection in preschool children in Taipei found that the type of bed was a significant factor. Pinworm infection is commonly observed among preschool children in South Taiwan and often occurs within families. In addition, the act of sharing a bed or bedroom with family members, as well as having carpeted or cement floors, has been recognized as notable risk factors.

The study provides an understanding of the correlations among hygiene practices, environmental conditions, and the occurrence of parasite infections. However, additional research is needed to explore this topic further. The lack of sufficient access to clean water can directly impede hygiene practices such as handwashing and sanitation, which may partially account for the observed differences in hygiene behavior. Moreover, the choice of sanitary toilets can have an impact on infection rates. Primitive pit latrines or the act of openly defecating can pollute the surroundings, thereby heightening the chances of disease transmission. Subsequent investigations should examine these variables, encompassing the efficacy of enhanced sanitation interventions, while also considering co-infections. Parasites are likely to be more common in individuals who already have other infections because their immune system is weakened. An analysis of the relationship between multiple infections and how they are influenced by hygiene and environmental factors could yield valuable insights. Ultimately, modifying the sample size per barangay in future studies would enable a more precise assessment of infection rates within each community.

CONCLUSION

The study shows that most respondents were 1-3-year-old males, predominantly having five or less than five family members and also having older brothers/sisters. Parents usually only have up to secondary education. Almost all participants wash their hands before eating and after using the toilet, play with others, take a bath without the assistance of family members, and play with others. The findings show that there is still a relatively high percentage of infection and suggest that this is still a very important public health concern. The age of the children and the mother's education level are significant factors for the spread of infection, as well as personal hygiene, such as washing hands before and after the toilet and before eating, bathing without assistance, sharing a bed, and the type of bed. This study's findings highlight the importance of comprehensive public health programs for preventing *E. vermicularis* infection. These actions should include targeted initiatives focused at particular demographic groups, encouragement of good personal hygiene habits, and

changes to the sanitary environment in the home.

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